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ELECTRICAL VAPORIZATION OF LIQUID
BY ABOVE-LIQUID ELECTRODES
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2,488,787

Fig. 1

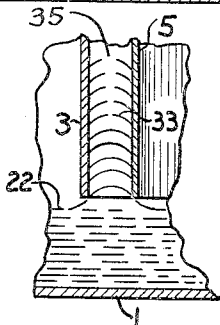
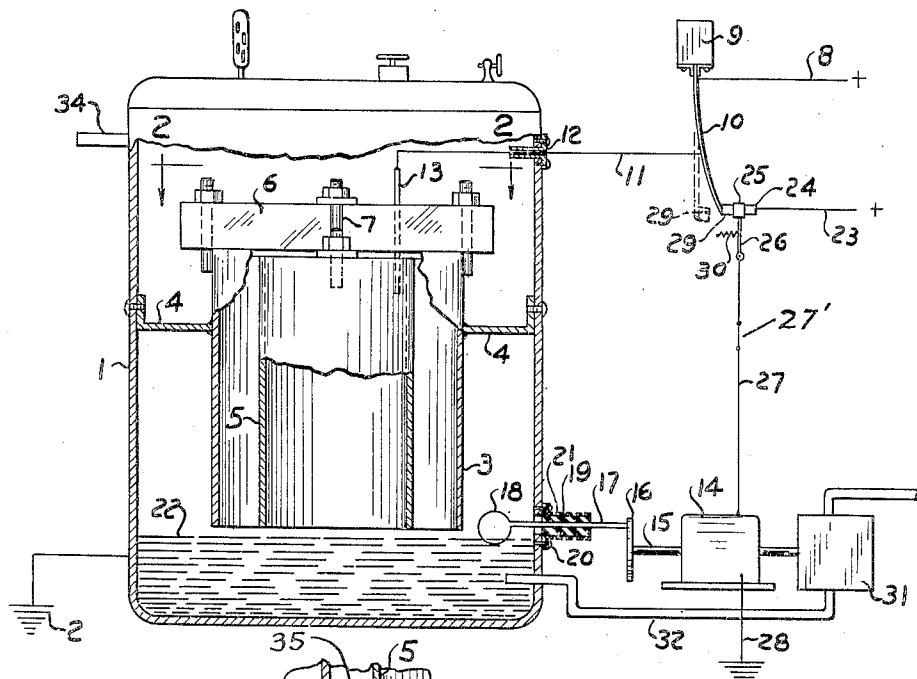


Fig. 4

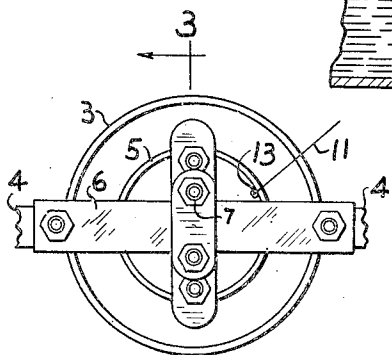


Fig. 2

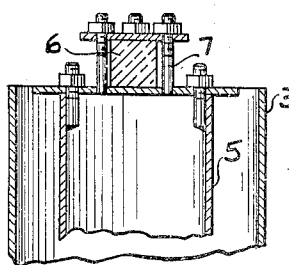


Fig. 3

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ELECTRICAL VAPORIZATION OF LIQUID BY
ABOVE-LIQUID ELECTRODES

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6 Claims. (Cl. 219—40)

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This application is a continuation-in-part of my co-pending applications Serial No. 544,254, filed July 10, 1944, now abandoned, and Serial No. 792,138, filed December 17, 1947, now Patent No. 2,451,594.

As in the earlier applications, this invention pertains to a novel method of vaporizing liquid by electrical action, and particularly by the formation of liquid films carrying current between a pair of spaced electrodes and finally becoming vaporized by the current. In the earlier applications, the electrodes are dipped in the surface of the liquid to initiate the formation of films and their ascent between the electrodes. The surface of liquid is heated by resistance or rheostat action only to the extent to which the electrodes are dipped therein. The resistance method of heating and vaporizing liquid is less efficient than the film-vaporizing method. The use of the resistance method in some degree in conjunction with the film-vaporizing method has heretofore been regarded as inevitable.

The object of the present invention is to eliminate the resistance or rheostat method entirely. To accomplish this object, the electrodes are supported at a significant distance above the surface of the liquid. The liquid is then agitated to produce undulations that come into contact with the lower ends of the electrodes. The formation of films is thus initiated. It has been found, moreover, that the formation of films continues for some time after the major surface of the liquid has calmed and dropped below the lower ends of the electrodes, by a peculiar attraction between the liquid and the electrodes after the film action has been started.

The film action continues until the surface of the liquid has fallen to one-quarter inch below the electrodes in the instance of water use. In a receptacle of substantial area, this represents a considerable volume of liquid and a corresponding amount of vapor. When the formation of films has stopped and less current flows between the electrodes, an agitator in the liquid comes automatically into operation and initiates another cycle such as described. A constant liquid level is automatically maintained so that this is not frequently required.

The electrodes will operate in the manner described on either alternating or direct current, although the former is preferred.

The invention is fully disclosed by way of example in the following description and in the accompanying drawings in which:

Figure 1 is a vertical section of the apparatus,

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showing the electrical equipment diagrammatically;

Figure 2 is a plan section on the line 2—2 of Figure 1;

5 Figure 3 is a section on the line 3—3 of Figure 2, and

Figure 4 is a detail section showing diagrammatically the formation of the liquid films or hammocks.

10 Reference to these views will now be made by use of like characters which are employed to designate corresponding parts throughout.

The apparatus as shown in Figure 1 includes a receptacle or casing 1 of suitable shape, consisting of an electrically conductive material and grounded at 2. Within the receptacle 1 and at a substantial distance from the bottom thereof is suspended a vertical tube or cylinder 3 by means of suitable conductive straps 4 fastened to the wall of the member 1. Within the tube 3 is suspended a concentric tube 5 by means of an overhead insulating cross bar 6 bolted at 7 to the member 5. Both tubes 3 and 5 consist of a material that conducts current, of the magnitude stated below, with substantially negligible heat loss. The tubes rest in a plane vertical to the liquid level and the lower ends and upper ends in a plane parallel with the liquid surface also preferably in one plane, although the upper ends may be in different planes if necessitated by convenience in construction.

Current is led from a line 8 to a fixed block 9 from which extends a bimetal strip 10 to which the line 8 is connected. From the free end of the strip 10, a conductor 11 passes through an insulator 12 in the wall of the receptacle 1 and is suitably connected at 13 to the inner tube 5. The power source (not shown) that supplies current to the line 8 is also grounded as in usual practice. It is now apparent that a circuit will be completed from the power source to the ground 2 on formation of conducting bridges between the tubes 3 and 5 in a manner presently to be described.

45 A small electric motor 14 is positioned adjacent to the receptacle 1, and its shaft 15 carries a disk 16 facing the receptacle. To the disk is eccentrically connected one end of a flexible rod 17 that passes through the wall of the receptacle 1 and carries at its inner end an enlargement or agitator 18. A relatively thick rubber sleeve 19 surrounds a portion of the rod 17 next to the outer surface of the receptacle 1. The sleeve is suitably fastened at 20 to the receptacle and is bound

to the rod 17 by spaced circular clamps 21 to prevent leakage from the receptacle.

The normal liquid level in the receptacle 1 is designated by the line 22, and it will be seen that the lower ends of the tubes 3 and 5 are spaced slightly above the liquid level. The agitator 18 is immersed about half way in the liquid. The liquid is agitated to form undulations that engage the lower ends of the tubes 3 and 5, and thereupon a bridge between the tubes is formed and subsequently vaporized, as described in detail below.

The current is supplied to the motor 14 from an independent source by a line 23 that carries a fixed contact 24. Adjacent to the latter is a swinging contact 25 on a hinged arm 26 joined by a conductor 27 to one of the terminals of the motor. The other terminal is connected to ground by a conductor 28. Both contacts 24 and 25 lie adjacent to the free end of the bimetal strip 10 which carries an insulating piece 29 adapted to push the contact 25 into engagement with the contact 24. The contacts 24, 25 and 29 are in the nature of an adjustable micro-switch, and the strip 10 bends to engage contact 25 when a predetermined small current or no current is flowing through it. On heating of the strip by flow of current therethrough, there is a movement of the piece 29 away from the contact 25, as shown in dotted line, permitting the contact 25 to be separated from the contact 24 by a light spring 30. Thus, the motor 14 operates to agitate the liquid only when there is no current or a determined reduced current flowing between the tubes 3 and 5. The motor also operates a pump 31 which replenishes liquid to the receptacle 1 through a pipe 32.

In the operation of the device, a wave of liquid engaging the lower ends of the tubes 3 and 5 will form a conducting bridge across the tubes to complete the main circuit as already indicated. The liquid rises between and in contact with the tubes in the form of inverted hammocks 33. These become thinner as they ascend and eventually evaporate into steam that is exhausted through a pipe 34 from the receptacle 1.

The spacing of the electrodes is determined by the character of the liquid being evaporated and to some extent by the applied voltage. In the case of water, for example, the spacing is about one quarter inch for 110 volts and may be increased to one half inch for 220 volts, etc. It will be understood that a small quantity of borax or a similar salt may be added to the water for conductivity and cleansing properties. The formation and evaporation of the films or hammocks of liquid are fully described in my application Ser. No. 792,138 in which the electrode spacing for sustaining films or hammocks of a given liquid is defined as the bridging limit of that liquid.

It will be understood, however, that the spacing between the electrodes may be somewhat less, if desired, than the maximum bridging limit of the liquid. Also, the current strength and frequency may be varied according to the kind of operation desired, and the voltage may be as low as six volts.

As liquid becomes vaporized and the major surface of the liquid lowers, no more films or hammocks will form and consequently the circuit will be broken between the tubes or electrodes 3 and 5. Thereupon the bimetal strip 10 moves the contact 25 into engagement with the contact 24 in the manner already described and

operates the motor 14 to actuate the agitator 18 and the pump 31. Liquid is delivered into the receptacle 1 until the undulations formed on the surface again come into engagement with the lower ends of the electrodes 3 and 5 to re-establish the cycle already described. At this time the contact 25 becomes separated from the contact 24 to stop the motor 14 and parts operated thereby.

In the preferred and more refined embodiment of the invention, a common adjustment for the bimetal strip 10 is provided for the purpose of causing the motor circuit to close at a predetermined low current limit rather than at zero current. The pump will thus be operated to deliver liquid to the case 1 without a complete cessation of current flow in the conductor 11. For a complete shutoff, a switch 27' in the line 11 is opened, and the flow of current in conductor 11 will stop when there are no longer any hammocks between the electrodes 3 and 5, and the motor 14 will not operate the pump and agitator again until the switch 27' is closed.

The liquid films rise in rapid succession and are arched upward. Current flows through the films until the latter become vaporized. The formation of films continues for some time after the surface of the liquid has settled and has dropped a substantial distance below the lower ends of the electrodes 3 and 5. There is a continued attraction between the surface liquid and the electrodes over this substantial distance above the liquid level after the film action has been initiated by agitation.

The electrodes are of such low resistance as to be practically unheated by the flow of current through them. This can be demonstrated by touching with the hand the electrodes after the generation of vapor has commenced and the current disconnected. The liquid body also is relatively cool. The electrodes have been found to be cool at this time although they eventually become warm by contact with the generated steam as does the liquid body 22. It follows therefore that the action of the electrodes in vaporizing the films is mainly the passage of current through or over the films rather than the conducting of heat from the electrodes. Also, the body of liquid remains cool, so that the vaporization does not depend upon any heating of the mass of liquid, as in the case of the usual water rheostat. In fact the electrodes may be dipped in a body of liquid of unlimited size, even a flowing river, and the formation of films and steam will commence almost immediately.

The film action is illustrated diagrammatically and somewhat mechanically in Figure 4. As the films rise, they become ruptured at 35, and the size of the rupture increases until the films disintegrate completely, although the entire action is almost instantaneous after the initial rupture. However, for an instant, the ruptured film is maintained, and current flows through the vapor that occupies the rupture. On disintegration the unvaporized part of the film collects upon the electrodes and the lower films. The flow of current through the vapor in the ruptured films reduces the moisture content and is therefore electric.

This has been demonstrated by public laboratory tests showing that steam formed herein has a moisture content of 6%, while steam produced by common methods has a moisture content of 12%. Therefore, the reduced moisture content

was brought about by the electronic action mentioned above.

In my previous applications the electrodes are partially dipped in the mass of liquid. To this extent, as indicated in these applications, the initial solid liquid is heated by mere resistance or rheostat action. This method of vaporization, which has been found to be less efficient than the film-vaporization method, is entirely eliminated in the instant invention. Also, resistant heating of the electrodes is reduced to a minimum, with the result that this 100% film method of vaporization is employed more efficiently.

Although a specific embodiment of the invention has been illustrated and described, it will be understood that various alterations in the details of construction may be made without departing from the scope of the invention as indicated by the appended claims.

What I claim is:

1. The method of electrically vaporizing liquid consisting in supporting a pair of spaced electrodes above and exposed to the surface of a body of liquid, applying unequal potentials to said electrodes, adjusting the distance between said electrodes to a distance greater than the capillary spacing for the liquid and within the distance that can be bridged by a film of the liquid, and agitating the surface of the liquid to form undulations that come into contact with said electrodes, whereby films of liquid are formed and raised across said electrodes.

2. The method of electrically vaporizing liquid consisting of supporting a pair of spaced electrodes above and exposed to the surface of a body of liquid, applying unequal potentials to said electrodes, adjusting the distance between said electrodes to a distance greater than the capillary spacing for the liquid and within the distance that can be bridged by a film of the liquid, agitating the surface of the liquid to form undulations that come into contact with said electrodes, whereby films of liquid are formed and raised across said electrodes, and discontinuing the agitation when said contact has been made.

3. The method of electrically vaporizing liquid consisting of supporting a pair of spaced electrodes above and exposed to the surface of a body of liquid, applying unequal potentials to said electrodes, adjusting the distance between said electrodes to a distance greater than the capillary spacing for the liquid and within the distance that can be bridged by a film of the liquid, and agitating the surface of the liquid to form undulations that come into contact with

said electrodes, whereby films of liquid are formed and raised across said electrodes, discontinuing the agitation when said contact has been made, and resuming the agitation and supplying of liquid on reduction or cessation of the formation of films.

4. The method of electrically vaporizing water consisting in supporting a pair of spaced electrodes above and exposed to the surface of a body of water, applying unequal potentials to said electrodes, adjusting the distance between said electrodes to about one-quarter inch for 110 volts or one-half inch for 220 volts, and agitating the surface of the liquid to form undulations that come into contact with said electrodes, whereby films of liquid are formed and raised across said electrodes.

5. The method of electrically vaporizing water consisting in supporting a pair of spaced electrodes above and exposed to the surface of a body of water, applying unequal potentials to said electrodes, adjusting the distance between said electrodes to about one-quarter inch for 110 volts or one-half inch for 220 volts, agitating the surface of the liquid to form undulations that come into contact with said electrodes, whereby films of liquid are formed and raised across said electrodes, and discontinuing the agitation when said contact has been made.

6. The method of electrically vaporizing water consisting in supporting a pair of spaced electrodes above and exposed to the surface of a body of water, applying unequal potentials to said electrodes, adjusting the distance between said electrodes from small spacing for six volts and upward to about one-quarter inch for 110 volts or one-half inch for 220 volts, agitating the surface of the liquid to form undulations that come into contact with said electrodes, whereby films of liquid are formed and raised across said electrodes, discontinuing the agitation when said contact has been made, and resuming the agitation on cessation or reduction of the formation of films.

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The following references are of record in the file of this patent:

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