Dec. 10, 1929. M. O. SCHUR ET AL 1,738,733

ELECTRIC BOILER

Filed March 4, 1924

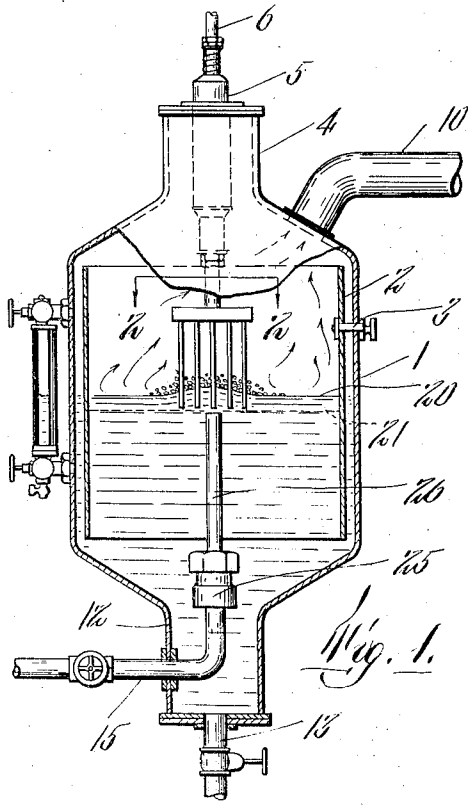


Fig. 1.

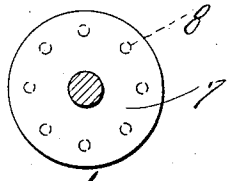


Fig. 2.

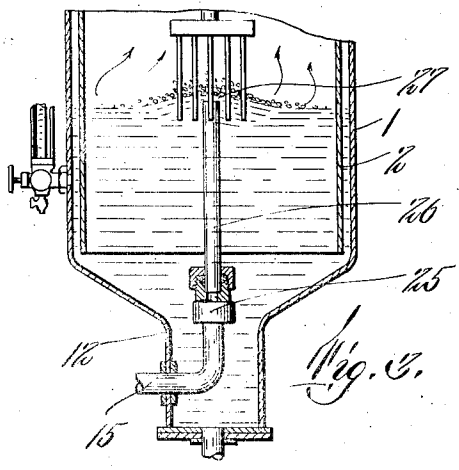


Fig. 3.

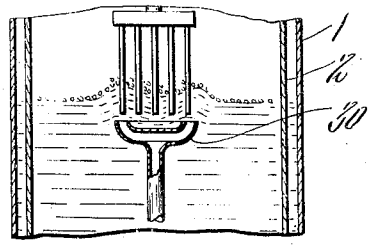


Fig. 4.

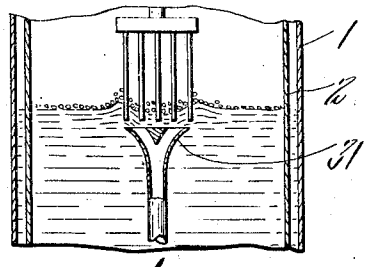


Fig. 5.

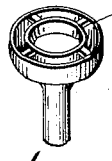


Fig. 6.

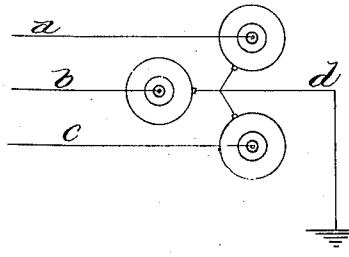


Fig. 7.

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UNITED STATES PATENT OFFICE

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ELECTRIC BOILER

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This invention relates to electric boilers of that type in which the heating effect is caused by the resistance afforded by the water to be vaporized to the passage of alternating current therethrough. Such a boiler comprises in general a steel drum or tank of sufficient strength to withstand the steam pressure desired and equipped with safety valve, gage glass and cocks and other fittings usual for boilers. Electrodes comprising a group of parallel rods are positioned centrally of the drum, the lower ends of the rods extending somewhat below the surface of the water to be vaporized. The current passes between these electrodes and the outer shell of the tank or drum through the water, the electrodes and drum having different electrical potentials impressed thereon. Usually also a metal shell is spaced slightly within the walls of the drum or tank and in electrical contact therewith. The path of a large proportion of the current through the water is roughly a horizontal disk, the thickness of which is that of the depth of immersion of the lower ends of the electrodes in the water. If this disk is of pure water its resistance is relatively high, but if the water contains salts in solution, as in practically all commercial water supplies, the resistance is much decreased. These salts remain behind for the most part when steam is drawn off from the boiler, hence if no means to prevent it is employed the concentration of the salts increases as the boiler is operated, resulting in increasing the conductivity of the current path and thus increasing the power load. For this reason it has been proposed to bleed off the water in the boiler and to supply fresh water in sufficient amount both to supply the steam demand and to compensate for the water bled off so that the level of the water in the boiler may be maintained substantially constant to insure a substantially uniform amount of submergence of the electrodes, and to maintain the resistance of the water sufficiently high. If it be attempted to counteract the increasing conductivity of the water as its saline content becomes greater by decreasing the extent of submergence of the electrodes rather than by removing the more concentrated solution, a condition is soon reached in which the current density adjacent the electrodes becomes so great that violent ebullition takes place with violent and rapid fluctuations in resistance as the steam bubbles form and burst. Destructive arcing may also take place between the electrodes and the water across the steam bubbles which pits and soon destroys the electrodes. The sudden and violent fluctuations in resistance also cause corresponding violent electrical surging in the power transmission lines sufficient to seriously disturb the operation of electrical apparatus feeding power into, or taking power from the lines, and to interfere even if it does not render impossible telephonic communication, especially if the telephone and power lines are closely paralleled for any distance. This violent action also sets up heavy mechanical vibrations which impose additional and serious stresses on the boiler shell and its mounting and causes the boiler to be very noisy in operation.

The difficulty from the concentration of salts in the water becomes of increasing moment as the impressed voltage is increased, heretofore the voltage recommended being not much above 6000. The use of this comparatively low voltage necessitates the employment of step down transformers in case the power is to be derived from high tension transmission lines.

In the usual type of electric boiler such as heretofore described, the feed water supply to take the place of the steam consumed and the concentrated water bled off has uniformly been admitted adjacent to the lower end of the boiler at a considerable distance from the electrodes so that the feed water distributing pipe is out of the zone of greatest activity. It is thus necessary for the fresh water to pass up through the heated water so that it becomes much contaminated therewith and likewise some of the fresh water mixes with and escapes in the bleed water. It is thus necessary to bleed off considerably faster than would be required if the fresh water were supplied directly in the active zone adjacent to the electrodes in order to

render the water in this zone more nearly free from salines.

In order that the fresh water supplied in this manner may reach the active zone contaminated as little as possible, it must be projected with considerable force from the ends of the distributer pipes, regardless of the load on the boiler. Hence if the load is low, comparatively little water being removed in the form of steam, a correspondingly greater amount must be removed as bleed water to maintain a satisfactory submergence of the electrodes, it having been found that a continuous flow of both feed and bleed is necessary for satisfactory continuous functioning of the boiler. The heat removed by the bleed water thus becomes the greatest source of energy loss of the electric boiler and is reclaimable only by using the bleed liquor as feed water for combustion boilers or in economizers. It of course can not be returned to the electric boiler as its saline content is too concentrated. This loss from the bleed water also becomes rapidly greater as the load on the boiler decreases, becoming some times as much as 50% of its entire energy.

The object of this invention therefore is to produce a boiler of this general type capable of operating at high efficiency under varying load conditions with a relatively high voltage so that power may be taken directly from high voltage transmission lines without the necessity of any transformer equipment and in the operation of which noise and vibration are reduced to a marked degree and violent electrical surging in the transmission lines is obviated, and destructive arcing at the electrodes is reduced to a minimum. This is accomplished by conducting the feed water directly into close proximity to the electrodes in a manner which does not interfere with the flow of current between the immersed portions of the electrodes and the boiler shell.

For a more complete understanding of this invention reference may be had to the accompanying drawings in which

Figure 1 is a central vertical section through an electric boiler of the general type of this invention.

Figure 2 is a detail section through the conductor on line 2—2 of Figure 1, showing a support from which the electrodes depend.

Figures 3, 4 and 5 are fragmentary views similar to a portion of Figure 1, but showing different methods of supplying the feed water.

Figure 6 is a perspective of the upper end of one form of feed water supply pipe.

Figure 7 is a diagrammatic view illustrating the electrical connections for these boilers utilizing three phase electric current.

Referring to these figures, 1 indicates a cylindrical tank or shell of the boiler proper. Within this tank is usually fixed a metallic shell 2 spaced somewhat therefrom and in electrical communication therewith as by means of connecting elements 3, this inner shell 2 protecting the outer shell 1 from powerful arcs which may tend to pass between the electrodes and the shell under certain conditions, especially in starting the boilers, or when the steam pressure is low. The shell is formed at its upper end with an extension 4 within which is fixed through an insulator 5, a conductor 6. This conductor terminates at its lower end in a plate 7 from which depend a circular series of rods 8 comprising the electrodes, the lower ends of which extend beneath the level of the water in the boiler. At 10 is shown an outlet pipe for the stream. At the lower end of the tank 1 is an extension 12 through which extends a valved pipe 13 from which the water constituting the bleed is taken. At 15 is shown a feed water supply pipe which enters through the extension 12. As heretofore constructed it has had at its upper end a series of branch pipes extending adjacent to the shell 2 and terminate adjacent to its lower edge. Such pipes have been metallic and it has therefore been necessary to keep them at a considerable distance from the electrodes otherwise more of the current would pass to these pipes than to the shell and shorten the resistance path through the water, thus increasing the load on the boiler and making it exceedingly difficult, if not impossible, to maintain stable operating conditions. It will be noted, however, that where the pipes terminate in this position, it is necessary for the water passing therethrough to be projected with considerable force in order that it may pass upward to the most active zone in the boiler in the path of maximum current flow which comprises a disk portion of the thickness represented by the depth of immersion of the electrodes, as indicated in Figure 1, this being between the surface line 20 and the dotted line 21. If the water is not fed in with considerable force, it is evident that it will be dispersed in the body of liquid and will not reach the active zone in a comparatively pure state. Consequently no matter what the load on the boiler may be, the feed water must be supplied in considerable quantity, depending on the size of the feeder pipes, to insure the feed water reaching the active zone before it has been largely contaminated by the more concentrated liquid which is already in the boiler. Consequently when the load is light and less steam is being drawn off through the pipe 10, it is necessary to draw off more water through the bleeder pipe 13 in order to maintain the level of the water at the desired point relative to the electrodes so that the extent of their immersion may be kept substantially uniform, and as this bleed liquid is heated it represents considerable energy loss in the operation of the boiler, this energy

loss increasing markedly as the load decreases.

According to the present invention means has been provided for introducing the feed water directly into the most active zone nearer to the electrodes than is the shell, but as this can not be done through a metal pipe which would form a conducting path for the current, the portion of this pipe extending adjacent to the electrodes has been formed of a non-conducting material such as a refractory glass such, for example, as is known in the trade as pyrex. One construction utilizing this glass is shown in Figure 1 in which the feed pipe is provided with a packing joint 25 within the lower portion of the boiler which joint fixes to this pipe a glass extension 26 which projects up in proximity to the water level. As this packing joint is entirely within the boiler it is at all times subject to substantially balanced pressure. As shown in Figure 1 the pipe terminates a little below this level so that when the feed water is supplied thereto it causes a swell on the surface, as shown at 27, which acts to raise the level of the water at the electrodes above the water adjacent to the boiler shell. This causes the contact area between the electrodes and the water to be increased somewhat at the point where the current density is greatest, it being evident that the equal potential lines in the active zone at the surface of the water are roughly in the form of circles of constantly increasing diameter outward toward the shell of the boiler from the electrodes, so that if the thickness of this zone is uniform the current density is much greater toward the center of the boiler where the electrodes are positioned than at the shell. By increasing the thickness of this zone at the electrodes the current density in this portion of the zone is reduced without decreasing the density at the boiler shell. This therefore tends to make the boiling action at the electrodes less violent and causes more of the boiling to take place away from the electrodes and toward the boiler shell, thus tending somewhat to reduce the violen. action at the electrodes, and reducing the surging, noise and vibration of the apparatus in operation. This action is further insured by the fact that the incoming feed water is at a lower temperature than the water in the boiler and therefore has lower conductivity, the conductivity of water increasing markedly with temperature rise. As the water is introduced into the active zone in this method, when the load on the boiler is reduced the feed water supply may be correspondingly reduced and yet insure the supply of fresh water reaching the active zone. Consequently it is unnecessary to increase the rate of bleed in order to keep the water level substantially constant and therefore the loss of energy due to the heat carried off by the bleed water is correspondingly reduced.

Instead of introducing the feed water slightly below the level of the water in the boiler it may be introduced at this level, or somewhat above, as shown in Figure 3, with substantially the same results. Where it is introduced slightly below this level, the swell in the water level may be made somewhat more pronounced than if introduced at or above this level.

As shown in Figure 1 the upper end of the pipe opens centrally within the circular series of electrodes. If desired it may be formed to project the water substantially against the ends of these electrodes so that the maximum swell in the water may be produced at the electrodes rather than between them. Such a construction is shown in Figures 4 to 6.

In Figures 4 and 6 the upper end of the non-conducting feed water pipe is shown as formed with an annular nozzle 30 formed to project the water in ring formation, the diameter of this ring being substantially that of the series of electrodes.

In Figure 5 a somewhat different shaped nozzle is employed, the water being directed in an annular flaring path by means of the flaring passage 31. In this case the water is directed from within the series of electrodes outwardly.

Particularly where a high polyphase voltage is employed, it is possible to somewhat cut down the effective voltage impressed on the boiler without the use of transformers by the method of connecting a series of such boilers in the electric circuit. For example, as shown in Figure 7, three such boilers are connected in Y formation between the three phase lines *a*, *b* and *c*, these lines being connected to the electrodes of each boiler, the shells of the boiler being grounded through the connection *d*. Of course other connections may be made to suit the particular type of current employed as may be evident to those skilled in the art.

It will thus be seen that by use of this invention high voltage may be successfully employed, thus permitting economical transmission of power without the necessity of expensive transformer equipment, and that the matter of increasing conductivity of water as the saline content becomes greater, which is an important consideration when high voltages are employed, has been properly taken care of so that it is not necessary to increase the size of the boilers or to complicate their construction in order to insure proper operation thereof.

Having thus described certain embodiments of this invention it should be evident that various changes and modifications may be made therein without departing from its spirit or scope as defined by the appended claims.

We claim:

1. A device of the class described compris-

ing a drum for containing water, an electrode dipping below the surface of the water, an outlet from said drum above the surface of the water, and means for supplying feed water adjacent to the surface of the water in said drum, said electrode and drum being constructed to have impressed thereon different electrical potentials.

2. A device of the class described comprising a drum for containing water, an electrode dipping below the surface of the water, an outlet from said drum above the surface of the water, and means for supplying feed water adjacent to the surface of the water in said drum and close to said electrode, said electrode and rum being constructed to have impressed thereon different electrical potentials.

3. In combination with an electric boiler comprising a drum for containing water, an electrode insulated from said drum and dipping below the surface of the water therein, said electrode and drum being constructed to have impressed thereon different electrical potentials, a steam outlet and a bleeder pipe, of a feed water supply pipe of insulating material having its outlet adjacent to said electrode.

4. In combination with an electric boiler comprising a drum for containing water, an electrode insulated from said drum and dipping below the surface of the water therein, said electrode and drum being constructed to have impressed thereon different electrical potentials, a steam outlet and a bleeder pipe, of a feed water supply pipe of insulating material having its outlet adjacent to said electrode and adjacent to the surface of the water in said drum.

5. In combination with an electric boiler comprising a drum for containing water, an electrode insulated from said drum and dipping below the surface of the water therein, said electrode and drum being constructed to have impressed thereon different electrical potentials, a steam outlet and a bleeder pipe, of a feed water supply pipe of insulating material having its outlet adjacent to said electrode, and just below the surface of the water in said drum and pointing upwardly to produce a swell in said surface at said electrode.

6. In an electric boiler, a cylindrical drum, a circular series of electrodes arranged coaxially with said drum, their lower ends extending beneath the surface of water contained in said drum, a steam outlet above the level of the water surface, a bleeder pipe extending from the lower end of said drum, and a feed water supply having a portion of non-conducting material directing the feed water closely adjacent to the water surface within said series of electrodes, said electrodes and drum being constructed to have impressed thereon different electrical potentials.

7. The combination in an electric boiler comprising a drum for containing water, an electrode insulated from said drum and dipping below the surface of the water therein, said electrode and drum being constructed to have impressed thereon different electrical potentials, of means for producing a swell in the surface of the water adjacent to said electrode whereby the current density at said electrode may be reduced.

8. In combination with an electric boiler comprising a drum for containing water, an electrode insulated from said drum and dipping below the surface of water therein, a steam outlet, a feed water pipe leading into said drum, and a pipe section of insulating material jointed at one end to the end of said feed water pipe and conducting the feed water adjacent to said electrode, said joint being entirely within said shell whereby it is subjected at all times to substantially balanced pressures.

9. In an electric boiler, parts in contact with the water in said boiler constructed and arranged to have impressed thereon differences of electrical potential, one of said parts comprising an electrode extending below the surface of the water, and means for supplying feed water closer to said electrode than is the other of said parts.

10. In the operation of electric boilers in which the water is heated by the passage of electric current therethrough, that step which comprises supplying fresh feed water substantially uncontaminated by water already in the boiler directly into the path of maximum current flow.

11. In the operation of electric boilers in which the water is heated by the passage of electric current between an electrode dipping thereinto and the boiler shell, that step which comprises introducing fresh water to the boiler closely adjacent to said electrode while protected against substantial contamination by boiler water of greater saline content.

12. In the operation of electric boilers in which the water is heated by the passage of electric current between an electrode dipping therein and the boiler shell, that step which comprises projecting fresh water substantially uncontaminated by water already in the boiler upwardly closely adjacent to said electrode with sufficient force to produce a swell in the surface of the water in the boiler at said electrode.

13. In the operation of electric boilers in which the water is heated by the passage of electric current therethrough, those steps which comprise supplying fresh feed water substantially uncontaminated by water already in the boiler directly into the path of maximum current passage, and drawing off

water of greater saline content than the feed water supplied.

14. In the operation of electric boilers in which the water is heated by the passage of electric current between an electrode dipping thereinto and the boiler shell, those steps which comprise introducing fresh water to the boiler closely adjacent to said electrode, and drawing off water of greater saline content than the feed water supplied.

15. In the operation of electric boilers in which the water is heated by the passage of electric current between an electrode dipping thereinto and the boiler shell, those steps which comprise projecting fresh water upwardly closely adjacent to said electrode with sufficient force to produce a swell in the surface of the water in the boiler at said electrode, and drawing off water of greater saline content than the feed water supplied.

16. In the operation of electric boilers in which the water is heated by the passage of electric current between an electrode dipping thereinto and the boiler shell, that step which comprises introducing fresh water to the boiler beneath said electrode while preventing contamination of said fresh water by the water in the boiler to within a short distance of said electrode.

17. In the operation of electric boilers in which the water is heated by the passage of electric current between an electrode dipping thereinto and the boiler shell, those steps which comprise introducing fresh water to the boiler beneath said electrode while preventing contamination of said fresh water by the water in the boiler to within a short distance of said electrode, and drawing off water of greater saline content than the feed water supplied.

In testimony whereof we have affixed our signatures.

MILTON O. SCHUR.
OSCAR L. ROBERTSON.