

June 7, 1932.

R. W. E. VICKERY

1,862,071

ELECTRIC STEAM GENERATOR

Filed Nov. 29, 1930

3 Sheets-Sheet 1

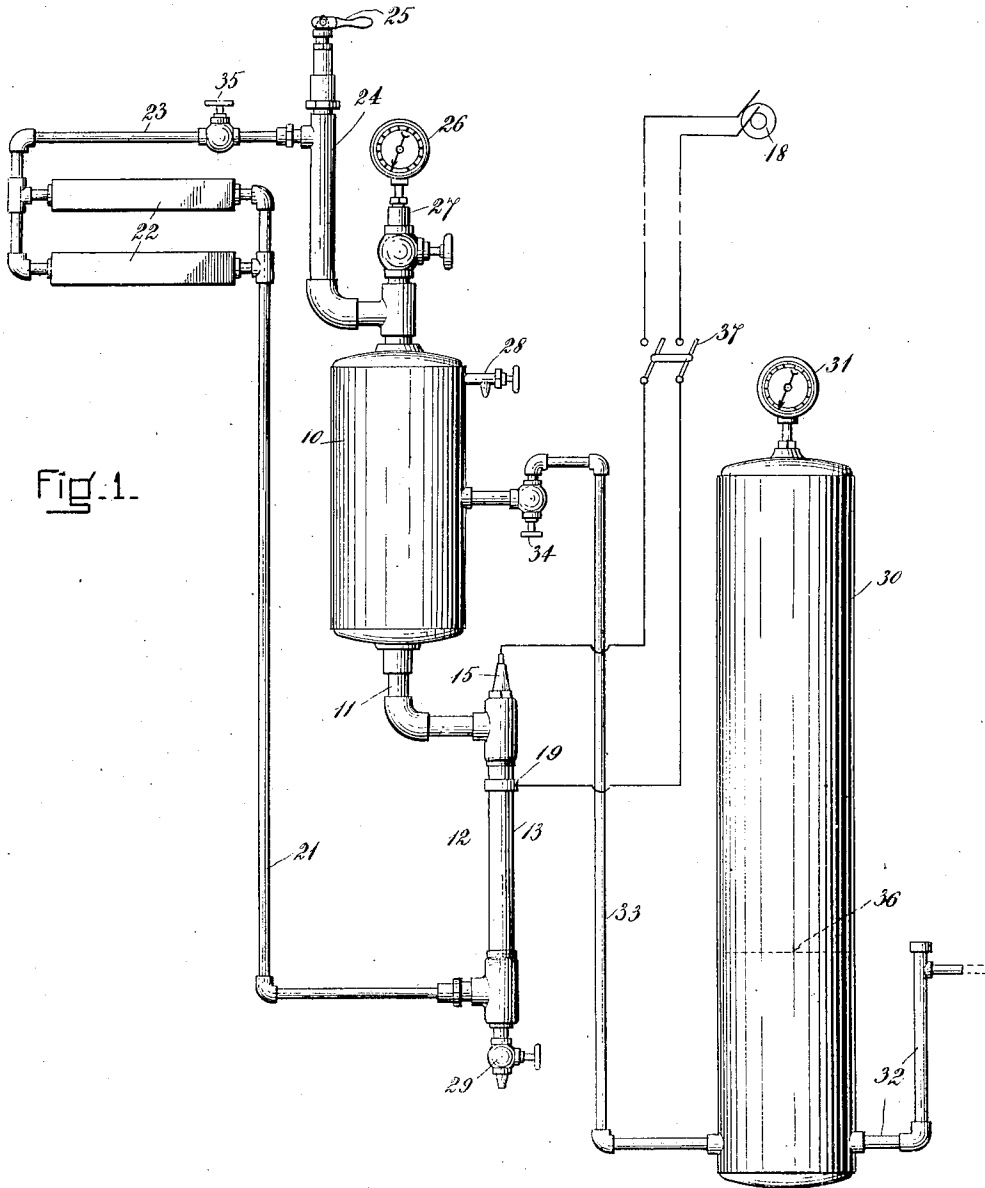


Fig. 1.

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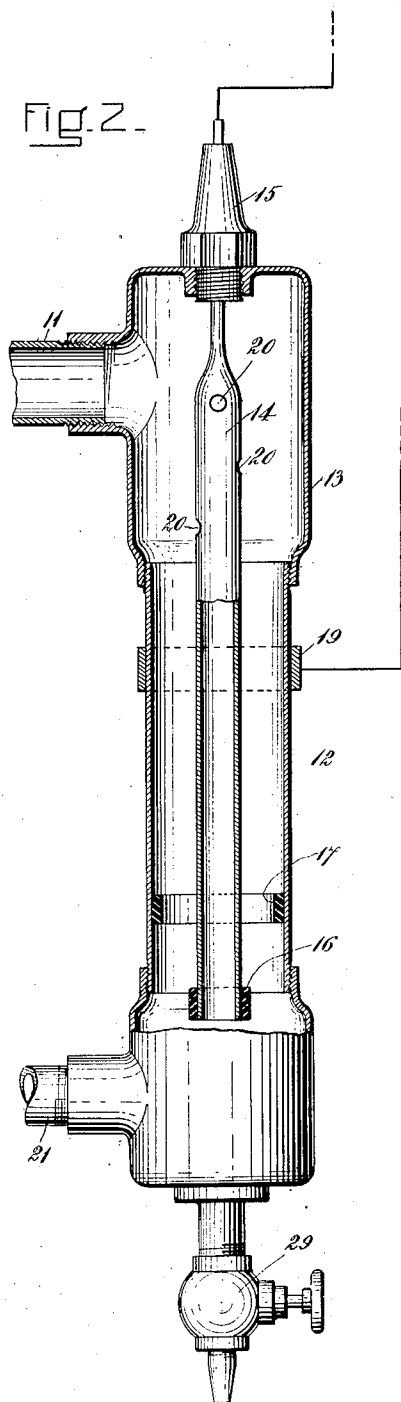
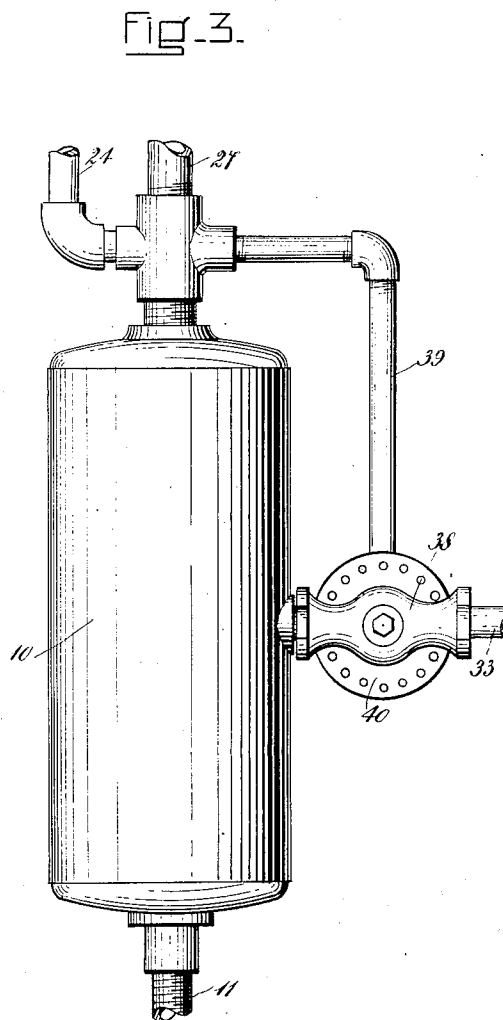
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3 Sheets-Sheet 2



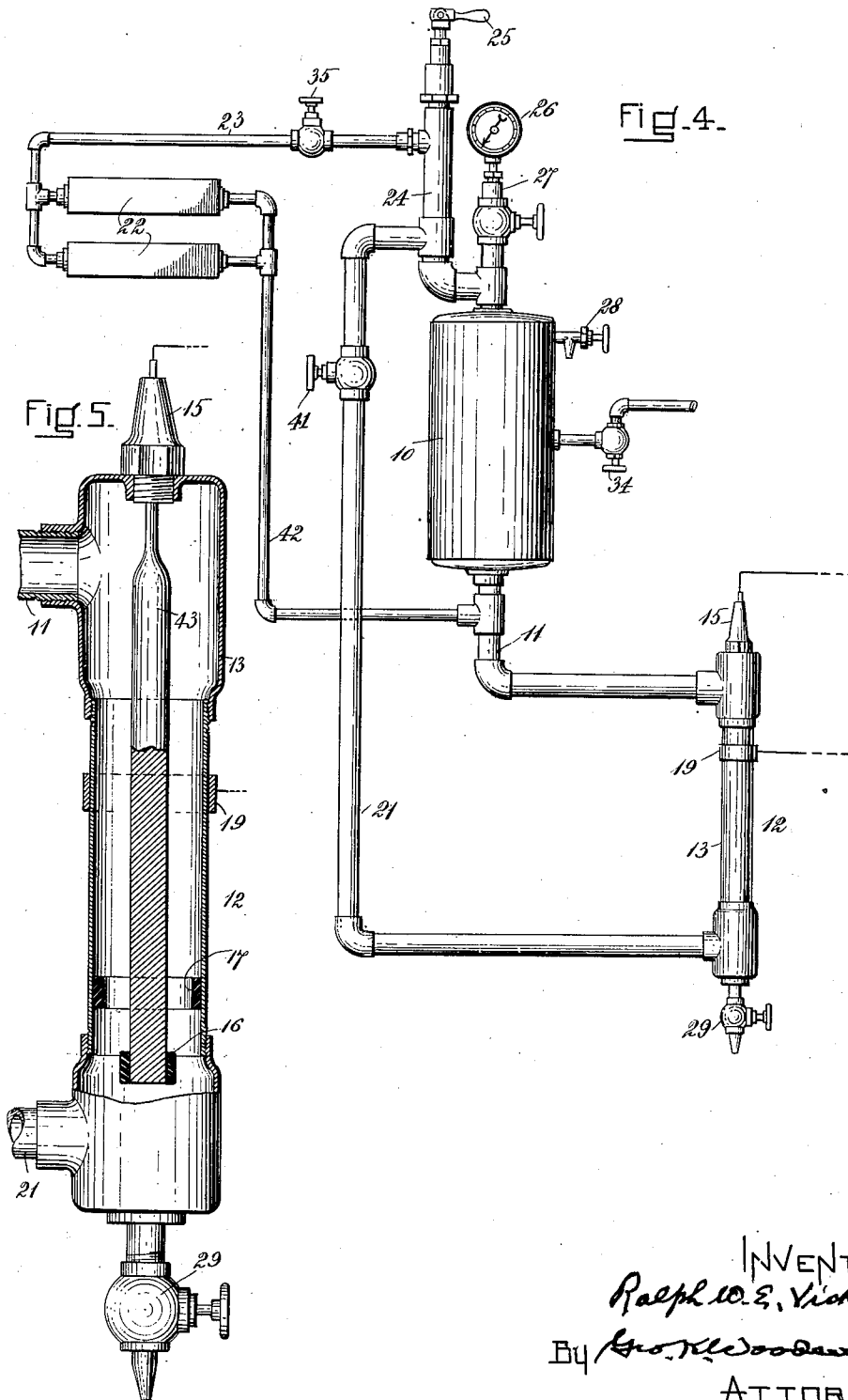
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3 Sheets-Sheet 3



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UNITED STATES PATENT OFFICE

RALPH W. E. VICKERY, OF MARSHFIELD, MASSACHUSETTS

ELECTRIC STEAM GENERATOR

Application filed November 29, 1930. Serial No. 498,945.

My invention relates to electric steam-generators adapted especially for use with steam-jacketed devices, garment-pressing machines, heating systems for houses, and the like, although it is capable of general application for any purpose where steam is required. My invention will be described in connection with a hydraulic press having steam-heated platens for molding bakelite forms.

In systems of this type, which in general comprise two electrodes immersed in water and connected to a source of electric energy, it has been found that upon the closure of the electrode circuit, the gas or steam formed in the vicinity of one or possibly both electrodes, causes a sudden recession of the water therefrom, thereby greatly increasing the resistance of the electrode circuit which is immediately reduced by the ensuing decrease in the temperature of the liquid and the renewal of the contact thereof with the electrodes, whereby there results a violent surging in the electrical system; and such surging continues as long as the electrode circuit is closed. It has been found also that in systems of this general type, it is difficult to maintain the steam generated thereby at a given constant pressure.

The objects of my invention are to overcome the two foregoing limitations to which electrical generators of steam are subject, and otherwise to improve and simplify such systems and increase the efficiency thereof.

According to my invention, the fluid-heating chamber in its preferred form consists of two concentric electrodes, both preferably hollow, the inner electrode being in communication at both ends of the interior of the outer electrode, and there being a clear and unobstructed space between the outer surface of the inner electrode and the inner surface of the outer electrode, so that the fluid circulating through the generator has a clear and unobstructed passageway through both of said electrodes. Said chamber made up of said electrodes is connected at its upper end to the lower end of a vessel constructed and arranged to hold liquid such as a liquid reservoir tank, and at its lower end to the upper

end of said tank through a connection which may be a return pipe in which may be placed the steam-consumption device, so that there will be a fluid circulation through the system from the heating chamber upwardly through said reservoir tank and back through the return pipe to the lower end of said heating chamber. Although, as stated above, the steam-consumption device may be placed in said return pipe, my invention contemplates also the provision of two parallel paths for the circulation of fluid through the system, one of said paths including the reservoir tank and heating chamber and the other the reservoir tank and steam-consumption device, in which case the heating chamber is connected in series with the reservoir tank; that is to say, the lower end of the tank is in communication with the upper end of said chamber and the lower end of the latter is in communication with the upper end of the tank, and the steam-consumption device is connected across the ends of the latter. While preferably the inner electrode is hollow, as above set forth, and by means thereof the surging is reduced to a minimum, nevertheless I may employ a solid inner electrode which by virtue of the fluid circulation through the heating chamber reduces the aforesaid surging to such a degree that it is no longer prohibitive.

My invention contemplates also the use of pressure-controlled means such as a diaphragm-actuated needle valve for governing the flow of replacement liquid to the reservoir whereby the generated steam is maintained at a given constant pressure.

In the drawings which accompany and form a part of this specification—

Figure 1 is an elevation, more or less conventional, showing an electric steam-generator embodying my invention, and applied to a bakelite-molding, hydraulic press having steam-heated platens;

Fig. 2 is a vertical section on a larger scale of the fluid-heating chamber;

Fig. 3 is a fragmentary view illustrating the application to my system of an automatic pressure-controlled needle-valve for govern-

ing the flow of replacement liquid to the reservoir tank;

Fig. 4 is an elevation of a further modification;

Fig. 5 is a vertical section of a modified form of the fluid-heating chamber.

In the particular drawings selected for more fully disclosing the principle of my invention, which is shown in the present instance, by way of example, as applied to a press for molding bakelite but is not, of course, limited thereto, 10 is a vessel constructed and arranged to hold liquid, shown herein as a liquid reservoir tank having its lower end in communication, as shown by the piping 11, with the upper end of the fluid-heating chamber 12 which consists in the present instance of the outer tubular electrode 13 and the inner tubular electrode 14 disposed within and insulated from the same, said heating chamber being shown herein as disposed below said tank. The electrode 14 is secured to and depends from the insulating plug 15 and carries at its lower end an insulating collar 16, while the outer electrode is provided near its lower end with an insulating ring 17 to ensure against possible short circuit. Current is applied to the electrodes by the alternating-current generator 18, ordinary house-light system, or other suitable source, by conductors connected to the inner electrode through the plug 15, and to the outer electrode by the metallic ring 19, suitably secured to the outer surface of the electrode 13.

The inner electrode is arranged to be in communication at both ends with the interior of the outer electrode, and in the present instance this is accomplished by providing the upper end thereof with one or more holes 20 near the upper end thereof and by leaving the lower end open. There must be a clear and unobstructed space between the outer surface of the inner electrode and the inner surface of the outer electrode so that the fluid circulating through the system will have a clear and unobstructed passage through both of said electrodes.

In Fig. 1 the lower end of the heating chamber is in communication, as shown, by the piping 21 with the outlet of the steam-consumption device shown herein as the steam-heated platens of a hydraulic press 22 for molding bakelite, and the inlet of said steam-consumption device is in communication as shown by the piping 23 with the reservoir tank by way of the tubular extension 24, the upper end of which may be provided with a safety-valve 25. It will be noted that in the arrangement shown in Fig. 1 there is a vessel 10 constructed and arranged to hold liquid and having its lower end in communication with the upper end of the chamber 12 which is constructed and arranged to heat

liquid electrically, and that the lower end of said heating chamber is in communication by way of the steam-consumption devices 22, if the same are used, with the upper end of said vessel. The tank 10 may be provided with a steam-gauge 26 screwed into the upright pipe 27 which is directly connected to the top of said tank. An air relief valve or pet-cock 28 is screwed into the tank near the upper end thereof and the heating chamber preferably is provided with a drip-cock 29.

The means preferred by me for supplying liquid to the reservoir tank consists, as shown, of the water tank 30 which may be provided with a pressure gauge 31 and which is in communication by the piping 32 entering the same near the lower end thereof, with a source of compressed air (not shown). An outlet pipe 33 is connected between the lower end of the water tank and the reservoir tank 10, such pipe being shown in the present instance as entering the tank 10 about midway between the ends thereof, and as having a valve 34.

It is desirable to provide a regulating valve for controlling fluid flow through the generator, and in the present instance, such regulating valve 35 is shown connected between the inlet of the steam-consumption device and the tubular extension 24, it being understood, however, that said regulating valve may be located at any convenient point in the system.

The operation is as follows, having regard specifically to the requirements of the bakelite-molding, hydraulic-press: Suitable air-pressure is created in the water tank 30, the level of the water in which is indicated by the dotted line 36, and the pet-cock 28, water valve 34 and regulating valve 35, are opened, whereupon water from the tank 30 is forced into the reservoir tank 10. As soon as said tank is filled, as shown by the flow of water from the petcock, the latter is closed and the water valve kept open until the gauge 26 registers between 12 and 15 pounds, which is the proper pressure in this particular case at which to start the generator in operation for producing steam having a pressure of from 140 to 145 pounds. The water valve is then closed and the switch 37 thrown to complete the circuit between the electrodes and the water in the heating chamber. As the water is heated and steam is generated, there is a fluid circulation through the system from the heating chamber upwardly through the tank 10, extension 24, thence through the several platens 22 of the hydraulic-press, and then back to the heating chamber through the return pipe 21.

If the pressure, as shown by the gauge 26, should arise above 145 pounds (in the case of bakelite molds), or in general, should exceed that desired for the particular purpose for which the steam is to be employed, the

petcock or relief valve 28 may be opened and the pressure reduced to the desired value. I have found in practice that the steam pressure may be regulated also by the valve 35 which controls the fluid flow through the generator, the pressure being reduced when said valve is partly closed, and also that it may be reduced by opening the drip-cock 29 and diminishing the amount of water in the system. It will be understood of course that the maximum steam pressure obtainable depends, among other things, upon the initial pressure to which the water in the tank 10 is subjected prior to the closing of the electric circuit. Usually this maximum pressure cannot be exceeded for the reason, probably, that as the density of the liquid in the reservoir tank and heating chamber is diminished due to steam condensation therein, the electrical resistance of such liquid increases and the energy consumption is diminished, by virtue of which the steam pressure is maintained substantially constant, if there is no loss of liquid due to leakage. I have found in practice that after the maximum pressure has been attained, such pressure remains constant, and that the electrical energy also remains constant so long as the radiation does not vary. If the radiation varies, the energy consumption varies accordingly.

The fluid which I prefer to employ is water made slightly alkaline by bicarbonate of soda, although I do not wish to be limited thereto, as various other fluids and alkaline substances can be used.

In the course of operation there will sometimes be a slight loss of water due to leakage and the like, and such loss will result in a reduction of steam pressure, notwithstanding that the heating chamber is filled at all times and the entire surface of both electrodes fully in contact with the liquid in the heating chamber. In such case the valve 34 may be opened and sufficient water forced into the tank 10 to compensate for such loss, whereupon the original pressure will be regained.

In order to maintain the generated steam at a substantially constant given pressure, I may employ, in place of the hand-operated valve 34, an automatic pressure-controlled device for governing the supply of liquid to the reservoir tank, thereby compensating for the loss of water by leakage or other causes and maintaining the supply of water practically constant, this resulting in a substantially constant steam pressure. In the present instance, the automatic pressure-controlled means consists of a diaphragm-actuated needle-valve 38 of any suitable construction placed in the pipe 33 leading from the water tank 30 to the reservoir tank 10, the diaphragm chamber of such valve being connected to the reservoir tank by way of the by-pass 39, and the diaphragm 40 adjusted

by known means to seat said needle valve when the pressure within the tank 10 reaches a given value. As the volume of water in the system is reduced the steam pressure is lowered, as has already been pointed out, and when such pressure becomes less than said given value, the diaphragm 40 unseats the needle valve whereupon additional water enters the tank 10, and the steam pressure restored to the desired value, such increase in steam pressure resulting in the re-seating of the needle valve. It has been found in practice, however, that the automatic pressure-controlled means may be eliminated and the steam pressure maintained constant by connecting the reservoir tank directly to a source of liquid under constant pressure, as for example, the city water mains and leaving the valve 34 open. When the tank is so connected to such source of water under constant pressure, the maximum steam pressure attainable has been found to be equal to the pressure of the water.

It has been found in practice that in that form of my invention shown in Fig. 1, the generation of said steam to the required pressure is somewhat retarded by the initial condensation caused by the passage of the steam over the large and relatively cool surfaces of the steam-consumption devices 22, and that the desired pressure can be obtained more expeditiously by employing the arrangement shown in Fig. 4 in which the pipe 21, provided with the fluid-flow regulating valve 41 is connected directly to the top of the reservoir tank by way of the tubular extension 24. In such case the outlet of the steam-consumption devices is connected by the pipe 42 to the lower end of the reservoir tank. It will be noted that in Fig. 1 the reservoir tank, heating chamber and steam-consumption devices are connected in series, while in Fig. 4 there are two parallel paths for the circulation of fluid through the system, viz, the reservoir tank and heating chamber and the reservoir tank and steam-consumption devices but in both cases the lower end of said tank is connected to the upper end of the heating chamber and the lower end of said heating chamber to the upper end of said tank. While I prefer to employ a heating chamber of the form shown in Fig. 2 consisting of two concentric tubular electrodes with a clear and unobstructed space therebetween, the inner tubular electrode being in communication at both ends with the interior of the outer tubular electrode, because thereby electrical surging is reduced to a minimum, it is nevertheless possible to substitute for the hollow inner electrode, a solid conducting body such as the rod 43 disposed within and insulated from the outer tubular electrode 13, said solid electrode depending from the insulating plug 15 and connected to the source through said

plug in the same manner as above described in connection with the hollow electrode 14. When said solid electrode is employed there is a certain amount of electrical surging, but it is not violent or prohibitive. It should be understood, however, that such solid electrode may be used effectively and efficiently only with a system involving the principle of my invention, the salient feature of which resides in so arranging matters that there is a flow of fluid through the system upwardly from the heating chamber to and through the reservoir tank and then back by a suitable connection such as the return pipe 21, to the lower end of the heating chamber. It is my belief that electrical surging is minimized (in the case of the heating chamber shown in Fig. 2), or reduced to a practicable limit (by the heating chamber shown in Fig. 5) because such liquid flow through the system maintains the electrodes at an even temperature.

I have already adverted to the facts that the steam pressure may be reduced by partially closing regulating valve 35 in Fig. 1, or 41 in Fig. 4, and also by diminishing the amount of water in the system by opening the drip-cock 39; and as above stated, I have found that the reduction of the water content of the system, due to leakage and the like, results in a reduction of steam pressure. Under each of these conditions, the heating chamber is at all times filled, for a slight closure of the regulating valves 35 or 41, or the opening of the drip-cock for a short period, will not, of course, drain the reservoir tank 10, or reduce the amount of water in the heating chamber. It will therefore be seen that in my invention, the heat intensity is not determined by the height of the column of water in the heating chamber, as is the case with various prior art devices, for at all times the height of such column of water is constant, and the heat intensity, together with the resulting steam pressure, is determined solely by other factors.

Having thus described illustrative embodiments of my invention, without however limiting the same thereto, what I claim and desire to secure by Letters Patent is:

1. An electric steam-generator comprising in combination a liquid reservoir tank, a tubular electrode, a connection from the lower end of said reservoir to the upper end of said tubular electrode, an electrode disposed within and insulated from said tubular electrode, a connection from the lower end of said tubular electrode to the upper end of said reservoir tank whereby there is a fluid circulation from said tubular electrode upwardly through said reservoir tank and back to the lower end of said tubular electrode, means for supplying liquid to said reservoir tank, and a source of electrical

energy electrically connected to said electrodes.

2. An electric steam-generator comprising in combination a liquid reservoir tank, a tubular electrode, a connection from the lower end of said reservoir to the upper end of said tubular electrode, an electrode disposed within and insulated from said tubular electrode, a connection from the lower end of said tubular electrode to the upper end of said reservoir tank whereby there is a fluid circulation from said tubular electrode upwardly through said reservoir tank and back to the lower end of said tubular electrode, means for supplying liquid to said reservoir tank, a regulating valve for controlling fluid flow through said reservoir tank and tubular electrode, and a source of electrical energy electrically connected to said electrodes.

3. An electric steam-generator comprising in combination a liquid reservoir tank, a tubular electrode, a connection from the lower end of said reservoir to the upper end of said tubular electrode, an electrode disposed within and insulated from said tubular electrode, a connection from the lower end of said tubular electrode to the upper end of said reservoir tank whereby there is a fluid circulation from said tubular electrode upwardly through said reservoir tank and back to the lower end of said tubular electrode, means for supplying liquid to said reservoir tank, automatic pressure-controlled means for governing the supply of liquid to said reservoir tank, and a source of electrical energy electrically connected to said electrodes.

4. An electric steam-generator comprising in combination a liquid reservoir tank, a tubular electrode, a connection from the lower end of said reservoir to the upper end of said tubular electrode, an electrode disposed within and insulated from said tubular electrode, a steam-consumption device, a connection from the lower end of said tubular electrode to said steam-consumption device, a connection from said steam-consumption device to the upper end of said reservoir tank whereby there is a fluid circulation from said tubular electrode upwardly through said reservoir tank and back to the lower end of said tubular electrode, and a source of electrical energy electrically connected to said electrodes.

5. An electric steam-generator comprising in combination a liquid reservoir tank, an outer tubular electrode, a connection from the lower end of said reservoir to the upper end of said outer tubular electrode, an inner tubular electrode disposed within and insulated from said outer tubular electrode, said inner tubular electrode being in communication at both ends with the interior of said outer tubular electrode, a connection

from the lower end of said outer tubular electrode to the upper end of said reservoir tank, means for supplying liquid to said reservoir tank, and a source of electrical energy electrically connected to said tubular electrodes.

6. An electric steam-generator comprising in combination a liquid reservoir tank, a liquid heating chamber, connections from the upper end of said heating chamber to the lower end of said reservoir tank and from the upper end of said reservoir tank to the lower end of said heating chamber whereby there is a fluid circulation from said heating chamber upwardly through said reservoir tank and back to the lower end of said heating chamber and a steam-consumption device connected across the ends of said reservoir tank, whereby there are provided two parallel paths for the circulation of fluid through the system, one by way of said reservoir tank and heating chamber and the other by way of said reservoir tank and steam-consumption device.

7. In an electric steam-generator, a fluid-heating chamber consisting of an outer tubular electrode having fluid inlet and outlet openings at the ends thereof, an inner tubular electrode disposed within and spaced apart from said outer tubular electrode, said inner tubular electrode being in communication at both ends with the interior of said outer tubular electrode and there being a clear and unobstructed space between the outer surface of said inner electrode and the inner surface of said outer electrode whereby the fluid circulating through said generator has a clear and unobstructed passageway through both of said electrodes, and means insulating said electrodes from each other.

8. In an electric steam-generator, a fluid-heating chamber consisting of a tubular electrode having fluid inlet and outlet openings at the ends thereof, and an electrode disposed within and insulated from said tubular electrode, in combination with a liquid reservoir tank and connections from the upper end of said heating chamber to the lower end of said reservoir tank and from the upper end of said reservoir tank to the lower end of said heating chamber, whereby there is a fluid circulation from said heating chamber upwardly through said reservoir tank and back to the lower end of said heating chamber.

9. An electric steam generator comprising in combination a vessel constructed and arranged to hold liquid, a tubular electrode, the lower end of said vessel being in communication with the upper end of said tubular electrode, an electrode disposed within and insulated from said tubular electrode, the lower end of said tubular electrode being in communication with the upper end of said vessel whereby there is a fluid circulation

from said tubular electrode upwardly through said vessel and back to the lower end of said tubular electrode, and terminals for said electrodes, respectively, arranged for connection to a source of electrical energy.

10. An electric steam generator comprising in combination a vessel constructed and arranged to hold liquid, a tubular electrode, the lower end of said vessel being in communication with the upper end of said tubular electrode, an electrode disposed within and insulated from said tubular electrode, the lower end of said tubular electrode being in communication with the upper end of said vessel whereby there is a fluid circulation from said tubular electrode upwardly through said vessel and back to the lower end of said tubular electrode, means for supplying liquid to said vessel, and terminals for said electrodes, respectively, arranged to be connected to a source of electrical energy.

11. An electric steam generator comprising in combination a vessel constructed and arranged to hold liquid, a liquid-supply source, a tubular electrode, the lower end of said vessel being in communication with the upper end of said tubular electrode, an electrode disposed within and insulated from said tubular electrode, the lower end of said tubular electrode being in communication with the upper end of said vessel whereby there is a fluid circulation from said tubular electrode upwardly through said vessel and back to the lower end of said tubular electrode, and said vessel being in communication with said liquid-supply source, and terminals for said electrodes, respectively, arranged for connection to a source of electrical energy.

12. An electric steam generator comprising in combination a liquid reservoir tank, a heating chamber constructed and arranged to heat a liquid electrically, and connections from the upper end of said heating chamber to the lower end of said reservoir tank and from the upper end of said reservoir tank to the lower end of said heating chamber, whereby there is a fluid circulation from said heating chamber upwardly through said reservoir tank and back to the lower end of said heating chamber.

13. An electric steam generator comprising in combination a vessel constructed and arranged to hold liquid, a liquid heating chamber constructed and arranged to heat a liquid electrically, the lower end of said vessel being in communication with the upper end of said heating chamber and the lower end of the latter in communication with the upper end of said vessel whereby there is a fluid circulation from said heating chamber upwardly through said vessel and back to the lower end of said heating chamber, and a source of electrical energy operatively associated with said heating chamber.

14. An electric steam generator compris-

ing in combination a vessel constructed and arranged to hold liquid, a liquid heating chamber constructed and arranged to heat a liquid electrically, the lower end of said vessel being in communication with the upper end of said heating chamber and the lower end of the latter in communication with the upper end of said vessel whereby there is a fluid circulation from said heating chamber upwardly through said vessel and back to the lower end of said heating chamber, means for supplying liquid to said vessel, and a source of electrical energy operatively associated with said heating chamber.

15 15. An electric steam generator comprising in combination a vessel constructed and arranged to hold liquid, a liquid supply source, a liquid heating chamber constructed and arranged to heat a liquid electrically, the lower end of said vessel being in communication with the upper end of said heating chamber and the lower end of the latter being in communication with the upper end of said vessel whereby there is a fluid circulation from said heating chamber upwardly through said vessel and back to the lower end of said heating chamber, and said vessel being in communication with said liquid supply source, and a source of electrical energy operatively associated with said heating chamber.

In testimony whereof, I have hereunto subscribed my name this 28th day of November, 1930.

RALPH W. E. VICKERY.