Sept. 4, 1928. 1,683,071

M. W. HANKS ET AL

LIQUID CONDUCTOR HEATER AND METHOD OF OPERATING SAME

Filed Jan. 12, 1925 4 Sheets-Sheet 1

Fig. 1

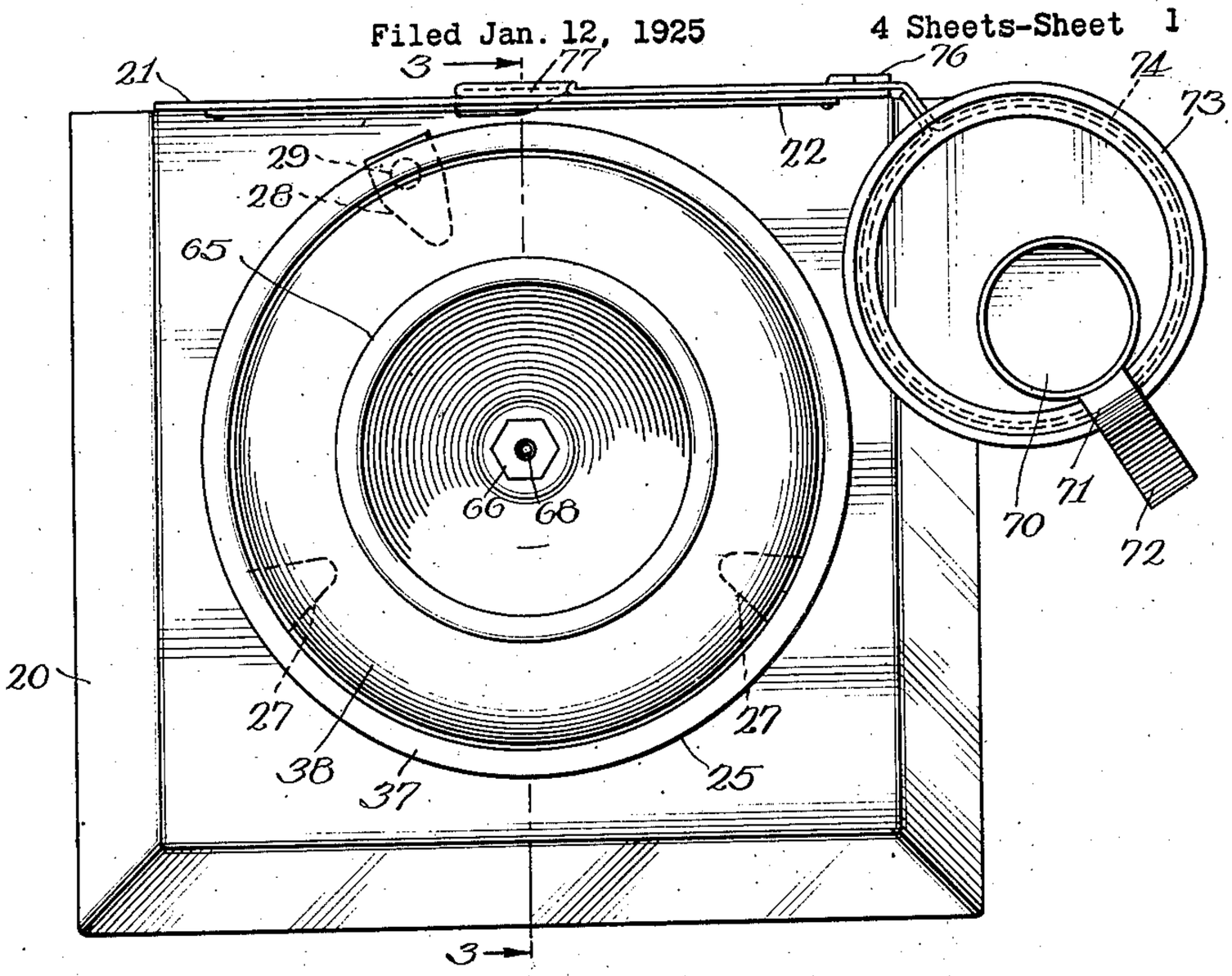

Fig. 2

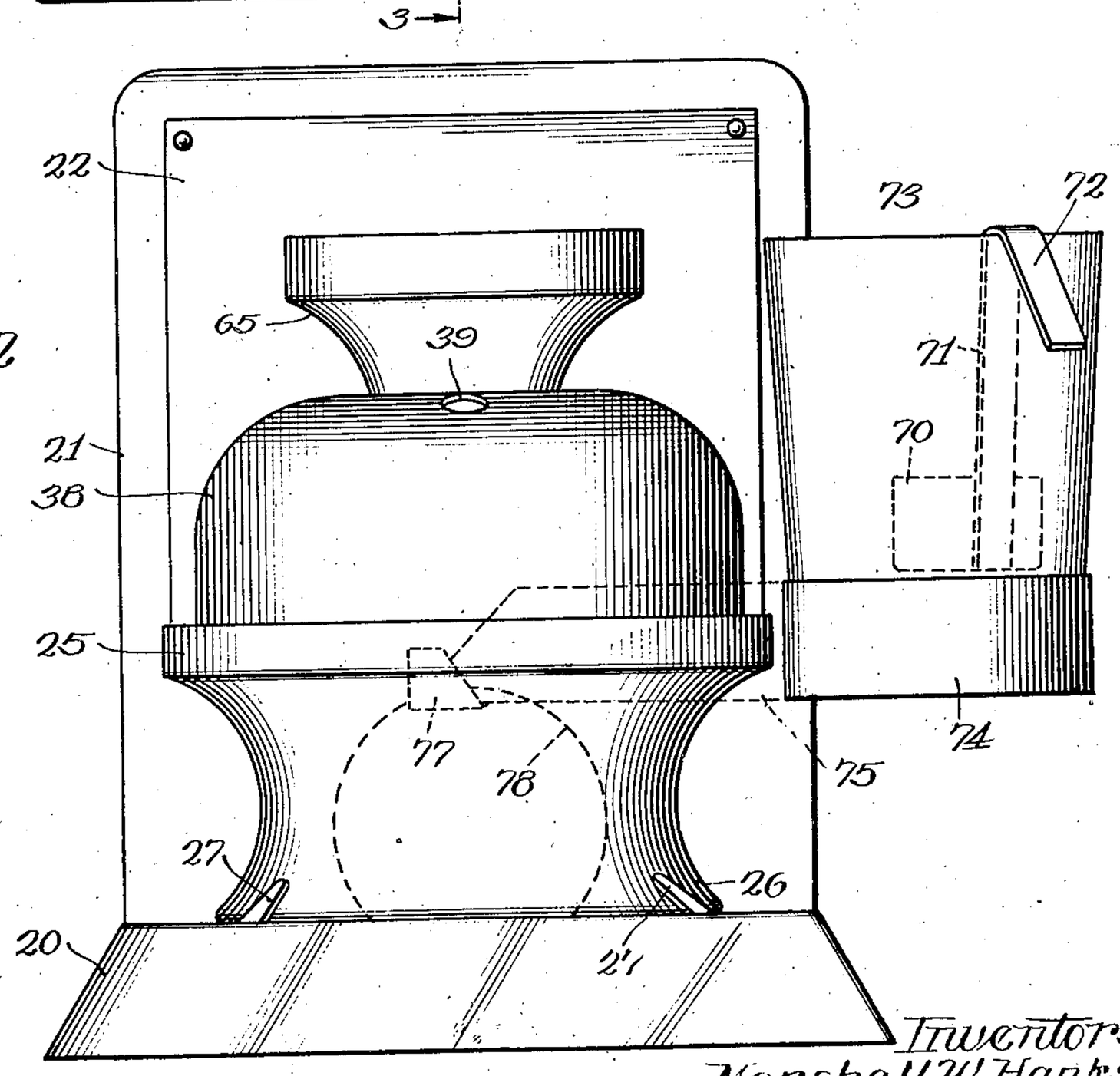

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Fig. 3

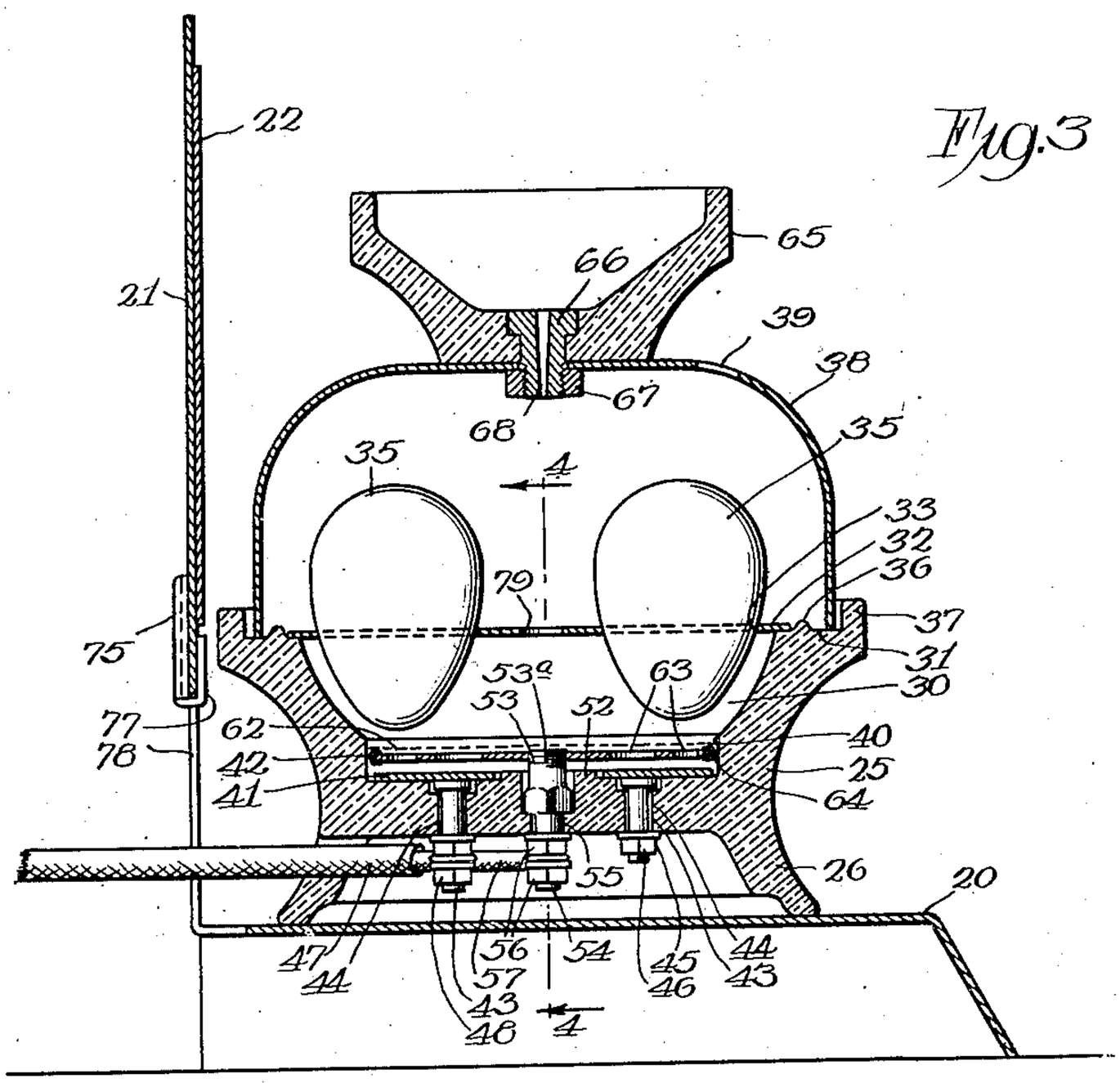

Fig. 5

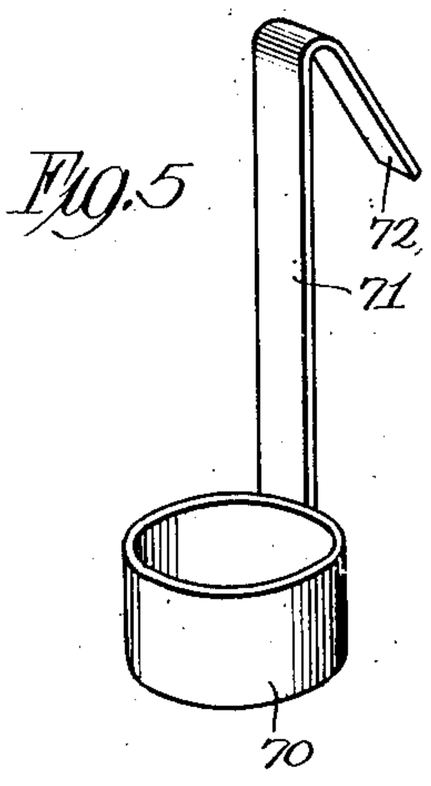

Fig. 4

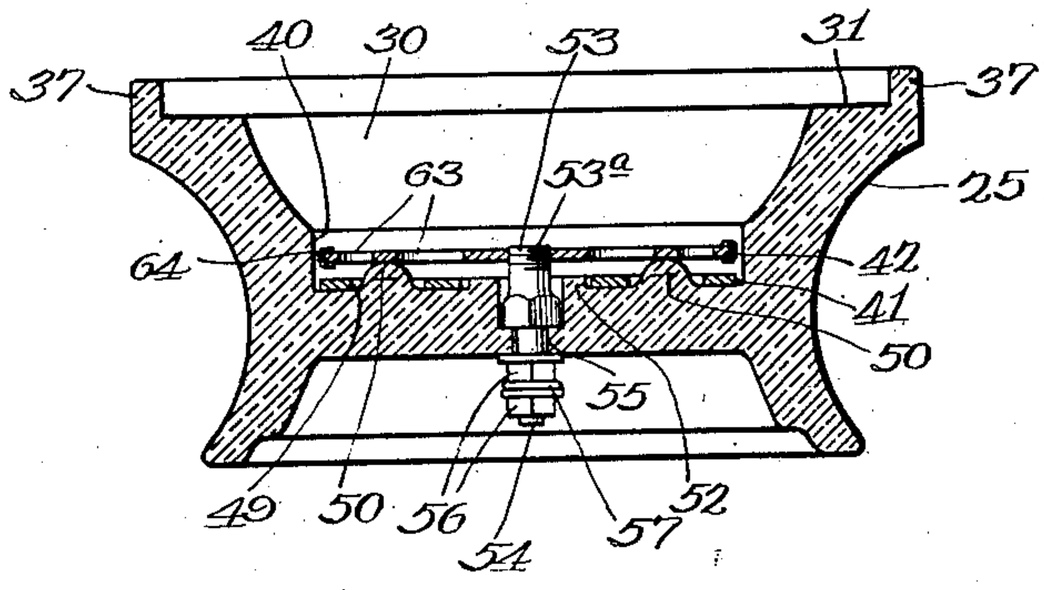

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Fig. 6

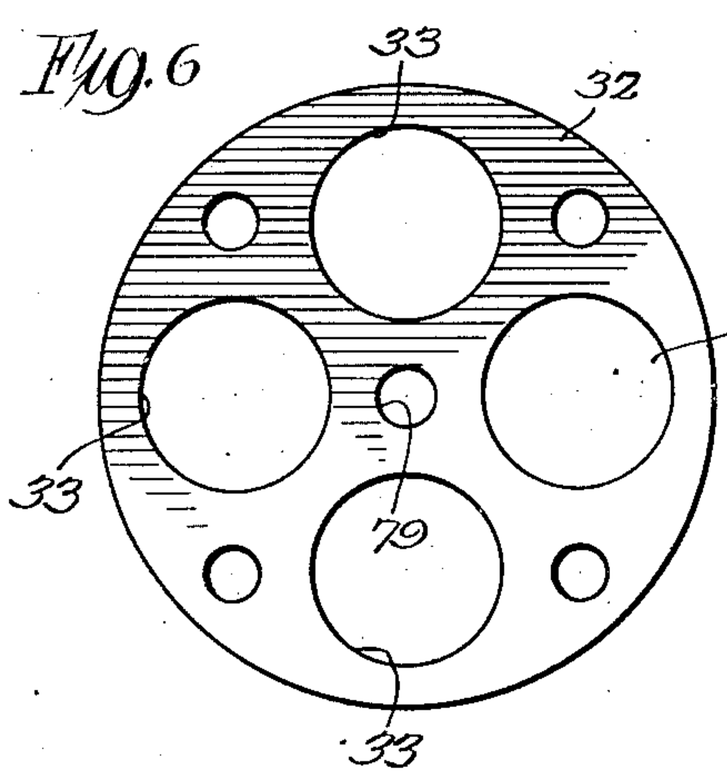

Fig. 7

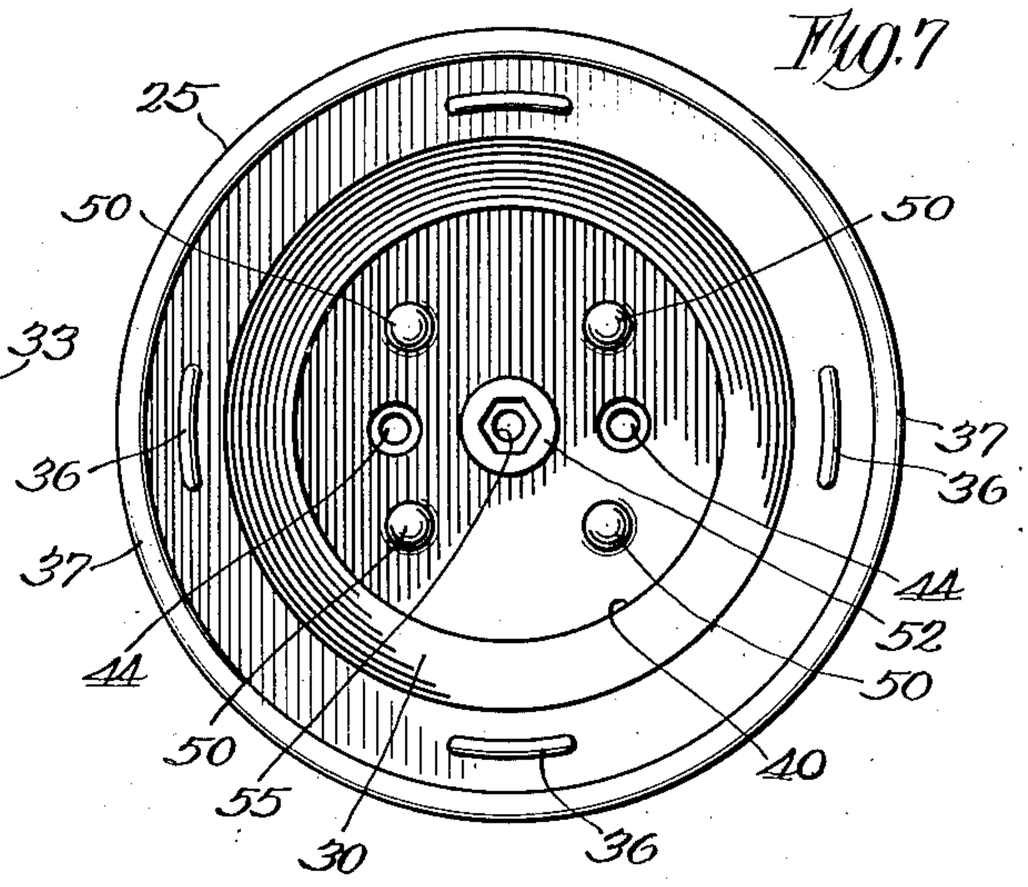

Fig. 8

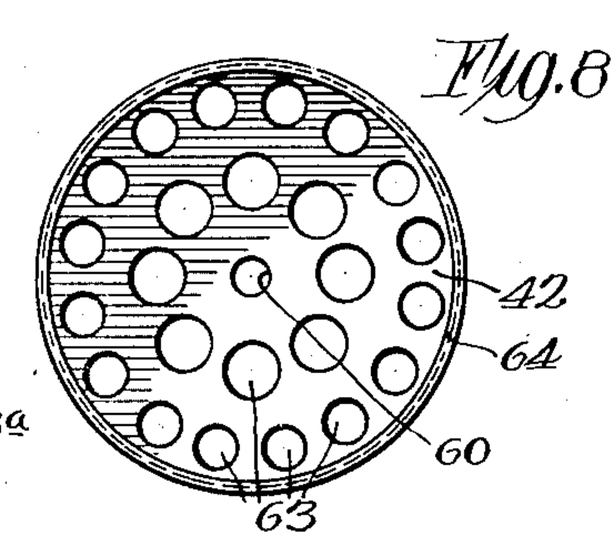

Fig. 9

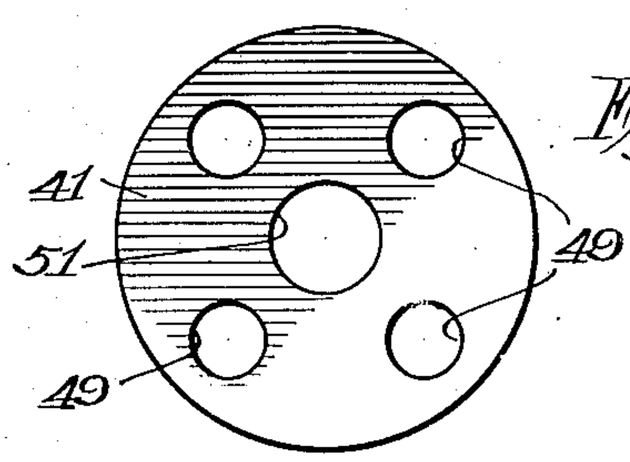

Fig. 10

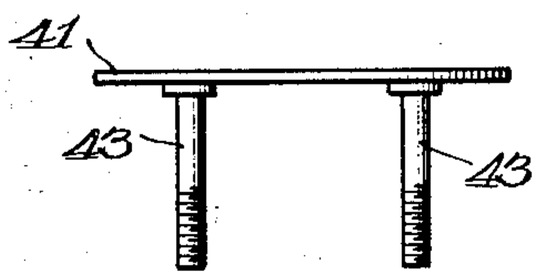

Fig. 11

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Fig. 12

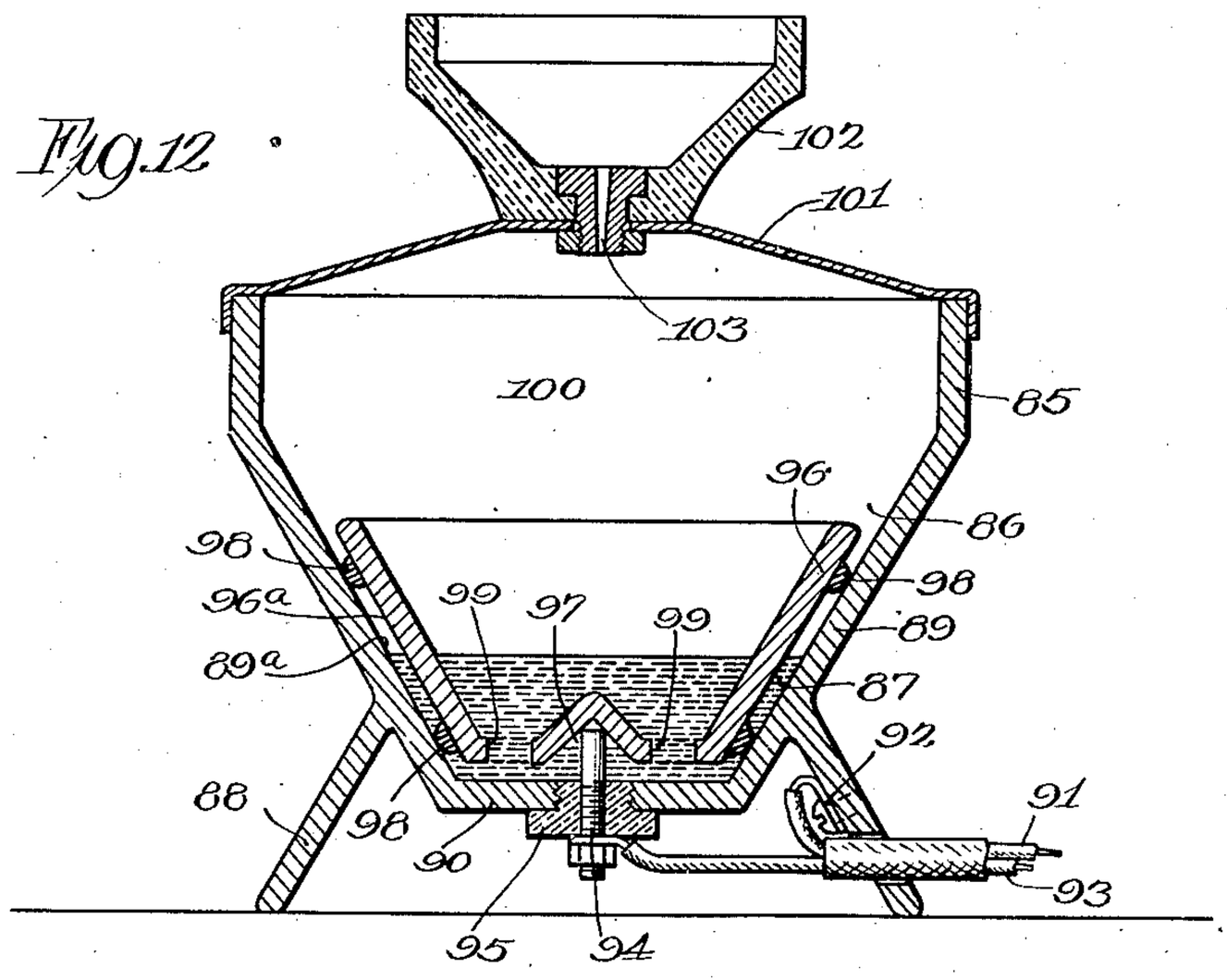


Fig. 13

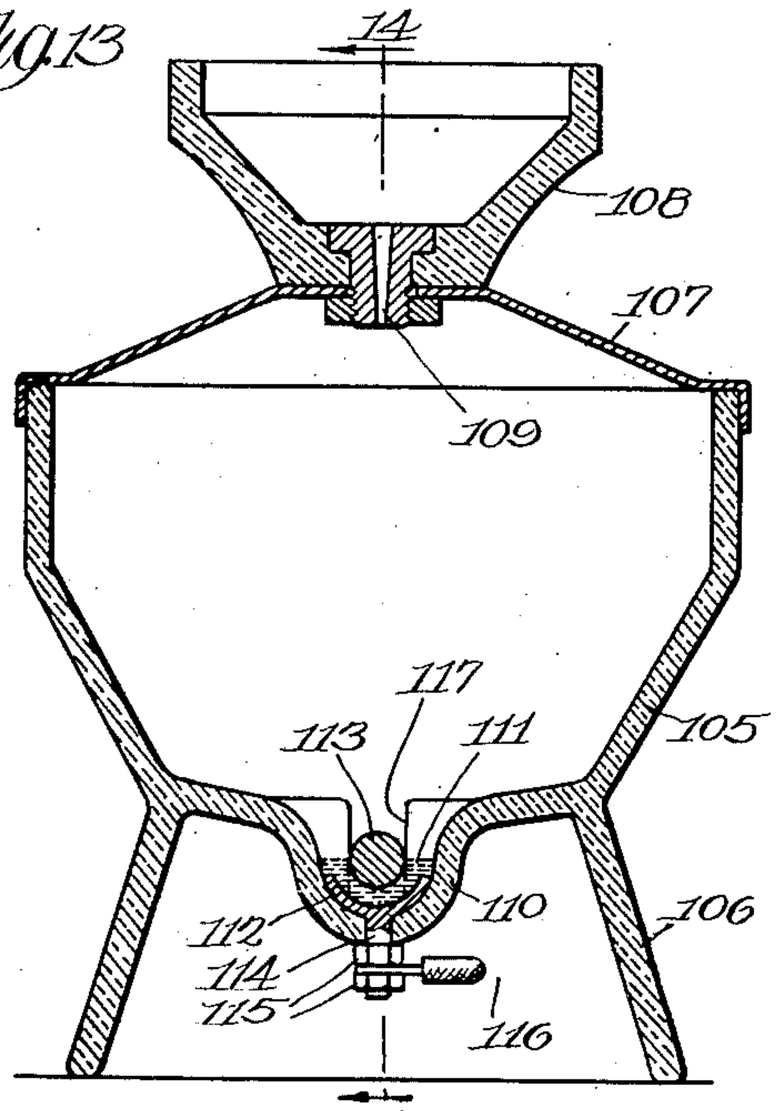
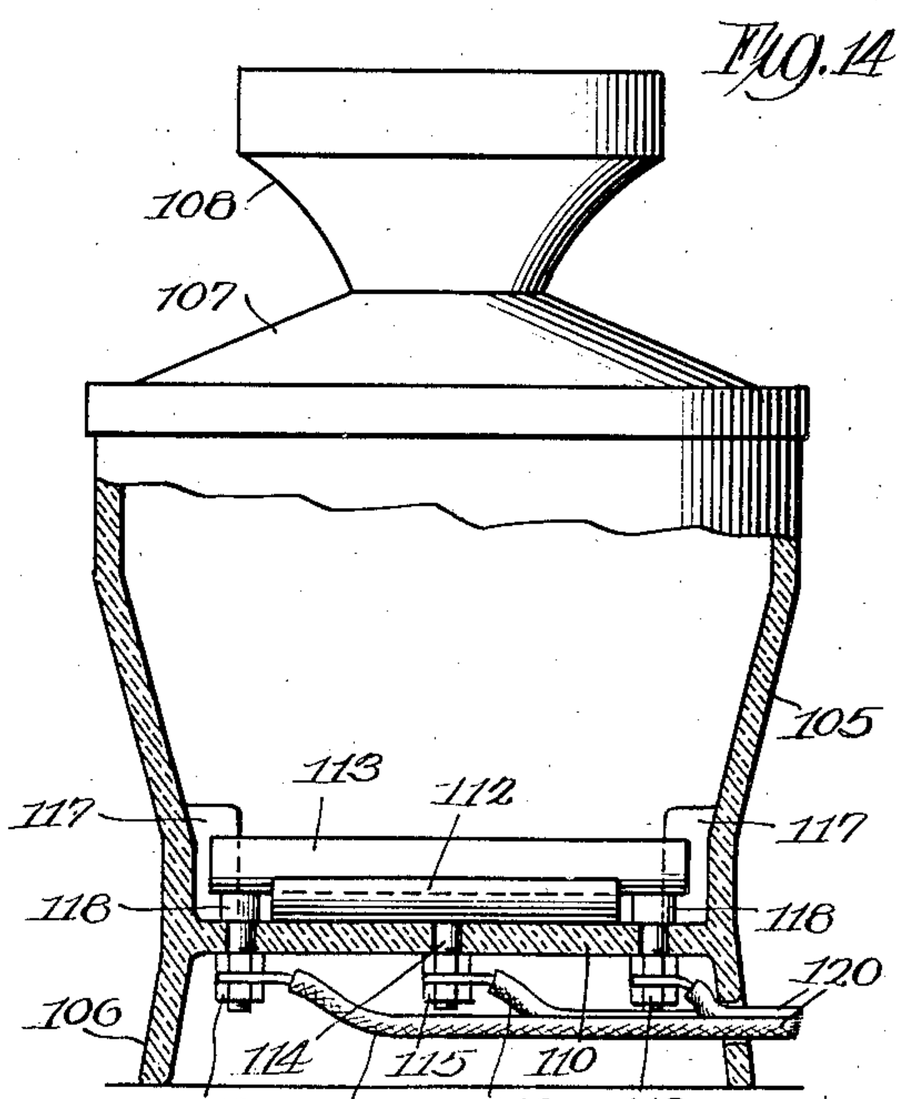


Fig. 14



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UNITED STATES PATENT OFFICE.

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LIQUID-CONDUCTOR HEATER AND METHOD OF OPERATING SAME.

Application filed January 12, 1925. Serial No. 1,784.

This invention relates to liquid conductor heating devices in which a measured or predetermined quantity of liquid is vaporized by the passage therethrough of an electric current which is automatically shut off to stop the operation of the device when the liquid becomes completely vaporized. Devices of this type may be employed, for example, for cooking eggs, warming milk bottles, or performing other tasks having a desired definite period or duration, or requiring a fixed amount of heat for their consummation, the cooking or heating being effected by the vapor of the liquid and being consummated when the liquid disappears.

In the operation of these devices, it is desirable to maintain a substantially constant current and a uniform rate of vaporization throughout the period of operation and to secure a relatively rapid or abrupt termination of the operation of the device at the end of that period, in order that the effects and durations of successive operations of the device will be uniform and in order that the device may be available for a succeeding task after a definite and predetermined period of operation. To obtain these results, one of the difficulties to be overcome is that arising from the variations in the conductivity of the liquid due to the bubble formation produced by the passage therethrough of a current sufficient to vaporize it. The vapor, so produced, forms in bubbles which may permeate the whole or a part of the liquid carrying the current, thereby tending to force the liquid away from the electrodes and to transform the original homogeneous liquid body into a cellular structure having a greatly reduced electrical conductivity per unit of volume, so that the current flowing at constant potential is greatly reduced. Thus, if the potential impressed on the electrodes is sufficient to produce the desired vaporization, the current tends to rise to undue limits at starting, before the bubbles have formed, and then to decrease to an undesirable extent during the remainder of the duration of operation without shutting off to zero sharply at the end of a definite predetermined period. These conditions also give rise to objectionable fluctuations in the current which are patricularly troublesome where the electrodes are mounted one above the other in horizontal position, because the bubbles collect between the electrodes and increase in size until their volume and vapor pressure is sufficient to cause them to escape around the edges of the electrodes, so that the effective resistance of the liquid conductor between the electrodes, at first decreases to a marked degree and then increases suddenly as new liquid flows into the space between the electrodes after the bubbles have escaped. In some instances, the violence of the escape of the bubbles may momentarily remove all of the conducting liquid from the space between the electrodes and thereby completely stop the flow of current, after which the current rises to an undue extent as new liquid, free of bubbles, flows in and re-establishes the circuit. This irregularity in the current flow is not only objectionable in its immediate effects, but it tends further to render indefinite and uncertain the duration of operation of the device in performing a particular task or cooking operation.

It is the principal object of the present invention to provide a liquid conductor heating device adapted to operate with a predetermined quantity of liquid in such a manner that the current flowing in the liquid is free of substantial fluctuations and is maintained at a relatively high value throughout the major portion of the period of operation and is shut off abruptly to zero at the end of a definite predetermined period. It has been discovered that this desirable result may be obtained by employing an electrode having means for permitting a ready dissipation of the vapor between the electrodes and for increasing the current density per unit of active area of the electrodes. If one of the electrodes be constructed as a perforated grid or plate, it is found that the holes in the plates permit a rapid dissipation of energy and a ready escape of the bubbles so that the liquid between the plates is maintained in a condition adapted to produce a substantially uniform current flow throughout the period of operation. This construction brings about a greater current intensity on each unit of the active area of the electrodes and brings into action a greater proportion of the total area of the electrodes, than would be the case if the perforations were not provided, so that the vaporization of the liquid is more rapid and a given cooking or heating operation may be performed in a lesser period of time. Moreover, it is found that after the quantity of liquid in the device is reduced by vaporization to a relatively small amount, the entire

quantity of liquid is kept very active by the relatively large area of the electrode over which it is distributed, so that there is a very rapid vaporization of this remaining quantity of the conducting liquid and a consequent abrupt termination of the operation of the device. In this way, the current is caused to decrease from the normal value which is maintained during the major portion of the operation to a zero value in a very short space of time at the end of the period of operation. Other objects of the invention relate to various features of construction and arrangement which will appear more fully hereinafter.

The nature of the invention will be understood from the following specification taken with the accompanying drawings in which Figure 1 shows a top plan view of the device; Fig. 2 shows a front elevation thereof; Fig. 3 shows a vertical section taken on the line 3—3 of Fig. 1; Fig. 4 shows a section taken on the line 4—4 of Fig. 3; Fig. 5 shows a perspective view of the measuring vessel; Fig. 6 shows a top plan view of the tray for holding the eggs to be cooked in the device; Fig. 7 shows a top plan view of the base portion of the device illustrated in Fig. 4; Fig. 8 shows a top plan view of the upper electrode; Fig. 9 shows a top plan view of the lower electrode; Fig. 10 is a side elevation of the lower electrode; Fig. 11 is a chart showing diagrammatically by means of curves a comparison of the operation of the device with and without the perforated electrode of the present invention; Fig. 12 shows a vertical section through a modified form of construction; Fig. 13 shows a vertical section through another modification and Fig. 14 shows a section on the line 14—14 of Fig. 13.

As illustrated in the drawings, the device comprises a sheet-metal base 20 adapted to rest on a table or the like, having formed integrally therewith an upwardly extending back plate 21 on which may be mounted a name plate 22 containing printed directions for the operation of the device. The base 20 supports a receptacle 25 of insulating material, preferably porcelain, having a lower annular flange 26 adapted to rest on the base 20 to which it is secured by means of the fixed clips 27 extending upwardly from the base at one side of the receptacle and a removable clip 28 which engages the other side of the base flange 26, being secured in position by a screw 29. The receptacle 25 is hollowed out on its upper side to form a chamber 30 and the ledge 31 at the upper edge of the chamber 30 is adapted to support a tray 32, having the form shown particularly in Fig. 6, which is provided with a plurality of circular apertures 33 adapted to receive and support the eggs 35 which are to be cooked by the vaporization of liquid contained in the chamber 30. The lateral displacement of the tray 32 is prevented by lugs 36 which are formed integrally on the upper surface of the ledge 31. The receptacle 25 is provided around the ledge 31 with an annular upwardly extending flange 37 which is adapted to receive within it the dome-shaped cover 38, formed preferably of sheet-metal, and having an aperture 39 therein through which the vapor is adapted to escape.

The lower part of the chamber 30 is cylindrical in form as shown at 40 and is adapted to contain the electrodes 41 and 42 which are of the grid type, being circular plates of slightly less diameter than the diameter of the cylindrical portion 40 of the chamber. The lower electrode 41 has formed thereon or secured thereto a pair of bolts 43 which extend downwardly through apertures 44 in the bottom wall of the receptacle 25, being engaged at their lower ends by washers 45 and nuts 46. One of these bolts, is adapted to serve as a binding post, having connected to it the extremity of an electrical conductor 47 which is held in place by a nut 48. The lower electrode 41 is provided with a plurality of apertures 49 which are adapted to receive lugs 50 formed integrally with the lower wall of the receptacle 25 and extending upwardly therefrom, as shown in Fig. 4, to engage the upper electrode 42 and space it from the lower electrode. The lower electrode 41 is also provided with a central aperture 51 through which extends the insulating boss 52 formed on the lower wall of the receptacle around the terminal post 53 which has a reduced part 54 extending through an aperture 55 in the lower wall of the receptacle to be engaged on its threaded extremity by nuts 56 which secure between them the end of an electrical conductor 57 which, with the conductor 47, completes the circuit to the device from a suitable source of electrical power. The terminal post 53 is threaded at its upper end as shown at 53^a to be threadedly engaged by a central aperture 60 which is formed in the upper electrode 42. This construction permits the upper electrode to be removed readily from the receptacle to permit the cleaning of the upper surface of the lower electrode and the projecting portion of the terminal post by which the connection is made to the upper electrode. When the upper electrode is in its normal position, as shown in Fig. 3, it is in proximity to the lower electrode but is spaced a fixed distance therefrom by the porcelain lugs 50. A quantity of liquid such as water is adapted to be contained in the chamber 30 of the receptacle 25, as shown at 62. Assuming that the conductors 47 and 57 are connected to a source of electrical potential, the introduction of the water or other liquid into the receptacle 25 completes the circuit between the electrodes 41 and 42 so that the liquid is heated by the passage of the current therethrough

and is vaporized with the result that the vapor passes upwardly into the chamber 30 and into the space within the cover 38, thereby cooking the eggs 35.

In order to obtain the desirable results heretofore described, the upper electrode 42 is provided with a plurality of perforations 63 which are distributed over the area thereof, preferably as shown in Fig. 8. As bubbles are formed between the electrodes by the boiling of the liquid, these bubbles are permitted to escape upwardly through the apertures 63 as well as around the peripheral edge of the electrode 42, so that the bubble structure between the electrodes is maintained in a condition adapted to produce substantially uniform current flow throughout the period of operation. The vaporization of the liquid proceeds at a substantially uniform rate with the flow of a substantially uniform current throughout substantially the entire period of operation of the device until the quantity of liquid between the electrodes is relatively small, when the distribution of this remaining quantity of liquid over a relatively large area of the perforated electrodes causes it to be vaporized rapidly so that the current is decreased suddenly from its normal value to zero as the end of the period of operation is reached.

The upper electrode 42 may preferably be provided adjacent its outer edge with a non-conducting coating 64 for preventing a short circuit in case it accidentally engages the lower electrode 41 in the operation of inserting or removing it from the receptacle 25. The coating 64 may extend over any desired portion of the upper electrode or it may be on any portion of the lower electrode or the containing vessel, as may be desired.

In order to prevent the passage of an excessive current through the liquid at the beginning of the operation of the device, the liquid, such as water or the like, is fed to the receptacle 25 from a feeding vessel 65, of porcelain or the like, which is mounted on the upper wall of the cover 38. The vessel 65 is secured in position on the cover by means of a clamping member 66 which is in the form of a bolt having a lower threaded extremity engaged by a nut 67 within the cover, as shown particularly in Fig. 3. The upper surface of the member 66 lies flush with the upper surface of the lower wall of the vessel 65 and the measured quantity of water which is placed in the vessel is adapted to pass downwardly through a small opening 68 having a relatively fine outlet so that the water or other liquid passes slowly into the receptacle 25 when the device is started in operation, thereby insuring a prompt vaporization of the initial quantity of water which comes into contact with the electrodes and preventing the rise of the current to an undue extent when the circuit is first completed.

The predetermined quantity of water which is introduced into the feeding vessel 65 may preferably be measured in a measuring cup or vessel 70, having the form shown in Fig. 5. This cup is provided with a handle 71 having a downwardly-turned extremity 72 so that it may be conveniently supported on the edge of a water glass 73, containing a supply of water and supported in a ring 74 carried by the bracket 75. The bracket 75 rests on a lug 76 which is pressed out of the back wall 21 of the base and the end of the bracket is provided with an upturned hook 77 which engages the upper edge of an aperture 78 formed in the plate 21, thus supporting the bracket 75 detachably on the plate 21 of the base so that it can be removed therefrom when desired.

In the operation of the apparatus, the operator measures a predetermined quantity of water with the cup 70, transferring the water from the supply vessel 73 to the feeding vessel 65, this being done after the eggs have been placed on the tray 32 and after the cover 38 has been placed in position on the receptacle 25. If it be desired to cook the eggs to the condition of soft boiled eggs, for example, the operator places in the vessel 65 one cup full of water as measured by the vessel 70, and if it be desired to have medium boiled eggs, for example, two cup fulls of water may be transferred from the vessel 73 to the receptacle 65, the extent of the cooking and the period of operation of the device being determined by the measured quantity of water which is placed in the feeding vessel 65. As soon as the water is placed in the feeding vessel it passes downwardly through the opening 68 and through an aligning opening 79 in the tray 32 into the space at the bottom of the chamber 30 where it forms a connection between the upper and the lower electrodes and thereby completes the circuit. As soon as the circuit is completed, a bubble structure forms in the small quantity of water which is present and as more water is added the bubble structure increases in extent and simultaneously increases the area of the electrodes which are in active operation. As the bubbles are formed, they escape upwardly through the openings 63 in the upper electrode 42 and around the outer edge of the upper electrode and this vapor, collecting beneath the cover 38, serves to cook the eggs 35. The perforated structure of the upper electrode produces such uniformity in the action of the device by effecting a regular escape of the bubbles, that the current passing through the liquid is maintained free of objectionable fluctuations.

For the purpose of illustrating the effect of the present invention in effecting an abrupt termination of the operation of the apparatus, there is illustrated in Fig. 11 a number of curves which represent diagrammati-

cally the operation of the apparatus described above as compared with the operation of a similar apparatus having solid electrodes. In the chart shown in Fig. 11, the abscissæ 80 represent minutes of time and the ordinates 81 represent amperes of current flowing in the circuit. The curve 82 represents the conditions prevailing in the circuit of the apparatus described above, embodying a perforated upper electrode, when the entire measured quantity of water is placed in the chamber 30 before the current is turned on. Under these circumstances, the upper and lower electrodes are connected by a solid body of water when the circuit is established so that the current at first rises to a relatively high value as shown at 82[a]. As the bubbles are formed in the liquid to decrease its conductivity the value of the current drops rapidly during the first few seconds of operation, as shown at 82[b]. After the bubble formation has increased sufficiently to establish a stable condition, the curve assumes a gradual incline as shown at 82[c]. The gradual decrease of the current continues until a point is reached where only a drop or so of liquid is left between the electrodes. As this remaining quantity of liquid is quickly evaporated, the current drops off rapidly as shown at 82[d] and the current finally shuts off sharply to zero as shown at 82[e]. This curve represents the condition when the feeding receptacle 65 is not employed for effecting a gradual application of the liquid to the electrodes. If the liquid were gradually fed to the electrodes, the initial value of the current would of course be much lower than that represented at 82[a]. It will be observed that the apparatus has a relatively brief period of operation during which the current is maintained at a relatively high value and at the end of which the current is shut off sharply to zero. The curve 83 represents the conditions which prevail in the circuit using the same apparatus as that which was employed in taking the data for curve 82 except that the upper grid electrode was free of perforations although of the same diameter and thickness as the corresponding electrode used in taking the data for curve 82. As before, the current was turned on after the entire measured quantity of liquid had been poured into the chamber 30 and upon closing the circuit, the current rose to a relatively high value as shown at 83[a]. The bubble formation in the liquid then caused the current to drop rapidly as shown at 83[b] until it finally assumed a substantially constant and relatively low value as shown at 83[c]. The value indicated at 83[c] continues with a gradual decrease as shown at 83[d], the current finally reaching zero as shown at 83[e]. This curve shows that with a solid electrode, the current has a much higher value at starting, a much lower value during the major portion of the operation of the apparatus, and a more gradual falling off to zero, so that the period of operation of the apparatus was more than twice the period of operation represented by the curve 82. The curve 84 represents the conditions prevailing in the circuit when a solid electrode was employed having the same area as the net area of the perforated electrode employed in taking the data for curve 82 after making allowance for the area of the perforations. With the solid electrode of reduced area, the current at first rose to a value 84[a] when the circuit was established through the body of liquid previously introduced into the chamber 30. This initial value of the current is substantially midway between the initial values indicated by the curves 82 and 83. After the circuit was established, the current fell off rapidly and then assumed a more nearly constant value as represented by the portion 84[c] of the curve, then the value of the current fell off gradually as shown at 84[d] and finally reached zero at 84[e]. This curve indicates that the reduction of the area of the electrode had some effect in reducing the initial value of the starting current and that it effected a slight decrease in the total period of operation, but the value of the current during the major portion of the period of operation was substantially the same as that represented by the curve 83 and the period of operation was substantially twice that represented by the curve 82. The perforated electrode not only maintains the current at a higher value during the period of operation but materially reduces the period of operation and when a point is reached where the quantity of water or other liquid remaining in the chamber 30 is relatively small, the distribution of this water over a relatively large active area of the perforated upper electrode causes this remaining quantity to be evaporated rapidly so that there is an abrupt shut-off of the current, indicated by the curve 82, as contrasted with the continuance for a protracted period of a relatively small current when solid electrodes are employed. With the present invention, therefore, the liquid is vaporized more rapidly and the same cooking operation is performed in a lesser period of time than is possible with the device constructed as represented by the curves 83 and 84. It will be understood that the showing of Fig. 11 is for illustrative purposes and that other desirable operating conditions may be obtained with apparatus embodying the present invention.

In Fig. 12 there is illustrated a modified form of construction in which a vessel 85 is provided with a chamber 86 adapted to contain a quantity of vaporizable liquid 87. The vessel 85 is supported on an annular base portion 88 and is constructed of conducting material so that the annular tapered wall 89 thereof constitutes one of the electrodes in

conjunction with the bottom wall 90. An electric connection is made to the vessel electrode through a conductor 91 having a connection with the base at 92 and another conductor 93 leading to a terminal 94 which is mounted in an insulating bushing 95 located in an aperture in the bottom wall 90. The terminal 94 is adapted to make contact with the other electrode 96 which is in the form of a hollow truncated cone mounted in inverted position with the terminal 94 engaging a recess 97 in the lower part thereof. The outer surface of the electrode 96 is preferably provided with a plurality of non-conducting spacers 98 which insulate the electrode 96 from the outer receptacle and electrode. One or more apertures 99 may be provided in the lower wall of the electrode 96 but these are not considered necessary to the successful operation of this form of device because of the arrangement of the upwardly inclined surfaces 89a and 96a of the electrodes which are adapted to effect an increase in the active area of the electrodes when a bubble formation is formed while at the same time permitting a ready escape of the bubbles upwardly to the vapor space 100 in which any desired cooking operation may be performed. The vessel 85 is provided with a cover 101 having mounted thereon a feeding receptacle 102, similar to that previously described, and provided with a restricted opening 103 through which a measured quantity of liquid may be gradually fed to the electrodes in order to limit the value of the starting current.

In Figs. 13 and 14, there is illustrated a third form of construction comprising a vessel 105 of insulating material supported on one or more legs 106 and provided with a cover 107 carrying a feeding receptacle 108 having a restricted opening 109 through which a measured quantity of vaporizable liquid may be fed gradually to the interior of the vessel 105. This vessel is provided in the lower part thereof with a pocket 110 adapted to contain a quantity of liquid 111 fed thereto from the receptacle 108. The pocket 110 contains a lower trough shaped electrode 112 and an upper electrode 113 in the form of a smaller tube or cylinder concentric with the electrode 112. The lower electrode 112 is mounted firmly in position in the bottom of the pocket 110 by means of a bolt 114 which is secured to or formed integrally with the electrode and which extends through the lower wall of the pocket being engaged on its threaded extremity by nuts 115. The bolt 114 also serves as a binding post for an electric conductor 116 which is clamped between the nuts. The upper electrode 113 is removably mounted in the guide slots 117, formed in the end walls of the pocket, and rests upon terminal posts 118 which pass through the lower wall of the pocket 110 and are engaged on their threaded extremities by nuts 119. The conductors 120 leading to the other side of the circuit are connected to both of the terminals 118 to insure greater security of contact with the removable electrode 113. This construction spaces the electrodes 112 and 113 from each other and when the current is established in the circuit the current flows between the electrodes through the liquid which is contained in the pocket 110. The current is distributed over the entire length of the electrodes and the curved surfaces of the electrodes, permits a ready escape of the bubbles as they are formed by the passage of the current so that the current is maintained at a relatively high value free of objectionable fluctuations and an abrupt termination of the operation of the apparatus is brought about.

A further advantage of the persent invention is that it enables the electric heating or cooking device to be used with liquids, such as water, which vary widely in chemical composition. The device may therefore be used in various localities without the necessity of any preliminary treatment of the water or the electrodes in order to secure the desired vaporization.

This application is in part a continuation of our co-pending application, Serial No. 665,761, filed October 1, 1923, in which the use of an electrode held in place entirely by gravity, and other features, are claimed. In the present specification, and in the accompanying claims, where reference is made to evaporation to substantial dryness of the measured quantity of liquid contained in the receptacle, it will be understood that this evaporation includes not only the evaporation of the liquid originally put into the receptacle but also of the water or other liquid condensate which collects and flows back to the bottom of the receptacle. The amount of this condensate may vary depending upon the condition and surface area of the objects, such as eggs, which are treated in the heating chamber of the receptacle.

Although one form of the invention has been shown and described by way of illustration, it will be understood that it may be constructed in various other embodiments without departing from the scope of the appended claims.

We claim:

1. A liquid conductor heater in which a measured quantity of liquid is evaporated substantially to dryness, comprising a receptacle provided with a heat treating chamber, and spaced electrodes in said receptacle adapted to make circuit closing contact with said liquid and formed to effect a ready escape from the space between said electrodes of bubbles produced in said liquid by the passage of current therethrough.

2. A liquid conductor heater in which a measured quantity of liquid is evaporated

substantially to dryness, comprising a receptacle provided with a heat treating chamber, and spaced horizontal electrodes located one above the other in said receptacle to make circuit closing contact with said liquid and formed to effect a ready escape from the space between said electrodes of bubbles produced in said liquid by the passage of current therethrough, the evaporation to substantial dryness opening the circuit between said electrodes.

3. A liquid conductor heater in which a measured quantity of liquid is evaporated substantially to dryness, comprising a receptacle provided with a heat treating chamber, and spaced horizontal electrodes in said receptacle adapted to make circuit closing contact with said measured quantity of liquid, one of said electrodes being perforated to effect a relatively rapid escape from the space between said electrodes of bubbles produced by the passage of a current through said liquid

4. A liquid conductor heater in which a measured quantity of liquid is evaporated substantially to dryness, comprising a receptacle for retaining said measured quantity of liquid until it substantially disappears by evaporation, and spaced electrodes located one above the other in said receptacle and comprising parts formed to effect a ready escape of bubbles from the space beween said electrodes, and means for supporting an object to be heated in a place having communication with the space occupied by said electrodes.

5. A liquid conductor heater in which a measured quantity of water is evaporated substantially to dryness, comprising a receptacle provided with a heat treating chamber, means for measuring said quantity of liquid, and spaced horizontal electrodes in said receptacle adapted to make circuit closing contact with said measured quantity of liquid, one of said electrodes being perforated to effect a ready escape from the space between said electrodes of bubbles produced by the passage of current through said liquid.

6. A liquid conductor heater in which a measured quantity of liquid is evaporated substantially to dryness, comprising a receptacle for retaining said measured quantity of liquid until it substantially disappears by evaporation, and a plurality of grid electrodes for making circuit closing contact with said liquid in said receptacle, one of said electrodes being perforated to permit the ready escape of bubbles from the space between said electrodes.

7. A liquid conductor heater in which a measured quantity of liquid is evaporated substantially to dryness, comprising a receptacle for a measured quantity of vaporizable liquid, means for effecting a gradual introduction of said liquid into said receptacle, and spaced electrodes located horizontally in said receptacle to make circuit closing contact with said liquid, said electrodes being formed and arranged to permit the ready escape of bubbles from the space between said electrodes.

8. A liquid conductor heater in which a measured quantity of liquid is evaporated substantially to dryness, comprising a receptacle for a measured quantity of vaporizable liquid, means for effecting a gradual introduction of said liquid into said receptacle, and spaced electrodes located one above the other in said receptacle to make circuit closing contact with said liquid, the upper one of said electrodes being perforated to permit the ready escape of bubbles from the space between said electrodes.

9. A liquid conductor heater for vaporizing a measured quantity of liquid to substantial dryness, comprising a receptacle for a measured quantity of vaporizable conducting liquid, means for introducing into said receptacle a measured quantity of said liquid, and a pair of spaced electrodes in the form of flat plates located one above the other in said receptacle for making circuit-closing contact with said liquid, the evaporation of the liquid opening the circuit between said electrodes, the upper one of said electrodes having a plurality of distributed perforations therethrough to permit the escape of bubbles formed between said electrodes.

10. A liquid conductor heater for vaporizing a measured quantity of liquid to substantial dryness, comprising a receptacle for a measured quantity of vaporizable conducting liquid, means for introducing into said receptacle a measured quantity of said liquid, and a pair of spaced electrodes in the form of flat plates located one above the other in said receptacle for making circuit-closing contact with said liquid, the upper one of said electrodes having a plurality of distributed perforations therethrough to permit the ready escape of bubbles formed between said electrodes, said upper electrode having its outer edge spaced inwardly from the surrounding wall of said receptacle.

11. A liquid conductor heater in which a measured quantity of liquid is evaporated substantially to dryness, comprising a receptacle for retaining a measured quantity of vaporizable liquid, means for permitting the unrestricted escape of vapor into the atmosphere from said receptacle, upper and lower grid electrodes in the form of circular plates mounted horizontally in the lower part of said receptacle and spaced apart, whereby the evaporation of the liquid to substantial dryness opens the circuit between said electrodes, means for forming electric connections with said electrodes, and insulating means for spacing said electrodes apart, said upper electrode being perforated to permit the ready

escape of bubbles created by the passage of current through the liquid between said electrodes.

12. A liquid conductor heater in which a measured quantity of liquid is evaporated substantially to dryness, comprising a receptacle for retaining said measured quantity of liquid until it substantially disappears by evaporation, spaced electrodes located one above the other in said receptacle for making circuit closing contact with said liquid, and insulating means covering a portion of said upper electrode.

13. An electric apparatus of the class described, comprising a receptacle for a body of vaporizable liquid, upper and lower grid electrodes mounted in said receptacle, said lower electrode having apertures therethrough, and insulating members formed on the bottom of said receptacle and extending upwardly through said apertures to engage said upper electrode and thereby space said electrodes apart.

14. An electric apparatus of the class described, comprising a receptacle for a measured quantity of vaporizable liquid, upper and lower grid electrodes mounted in said receptacle, means for forming an electric connection with said lower electrode, and a terminal post extending upwardly through and insulated from said lower electrode, said upper electrode having a threaded connection with said terminal post.

15. An electric apparatus of the class described, comprising a receptacle for a measured quantity of vaporizable liquid, upper and lower grid electrodes mounted in said receptacle, means for forming an electric connection with said lower electrode, a central terminal post extending upwardly through and insulated from said lower electrode, said upper electrode having a threaded connection with said terminal post, and insulating means spacing said upper electrode from said lower electrode.

16. An electric apparatus of the class described, comprising a receptacle for a measured quantity of vaporizable liquid, upper and lower grid electrodes mounted in said receptacle, an electric circuit connected to said lower electrode, a terminal post connected to said circuit and extending upwardly through said lower electrode, means for insulating said terminal post from said lower electrode, said lower electrode having an aperture therethrough, and an insulating member extending through said aperture and engaging said upper electrode to space said electrodes apart, said upper electrode being connected to said terminal post.

17. An electric apparatus of the class described, comprising a receptacle for a measured quantity of vaporizable liquid, upper and lower grid electrodes mounted in said receptacle, an electric circuit connected to said lower electrode, a terminal post connected to said circuit and extending upwardly through said lower electrode, means for insulating said terminal post from said lower electrode, said lower electrode having an aperture therethrough, an insulating member extending through said aperture and engaging said upper electrode to space said electrodes apart, said terminal post being threaded, said upper electrode having a threaded connection with said terminal post.

18. The method of operating a liquid conductor heater in which electrodes are adapted to be connected by a liquid conductor, which consists in impressing an electrical potential on said electrodes, applying a measured quantity of liquid to said electrodes, retaining said liquid in contact with said electrodes until said liquid has been evaporated substantially to dryness, and effecting an abrupt shut-off of the passage of current between said electrodes as the condition of dryness is reached.

19. The method of operating a liquid conductor heater in which electrodes are adapted to be connected by a liquid conductor in a vessel which consists in impressing an electrical potential on said electrodes, restricting the starting current by effecting a gradual application of the liquid to the electrodes and by forming the electrodes to effect a rapid dissipation of the energy created by the passage of the current, retaining said liquid in said vessel for heating by said current until it has been evaporated substantially to dryness, and causing an abrupt shut-off of the current passing between said electrodes as the condition of dryness is reached.

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