Nov. 29, 1949 J. M. BIALOSKY 2,489,739

ELECTROLYTIC WATER CORRECTION DEVICE

Filed May 31, 1946

Fig. 1.

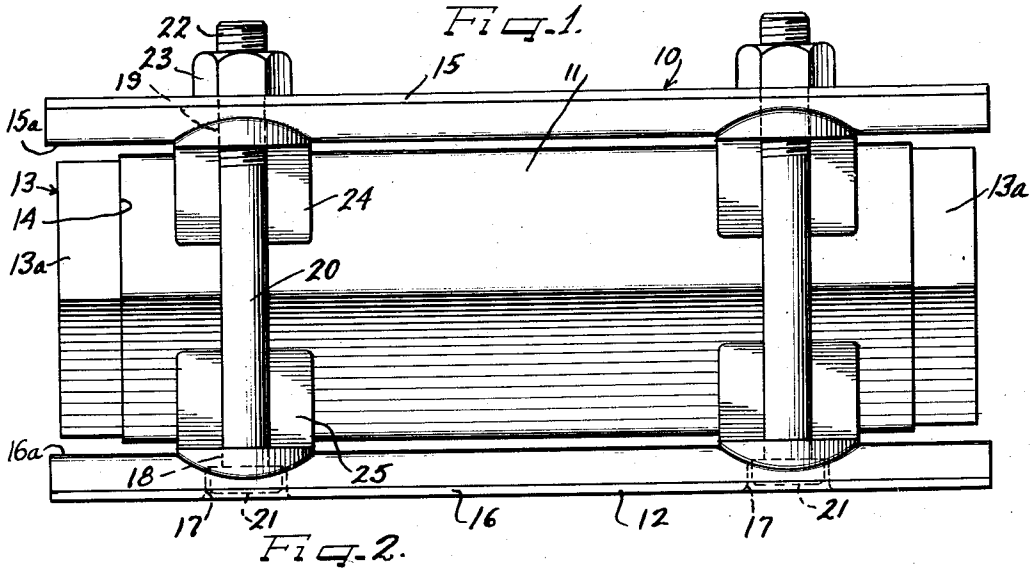



Fig. 2.

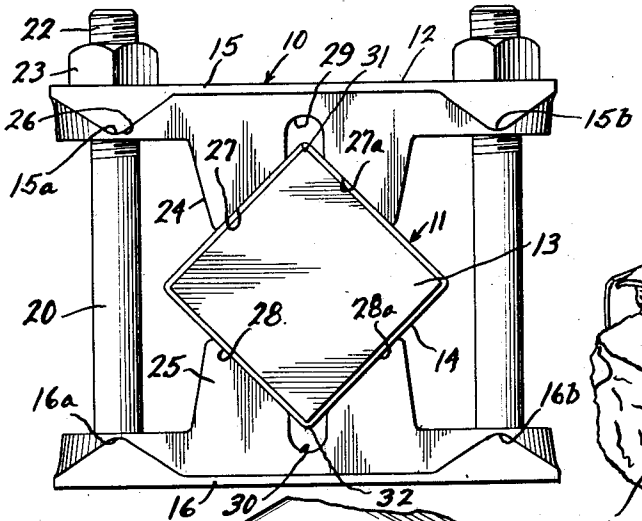
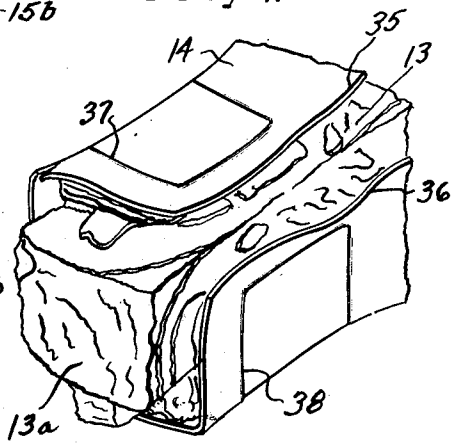



Fig. 4.



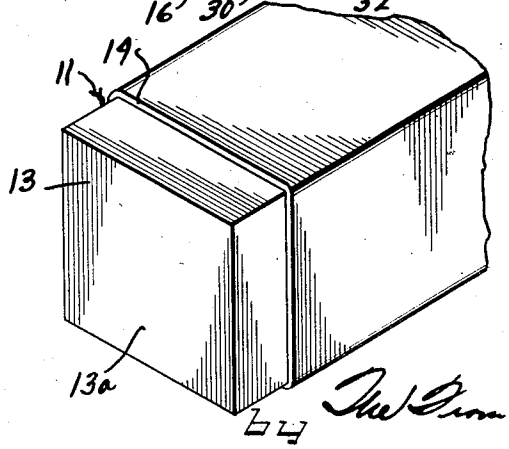




Fig. 3.

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## ELECTROLYTIC WATER CORRECTION DEVICE

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6 Claims. (Cl. 204—248)

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This invention relates to an electrolytic water correction device, and more particularly to an electrolytic couple for use in the prevention of scale in boilers and the like.

Self-energizing electrolytic water correction devices have heretofore been constructed of zinc bars or blocks mounted in a supporting clamping assembly. During use, however, the electrochemical corrosion of the zinc anode gives rise to a number of problems that have not previously been solved by proper mechanical and electrochemical design of the unit. Since the solid corrosion products of the zinc anode have a much larger volume than the original anode, sufficient pressure may develop to distort the cathode and cause the loss of good contact between the anode and cathode, with consequent loss in the rate of corrosion of the zinc. Also, as corrosion of the zinc progresses, there is the possibility of large portions of the zinc becoming displaced from the unit and lodging in the tubes of the boiler, or even causing the assembly to fall apart.

Furthermore, in the units as heretofore constructed, difficulty has been experienced in maintaining good electrical contact between the zinc anode and the clamping elements that have been employed to support the anode in place. The normal electrochemical corrosion of the zinc anode is most severe at the contact area. Corrosion products are there formed that are very dense, hard and adherent to the cathode contact clamps and hence difficult to remove. If the corrosion products are not completely removed prior to the insertion of new anodes into the cathodic clamping elements, a poor electrical contact will result with consequent low efficiency of the unit.

The present invention has for its purpose the elimination of these difficulties that have been encountered in previously designed units. According to the present invention, a cathodic case or sheath encloses a substantial intermediate area of the anode while leaving the end areas exposed. The sheath may suitably be formed of relatively thin cathodic metal in the form of a band or tube, into which the anode may be driven to provide a press fit. Alternatively, the sheath may be formed by spraying cathodic metal over the desired area of the anode, or by electroplating a cathodic metal over such area. Good electrical contact between the sheath and the anode may also be obtained by soldering or brazing the sheath to the anode, using a soldering or brazing material that will withstand the highest temperatures to which the unit may be subjected in a boiler.

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The sheathed or jacketed anode, or a plurality of them, is then clamped in a larger cathode unit to obtain the desired anode-to-cathode area ratio. The unit suitably includes massive clamping elements, which may be formed of cast iron, copper, or brass, and which serve to press the sheath into tight surface contact with the anode, to thereby maintain good electrical contact during use of the unit.

The provision of the sheath or jacket for the anode causes corrosion of the anode to proceed from the exposed ends toward the clamped intermediate portion, thereby realizing the maximum efficiency from the anode elements. Good electrical contact is maintained throughout the disintegration period of the anode. This is in contrast with previous constructions, in which the area and closeness of contact became reduced within a comparatively short period of use. The corrosion would be concentrated at the contact, and this would result in an intense local attack on the intermediate portion of the anode elements, which, if allowed to continue, would result in cutting the anode into two pieces, which could drop into the boiler and cause damage to valves, tubes or other equipment.

It is therefore an important object of this invention to provide a novel and improved construction of a self-energizing electrolytic water correction device, wherein the anode element is encased within a tightly fitting sheath or jacket to insure good electrical contact throughout the life of the anode elements.

It is a further important object of this invention to provide a water correction device comprising an electrolytic couple so constructed that the cathode contact areas do not become fouled by corrosion products and that, therefore, replacement of anode cartridges is a simple matter, requiring a minimum expenditure of time and effort.

It is a still further important object of this invention to provide a self-energizing electrolytic water correction device in which the anode is encased within a sheath of cathodic metal over a substantial intermediate surface area thereof, and the sheathed anode assembled within a unit including relatively massive clamping elements also of cathodic metal to provide an exposed cathodic surface that is greatly in excess of the exposed anodic surface during use.

Other and further important objects of this invention will be apparent from the disclosures in the specification and the accompanying drawings.

As shown on the drawings:

Figure 1 is a side elevational view of a unit water correction device embodying the principles of my invention.

Figure 2 is an end elevational view of the same.

Figure 3 is a fragmentary end perspective view of the sheathed anode.

Figure 4 is a view similar to Figure 3 of a sheathed anode after having been in use for a considerable length of time.

On the drawings:

The reference numeral 10 indicates generally a self-energizing electrolytic water correction device unit embodying the principles of my invention. Said unit comprises a sheathed anode 11 and a clamping assembly 12.

The sheathed anode 11 comprises a cartridge, or core, 13, and a sheath 14 tightly encasing the major intermediate portion of the core 13, while leaving the ends 13a of said core exposed. The core 13 is preferably a bar of high purity rolled zinc, although it may be formed of aluminum or magnesium. As illustrated, the core 13 is an elongated bar of rectangular cross section, but it may be of circular cross section, polygonal or other preferably regular cross section.

The sheath 14 is formed of copper, brass, or other metal that is relatively lower than zinc in the electromotive force series. Alternatively, the sheath 14 may be formed of any suitable foundation metal and copper or silver plated throughout its entire surface to serve as the cathode. Also, instead of using a thin metal sheath or jacket, a cathodic metal, such as copper or silver, may be sprayed or electroplated over the desired surface area of the anode 13. The important thing is that the sheath 14 enclose a substantial surface area of the anode 13 and closely engage the same to establish and maintain good electrical contact therewith. To this end, if the sheath 14 is a pre-formed sleeve or hollow tube, it may be shrunk or press fitted upon the anode 13, or it may be made slightly undersize and the anode 13 driven thereinto to expand the same and form the desired tight fit. According to another method of applying the sheath 14, a slightly over-size jacket may be used and the jacket soldered or brazed into place using a solder or brazing material that will withstand the highest temperature to which the device may be subjected when placed in a boiler.

The clamp 12 comprises a pair of opposed plates 15 and 16 having longitudinally extending V-shaped ridges 15a and 15b and 16a and 16b, respectively, with the set of ridges 15a and 16a in opposed alignment to each other and the set of ridges 15b and 16b in opposed alignment to each other. One of said plates, such as the plate 16, is recessed, as at 17, and both plates are provided with aligned apertures centered with respect to said recesses 17, such as the apertures 18 in the plate 16 and the apertures 19 in the plate 15. These apertures are for the purpose of receiving bolts 20, the heads 21 of which are received in the recesses 17. The bolts 20 pass completely through the plate 15 and are provided with threaded extended ends 22 for receiving nuts 23.

A pair of opposed clamping elements, or blocks, 24 and 25, apertured to receive the bolts 20, are associated with each pair of said bolts 20. Each of said clamping elements is adapted to be mounted upon a pair of the bolts 20 to lie up against the inner side of a plate 15 or 16. For this purpose, each of the clamping elements



is provided with a V-shaped notch, such as the notch 26, to receive one of the V-shaped ribs, 15a, 15b, 16a, or 16b.

Each of the clamping elements 24 and 25 is also provided with a set of angled faces, such as the faces 27 and 27a on the element 24 and the faces 28 and 28a on the element 25, which faces are adapted to engage corresponding surfaces of the sheath 14 when the sheathed anode 11 is assembled in place. Each of the bearing blocks 24 and 25 is further provided with a cutaway or notched-out portion 29, or 30, between the pairs of angled surfaces 27 and 27a, or 28 and 28a. These notched-out portions 29 and 30 provide through passages for the circulation of water between the clamping elements and the sheathed anode 11, and, more importantly, provide clearances for the adjacent corner edges, such as the edges 31 and 32, of the sheathed element so that uniform clamping pressure may be applied upon the sheathed anode 11 without the necessity of accurately conforming the angled surfaces of the bearing blocks to the surfaces of the sheathed anode.

Depending upon the length of the unit, one or more sets of clamping blocks and bolts may be employed. Also, by merely duplicating the unit illustrated in the drawings and making the bolts 20 correspondingly longer, tiers of such units may be superimposed one on the other with the bolts holding the units together and clamping the sheathed cartridges in place.

The clamping assembly 12, including the plates 15 and 16, bolts 20 and clamping blocks 24 and 25, may all be formed of a metal or alloy that is positive electrolytically to the anode cartridge or core 13. Both plates 15 and 16 and the clamping blocks 24 and 25 may be integrally cast from the same cathodic metal or alloy, or they may be cast from a ferrous metal and then copper or silver plated all over. The bolts 20 and nuts 23 may also be copper or silver plated. Silver plating is preferred since it not only gives a greater potential difference between the metal, such as zinc, of which the anode 13 is formed, and the cathode elements, including the sheath 14 and clamping assembly, but also reduces the amount of corrosion that would otherwise take place on the surfaces of the clamping assembly. Thus, if all of the surfaces of the clamping assembly and also the surface of the sheath 14 are silver plated, corrosion of the cathode surfaces is reduced to a minimum and the clamping assembly can be repeatedly reused by merely replacing the sheathed anode.

The portion of the area of the anode 13 that is covered by the sheath 14 affects the action of the electrolytic device by affecting the total electrical resistance to passage of current through the metallic portion of the cell circuit, which may be termed the "external resistance" of the cell. The resistance through the electrolyte, which in the case of a boiler installation will be the water in the boiler, may be termed the "internal resistance." The total voltage developed by the cell, neglecting polarization effects, may be said to equal the voltage through the metal plus the voltage through the electrolyte, where

$$\frac{\text{Voltage through electrolyte}}{\text{Voltage through metal}} = \frac{\text{Internal resistance}}{\text{External resistance}}$$

Since the voltage used to force current through the metal is wasted, so far as the galvanic action of the device is concerned, it is obviously necessary to reduce the external resistance to a mini-

mum. This implies a certain minimum contact area. While there is no sharp line of demarcation above which the unit will operate successfully and below which it fails, as the area of contact is reduced, efficiency of the unit gradually decreases until effective action is lost. The actual numerical ratios of areas of contact between the anode and cathode and exposed area of the anode will depend upon factors of design, including cross sections of both the anode cartridge and the cathode sheath, and geometrical arrangements of the exposed surfaces of both the anode and cathode. In general, however, the area of contact between the anode cartridge and the cathode sheath should be between 25% and 85% of the total anode surface area. Conversely, a minimum of 15% of the surface area of the anode **13** and a maximum of 75% of the surface area of the anode **13** may be left uncovered by the sheath **14** so as to be exposed to the electrolyte, or water of the boiler if the device is used in a boiler. While only the ends **13***a* of the anode cartridge **13** have been illustrated as left exposed, intermediate surface areas of the cartridge may be exposed, as by cutting away the sheath **14** or spacing portions of the sheath from the surface of the cartridge to leave water passages therebetween. Such spacing may be at the minimum distance which will allow free circulation of water following expansion of the cartridge in use. While such separated and opposed electrode surfaces are not by themselves effective in producing the required galvanic action, the exposing of relatively larger surface areas of the anode results in increasing the activation of the anode cartridge at temperatures and concentrations too low to activate an anode cartridge having proportionately less surface area exposed to electrolytic attack.

The results of electrolytic attack upon the anode cartridge are illustrated in Figure 4, in which similar reference numerals are applied to the corroded anode and cathode sheath. It will be noted that the anode **13** of Figure 4 has expanded greatly and has taken on a badly corroded, somewhat laminated appearance. The expansion of the anode **13** has caused the sheath **14** to break along one of its longitudinal corner edges, as indicated by the free edges **35** and **36**. The pressure with which the sheathed anode was clamped during use is indicated by the indented surface portions **37** and **38** formed by the contacting faces of the clamping blocks **24** and **25**. It will be observed that the clamping pressure was sufficiently great to maintain continuous contact between the sheath **14** and the portion of the anode **13** underlying the clamped areas **37** and **38**, thereby insuring good electrical contact notwithstanding the badly corroded and expanded condition of the anode. At the same time, the sheath **14** in combination with the clamping blocks **24** and **25** served to retain the major portion of the anode **13** in supported relationship notwithstanding the rupture of the sheath **14**, while permitting continued corrosion of the anode from the exposed ends **13***a*.

As can well be appreciated from the appearance of the corroded anode in Figure 4, if it were not for the sheath **14**, the anode **13** might have corroded away sufficiently between the clamping blocks **24** and **25** to have allowed portions of the anode to fall away from the clamping assembly and to have reduced the area of contact between the anode and cathode clamping blocks so greatly as to have rendered the device wholly



ineffective before any substantial useful corrosion of the anode had occurred. This illustrates the utility of provided a sheath for a substantial area of the anode and providing relatively massave clamping blocks capable of exerting considerable pressure upon the sheath and insuring good electrical contact throughout the useful life of the anode.

In use, the device **10** may be supported within a boiler, as for instance upon the boiler tubes, so as to be submerged in the water of the boiler. As a result of the galvanic action that takes place due to the presence of dissolved salts in the boiler water, the zinc anode **13** is electrolytically attacked with formation of zinc ions. Reaction between the zinc ions and water results in the formation of colloidal particles of zinc hydroxide or hydrated zinc oxide, which act as neuclei for the precipitation of the scale-forming solids which are dissolved in the boiler feed water. These scale forming solids, although inoccuous in the cold water, are concentrated in the boiler to the point at which they will precipitate out on the heating surfaces as a hard flint-like insulating scale. This scale reduces boiler efficiency and results in a considerable loss of time and effort, since the scale must be removed periodically by mechanical means. When, however, colloidal zinc corrosion products are present in the water, the scale-forming solids will precipitate on the zinc hydroxide or hydrated zinc oxide to form a soft sludge. This sludge can be removed from the boiler by periodic blowdowns. As a result, the boiler is maintained at a high efficiency because the heat transfer surfaces do not become covered with a hard insulating scale. A continuous supply of the zinc corrosion product is required to compensate for the dissolved solids in the make-up water. A uniform and continuous supply of the zinc corrosion product is dependent upon the efficient action of the galvanic couple. This, in turn, is dependent upon a low resistance contact between the zinc and the cathode sheath.

It will, of course, be understood that various details of construction may be varied through a wide range without departing from the principles of this invention and it is, therefore, not the purpose to limit the patent granted hereon otherwise than necessitated by the scope of the appended claims.

I claim as my invention:

1. A self-energizing electrolytic water correction device comprising a bar of rectangular cross-section constituting the anode, a relatively thin sheath completely enclosing an intermediate portion of said bar and constituting the cathode, and a clamp including massive clamping elements engaging opposed faces of said thin sheath to cause said sheath to tightly engage said bar for maintaining good electrical contact therebetween.

2. A self-energizing electrolytic water correction device comprising a bar of rectangular cross-section constituting the anode, a relatively thin sheath lightly enclosing an intermediate portion of said bar and constituting the cathode, and a clamp including massive clamping elements constituting an additional cathode and engaging opposed faces of said thin sheath to cause said sheath to tightly engage said bar for maintaining good electrical contact therebetween, said clamping elements leaving edge portions of said sheath unengaged to permit rupture of said sheath along

such edges upon expansion of said bar during use.

3. A self-energizing electrolytic water correction device comprising a bar of rectangular cross-section formed of high purity rolled zinc and constituting the anode, a relatively thin sheath of copper press fitted on said bar to tightly surround an intermediate portion thereof and constituting the cathode, and a clamp including massive clamping elements of cast copper engaging opposed faces of said thin sheath to cause said sheath to tightly engage said bar for maintaining good electrical contact therebetween.

4. A self-energizing electrolytic water correction device comprising a bar anode, a relatively thin cathode sheath press fitted on said anode to completely enclose a substantial intermediate portion of said bar anode while leaving the ends thereof exposed, and a clamp pressing against spaced opposite portions only of said sheath to press said portions tightly against said bar anode to maintain good electrical contact therebetween despite expansion of the anode and rupture of the sheath during use.

5. A self-energizing electrolytic water correction device comprising a cartridge of a negative



element and a relatively thin sheath of a positive metal in tight gripping engagement with said cartridge, said sheath completely enclosing an extended intermediate portion of said cartridge while leaving the ends thereof exposed.

6. A self-energizing electrolytic water correction device comprising a core of negative metal constituting the anode and a relatively thin sheath of positive metal constituting the cathode completely surrounding and in close gripping mechanical and electrical contact with an extended surface area of said core but leaving end portions of said core exposed for electrolytic attack.

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