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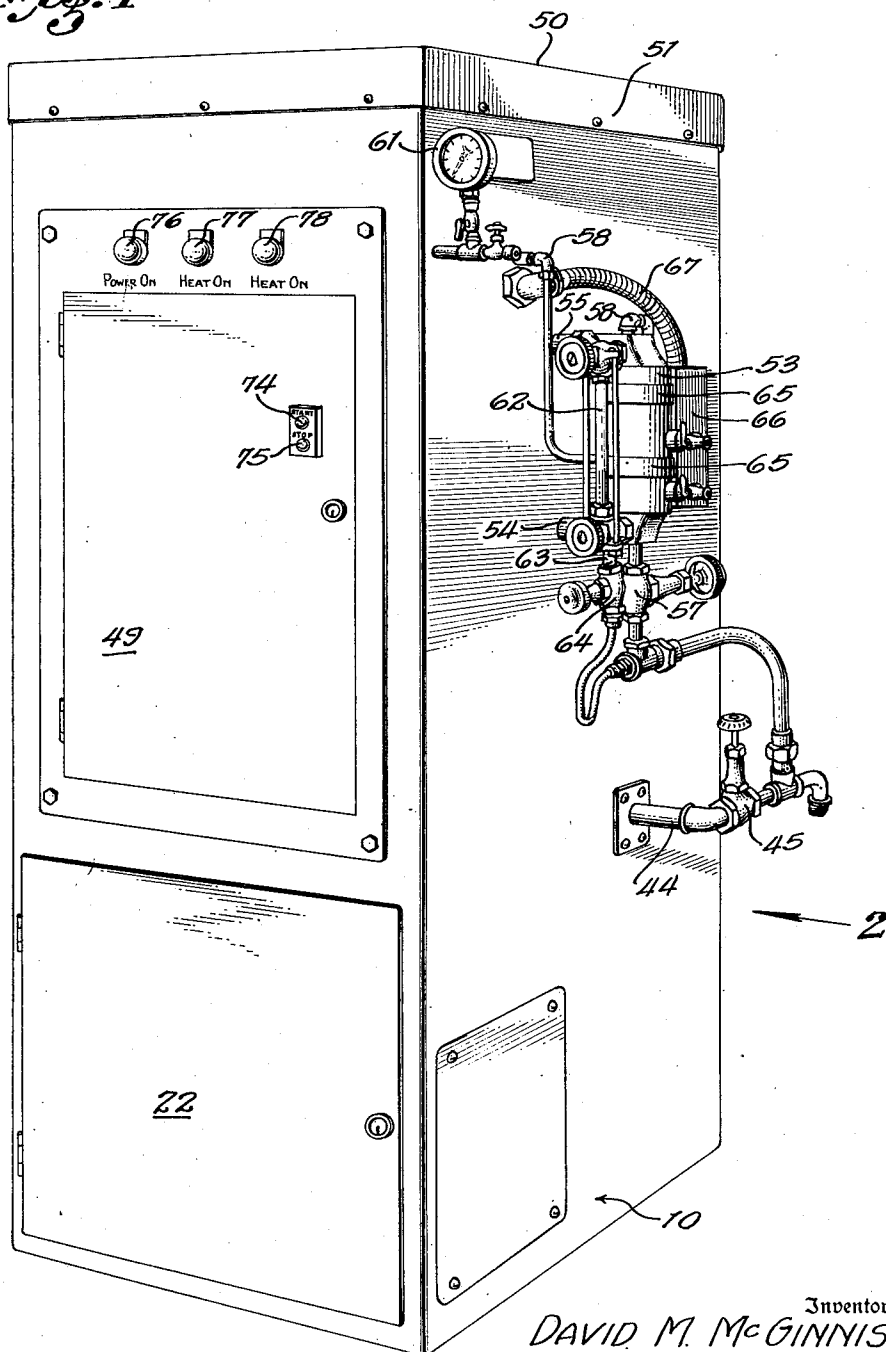
D. M. McGINNIS  
ELECTRIC WATER HEATER

2,623,153

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5 Sheets-Sheet 1

*Fig. 1*



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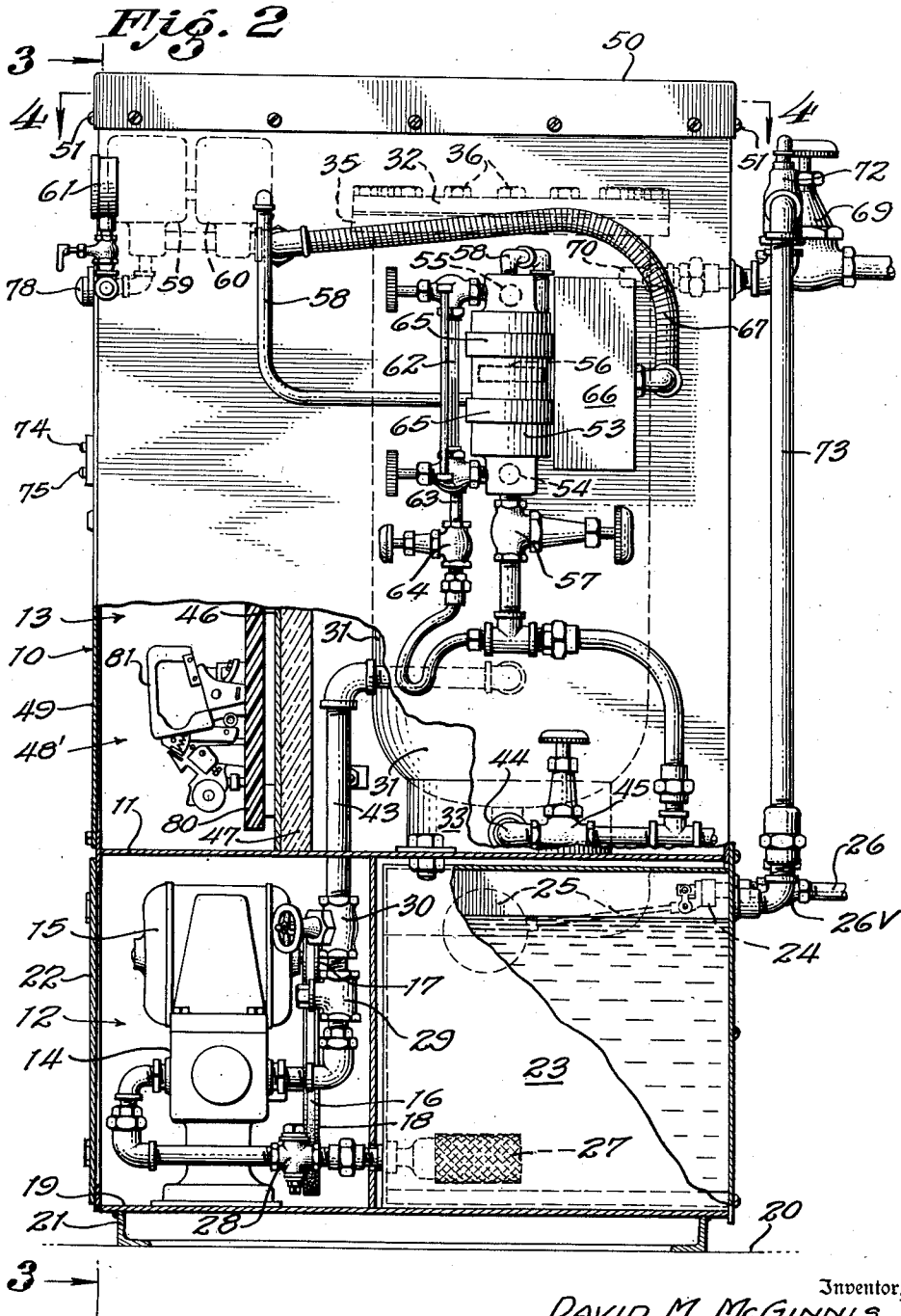
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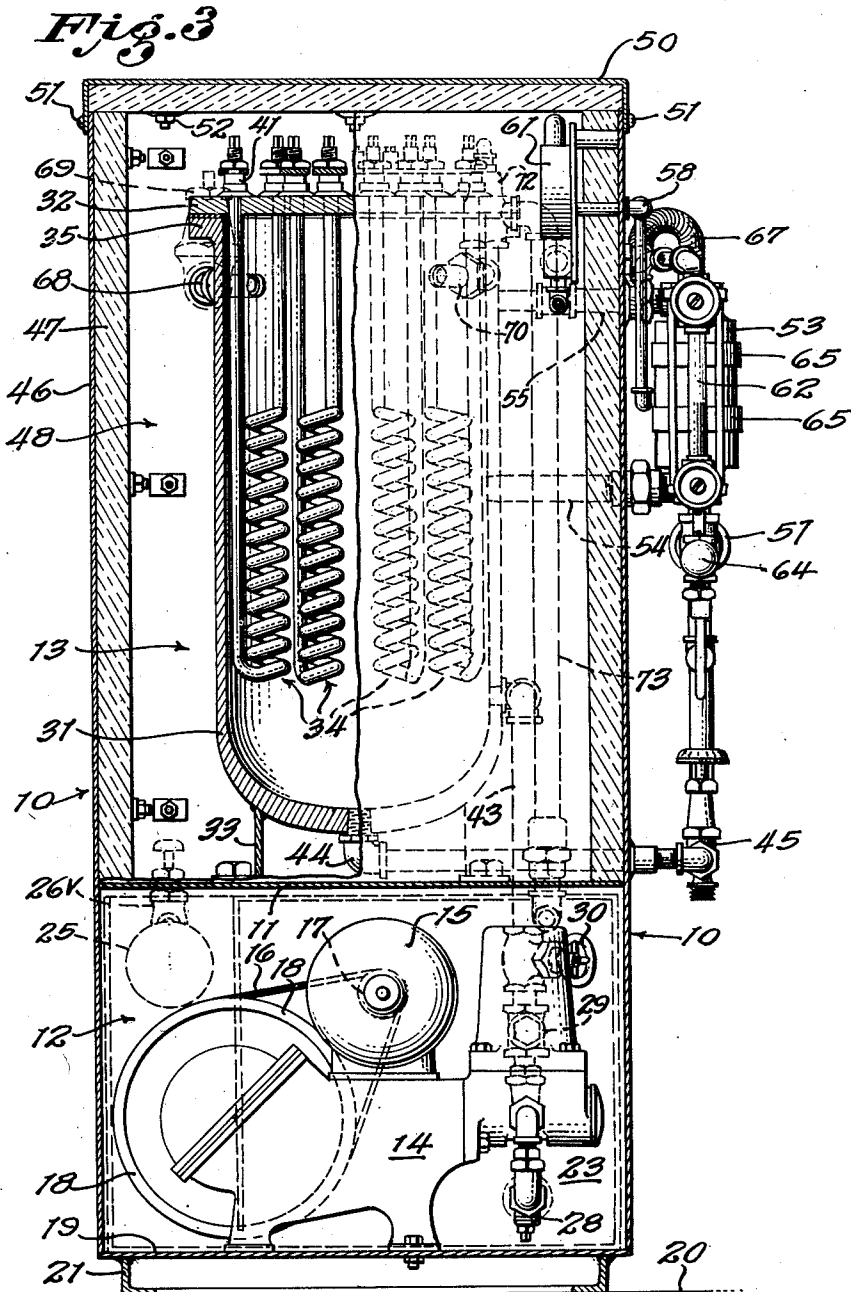
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5 Sheets-Sheet 3



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5 Sheets-Sheet 4

Fig. 4

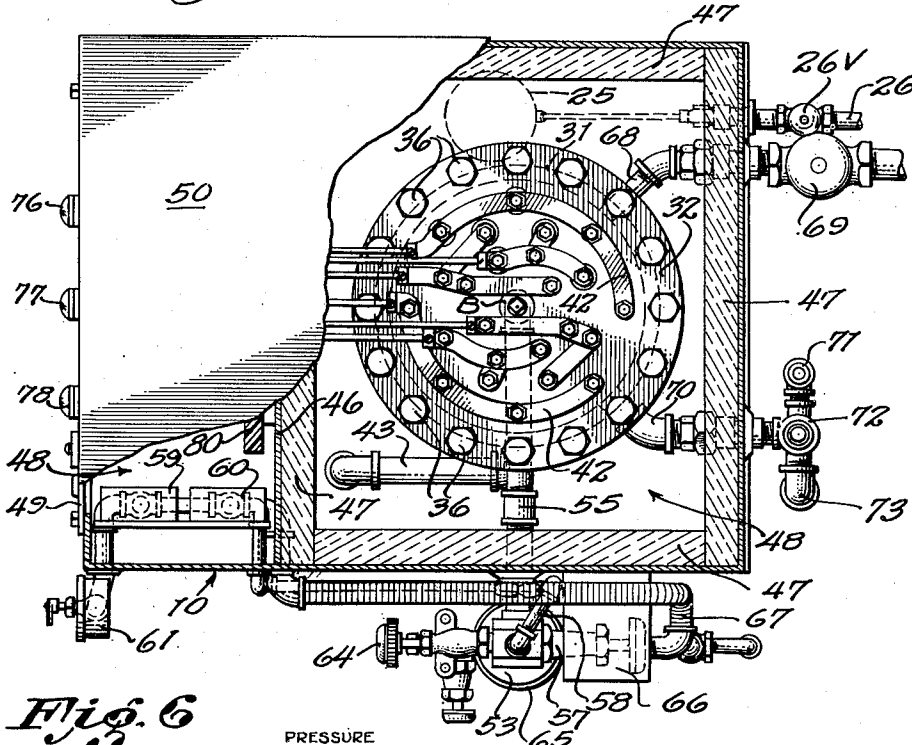
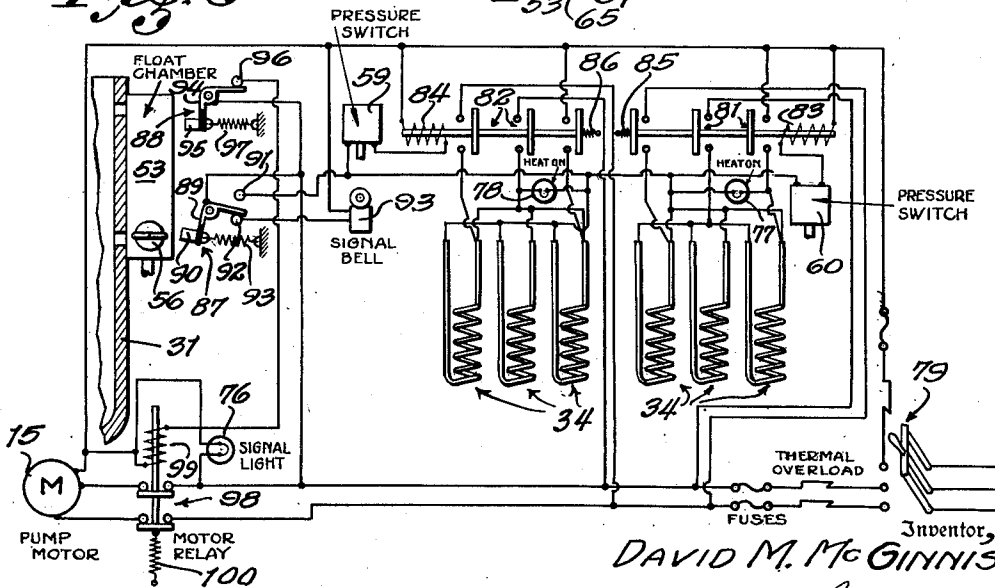


Fig. 6



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238

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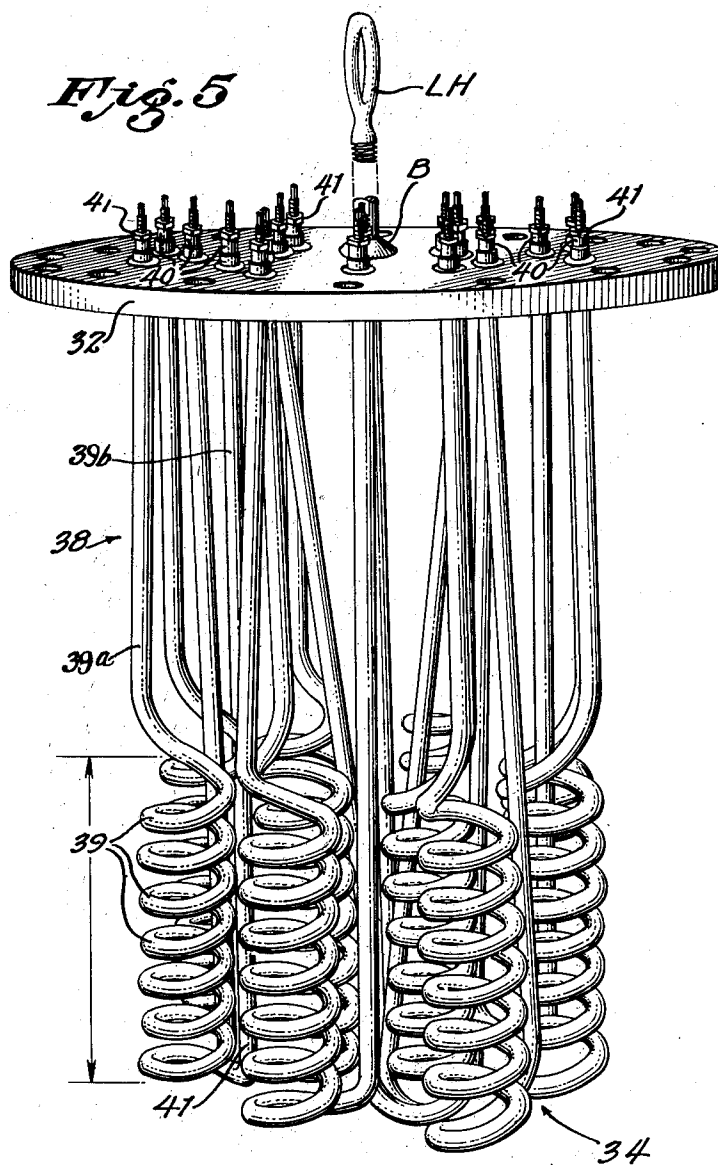
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5 Sheets-Sheet 5



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## UNITED STATES PATENT OFFICE

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## ELECTRIC WATER HEATER

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4 Claims. (Cl. 219—38)

1

This invention relates to apparatus for electrically heating fluids and particularly to electrically heated steam generators.

A great number of industries utilize steam generators of various types for purposes other than the generation of power, for instance, in the garment industries, cleaning and dyeing plants, in the dairy industry, in bottling plants, rubber and plastics molding, in hospitals and laboratories, laundries, and for heating and air conditioning in hotels, restaurants and business buildings.

The personnel making use of steam generators in industries, such as mentioned, are generally untrained mechanically, and it is, therefore, very desirable to provide steam generators so designed that they will operate automatically with little more manipulation than pushing "start" and "stop" push buttons.

While electrically heated steam generators have been provided previously because of their advantages in some respects, such as the absence of flame and consequent danger of explosion and of water tubes with their need of periodical cleaning and other advantageous features, they have not come into wide use to the best of my knowledge because of various disadvantages.

Electrically heated steam generators at present in use are often of complicated, bulky and inefficient design, in part due to want of proper understanding and faulty application of correct principles. Such previous installations were consequently expensive both in first cost and in maintenance and required the frequent attention of skilled personnel. Such installations were also generally slow in generating steam both in starting and recovering loss of pressure.

It is an object of this invention to provide a compact electrically heated steam generator so arranged that steam at the generally required pressure of 100 lbs. per square inch, for instance, is generated from cold water in less than five minutes, and loss of pressure due to average use is made up in a matter of seconds.

It is a further object of the invention to provide a complete electrically heated steam generating plant arranged in a single casing so that it may be set up for use merely by connecting water and power lines to the casing.

Another object of the invention is to provide a complete electrical steam generator plant in a single compact casing which may be shipped assembled, wired and ready for use, yet which is so arranged that all component parts may be readily inspected or serviced.

A still further object of my invention is to pro-

2

vide an electrically heated steam generator fitted with controls providing an automatically operated plant requiring no other manipulation than the operation of simple "start" and "stop" control means.

Another object of my invention is to provide heating elements for an electric steam generating plant, said elements being so constructed and arranged that exceptionally fast steam generation is provided both in raising steam and recovering steam pressure lost due to use of the steam.

A further object of my invention is to provide a steam generator in which the boiler shell is arranged in a heat insulated compartment and is surrounded by a dead air space, the boiler being uninsulated whereby it may be inspected by removing the top of the compartment.

Still further objects and features of the invention will appear from the following description read with reference to the accompanying drawings, which illustrate one embodiment of the invention, at present considered preferable by me.

In the drawings:

Figure 1 is a perspective view of the electrically heated steam generator of my invention in completely assembled condition;

Figure 2 is a side elevation looking in the direction of the arrow 2 in Figure 1, but with part of the exterior casing of the steam generator broken away and showing some interior parts in section and others unsectioned.

Figure 3 is a vertical cross-section on the line 3—3 of Figure 2;

Figure 4 is a horizontal cross-section on the line 4—4 of Figure 2;

Figure 5 is an enlarged detail view of the heating elements mounted on a common base plate disassembled from the heater; and

Figure 6 is a schematic diagram showing the electrical circuit for the electrically operated components of the steam generator.

In the drawings, the numeral 10 indicates the outer casing of the steam generator which is divided by a partition 11, as clearly shown in Figure 3, into a smaller lower compartment 12, and a larger upper compartment 13.

In the lower compartment, a piston-type water pump 14 is positioned. The pump is driven by electric motor 15 and a belt 16 mounted on the motor belt pulley 17 and pump belt pulley 18. The pump and motor form an assembly mounted on the base panel 19, which is supported above the floor 20 on a frame 21 of any suitable construction.

The front of the lower compartment is fitted

with a large door 22 (Figure 1) enabling ready access to be had to the pump which is fitted in the front portion of the lower compartment. A water storage tank 23 is fitted in the rear portion of the lower compartment. Boiler feed water is admitted to the tank and maintained at a constant level therein by a valve 24 operated by a float and lever 25 which controls the inlet of water from water supply pipe 26, through feed valve 26V.

Water from the tank is drawn by the pump through a strainer 27 in the tank and a shutoff cock 28 between the tank and the pump, which permits the pump to be removed for any reason without requiring the tank to be emptied.

The pump discharge is controlled by a check valve 29 and a stop valve 30 as required by steam boiler regulations.

The boiler is formed as a shell 31 serving as a combined water and steam chamber U-shaped in cross-section, the top of the boiler shell being closed by a removably mounted flat plate 32. The rounded bottom of the shell is supported on a cylindrical supporting flange 33 bolted to the horizontal partition 11 and welded around the bottom portion of the shell. The heating elements indicated generally at 34 (Figure 3) are supported as a unit from plate 32 which is secured to an outturned flange 35 around the top of the boiler shell by cap screws 36.

Each of the heating units, of which there are an outer circle of eight and an inner circle of four, consists of an elongated element having an outer sheath of metal, such as a copper tube, within which the heating filament is contained, such as a helically wound length of nichrome insulated from the copper tube by any suitable means. The heating element is used in the immersed portion of the heating unit, the remainder of the length of the unit being inactive for heating but containing the lead in wires for the heating element.

A typical heating element 38 as shown in Figure 5 comprises the active portion 39 coiled into a helix, and straight inactive portions 39a and 39b connecting the helical active portion with plate 32 from which the lead wire is insulated by insulating sleeves 40, and held in place by a nut 41 engaging the binding posts secured within and insulated from the copper sheath but connected to the lead in wire of the heating element. Bus bars 42 connect one end of each unit to another line of the power supply. The heating units are arranged in two groups of six, each group being switched into and out of circuit as a unit. Automatically controlled operating means for the heating units will be later described. The heating elements are arranged in three phase delta connection.

For convenience in lifting out the plate 32 with the heating elements attached thereto, I provide a central boss B provided with a threaded hole into which the lifting hook LH shown in Figure 5 may be screwed, and I may insert a corrosion rod to reduce electrolytic corrosion fitted with a threaded sleeve into the hole, if desirable, removing the rod, of course, before fitting the hook in place. If a corrosion rod is not positioned in the hole in boss B during the operation of the generator, the hole is closed by a removable threaded plug.

Water from the pump 14 enters the boiler shell through supply pipe 43. A pipe 44 is connected to the bottom of the boiler shell and is fitted with a blow-down valve 45, enabling the

boiler to be cleared of sediment accumulating in the bottom.

It will be noted from Figure 3 that the heating units 34 are suspended well above the bottom of the boiler shell out of the area of sediment deposit.

The boiler shell is mounted within a compartment 46 lined with slabs of insulating material 47, a dead air space 48, being provided between the surface of the insulation and the outer surface of the boiler shell, which is effective in reducing corrosion of the latter.

A relatively narrow compartment 48' is provided between the front wall of the boiler compartment and the front wall of the casing 10 and a number of electrical controls are mounted therein. The front wall of the casing is provided with a door 49 giving access to the controls in compartment 48'.

The top of the casing 10 is formed as a cap or cover 50 held in position by sheet metal screws 51, the slabs of insulation applied to the cover, over the boiler compartment, being secured thereto by fastening means 52. By removing screws 51, the cover may be lifted off exposing the boiler shell for inspection and the heating units for removal. It will be noted that when plate 32 closing the boiler shell is removed, the interior of the latter may be inspected.

Various control devices are mounted on the right-hand side of the casing 10, as seen in Figure 3, and are shown in Figure 2. Further control devices are mounted on the back of the casing and are indicated in Figure 4. It will be obvious that I may arrange some or all of such devices within the casing of the generator if desired.

The devices mounted on the right-hand side of the casing comprise a vertical vessel 53 (Figures 2 and 3) connected by a pipe 54 to the lower level at which water is maintained in the boiler shell during normal functioning of the steam generator and by a pipe 55 with the boiler shell at the upper limit of the water level therein. Vessel 53 therefore contains a column of water, the surface of which is at the same level as the water in the boiler, between the predetermined upper and lower limits. The material of which vessel 53 is made is non-magnetic, as for instance, brass. Within the vessel, a float 56 made of magnetic material is arranged which freely rises and falls with the level of the liquid in the vessel. A pipe fitted with blow-down valve 57 is connected to the bottom of vessel 53 and enables it to be cleaned out from time to time.

A pipe 58 is connected to the top of vessel 53 and transmits the pressure in the boiler to pressure operated electrical switches 59, 60 (Figure 2) arranged in control compartment 48', the function of which will be later described, and to a pressure gauge 61.

A water level gauge 62 is connected across the top and bottom of vessel 53 and is provided with a blow-down tube 63 connected through gauge blow-down valve 64 with the blow-down pipe from vessel 53 beyond its blow-down valve 57. Secured to the vessel 53 by straps 65 is a switch box 66 in which are mounted a low water level switch and a high water level switch which switches are of similar construction and are operated automatically by the position of float 56 as will be described when later explaining the electrical controls of the steam generator. Electrical wiring between switch box 66 and the electrical com-

5

ponents mounted in the control compartment is carried within electrical conduit 67.

Steam is led from the steam space in the upper portion of the boiler shell through pipe 68 and steam valve 69 mounted at the back of the steam generator casing (Figures 2 and 4).

A pipe 70 connected to the steam space of the boiler shell also projects through the back of the generator casing and is fitted with a thermostatic vacuum and air release valve 71, which closes at a predetermined temperature but is open at lower temperatures and admits air to the boiler shell thus preventing lower than atmospheric pressures from being set up in the boiler shell when the generator is not in operation.

Pipe 70 is also fitted with a safety valve 72 to relieve steam pressures in the boiler shell in excess of a predetermined value. Any steam passing into valves 71 and 72 is returned by pipe 73 in which the steam condenses to the water storage tank 23.

The electrical control elements and the control circuits are shown diagrammatically in Figure 6 and comprise a "start" button 74 and "stop" button 75 mounted on the door 49 of the control compartment, a red light 76 which is lit when electrical power is switched on, and two amber colored lights 77 and 78 which are lit when the heating units are energized; these lights being mounted in a row on the front of the steam generator casing above door 49. The "start" and "stop" buttons are connected by flexible leads (not shown) to operate a multipole main (pole-main) switch. The push buttons and multipole (pole-main) switch are represented by the manually operated switch 79 shown in Figure 6. Electrical control elements in addition to the pressure operated switches 59, 60 arranged in the control compartment 48, comprise elements mounted on a control panel 80 secured to the front of the boiler shell compartment. The elements include contactors 81, 82 effective to make and break the circuits of the two groups of heating units generally indicated by numeral 34. The contactors are operated by solenoids 83, 84, operating when energized to put the contactors in circuit against the resistance of springs 85, 86. The leads of the solenoids pass through the pressure operated switches 59 and 60 which are effective to interrupt the solenoid circuits when a predetermined steam pressure has been attained in the steam space of the boiler.

The leads of the contactors after passing through the pressure operated switches are connected to the terminals of low water level and high water level switches 87 and 88, respectively, which are housed in switch box 66. The construction of both switches is similar, the low water level switch comprising a pivoted bell crank 89, carrying a permanent magnet 90 on one arm and having its other arm operating as a movable contact arm between contact 91 to which the leads from the pressure responsive switches are connected, and a contact 92 connected to a signal bell 93, the vibrator coil of which is connected to a power line of the circuit. The bell crank 89 is connected to the return line of the three wire system shown. A tension spring 93 normally holds lever 89 against contact 91.

The high water level switch 88 comprises a pivoted bell crank lever 94 carrying a permanent magnet 95 on one arm and having its other arm arranged to make and break contact with a contact 96. A tension spring 97 normally holds the arm engaged with contact 96. The bell crank

6

lever 94 is connected to the return lead of the three wire circuit. Bell crank levers 89 and 94 are rocked about their pivots by the magnetic attraction of their permanent magnets when float 56 is closely adjacent the magnets.

While I have described a specific form of magnetic high and low water level control switch, it is to be understood that other suitable forms of limit switches may be utilized.

The circuit of the motor 15 is controlled by a switch 98 closed by a solenoid 99 when energized by a lead from a power lead of the circuit, the solenoid being connected to the terminal 96 of the high water level switch. A tension spring 100 acts to open the switch when the solenoid 99 is not energized.

Signal lights 77 and 78 are placed across the leads to the heating elements, which in the described embodiment are arranged in two groups, and signal light 76 is placed across the leads of the pump 15.

It will be assumed that the boiler shell 31 has previously been drained of water for cleaning purposes and that it is desired to again generate steam, and that the water supply or inlet valve 26V is open.

Push button 74 is depressed, closing main switch 79, signal bell 93 will start ringing since the float 56 is aligned with the low water level switch 89, which will hold the circuit for the contactors open, but the pump will start delivering water to the boiler since the circuit for solenoid 99 is established through the high water level switch 88. The level of the water will rise rapidly in the boiler and therefore also in the water column in vessel 53, raising float 56 so that switch 87 assumes a position due to the action of spring 93 breaking the bell circuit and completing the solenoid circuits, through contact 91, of the contactors 81 and 82, which thereupon close sending current through the heating units 34. The water level continues to rise in the boiler, air above the water being displaced through thermostatic valve 71 and water rises in the water column in vessel 53 until float 56 becomes aligned with high water level switch 88, causing it to interrupt the circuit of the solenoid 99 holding the pump switch 98 closed and thereby enables spring 100 to open the switch which causes stoppage of the pump motor. The heating elements continue to raise the temperature of the water until the temperature of the water vapor and air in the steam space of the boiler rises to value sufficient to cause the thermostatic vent valve 71 to close, after which steam is rapidly generated to the predetermined pressure which operates the pressure responsive switches 59 and 60 to interrupt the circuits of the solenoids holding the contactors closed. The current to the heating elements is thereby cut off and steam generation suspended momentarily until the pressure falls the few pounds required to enable the pressure responsive switches to again close and complete the heating circuit through elements 34. Because of the delicate and quick acting arrangement described, a loss of ten pounds in pressure is made up in about six seconds. The very fast steaming characteristic of my steam generation is due to the very large heating surface brought into contact with the small columns of water flowing upwardly with the turns of the helically wound heater elements.

It is pointed out that the heating elements are constructed to provide long inactive lengths with a low watt density, and active lengths of high watt density, and I have discovered that, by sub-

merging the high watt density portion of the heating elements covered by a sheath of suitable material, such as copper, in the water in the boiler, and leading the low watt density portion of the heating element through the steam or vapor space, I can provide a steam generator of simple and compact arrangement since a greater heating surface may be provided in a smaller boiler than has hitherto been possible.

The push button 75 when operated will stop the operation of the steam generator by opening the main switch 79, thus cutting off current to the heating elements and to the pump, leaving whatever water is in the boiler to cool down. As the pressure and temperature in the boiler shell falls, the thermo-responsive vacuum release valve 71 will open, admitting air to the boiler and preventing a pressure below atmospheric from being set up therein.

While I have described and illustrated a preferred embodiment of my invention, it is to be understood that various changes and modifications may be made therein by those skilled in the art without departing from the scope of the invention as defined by the appended claims.

I claim:

1. An electrically operated steam generator assembly comprising: a vertically mounted boiler shell; electrical heater elements suspended vertically within said boiler shell; a water tank mounted at a lower level than said boiler; an electrically operated pump delivering water from said tank into the boiler; a vessel of nonmagnetic material connected to the water space of the boiler and containing a column of water at the same level as the water in said space; a float of magnetic material within said vessel; a low water level switch and a high water level switch spaced vertically therefrom, each of said switches being mounted closely adjacent said vessel and having a pivoted arm; a magnet mounted on each switch arm, the switches being operated by the magnetic attraction between said float and magnets when the water level brings the float into position adjacent one or the other of said magnets; contacts operated by said high water level switch when actuated break the circuit to said electrically operated pump and contacts operated by the low water level switch, when actuated to break the circuit

to the heater elements; said switches being normally held in closed position, and a control panel carrying electrical control means governing the operation of the steam generator.

2. An electrically operated steam generator, as set forth in claim 1, and in addition comprising a warning signal operated by the low water level switch when actuated by the float to interrupt the circuit of the heating elements.

3. In an electrically heated steam generator, a chamber member provided with a removable top plate, the said chamber member adapted to have water maintained at a certain level therein and a steam portion included between the top plate and the water level, electrical heating units within said chamber member, said electrical heating units in each instance comprising two substantially parallel straight conducting portions suspended from the top plate and a helically coiled portion, ends of which connect with said straight portions, the axis of said helically coiled portion being substantially parallel to the straight conducting portions, said straight conducting portions and the helically coiled portion at the zone within the chamber member containing water having an active portion of high watt density and the straight portions in said steam portion of the chamber member being of low watt density.

4. The device as set forth in claim 3 characterized in that: the chamber member is of small water capacity.

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#### REFERENCES CITED

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

#### UNITED STATES PATENTS

| Number    | Name          | Date          |
|-----------|---------------|---------------|
| 1,456,863 | Blong         | May 29, 1923  |
| 1,682,448 | Vaughan       | Aug. 28, 1928 |
| 1,775,122 | Emerson       | Sept. 9, 1930 |
| 1,781,057 | Elmwall       | Nov. 11, 1930 |
| 1,866,221 | Pennington    | July 5, 1932  |
| 1,965,218 | Carr          | July 3, 1934  |
| 2,096,912 | Dillman       | Nov. 9, 1937  |
| 2,133,838 | Abbott        | Oct. 18, 1938 |
| 2,244,131 | Van Norstrand | June 3, 1941  |