Nov. 22, 1960 F. J. RIKER 2,961,525

ELECTRODE REGULATED STEAM GENERATOR

Filed Aug. 6, 1958

2 Sheets-Sheet 1

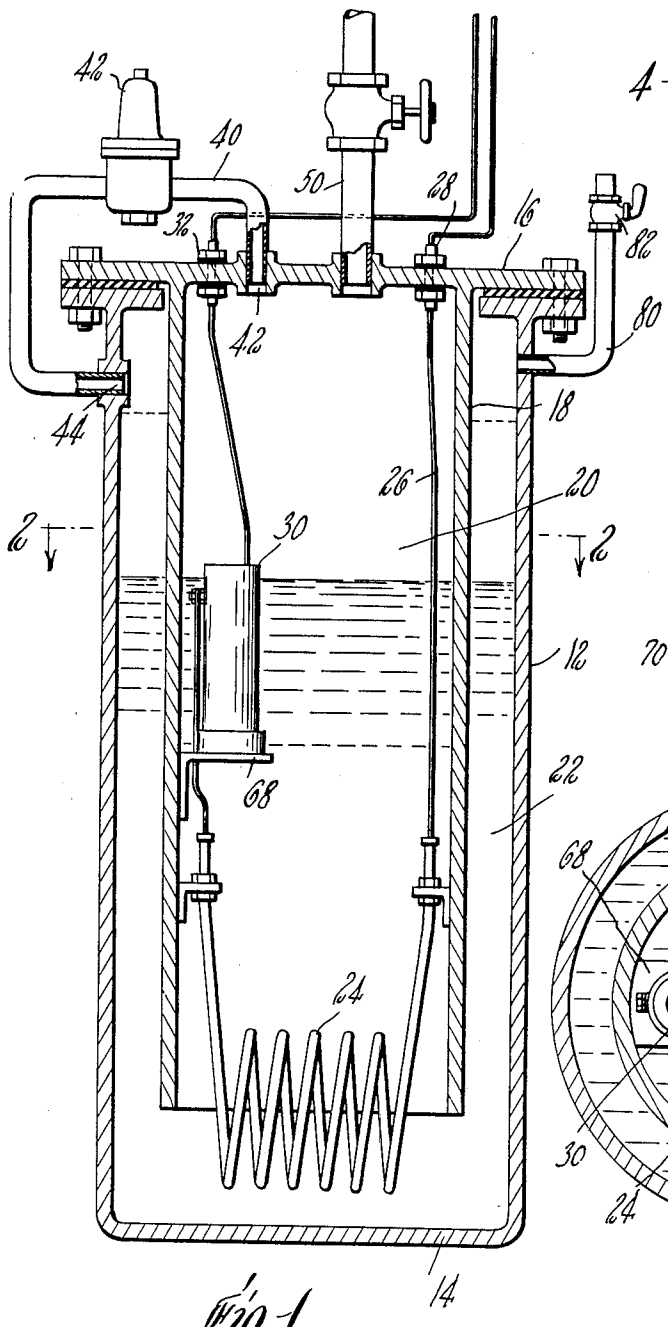


Fig. 1.

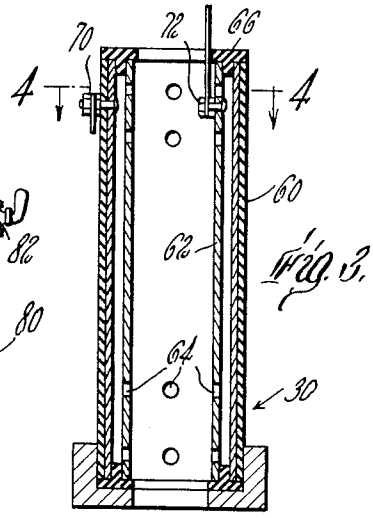


Fig. 3.

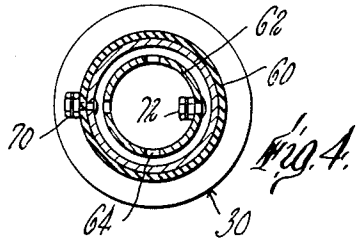


Fig. 4.

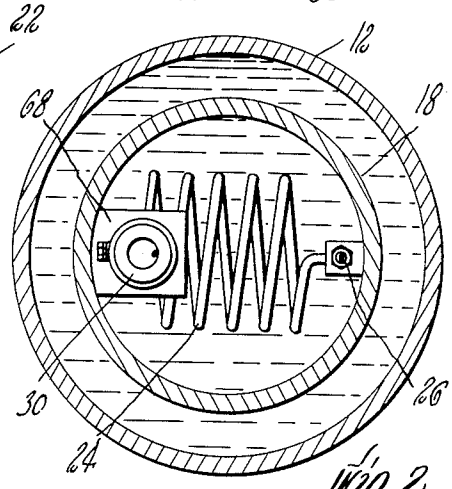


Fig. 2.

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2 Sheets-Sheet 2

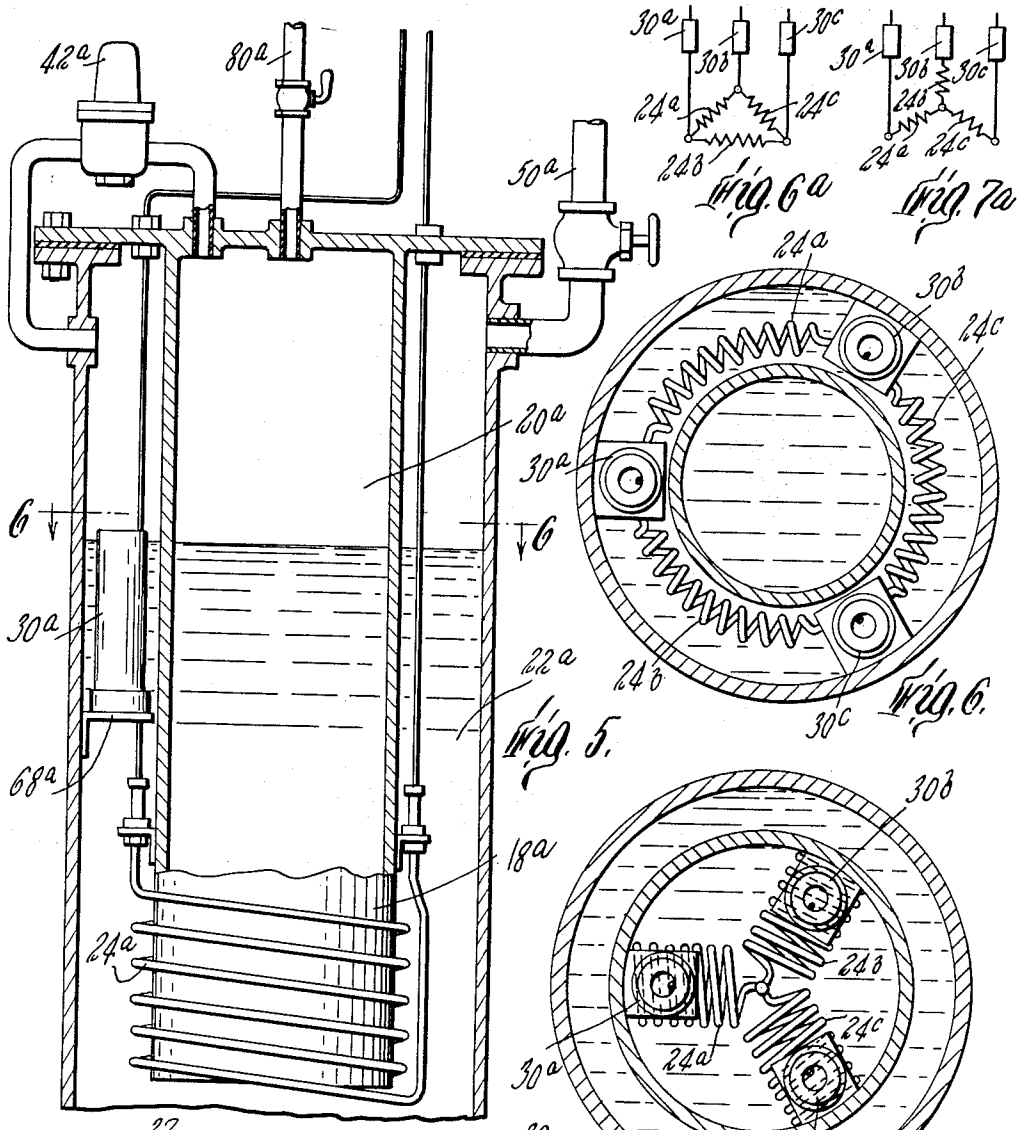


Fig. 5.

Fig. 6.

Fig. 6a

Fig. 7a

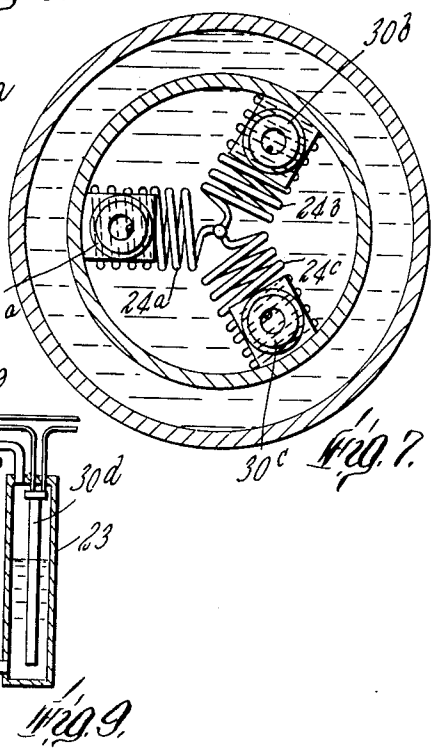


Fig. 7.

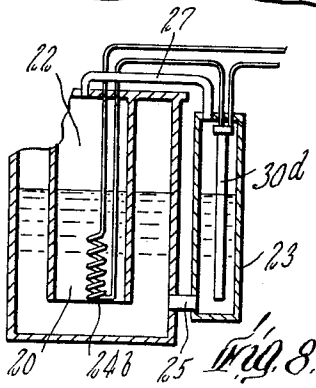


Fig. 8.

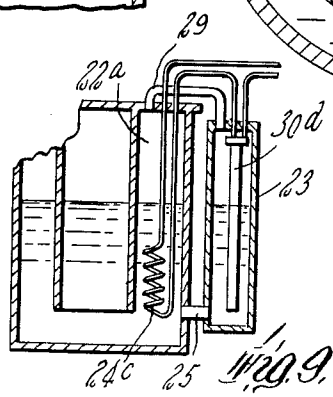


Fig. 9.

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ELECTRODE REGULATED STEAM GENERATOR

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2 Claims. (Cl. 219—38)

This invention relates to electric boilers and more particularly to a novel control for boilers which have as a primary source of heating energy a resistance coil immersed in the liquid to be heated.

The device of this invention provides a highly-inexpensive and very neat and precise control for automatically modulating the electric current input in accordance with a desired output from the boiler. The control is adapted for use with either high or low pressure steam generators.

A further object of the invention is to provide a regulating control for the current input to the resistance heating coil which also acts to break the circuit to the resistance heating coil whenever the liquid in the boiler falls below a predetermined level. The control thus provides a "safety shutoff" to preclude any possibility of burning out the resistance coil due to the liquid level falling to a point where the coil is no longer completely immersed in the liquid to be heated.

Further advantages of the invention will be found in the following description of a typical boiler embodying the invention, as shown in the accompanying drawings wherein:

Fig. 1 is an elevational view partly in cross-section of a boiler in accordance with the invention;

Fig. 2 is a horizontal cross-sectional view taken along the line 2—2 of Fig. 1;

Fig. 3 is an enlarged detail cross-sectional view of the regulating control of the invention;

Fig. 4 is a cross-sectional view taken along the line 4—4 of Fig. 3;

Fig. 5 is an elevational view partly in cross-section showing a modified form of boiler;

Fig. 6 is a horizontal cross-sectional view of an arrangement for three-phase operation in a boiler of the type shown in Fig. 5;

Fig. 6*a* is a circuit diagram of the device of Fig. 6;

Fig. 7 is a horizontal cross-sectional view of an arrangement for three-phase operation in a boiler of the type shown in Fig. 1;

Fig. 7*a* is a circuit diagram of the device of Fig. 7; and

Figs. 8 and 9 are respectively, modifications, on a reduced scale of the devices of Figs. 1 and 5, respectively to provide a third chamber for the electrode control.

The boiler includes casing elements providing an external cylindrical wall 12 and bottom wall 14 together with a cover member 16 which has a depending cylindrical casing 18 which extends downwardly into the outer casing and has an opening in the bottom to provide communication between the inner chamber 20 defined by the cylindrical wall 18 and the outer annular chamber 22 disposed between the inner cylindrical casing wall 18 and the outer casing wall 12.

The chamber 20 is the main boiler or generating chamber while the outer chamber 22 is an auxiliary regulating chamber.

A resistance heating coil, for example, a Calrod unit 24 is located near the bottom of the boiler. The right-hand end of the coil 24 is connected by a lead 26 to a terminal 28, connected in turn to one side of a power source.

The other end of the coil is connected through a regulating device 30 to another terminal 32 connected to the other side of the power source. As shown, suitable insulators are provided to insulate the leads from the casing elements.

The boiler is provided with a pressure-regulating device, as known in the art of immersed electrode steam generators, including a pipe line 40 extending from the top of the generating chamber 20 having an aperture 42 and the auxiliary chamber 22 having an aperture 44 for this purpose.

Interposed in the line 40 is a pressure-regulating valve 42 which is normally open but is set to close upon, in the case of a steam generator, the pressure in the line 40 on the main chamber 20 side reaching a predetermined set pressure.

Pipe 50 is the output pipe from the boiler leading to the load.

By reason of the existence of the pressure-regulating valve 42, as the resistance coil 24 heats the liquid, water, for example, the pressure at the top of the main chamber 20 will build up subject to the load demand. If that pressure rises to the value for which the pressure-regulating valve 42 is set, that valve will close with the result that any further build-up of pressure in the chamber 20 will result in pushing down the level of the water in the chamber 20 with a corresponding rise in the level of the water in the auxiliary regulating chamber 22 until the pressure in the top of the chamber 20 drops to a level at which the pressure-regulating valve 42 again opens to permit a return of the water to the generating chamber 20 and equalization of the levels of water in both chambers.

In practice, the pressure-regulating valve 42 will tend to throttle, and with constant load, the levels in the two chambers become relatively fixed.

Such a device, of course, requires, for efficient operation, an additional control to regulate the energy input to that required by the load demand.

According to this invention, such a control is provided by the device 30 which comprises a pair of cylindrical electrodes partially immersed in the liquid to be heated.

As shown in Fig. 3, the device 30 comprises an external cylindrical electrode 60 and an internal cylindrical electrode 62 which is tubular in form so that it is open at the bottom and the top and which has apertures 64 permitting flow of the liquid in the boiler into the annular space between the concentric electrodes 60 and 62.

The two electrodes are insulated from one another by spacers 66 and the whole device 30 is held in position by a bracket 68 affixed to the inner side of the casing element 18 or is suspended from the top or cover of the boiler.

As shown in Figs. 3 and 4, these two electrodes 60 and 62 are connected in series with the resistance coil 24 through the terminal 70 on the outer electrode 60 and the terminal 72 on the inner electrode 62.

As shown in Fig. 1, the device 30 is so mounted with respect to the normal level of the liquid in the boiler that the surfaces of both electrodes 60 and 62 are substantially entirely covered by the liquid at the start of the operation.

Because of the close spacing of the electrodes, and large areas of immersion, the intervening conductive water provides little resistance and a large current input goes to the heating coil 24. If, however, the heating energy supplied by the resistance coil 24 exceeds the de-

mand, the pressure in the top of the chamber 20 will start to build up, regulator valve 42 will close, with the result that the level of liquid will begin to fall in the generating chamber 20, thus reducing those areas of the electrodes 60 and 62 which are immersed in the liquid and increasing the resistance in the internal circuit of the device 30, thereby cutting down the current input to the coil 24 until such time as the pressure-regulating valve 42 again opens to permit the level of the liquid in the chamber 20 to return and thereby again reduce the resistance provided by the device 30.

It will also be seen that the circuit to the coil 24 is always open whenever there is insufficient liquid in the chamber 20 to immerse at least some portions of the electrodes 60 and 62 in the liquid and thereby provide a conductive circuit through the liquid. Accordingly, the heating coil can never be operated under conditions of too little liquid being present and the danger of burning out the coil 24 on this account is thus completely precluded.

80 indicates a vent for the auxiliary chamber 22 having a vent valve 82 which may be opened to permit the escape of air but not of steam or water. A thermostatically actuated valve may be substituted for the manually operated valve shown. Such a vent valve is conventional in immersed electrode-type boilers.

Fig. 5 shows a modification wherein the inner chamber 20*a* operates as the regulating chamber and the outer chamber 22*a* is the main boiler or generating chamber. Accordingly the regulating device 30*a* is now affixed on a bracket 68*a* or is suspended in the outer annular main chamber and the resistance coil 24*a* in Fig. 5 is positioned around the outside of the dividing casing 18*a*.

The circuit through the regulating valve 42*a* therefore works in the reverse direction and the out-put pipe to the load 50*a* now leads from the outer chamber 22*a* whereas the vent 80*a* leads from the central auxiliary chamber 20*a*.

Figs. 6 and 6*a* show an adaptation for operation utilizing three-phase A.C. power supply. The three resistance coils (which may be single or in multiple) are connected in delta end to end. At each of the three points of connection between the coils one wire is connected through one of three regulating devices to one of the three wires of the three-phase power supply circuit. The regulating devices and connections thereto are generally similar to those shown in Figs. 1, 2, 3 and 4. This arrangement of heating coils, 24*a*, *b* and *c*, regulating devices 30*a*, *b* and *c* and connecting wires to the three-phase power supply is shown schematically in Fig. 6*a* and may be referred to as delta connected.

A similar modified arrangement may also be used for three-phase A.C. power supply with the heating coils and regulating devices located within the inner chamber as shown in Figs. 1 and 2 instead of the outer chamber as shown in Figs. 5 and 6.

Fig. 7 shows another adaptation for operation utilizing three-phase A.C. power supply. The three resistance coils (which may be single or in multiple) are Y connected to each other at the center of the Y. Each of the other ends of the coils is connected through one of three regulating devices to one of the three wires of the three-phase power supply circuit. The regulating devices and connections thereto are generally similar to those shown in Figs. 1, 2, 3 and 4. This arrangement of heating coils, 24*a*, *b* and *c*, regulating devices 30*a*, *b* and *c* and connecting wires to the three-phase power supply is shown schematically in Fig. 7*a* and may be referred to as Y connected. A similar modified arrangement may also be used for three-phase A.C. power supply with the heating coils and regulating devices may be located in the outer chamber as shown in Figs. 5 and 6 instead of within the inner chamber as shown in Figs. 1 and 2.

Fig. 8 shows a modification wherein the inner chamber 20 operates as the main boiler or generating chamber, the outer chamber 22 serves as the regulating chamber as described in reference to Fig. 1, and the regulating device 30*d* is housed in a third chamber 23. This third chamber 23 is connected at the top to the inner chamber 20 through a pipe 27 and at the bottom to the common chamber through a pipe 25. The water level in the chamber 23 will then coincide at all times with the water level in the inner chamber 20 and the regulating device, connected electrically in series with the heating coil 24*b*, will function in the same manner as previously described in reference to Fig. 1. This construction facilitates insulating and isolating the electrodes from other parts of the boiler, if desired, to avoid electric loss to ground and possible electric shock to operators adjusting valves, etc.

In Fig. 9, the generating chamber is disposed as in Fig. 5 with coil 24*c* in the outer chamber 22*a* but the electrode control 30*d* is in a separate casing as in Fig. 8. The connection 29 then runs between the generating chamber 22*a* and the third chamber 23. It will be understood that in Figs. 8 and 9, the regulating valves 42 and 42*a* and other connections 50 as shown in Figs. 1 and 5 have been omitted.

In the case of Figs. 8 and 9, it will be seen that any steam generated by the electrodes 30*d* will be added to the output through the connections 27 or 29 and thus cut down any losses.

Instead of a pressure-regulating valve 42, any other equivalent control may be used in the line 40, for example, an electrically actuated valve operated either by a pressure switch or by a thermostatic control.

The present device has certain advantages over boilers operated solely by immersed electrodes because it is not necessary to precisely regulate the quantity of electrolyte or salts added to the boiler water to render it conductive. In many localities the water contains sufficient natural salts and minerals to insure its electrical conductivity but in other areas the water is so pure as to be non-conductive. In such cases an electrolyte should be added to the water in the boiler to render it conductive. Suitable electrolytes may be sodium carbonate, sodium sulphate, trisodium phosphate, potassium chloride, common table salt and many other chemicals or compounds. The quantity is unimportant except that it be enough to provide conductivity. The electrolyte remains in the boiler until drained out in liquid form because it will not vaporize and pass out with the steam. The operation of the control 30 is not affected by any accumulation of natural salts from ordinary tap water, a condition which requires careful control (in conventional immersed electrode boilers) to avoid building up conductivity with consequent excessive amperage and energy input.

In the device shown in the drawings, it will be found that, if the load is constant, the current input levels off due to the water seeking an operating level which provides just the right amount of resistance in the circuit to the coil 24 to maintain the current input equivalent to just that required to satisfy the load. With varying load, only that input is used during periods of light load, which is required, yet the input is quickly adjusted for operation during periods of heavier load. Efficient operation is thus simply accomplished.

I claim:

1. An electric boiler comprising casing elements providing a main generating chamber for a liquid to be vaporized, an electric resistance heater positioned in said generating chamber for providing the primary heating energy for liquid in said boiler, a regulating chamber, a control system for regulating the level of the liquid in the generating chamber responsive to the pressure in the generating chamber, said level dropping with increasing pressure, with passage of a portion of said liquid from said generating chamber into said regulating chamber and rising again with reversing liquid flow as said pressure drops, and spaced electrode elements connected in series with said resistance heater, at least one of said

elements being disposed for exposure of varying surface areas thereof to said liquid as its level varies in the generating chamber and acting by virtue of the varying resistance of the body of liquid therebetween depending upon the varying degree of immersion of said one electrode, to regulate the current input to said resistance heater, lessening the input as the liquid level falls and increasing the input as the liquid level rises, and to break the circuit to said resistance heater when the liquid level falls to a predetermined minimum level.

2. An electric boiler comprising casing elements providing a main generating chamber for a liquid to be vaporized, a regulating chamber and a control chamber, connections between the generating chamber and the control chamber for maintaining the level of liquid equal in said generating and control chambers, an electrical resistance heater in said generating chamber for providing the primary heating energy for liquid in said boiler, a pressure control system for regulating the level of the liquid in the generating and control chambers responsive to the pressure in the generating chamber, said level dropping with increasing pressure, with passage of a portion of said liquid from said generating and control chambers into said regulating chamber and rising again with reversing liquid flow as said pressure drops, and spaced electrode elements connected in series with said resistance heater and normally immersed in said liquid in said control chamber for exposure of varying surfaces thereof to said liquid as its level varies in the generating chamber and acting by virtue of the varying resistance of the body of liquid therebetween depending on the varying degree of immersion of said electrodes, to regulate the current input to said resistance heater, lessening the input as the liquid level falls and increasing the input as the liquid level rises, and to break the circuit to said resistance heater when the liquid level falls in said generating chamber to a predetermined minimum level.

References Cited in the file of this patent

UNITED STATES PATENTS

1,335,021	Papini	Mar. 30, 1920
1,358,982	Papini	Nov. 16, 1920
1,456,755	Bergeon	May 29, 1923
1,561,243	Keene	Nov. 10, 1925
1,981,765	Weiss	Nov. 20, 1934
2,016,291	Noll	Oct. 8, 1935