Sept. 17, 1963 E. E. WILSON 3,104,308

ELECTRICALLY OPERATED CONTINUOUS STEAM GENERATOR

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Fig.2

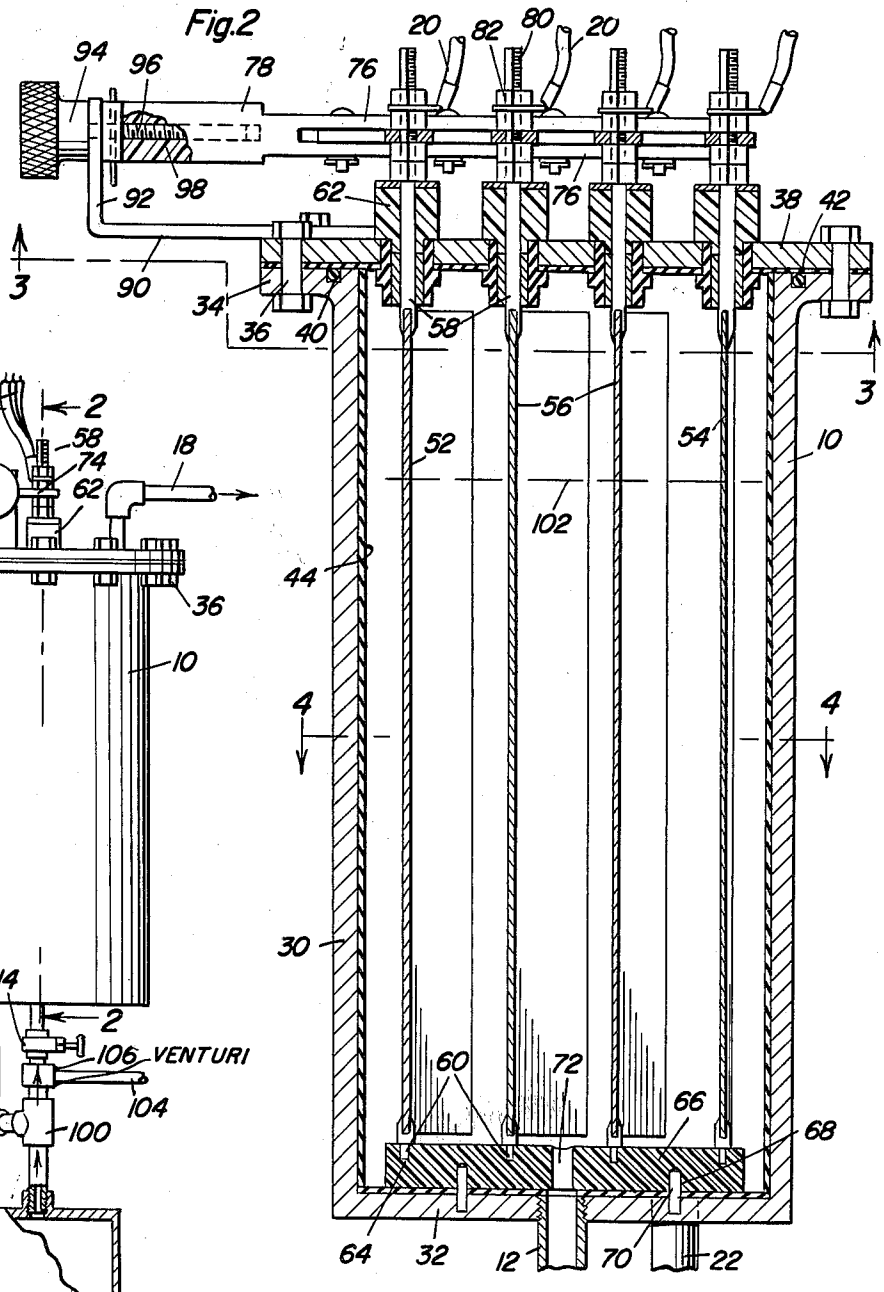


Fig.1

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Fig.3

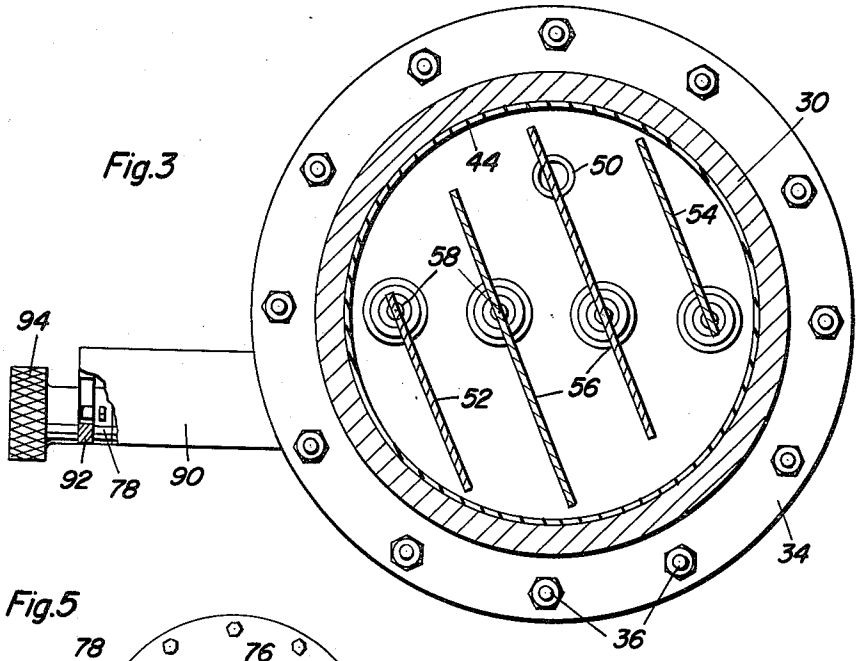


Fig.5

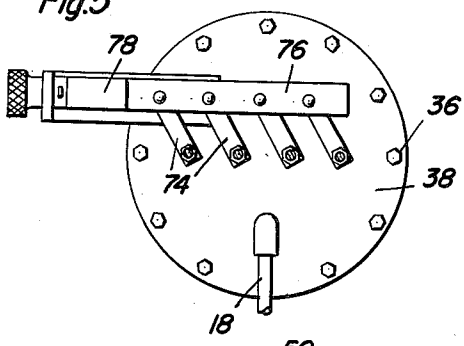
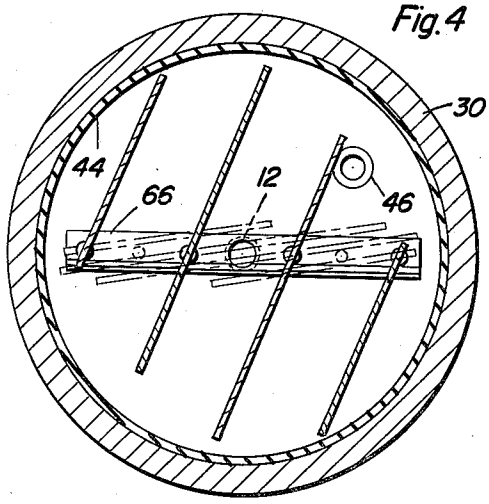


Fig.4



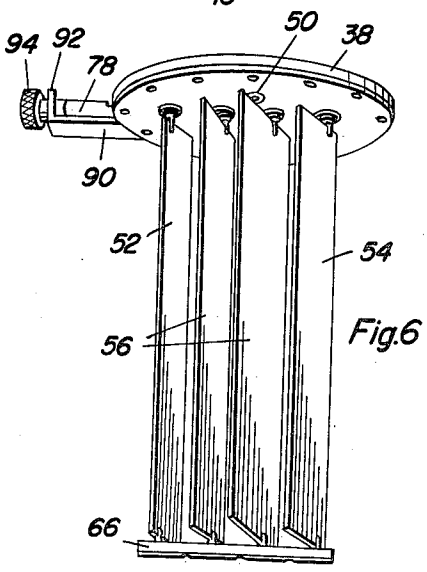


Fig.6

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ELECTRICALLY OPERATED CONTINUOUS STEAM GENERATOR

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6 Claims. (Cl. 219—40)

This invention comprises a novel and useful electrically operated continuous steam generator and more specifically pertains to an apparatus which embodies the same basic principles as those set forth in my prior Patent No. 2,681,974 of June 22, 1954, but constitutes certain important improvements thereover.

The primary purpose of this invention is to improve the water treating and heating device of my prior patent and to adapt the principles thereof to a much greater utility in a wider variety of fields of usefulness.

An important object of this invention is to provide an electrically operated steam generating device which shall be capable of ready adaptability to enable it to satisfactorily generate steam from water whose mineral content varies widely throughout various localities of the country.

A further object of the invention is to provide a device in accordance with the preceding objects which will enable an easy and very accurate control as to the rate of steam generation by the device.

A further object of the invention is to provide a device in accordance with the preceding objects which shall be of a construction which renders it substantially proof against the detrimental effects of corrosion of the water which is boiled therein.

Still another object of the invention is to provide a device in accordance with the aforementioned objects which shall be readily adjustable and easily controlled in order to selectively supply therefrom water at any temperature from that of the supply line to the boiling point; any desired proportion of steam and hot water separately or simultaneously; and superheated and dry steam exclusively as desired.

Still another object of the invention is to provide a device in which the heating is effected by electrical means and which readily lends itself to a considerable variety of electrical connections, differences of electrical current and the like to effectively perform its water heating and/or steam generating functions.

More specifically, it is an important purpose of the invention to provide a steam generating device as set forth in the preceding objects wherein the rate at which the water is converted into steam by the electrical means may be controlled by regulating the water level within the boiler to thereby vary the area of the electrodes that are immersed in the liquid therein and thus control the heat output of the electrodes; to vary the spacing of the electrodes from each other to thereby vary the heating effect and also adapt the device to more effectively handle waters having different mineral content; and to vary by the electrical input the rate of heating of the water therein.

A further and more specific object of the invention is to provide an electrically operated steam generator in compliance with the above mentioned objects which shall be of a simple, sturdy, long lasting and very compact and effective construction for the purpose intended.

It is a further specific object of the invention to provide a means for mounting and supporting the electrodes and render the same adjustable so as to vary the distance of the electrodes from each other while at the same time minimizing the tendency of the electrodes to form carbon short circuiting paths across their insulators which would thereby detrimentally affect the efficiency and operation of the device.

It is another specific object of the invention to provide an apparatus which will enable the steam generated by the

device, after its intended use, to be condensed and then returned into the feed water supply line of the boiler to thereby effect an economy in the operation of the device as well as eliminate the necessity for separately disposing of the used steam.

Still another important object of the invention is to provide an apparatus in compliance with the hereinbefore set forth objects wherein the electrodes may be formed as plates, either flat or curved in cross-section and whereby the surfaces of the electrodes will remain parallel to each other under all conditions of their adjustment.

These together with other objects and advantages which will become subsequently apparent reside in the details of construction and operation as more fully hereinafter described and claimed, reference being had to the accompanying drawings forming a part hereof, wherein like numerals refer to like parts throughout, and in which:

FIGURE 1 is a side elevational view, parts being broken away and shown in vertical section, showing a suitable embodiment of a continuous steam generator in accordance with the principles of this invention;

FIGURE 2 is an enlarged view taken in vertical section substantially upon the plane indicated by section line 2—2 of FIGURE 1 and showing the internal construction of the boiler of the apparatus;

FIGURE 3 is a horizontal sectional view taken substantially upon the plane indicated by the broken section line 3—3 of FIGURE 2 and showing in particular the disposition of the heating electrodes within the boiler chamber of the device;

FIGURE 4 is a horizontal sectional view taken substantially upon the plane indicated by section line 4—4 of FIGURE 2 and showing the lower end of the boiler chamber, the electrode disposition and the mounting of the same in the chamber;

FIGURE 5 is a top plan view of the device of FIGURE 1; and

FIGURE 6 is a perspective view of the removable closure plate or top of the boiler together with the heating electrodes mounted thereon.

In my prior above identified patent there is disclosed a water treating and heating apparatus which involves the provision of a pair of stationary electrodes immersed in liquid in a boiler whereby the liquid is heated through the passage of electric current between the electrodes and through the liquid. While this device has proved to be quite satisfactory for a number of purposes, it has been found desirable to improve the operation of the same and render the device applicable to a greater variety of different conditions by forming the electrode assembly adjustable so as to vary the space between the electrodes and thus the length of the path of travel of the heating current through the water in which the electrodes are immersed. Further, it is desirable to increase the utility and improve upon the apparatus of my prior patent by rendering the same adaptable to a number of different voltage sources of electric current; the providing of different electrical circuits through the device to effect the heating operation; a control of the liquid level within the device to thereby vary the area of the electrodes which are immersed in the liquid and thus are effective for the heating operation. The present invention provides an apparatus and a means to effect the above mentioned desired improvements in the apparatus of my prior patent and to render the principles of the invention as disclosed in my prior patent capable of application to a wider variety of uses.

Referring first to FIGURE 1 for an illustration and understanding of a typical installation in accordance with the principles of this invention, there is shown at 10 a steam generator or boiler of a construction to be hereinafter set forth to which feed water is supplied as by a conduit 12 under the operation of a manually operated

feed regulating valve 14, there being interposed a reservoir tank or chamber as at 16 on the supply side of the control valve 14. There is further provided a delivery conduit 18 in the top of the boiler by which water and/or steam in any desired proportions are delivered by the device. Electric current is supplied to the device in any source as by means of conductors shown at 20, while a by-pass line 22 provided with a non-return adjustable pressure check valve assembly 24 is employed to effect return flow from the interior of the boiler into the supply conduit 12 for a purpose to become subsequently apparent.

Referring now specifically to FIGURE 2 it will be observed that the boiler 10 comprises a suitable tank or container which may be provided with a cylindrical wall 30, an integral bottom wall 32 together with an outturned flange 34 at its upper end to which is attachably secured as by fastening bolts 36 a removable plate 38 constituting a cover or closure to render the boiler airtight. In order to effect a fluid-tight seal between the cover and the interior of the boiler the flange 34 is provided with a circumferentially extending channel or groove 40 in its top surface in which is received a sealing means such as an O-ring or other packing ring 42.

The entire interior of the boiler is provided with a corrosion resisting coating or lining of a suitable dielectric material indicated by the numeral 44. This liner extends upon the cylindrical interior of the wall 30, and upon the bottom wall 32 and the cover or closure 38 as shown in FIGURE 2. While various insulating materials can be employed for this liner a quite satisfactory material is one commercially available and known as Silastic.

The bottom wall 32 of the boiler is provided with a threaded bore into which the supply conduit 12 opens, and there is a further threaded opening therethrough which receives the by-pass conduit 22, this opening being indicated at 46 in FIGURE 4.

As shown best in FIGURE 3, the closure or cover plate 38 is provided with a threaded bore or opening 50 with which the delivery line or conduit 18 is connected.

The heating operation of this apparatus is effected by electrical means through a series of electrodes adjustably supported by the cover 38 and the bottom 32 of the boiler unit 10. As will be best apparent from FIGURE 2 in conjunction with FIGURES 3, 4 and 6, each electrode consists of a plate of electrically conductive material and preferably one which is corrosion resistant such as stainless steel or the like. In the embodiment illustrated there are disposed a pair of end electrodes as at 52 and 54 together with a pair of central electrodes each designated by the numeral 56. As shown in FIGURES 3 and 4 these electrodes are preferably spaced and positioned so that they will be uniformly spaced from each other and the space between the electrodes will extend substantially over the entire cross-sectional area of the interior of the boiler. Each electrode is provided at its upper and lower end with a projecting axle, the set of upper axles being indicated by the numerals 58 while the lower axles are indicated by the numerals 60. As shown in FIGURE 3, the axles are disposed closely adjacent the one edge of the two outer electrodes 52 and 54, but more nearly at the center of the two electrodes 56, the arrangement being such that the four upper axles are disposed in the same diametrical line across the boiler, and as shown in FIGURE 4 the bottom set of axles 60 are likewise disposed along a diameter of the boiler, these two diameters lying in the same vertical plane extending centrally of the boiler. By this arrangement, rotation of the electrodes and their axles will result in causing the electrodes to vary their spacing with respect to each other while their adjacent surfaces will always remain equidistantly spaced from each other. This condition is true regardless of whether the electrodes consist of flat plates of material, or consist of plates having various desired cross-sectional curvatures.

When the electrodes are rotated into their maximum spacing between their adjacent faces, this being the position shown in FIGURES 3 and 4, it will be observed that the opposite vertical edges of the electrodes will be closely adjacent to the corrosion proof lining 44 of the side wall of the boiler, with the electrodes being uniformly spaced over the cross-sectional area of the interior of the boiler. However, the electrodes are rotated into a position more closely adjacent each other, as shown in dotted lines in FIGURE 4, the spacing between the adjacent faces of the electrodes will be at a minimum and the electrodes will occupy their least proportion of the cross-sectional area of the boiler. The importance of this adjustment is that it enables the electrodes to be spaced from each other varying distances so as to obtain the most effective length for the flow of current between the electrodes and therefore the most effective length of passage of the current through the liquid being heated. This variability is necessary since the mineral content and consequently the electrical conductivity of waters in various localities of the country is subject to wide variation and a single fixed spacing of the electrodes would not permit the device to operate with equal efficiency in heating waters of widely varying mineral content. Therefore, the rotationally adjustable mounting of the electrodes enables the same device to be adjusted to operate at maximum efficiency with waters of widely varying mineral content.

The upper set of axles 58 are rotatably journaled in insulating bushings 62 which are of any suitable material, Teflon being found to be satisfactory for this purpose, with the upper ends of the axles projecting above these bushings for a twofold purpose. The lower axles 60 in turn are journaled and supported in suitable sockets or bores 64 provided in a dielectric body or block 66, the latter in turn having positioning bores 68 in its bottom surface in which are received upstanding positioning dowel pins 70 rising from the bottom wall 32. A central opening 72 through the dielectric body is registered with the inlet of the supply line 12 to facilitate inlet of feed water into the boiler.

By the foregoing construction, it will be seen that the set of electrodes is rotatably mounted and journaled in bearing members of a dielectric character in the removable cover plate 38 whereby they may be removed with this cover as indicated in FIGURE 6, and at their lower ends are journaled in a dielectric body 66 which likewise can be removed with the cover plate if desired or may remain attached to the bottom wall of the boiler when the cover and electrode assembly are removed.

The previously mentioned upwardly extending and projecting ends of the upper set of axles 58 have secured thereto in any suitable manner for fixed but removable attachment thereto a set of actuating arms or cranks 74, see in particular FIGURE 5. The outer ends of these arms are pivotally connected to and embraced by the bifurcated arms 76 of a dielectric body 78 whereby the arms of each of the electrodes is connected together for simultaneous operation by a push and pull motion on the body 78. Further, the previously mentioned electric conductors 20 are connected each to one of the upwardly extending portions of the axles 58, in good electrical contact therewith by means of external threads 80 on the axles upon which lock nuts 82 are provided.

At this point it should be observed that the actual means and arrangement by which electric current is supplied to the electrodes is not a critical limitation of the principles of this invention, it being contemplated that the device shall be capable of being activated by electric current of different voltages as for example 110 volts, 220 volts, 440 volts and the like. In addition, the various electrodes shall be connected in various electrical circuit arrangements with each other as desired. For example, current may flow into the electrode system through the end electrodes 52 and 54 and be educted therefrom to the electrodes 56. Other arrangements may readily be em-

ployed since the invention lends itself to a wide variety of such arrangements, and since the number of electrodes can likewise be considerably varied. However, it is an essential feature of the invention that the electric circuit shall be so arranged that the current will necessarily enter the water in the boiler to one electrode, pass through the water to an adjacent electrode in order that the resistance to the flow of current through the water be utilized to effect a heating action. Inasmuch as relatively wide areas of adjacent electrodes are involved, it is obvious that electric currents of relatively heavy strength can be handled to thereby obtain rapid heating effects. In fact, the operation of this generator is substantially instantaneous and is effective to raise the temperature of the feed water to any desired temperature of water or to produce therefrom wet or superheated steam as desired in a relatively short time.

It will be readily understood that the electric current flowing through the device may be controlled by the usual types of electrical control means such as rheostats or adjustable transformers in order to vary the heating effect of this device as desired and such controls can also be readily operatively connected to various conditions of the apparatuses to which the heated water or steam is to be supplied in order to through such conditions control the generation of steam by this generator.

The manual adjustment of the spacing of the electrodes can be effected in a number and variety of ways. One convenient manner is that shown in FIGURES 2, 3 and 5, and may consist of a mounting bracket as at **90** which is secured to the top cover **38** of the boiler as by one of the fastening bolts **36**, and which has an upstanding apertured projection **92** which is disposed adjacent the end of the enlarged portion **78** of the dielectric body. Secured in this aperture against axial displacement but rotatable therein is a thumb screw **94** having an externally threaded stem **96** which is received in an internally threaded bore **98** formed in the end of the dielectric body **78**. The arrangement is such that as the thumb screw **94** is rotated, and is held against axial displacement by the arm **92** of bracket **90**, it will in turn impart a longitudinal pushing or pulling motion to the dielectric body and through the connection of the bifurcated arm **76** thereof with the crank arm **74** of the electrodes, will effect a rotation of the electrodes in unison.

It will be understood that in place of the thumb screw means such power operating means as solenoids, devices responsive to fluid pressure such as water pressure, steam pressure and the like, thermostatic controls, or a combination of the same may be utilized to effect the rotational adjustment of the electrodes for the purpose of varying the rate of heat input into the boiler.

Referring now more specifically to the arrangement shown in FIGURE 1, it is to be here noted that the by-pass line **22** is provided with a check valve **24**. This valve may be of any conventional design but is of the type preferably which will open and permit the flow of fluid from the interior of the boiler downwardly therefrom and into the supply line **12** through a fitting **100**. The check valve is preferably of the pressure relief type and is also preferably capable of being adjusted to regulate the pressure at which the valve will open and permit the escape of fluid from the tank. Inasmuch as valves of this character are well known in themselves, and the principles of the invention are not limited to the particular details of any valve of such type, a further description of the same is deemed to be unnecessary.

In operation, the valve **24** will be set to open at a predetermined pressure which it is desired to maintain in the boiler. When this pressure is exceeded as by reason of the generation of steam in the boiler which thus rapidly increases the pressure therein, the valve will open and permit the escape of fluid from the bottom of the boiler, this fluid being discharged into the supply line **12**, the reservoir tank **16** provides means to receive this fluid

which displaces any fluid already in the tank and forces it down line **12** in opposition to the pressure therein. Thus, by continuing to supply heat to the boiler and thus generating steam in the boiler faster than the same is to be withdrawn under the controls imposed upon the delivery conduit **18**, the pressure therein will rise and this pressure increase will eject water from the lower end of the boiler as just mentioned. Thus, by this controlled ejection of water, the liquid level in the boiler can be caused to drop to a lower level such as that shown at **102** which will thus result in steam being present above this level in the boiler while heated water will lie below this level. It is evident that the lowering of the level will reduce the total area of the electrode plates which are exposed or immersed in the liquid and therefore decrease the surfaces from which the electric current is flowing to thereby in turn diminish the heating capacity of the system.

Still further, this operation can be controlled and continued until the liquid level passes entirely beneath the electrodes, or until the boiler is entirely filled with steam if desired. Under this condition the heating effect can be employed to produce a superheated dry steam, or steam of varying degrees of wetness in order to adapt the device to supply steam to apparatuses in accordance with their specific requirements. It will be observed that the heated liquid thus ejected from the boiler is not wasted but is temporarily stored in reservoir **16** for future use. Without reservoir **16**, the hot water would be forced into the length of pipe **12** and thereby rapidly cooled.

The present invention also includes the provision of means for economizing on the use of the steam delivered by the line **18**. When such steam has served its desired function in the apparatus to which it is discharged, it may be reclaimed in any suitable manner, condensed, and the condensed water therefrom returned by condensate return line **104** into the feed line **12**. For this purpose there is provided a fitting **106** which preferably is of a venturi nature so that the flow of feed water therethrough under the control of valve **14** will inspirate or draw in the water condensate to the line **104** thus returning this into the boiler. The fitting **106** comprises a conventional venturi sleeve and has a tapered passage therethrough which is restricted at its center and enlarged at its ends. The center of the venturi sleeve comprises the throat of the venturi. The velocity of the fluid through the center of the venturi passage being relatively great causes the pressure to drop thereby drawing fluid from line **104**. This effects a great economy in the use of water by the device as well as an economy in the heat required for the operation of the apparatus.

The foregoing is considered as illustrative only of the principles of the invention. Further, since numerous modifications and changes will readily occur to those skilled in the art, it is not desired to limit the invention to the exact construction and operation shown and described, and accordingly all suitable modifications and equivalents may be resorted to, falling within the scope of the invention as claimed.

What is claimed as new is as follows:

1. An electrical steam generator comprising a boiler closed from the atmosphere, means for supplying water into said boiler for heating, means for discharging steam or heated water from said boiler, an immersion heater in said boiler, said heater comprising a plurality of elongated electrodes disposed in side-by-side spaced relation and immersed in said water whereby to heat said water upon flow of electric current between said electrodes and through said water, each of said electrodes pivotally mounted in said boiler on a longitudinal axis, all of the axes being parallel and coplanar, means for supplying an electric current to said electrodes, operating means connected to said electrodes so as to simultaneously vary the distance between said electrodes, a pressure responsive fluid discharge means communicating with the lower por-

tion of said boiler and a reservoir chamber for receiving and storing the hot water discharged from said boiler by steam pressure therein, said reservoir being directly below said boiler and connected thereto by a short conduit including said pressure responsive fluid discharge means.

2. An electrical steam generator comprising a boiler closed from the atmosphere, means for supplying water into said boiler for heating, means for discharging steam or heated water from said boiler, an immersion heater in said boiler, said heater comprising a plurality of elongated electrodes disposed in side-by-side spaced relation and immersed in said water whereby to heat said water upon flow of electric current between said electrodes and through said water, each of said electrodes pivotally mounted in said boiler on a longitudinal axis, all of the axes being parallel and coplanar, means for supplying an electric current to said electrodes, operating means connected to said electrodes so as to simultaneously vary the distance between said electrodes, said electrodes comprising flat plates, insulating means journaling and supporting said plates at opposite ends for rotation about the longitudinal axes, said axes disposed in side-by-side relation whereby to vary the distance between adjacent surfaces of adjacent plates, each plate having an axle concentric with the axes, at least one of said axles extending through a wall of said boiler to the exterior thereof, said operating means being connected to said extending axle.

3. An electrical steam generator comprising a boiler closed from the atmosphere, means for supplying water into said boiler for heating, means for discharging steam or heated water from said boiler, an immersion heater in said boiler, said heater comprising a plurality of elongated electrodes disposed in side-by-side spaced relation and immersed in said water whereby to heat said water upon flow of electric current between said electrodes and through said water, each of said electrodes pivotally mounted in said boiler on a longitudinal axis, all of the axes being parallel and coplanar, means for supplying an electric current to said electrodes, operating means connected to said electrodes so as to simultaneously vary the distance between said electrodes, a fluid discharge means communicating with the lower portion of said boiler for regulating the level and pressure of liquid in said boiler and thereby regulating the area of the electrodes submerged in said liquid and which is effective as a heating agent, said fluid discharge means including a non-return pressure relief check valve allowing escape of fluid from said boiler at a predetermined pressure therein whereby increase in steam pressure in said boiler above said predetermined pressure will discharge fluid and lower the liquid level in the boiler, said fluid discharge means delivers into said supply means, a reservoir tank communicating with said supply means via said check valve.

4. An electrical steam generator comprising a boiler closed from the atmosphere, means for supplying water into said boiler for heating, means for discharging steam or heated water from said boiler, an immersion heater in said boiler, said heater comprising a plurality of elongated electrodes disposed in side-by-side spaced relation and immersed in said water whereby to heat said water upon flow of electric current between said electrodes and through said water, each of said electrodes pivotally mounted in said boiler on a longitudinal axis, all of the axes being parallel and coplanar, means for supplying an electric current to said electrodes, operating means connected to said electrodes so as to simultaneously vary the distance between said electrodes, said operating means including an axle connected to each electrode and having one end extending through a wall portion of the boiler, a lever exterior of said boiler fixed to said one end of each axle, rigid means pivotally connecting each lever whereby all the levers and electrodes may be pivoted simultaneously.

5. A device as defined in claim 4 wherein each lever is parallel to the other levers, said rigid means comprises a plate pivotally connected to a free end of each lever, an operating knob rotatably mounted on the exterior of said boiler and fixed against axial movement, screw means operatively connecting said knob and plate.

6. An electrical steam generator comprising a boiler closed from the atmosphere, means for supplying water into said boiler for heating, means for discharging steam or heated water from said boiler, an immersion heater in said boiler, said heater comprising a plurality of elongated electrodes disposed in side-by-side spaced relation and immersed in said water whereby to heat said water upon flow of electric current between said electrodes and through said water, each of said electrodes pivotally mounted in said boiler on a longitudinal axis, all of the axes being parallel and coplanar, means for supplying an electric current to said electrodes, operating means connected to said electrodes so as to simultaneously vary the distance between said electrodes, said means for supplying water including a conventional venturi connected at its throat to a condensate return line so as to siphon fluid therefrom.

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