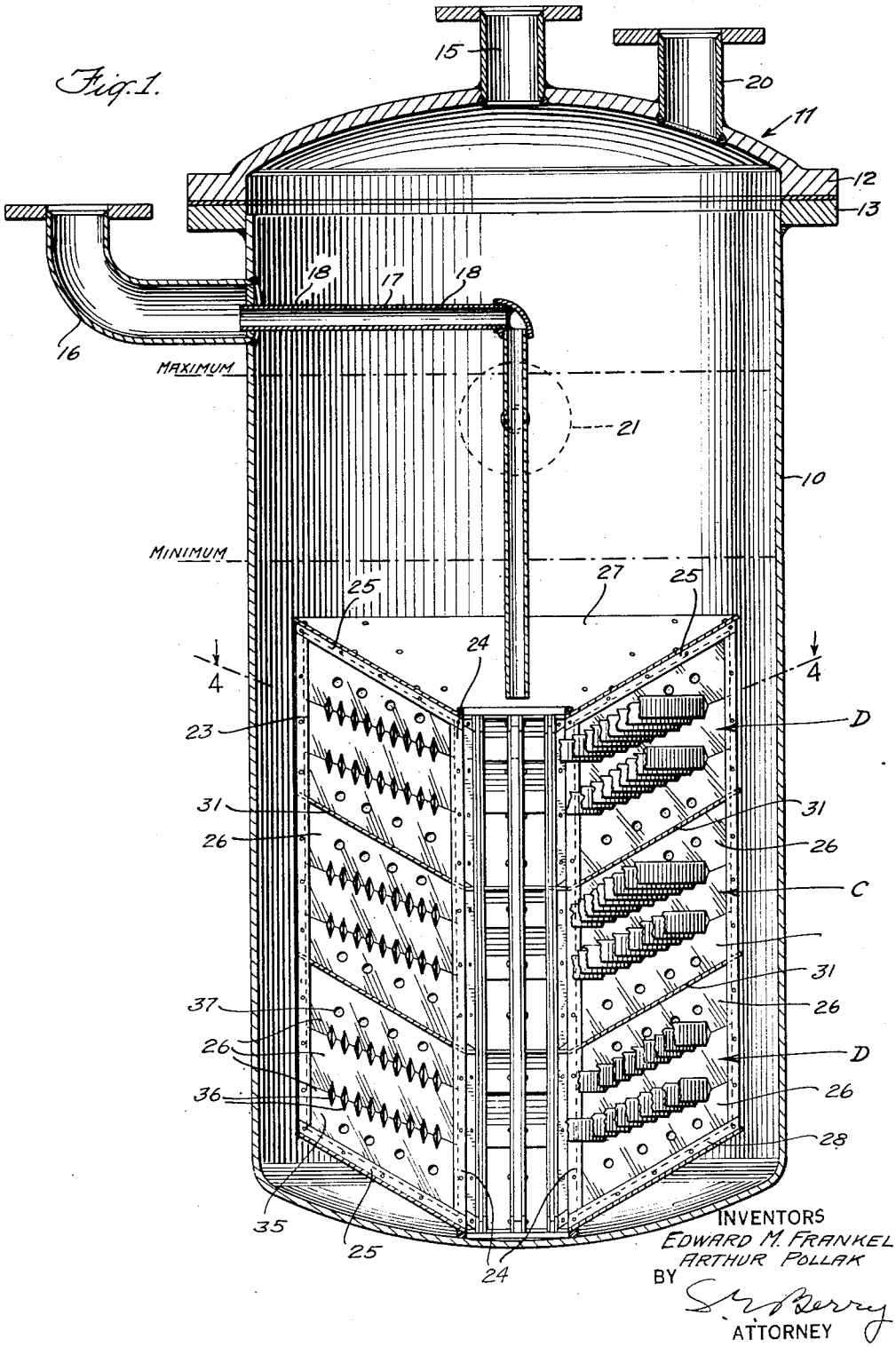
Nov. 14, 1939. E. M. FRANKEL ET AL 2,179,781

ELECTRIC BOILER

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Fig. 1.



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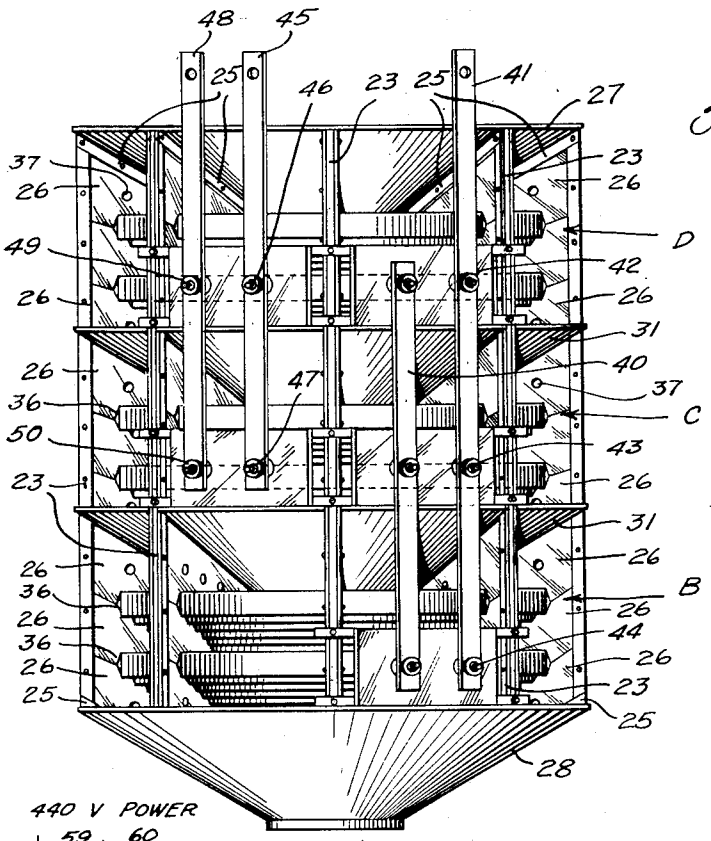
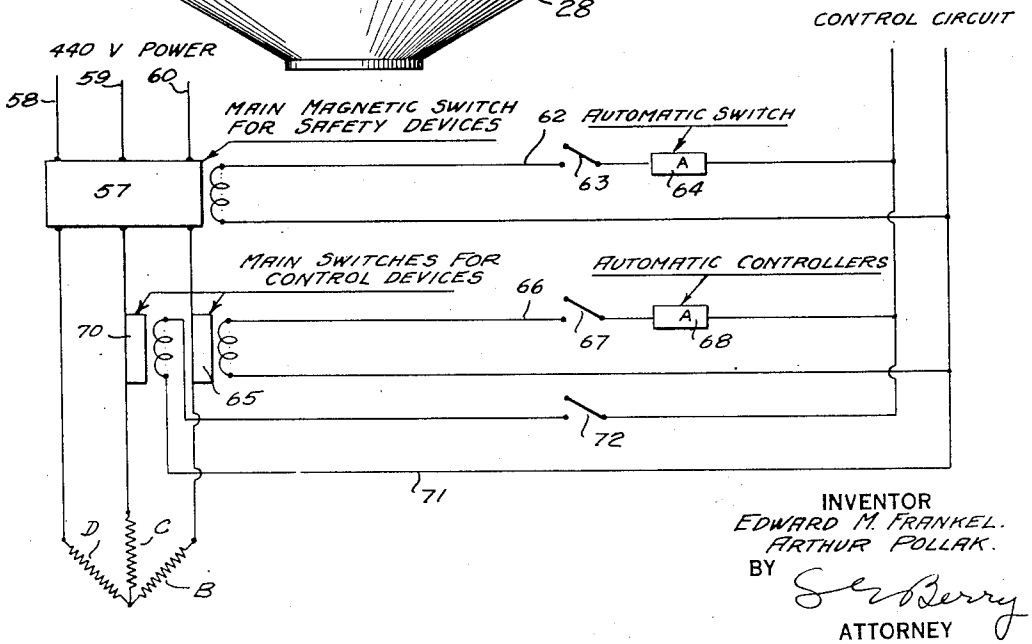


Fig. 2.

Fig. 3.



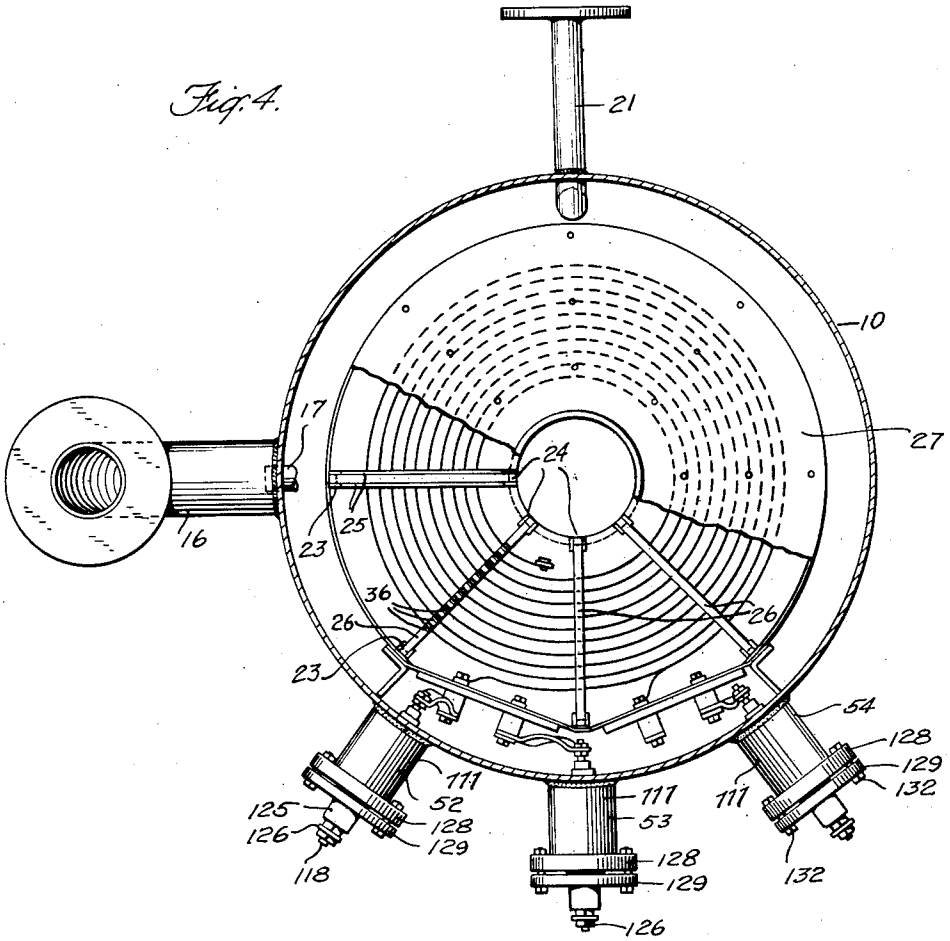
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Fig. 4.



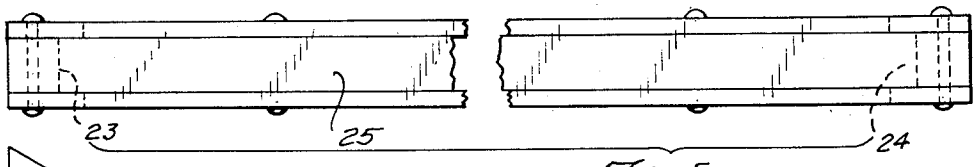


Fig. 5.

Fig. 5a.

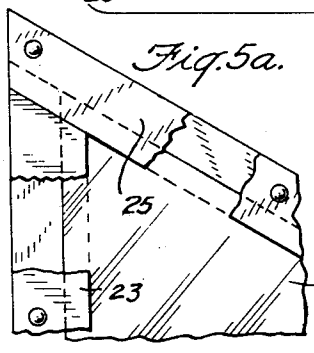
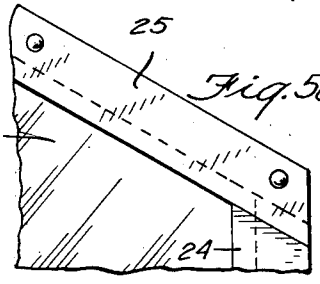


Fig. 5b.



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Fig. 6.

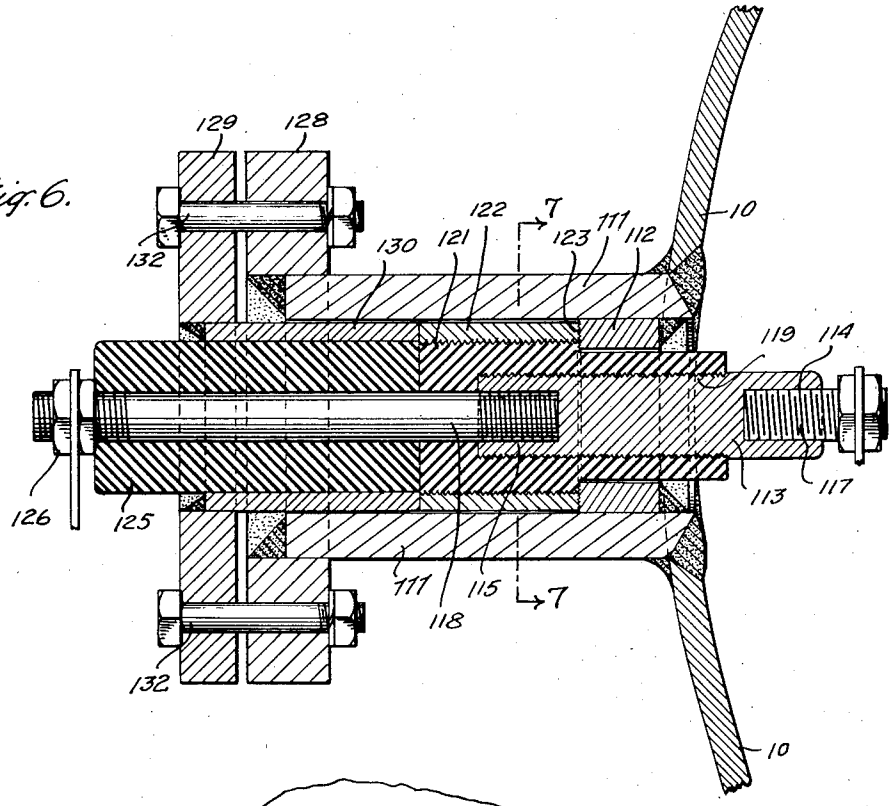
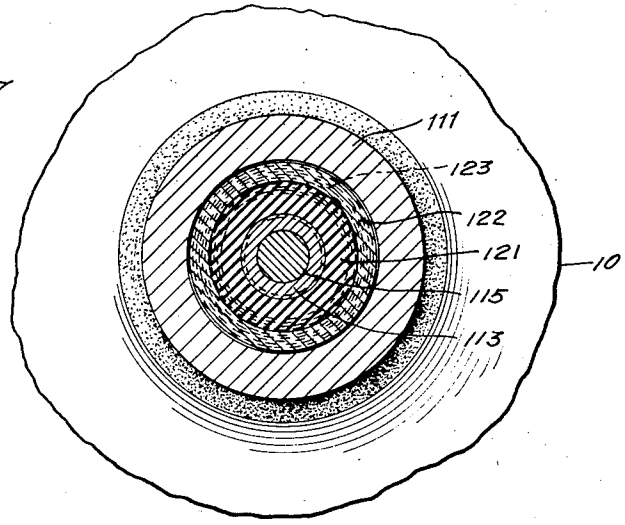


Fig. 7.



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Fig. 8.

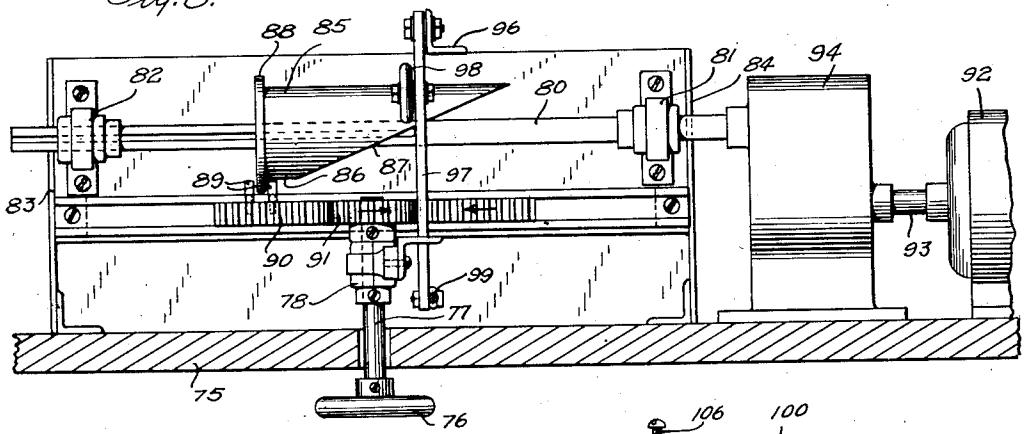
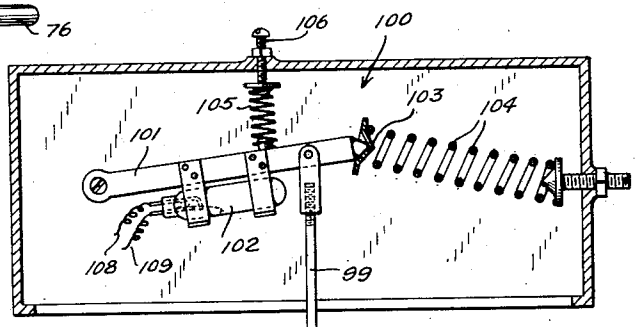


Fig. 9.



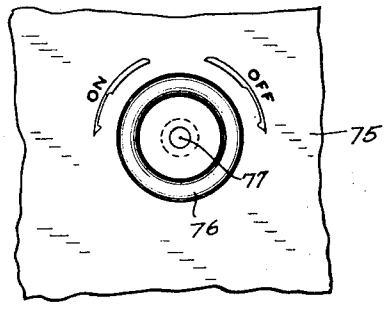
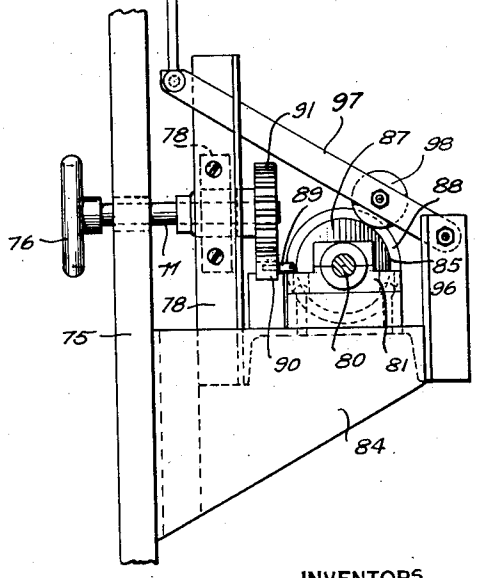


Fig. 10.



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UNITED STATES PATENT OFFICE

2,179,781

ELECTRIC BOILER

Edward M. Frankel and Arthur Pollak, New York, N. Y., assignors to West Virginia Pulp & Paper Company, New York, N. Y., a corporation of Delaware

Application March 23, 1936, Serial No. 70,328

7 Claims. (Cl. 219—39)

Our present invention relates to electric boilers especially adapted for use with diphenyl or other substances boiling at high temperature, although other liquids, especially those which are non-conducting may be heated or evaporated therein irrespective of their boiling point. Boilers of this type are useful in heating systems depending upon the supply of a heating vapor as for example that of diphenyl, the vapor of which is circulated through various heating spaces and then returned as liquid to the boiler. Because of the nature of such use it is highly important that the vapor be furnished at a uniform temperature as otherwise the benefit of applying heat by means of a vapor is largely lost. Also it is of the utmost importance that proper circulation be had of the liquid undergoing evaporation since otherwise decomposition of the liquid will take place and the resulting deposition of carbon upon the heating elements will cause them to burn out by further obstructing circulation and removal of heat. To this end it is essential that the heating elements be kept immersed in the liquid.

One of the principal objects of our invention is, therefore, to devise such a boiler which will provide an even and positive circulation of the liquid to be evaporated, and making for disengagement of the vapor at a multiplicity of points within the heating space without exposing the electric resistance elements.

A further object is to mount the electric resistance elements in a manner which will promote circulation and avoid decomposition of the liquid at the places where the elements are supported.

Still further objects of the invention and various advantages thereof will be apparent as the description proceeds and the novel features will be pointed out in the appended claims.

According to our preferred embodiment, we provide a preferably cylindrical vessel in which is immersed a heating unit of special construction. This unit consists of a plurality, preferably three, of upwardly directed heating compartments, each containing a coiled electric resistance unit, all said compartments communicating with one another by means of a preferably centrally disposed down-take passage, the vapor formed leaving the compartments between the heating element and the sides of the vessel. In the manner described, a positive circulation is obtained of the fluid downwardly through the central passage and radially and upwardly through the various compartments.

The invention will be best understood by reference to the following detailed description taken with the annexed drawings, in which

Figure 1 is a view in central vertical section of a preferred embodiment of the boiler;

Figure 2 is a view in vertical elevation of the entire heating unit;

Figure 3 is a diagram of the control circuits for the heating elements;

Figure 4 is a view taken on section 4—4 of Figure 1;

Figure 5, 5a and 5b are three views showing details of the baffling and supporting members used;

Figure 6 is a view on an enlarged scale of a lead-in for the current supplied to the boiler;

Figure 7 is a view taken on section 7—7 of Figure 6;

Figure 8 is a plan view of a control device for said boiler;

Figure 9 is a view on a larger scale of certain operating mechanisms of said control device; and

Figure 10 is a fragmentary view seen to the left of Figure 9.

Referring to Figure 1, 10 denotes the shell of the boiler which has a cover 11 bolted thereto by means of bolts (not shown) which pass through flanges 12 and 13, respectively, of the cover and shell. The vapor produced is withdrawn through outlet 15. The condensate is returned to the boiler through pipe 16 which is preferably provided with an L-shaped pipe 17 within the boiler, it being noted that the horizontal portion of this pipe is provided with perforations 18 to prevent sucking up of the liquid should a vacuum develop in the system exterior to the boiler. An outlet 20 is provided for gauge fittings while an opening 21 is had for the purpose of draining the boiler for inspection and repairs.

Coming now to a description of the heating unit, which is shown in Figures 1, 2, 3 and 4, the framework thereof is composed conveniently of so-called channel iron and consists of a plurality of outer uprights 23 and a plurality of inner uprights 24 (which form a central hollow core for the unit), said inner and outer uprights being respectively arranged in radial alignment, corresponding bars being joined by radial cross pieces 25 at the top and bottom thereof. It will be noted that the uprights 23 and 24 provide receiving channels into which may be secured vertically disposed members 26 for holding the individual heating units as will be described. It will further be observed that the uprights 23 are higher than uprights 24 so as to make the top 27 concave and the bottom 28 convex. The unit is desirably divided into preferably three compartments denoted B, C, D by means of parallel partitions 31 of generally conical shape. Each compartment so formed is adapted to contain a heating unit as will be described.

The individual heating units are formed by first securing in place the lowermost layer of partitions 26, which it will be noted are provided with spirally arranged notches 36 in which the electrict resistance metal preferably in the form of a ribbon is wound. When the first layer is thus wound, a second layer of partitions 26 having

registering notches is laid in place whereupon a second spiral is wound, it being desirable that the coils thus formed are of dish shape as shown. In the embodiment illustrated, two coils are provided for each campartment, each pair of coils preferably being of one length of ribbon having a double band in the portion joining the coils at their inner ends. It being understood, however, that this number of coils per compartment is not essential and that a different number can be employed if desired.

The supporting members on partition 26 which fit into the recesses of the channel members as best shown in Figures 4 and 5 may be of any suitable material. An example of material we have found satisfactory is a composition of Portland cement and asbestos sold under the name "Transite". The notches 36 in the partitions 26 while securely retaining the metal ribbon, which is disposed edgewise therein, yet permit circulation of the liquid being heated whereby danger of the units burning out due to imperfect heat transfer is eliminated. The free circulation of the liquid is further promoted by perforating the partition 26 as at 37, etc.

It will be noted that by virtue of the upward displacement of the compartments and of the spirals, the vapor as it is formed will rise and pass to the outer periphery of the unit and thence upward between the shell 10 and the unit, the liquid evaporated being replaced by liquid descending the central core of the unit. The upward pitch of the compartments and of the spirals thus gives rise to a positive circulation which keeps the heating units bathed in liquid whereby danger of the resistance units burning out for lack of sufficient heat transfer is completely overcome.

The three units shown are preferably connected for three phase operation, the diagram of such connections being shown in Figure 3, whereas the actual connections are shown in Figure 2. The common connection of the three coils is had by means of the conductor 40, Figure 2; the connection for compartment B is made by conductor 41 which is held in place by non-electrical connections 42 and 43 and also electrical connection 44. Similarly, compartment C is connected by conductor 45 having non-electrical connection 46 and electrical connection 47. Compartment D is served by conductor 48 which has electrical connection 49 and non-electrical connection 50.

Conductors 41, 45 and 48 are provided with lead-in connections 52, 53, 54, Figure 4, preferably of special construction as will be hereinafter described.

The electrical conductors to the three coils B, C, D are provided with various switches desirably of the electro-magnetic type. Magnetic switch 57 shown in Figure 3 operates all three conductors 58, 59, 60. Magnetic switch 57 is operated by circuit 62 provided with a manually actuated switch 63 and an automatic switch responsive to any desired variable in the external system, e. g. temperature, pressure. Conductor 60 is additionally provided with magnetic switch 65 operated by circuit 66 having a manual switch 67 and an automatic switch 68. Similarly, conductor 59 has a magnetic switch 70, circuit 71, manual switch 72. It is a familiar law governing three-phase circuits that when one leg of the system, as for example the conductor 60, is interrupted, the power input is thereby halved. We have therefore found that the automatic control of such leg of the three-phase system affords a control of means of great accuracy. To accomplish this we provide for periodic cutting in and cutting out of the coil B, advantage being taken of the large heat capacity of the boiler and contents to absorb the heat contributed by coil B during the heating period and distribute it during the non-heating period whereby the temperature-time curve in respect to the vapor furnished by the boiler is for all practical purposes a straight line.

To accomplish this control we have devised the following apparatus: 75, Figure 8, denotes a panel board having an operating wheel 76 attached to a shaft 77 journaled in a bracket 78 attached to the rear of said panel. A shaft 80 is also mounted in the rear of the panel in journals 81, 82 attached to brackets 83, 84, respectively. Loosely mounted on said shaft but keyed thereto is a cylinder 85 having a non-truncated portion 86 and a portion 87 truncated as by an obliquely disposed plane. Cylinder 85 has an end flange 88, engaging which are fingers 89, 89 attached to a slidable rack 90, said rack engaging a gear 91 attached to the shaft 77. When the wheel 76 is turned, the rack 90, and consequently the cylinder 85, is moved back or forth along the shaft 80. Shaft 80 is driven by an electric motor 92 of constant speed type through shaft 93 and gear reduction box 94. Journaled in a support 96 is a lever 97 having a follower roller 98 which is adapted to follow the curved surface of the roll 85. Attached to the end of lever 97 is link 99 which connects with a switch denoted generally by 100. Switch 100, which is of conventional design, consists of a lever 101 carrying a mercury cell 102, said lever 101 engaging a shield 103 carried by a toggle spring 104. In order further to control the movement of lever 101, the same is attached to compression spring 105, the tension of which is regulated by a screw 106. The operation of the control device will now be evident. When the follower 98 is in contact with the curved surface of the cylinder 85, the switch 100 is in the position shown in Figure 9 in which the mercury cell connects the leads 108 and 109, thereby actuating control circuit 66 to cut in the coil B. When, however, the cut-out portion of the cylinder 85 comes in contact with the follower 98, the spring 105 acts to tilt the lever 101 downwardly past the dead center of the toggle to the off position. When the cylinder is moved to the right of Figure 8 by turning the wheel 76, a greater proportion of the curved surface is presented to the follower 98 and the coil B is cut in for a longer time. Should it be desired to keep the coil cut in for an indefinite period, the cylinder 85 is moved until the non-truncated portion 86 is in contact with the follower 98. When the cylinder 85 is moved to the extreme left, Figure 8, the coil B will be cut out for an indefinite period.

Claims to the control arrangement above described involving the three-phase circuit which were divided out of this application have been made in our co-pending application Serial No. 185,120 filed January 15, 1938.

In order to bring the current into the boiler, it has been found desirable to employ lead-ins of special construction. This is shown best in Figures 6 and 7 wherein a short length of pipe or nipple 111 is fitted within an opening in the boiler shell 10 and is welded to the shell as indicated in Figure 6. The pipe 111 carries an inner bushing 112 which may also be welded in place. Bushing 112 provides a shoulder against which the lead-in proper is secured. The latter consists of a

metallic core 113 of conducting metal, as for example steel, having a threaded recess 114 at one end and a similar recess 115 at the other to receive the electric conduits 117, 118, respectively. Core 113 is provided preferably with an exterior screw thread 119 around which is molded a suitable plastic, as for example so-called mycalex (a composition containing mica-lead borate glass and capable of withstanding moderately high temperatures) to form a bushing 121 around an enlarged portion of which may be provided a sleeve 122 which is preferably threaded thereto in order to give a large contact area with the bushing. The bushing 121 and sleeve 122 thus offer a shoulder 123 to contact with the shoulder of bushing 112. One of said contacting shoulders is roughened or given a so-called phonograph finish so as to give a tight contact. Next to the mycalex bushing 121 there may be inserted an insulating bushing 125 of ordinary material such as soapstone or transite, the same being secured on the conductor 118 by means of the nut 126. To maintain the lead-in tightly in place, the following construction may be provided: A flange 128 is secured to the pipe 111 preferably by welding. Disposed opposite the flange 128 is a flange 129 having preferably welded thereto a gland 130. The flanges 128 and 129 are brought together by means of screw bolts 132. By taking up on these bolts the bushing 121 is brought firmly home against the bushing 112 and a tight joint results.

Reverting to the boiler, the improved arrangement of parts gives a highly compact construction enabling the resistor to be operated at a low emission rate but with a high total output of electrical energy; for example, in a space 30 inches in diameter and 36 inches high we have been able to wind about 200 feet of one and one half inch resistance ribbon of sufficient resistance to permit direct connection to a three phase 440 volt power line. At 60 kilowatt output, the emission per square inch of heating surface per hour is only 10 watts thus making for an extremely long life of the ribbon.

While we have described our improved embodiments in considerable detail, it is understood that we have done so by way of example only and that various changes will occur to those skilled in the art without either departing from the spirit of the invention or the scope of the appended claims.

We claim:

1. In an electric boiler adapted for heating and/or evaporation of high boiling substances, a boiler shell, a plurality of vertically spaced heating units therein, said units being adapted to be completely covered by the liquid to be evaporated and arranged to afford separate uptake and downtake passages for circulation of liquid, baffles between horizontal layers of units, said baffles extending from one to the other of said passages whereby circulation is directed both upwardly and laterally and the flow of liquid is upwardly of one of said passages and downwardly of the other, said baffles preventing the liquid or its vapor from coming into contact with more than one unit.

2. In an electric boiler adapted for evaporation of high boiling substances, a boiler shell, a plurality of vertically spaced annular heating units of dish shape therein, said units being adapted to be completely covered by the liquid sage for downward circulation of liquid and a passage between said units and the wall of the shell for upward circulation, baffles between said units, said baffles directing circulation both upwardly and laterally, and preventing the liquid or its vapor from coming into contact with more than one unit.

3. The boiler according to claim 1 in which said units are constituted by coils of bare electrical resistance metal.

4. In an electric boiler adapted for evaporation of high boiling substances, a boiler shell, heating units therein, said units being adapted to be completely covered by the liquid to be evaporated and arranged to afford a passage for circulation of liquid between said units and the wall of said shell and a passage interiorly of said units, and baffles above and below a horizontal layer of said units, said baffles extending from one to the other of said passages and directing circulation both upwardly and laterally whereby the flow of liquid is upwardly of one of said passages and downwardly of the other, and said baffles preventing the liquid or its vapor from coming into contact with more than one unit.

5. In an electric boiler adapted for evaporation of high boiling substances, a boiler shell, a plurality of vertically spaced heating units therein, said units being adapted to be completely covered by the liquid to be evaporated and arranged to provide a passage for upward circulation of liquid between said units and the wall of said shell and a passage for downward circulation interiorly of said units, baffles between horizontal layers of units, said baffles directing circulation both upwardly and laterally, said baffles preventing the liquid or its vapor from coming into contact with more than one unit.

6. In an electric boiler adapted for heating and/or evaporation of high boiling substances, a boiler shell, a plurality of vertically spaced heating units therein, said units being adapted to be completely covered by the liquid to be evaporated and arranged to afford separate uptake and downtake passages for circulation of liquid, baffles between said units, said baffles extending from one to the other of said passages and whereby circulation is directed both upwardly and laterally and the flow of liquid is upwardly of one of said passages and downwardly of the other, said heating units having an emission rate per square inch on the order of ten watts.

7. In an electric boiler adapted for heating and/or evaporation of high boiling substances, a boiler shell, a plurality of vertically spaced heating units therein, said units being adapted to be completely covered by the liquid to be evaporated and arranged to afford separate uptake and downtake passages for circulation of liquid, baffles between horizontal layers of units, said baffles being inclined upwardly from and extending from one to the other of said passages and directing circulation both upwardly and laterally whereby the flow of liquid is upwardly of one of said passages and downwardly of the other, said baffles preventing the liquid or its vapor from coming into contact with more than one unit.

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