Oct. 12, 1948. E. M. BUTLER 2,451,066

ELECTROLYTIC WATER CORRECTION DEVICE

Filed July 25, 1946 2 Sheets-Sheet 1

Fig. 1.

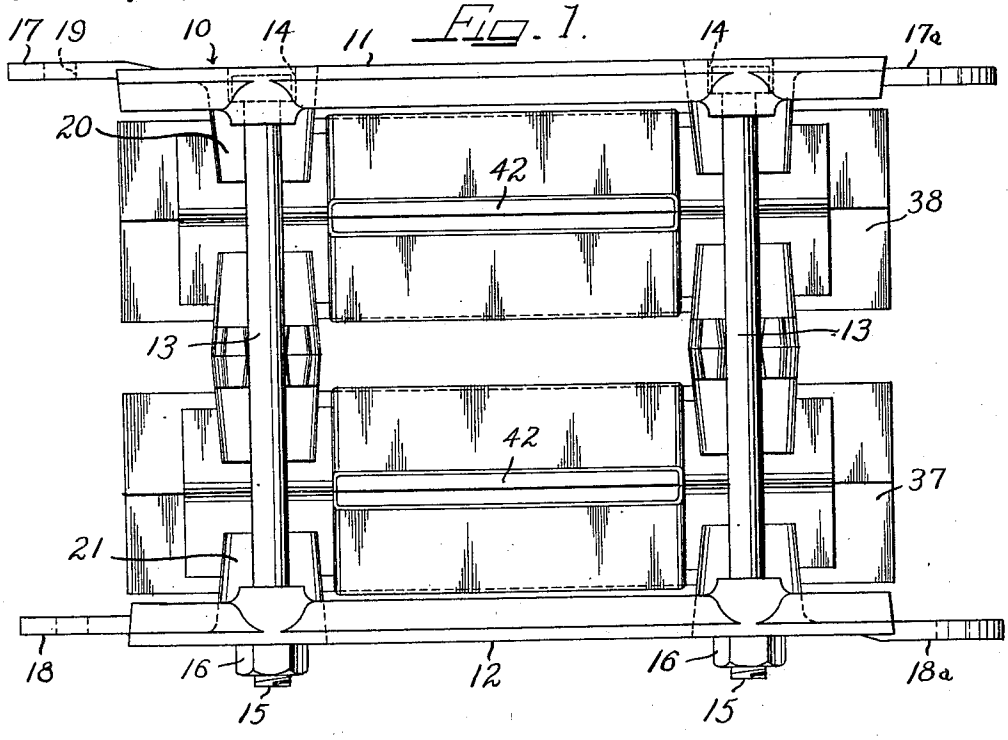
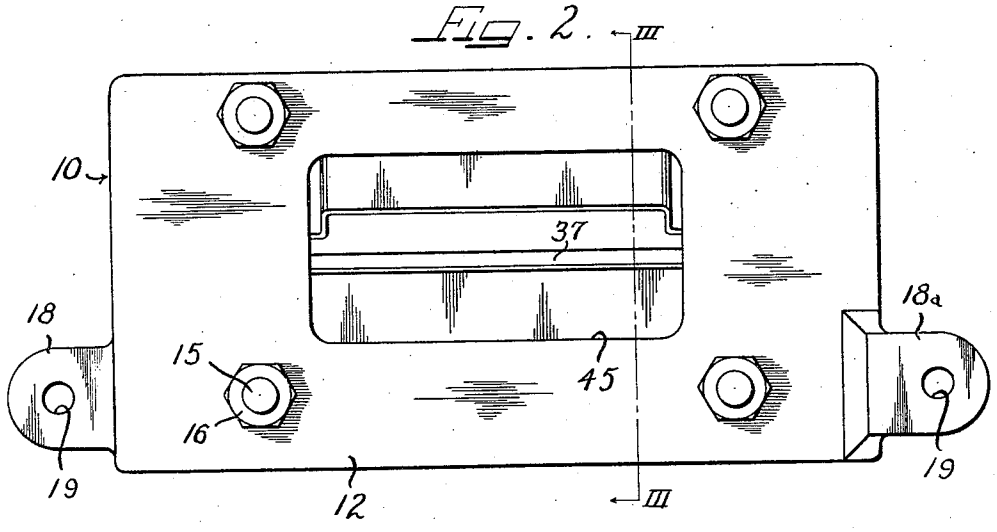


Fig. 2.



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Fig. 3.

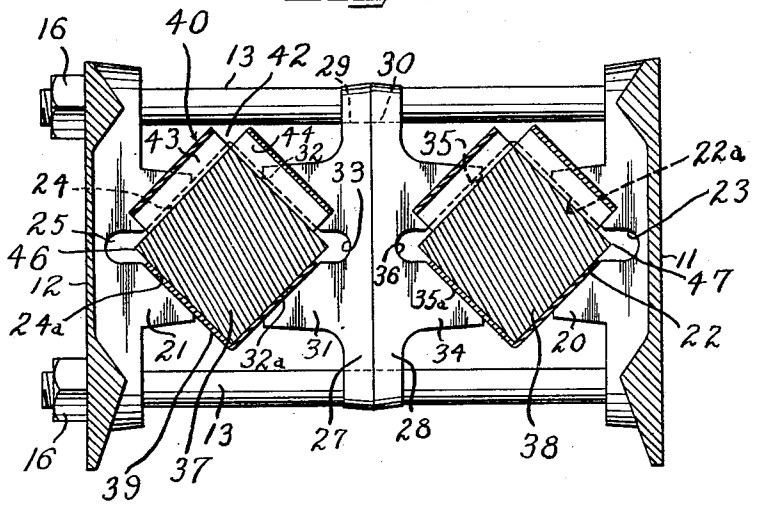
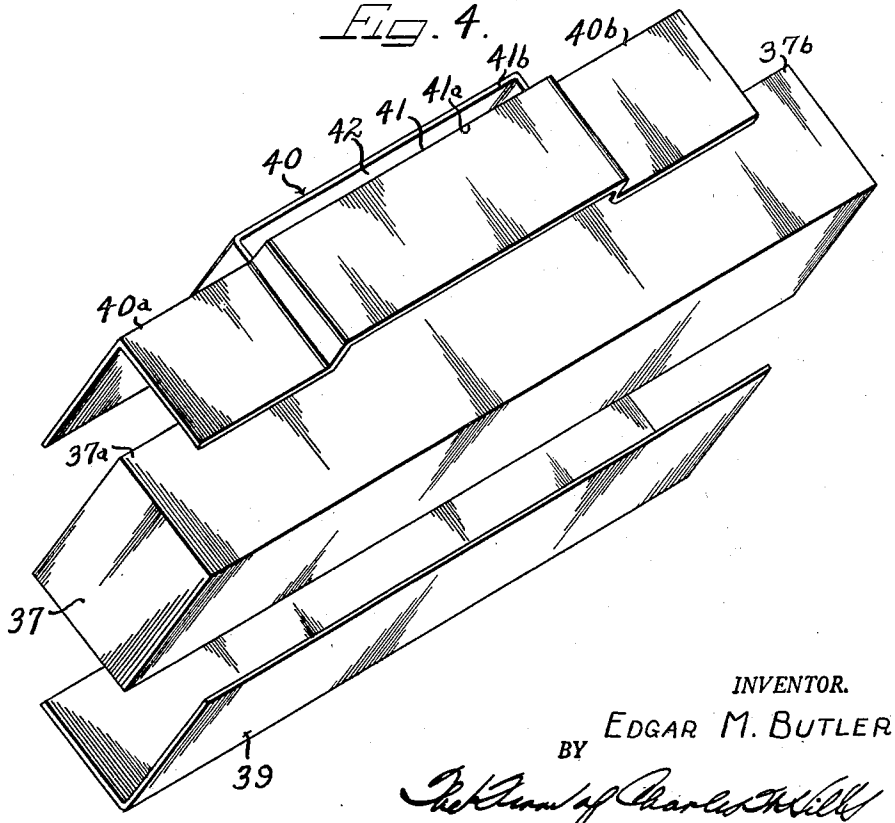


Fig. 4.



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ELECTROLYTIC WATER CORRECTION DEVICE

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3 Claims. (Cl. 204—248)

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This invention relates to an electrolytic water correction device, and more particularly to a self-energizing electrolytic device for use in water boilers for reducing or eliminating the formation of a hard scale on the boiler surfaces.

The present application is a continuation-in-part of my application entitled Self-energizing electrolytic water correction devices," Serial No. 618,114, filed September 24, 1945. There is described in that application a device comprising bars constituting the anodes and formed of a negative metal or alloy, and clamps for said bars comprising saddle blocks, face plates and tie bolts, all formed of a positive element or having a positive element outer surface and constituting the cathode of the galvanic cell. In a modification of the invention described in the earlier application, the anode bars are partially sheathed in copper jackets that tightly fit a substantial intermediate portion of the bars to leave the ends thereof exposed.

The function of such sheaths, or jackets, is to provide adequate continuous electrical contact between the anode cartridge, or bar, and the cathode during the entire life of the cartridge; to prevent chunks of solid cartridge metal from falling into the boiler due to decomposition during use; and to facilitate the removal of the expended cartridge and the reuse of the cathode clamp assembly without necessitating difficult cleaning operations on the surfaces of the clamp assembly that would normally contact the cathode cartridges except for such sheaths, or jackets. While performing the foregoing functions satisfactorily, the construction shown in my earlier application neverthelsess had some drawbacks when used under certain boiler conditions. For instance, at boiler pressures of less than around 100 pounds per square inch, the area of the anode cartridge initially exposed beyond the ends of the sheathing is so small that decomposition of the metal of the anode does not take place rapidly enough to produce effective concentration of the anode metal ions in the boiler. At higher boiler pressures, this difficulty is avoided because the rapid expansion of the cartridge brought about by its decomposition during use splits the sheath back from each end to a point where further expansion of the cartridge is prevented on account of the pressure there exerted by the clamping blocks. Such splitting of the sheath increases the amount of anode surface exposed to the electrolytic action of the water of the boiler. Furthermore, after the sheath has been split in this way, the ends of the sheath themselves become cathode surfaces closely opposed to the cartridge surface, thereby producing a relatively heavy current flow over the additionally exposed area, with consequent rapid decomposition of the cartridge.

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I have found that in the case of the sheathed cartridge construction of my earlier application there are several conditions which, if present, may render devices of that construction ineffective to prevent the formation of a hard scale on boiler surfaces. These conditions include an operating boiler pressure of below 100 pounds per square inch, unusually low concentrations of dissolved salts (electrolyte) in the boiler water, and the presence of specific substances that deposit on the unit and insulate before sufficient action has occurred to bring about the precipitation of such substances as a sludge. An example of this latter is a water containing 100 grams per gallon or over of magnesium sulfate ($MgSO_4$) and 10 grams per gallon or over of SiO_2 present as sodium silicate, plus sufficient acid forming compounds to give a pH of about 5. Such a water causes a deposition of an insulating coating over the unit that prevents the desired electrolytic action.

The electrolytic water correction device of my present invention is so designed and constructed as to be capable of effective operation right from the start when used in boilers operating at pressures either above or below about 100 pounds per square inch, although at very much higher boiler pressures the present device has no substantial advantages over the device of my earlier application. By virtue of the construction of my present device, the area of metal-to-metal between the anode and cathode contacting surfaces is that necessary for proper operation; the area of exposed cartridge in contact with the cathode is that necessary for proper operation; there is a sufficient total exposed cartridge area for effective action; and there is a sufficient area of cathode surface closely opposed but not in contact with the exposed anode surface to assist in the initial activation of the cartridge and increase the efficiency of the galvanic action set up. These conditions are satisfied regardless of whether or not expansion of the cartridge occurs, as explained above in the case of the device of my earlier application.

The manner in which these objects are accomplished will hereinafter be described in greater detail. Briefly, the unit of my present invention includes a long bottom sheath running almost to the full length of the cartridge and in surface

contact therewith and an upper sheath of similar length but having a considerable intermediate portion offset to lie in parallel, closely spaced relationship to the corresponding surface of the cartridge. The contact areas at the ends of the upper offset sheath and the corresponding areas of the lower sheath are tightly clamped between clamping blocks, to which pressure is applied by means of tie bolts. The closely spaced sheath area of the upper sheath functions immediately upon immersion of the unit in the boiler water as a closely opposed cathode area over an additional exposed cartridge area, thus initiating activation of the cartridge right from the start. Even if the expansion of the cartridge in use destroys all direct contact between the cathode sheaths and the cartridge except that held in pressure contact by the clamping blocks, there is sufficient contact area maintained at the points of pressure exerted by the clamping blocks to give satisfactory and effective operation.

The closely opposed, but not contacting, cathode surface provided by the offset portions of the upper sheath insures that my present unit will function perfectly under boiler operating pressures and at concentrations of dissolved salts in the boiler water that are too low to activate a unit such as that described in my earlier filed application. Furthermore, since the present unit becomes immediately activated upon immersion and heating, the decomposition products that form will be initially dispersed rapidly enough to precipitate certain hardness salts before these salts can insulate and render the unit inactive. The design of my present unit is such that almost the entire exposed cartridge surface is active, thereby reducing to a negligible quantity the danger of a large chunk being decomposed locally and dropping into the boiler. In the event that the center of the cartridge were in a particular installation to become separated as a solid block, such block would still be supported by the lower sheath and could not fall into the boiler to cause damage.

From the standpoint of providing for ease of removal of expended cartridges and eliminating the necessity for cleaning the clamping blocks, the sheaths of my present unit operate in exactly the same manner as those described in my pending application. The purpose of the present invention is to provide a construction that does not depend upon cartridge expansion to bring the unit to its full efficiency and that will operate in systems where, for any of the various reasons outlined above, proper expansion of the cartridges in the construction of my earlier unit would not occur sufficiently rapidly to activate the unit.

It is therefore an important object of this invention to provide an electrolytic water correction device of improved construction, capable of operating efficiently in steam boilers and hot water boilers where boiler pressures of under about 100 pounds per square inch and corresponding temperatures are employed.

It is a further important object of this invention to provide an electrolytic water correction device of such construction and so arranged as to make the operation of the device independent of the extent of expansion of the anode metal during operation, whereby the device is self-energizing under conditions as to pressure and temperature that result in little or no expansion of the metal of the anode.

It is a further important object of this invention to provide a self-energizing electrolytic water correction device in which the anode metal is enclosed in sheaths of a cathode metal, so arranged and constructed as to prevent the separation of portions of the anode metal while at the same time initially exposing a sufficient area of the anode metal to render the unit self-activating from the start of its operation, even where boiler pressures lower than 100 pounds per square inch are employed.

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

On the drawings:

Figure 1 is a top plan view of a unit assembly embodying the principles of my invention.

Figure 2 is a side elevational view of the same.

Figure 3 is a sectional view taken substantially along the line III—III of Figure 2.

Figure 4 is an isometric, exploded elevational view of the cartridge and sheath structures of my invention.

As shown on the drawings:

The reference numeral **10** indicates generally the self-energizing electrolytic water correction unit embodying the principles of my invention. Said unit comprises a pair of side plates **11** and **12** that are adapted to be held together by means of tie bolts **13** having their head ends received in counter sunk recesses **14** in the side plate **11** and having their threaded ends **15** extending freely through the side plate **12** for receiving nuts **16**. As illustrated, there are four such tie bolts **13**, but it will be understood that a larger or smaller number of tie bolts may be employed depending upon the size of the unit.

Each of the end plates **11** and **12** may suitably be made of a copper or copper alloy casting, and then silver plated. Preferably, the surface of the end plates, or frame, including that of the tie bolts **13** is provided by a metal or alloy at least as electropositive as copper, but a ferrous foundation metal may be used and the ferrous foundation metal then copper or silver plated. Each of the end plates **11** and **12** is provided with apertured ears, such as the ears **17**, **17***a*, and **18**, **18***a*, respectively, the apertures **19** of which are aligned for receiving a member (not shown) for securing the unit to boiler tubes, or other part of a boiler.

As best illustrated in Figures 1 and 3, the end plates **11** and **12** are formed with inwardly directed, opposed core supporting abutments **20** and **21** of identical construction. The abutment **20** is provided with inclined surfaces **22** and **22***a* lying at 90° to each other and interrupted at their line of convergence by a slot **23** passing completely through the abutment **20**. The abutment **21** is similarly provided with inclined plane surfaces **24** and **24***a* and a through slot **25**.

A pair of clamping members **26** and **27** are mounted in back-to-back relationship upon the tie bolts **13** for cooperation with the clamping abutments **21** and **20** of the end plates **12** and **11**. Each of said clamping members **27** and **28** may be formed of a cast copper metal, or copper alloy, and then silver plated, the same as the end plates **11** and **12**. The clamping members **27** and **28** are provided with slotted ends **29** and **30**, respectively, for mounting upon the tie bolts **13** for adjustable positioning thereon. The clamping member **27** has an abutment **31**, which when the unit is assembled, lies in opposed relationship to the abutment **21** and has inclined plane surfaces **32** and **32***a* lying at right angles to each other and paral-

lel, respectively, to the surfaces 24*a* and 24. A slot 33 is provided at the line of convergence of the surfaces 32 and 32*a*.

Similarly, the clamping member 28 is provided with an abutment 34 adapted to be positioned in opposed relationship to the abutment 20 and provided with inclined plane surfaces 35 and 35*a* lying at right angles to each other and parallel, respectively, to the plane surfaces 22 and 22*a*. A slot 36 extends along the line of convergence of the inclined surfaces 35 and 35*a*.

The frame comprising the end plates 11 and 12, clamping members 27 and 28, and tie bolts 13 and nuts 16 serve as a clamping assembly for sheathed anodes 37 and 38. As illustrated, each of said anodes comprises an elongated bar of square or rectangular cross section and may be formed of zinc, aluminum or magnesium, or any suitable alloy of any of these metals that is at least as electronegative as zinc itself. Preferably, each of the bars or cartridges is formed of zinc produced either by a rolling or extrusion process and of comparatively high density.

Referring to the bar, or cartridge, 37 illustrated in Figure 4, it will be seen that there are provided a pair of sheaths, comprising a lower sheath 39 and an upper sheath 40, each of a length slightly less than the length of the bar 37 to leave the ends thereof exposed as at 37*a* and 37*b*. The lower sheath 39 may be suitably be formed of annealed bronze or shim stock, bent to a right angular form to fit convergent faces of the bar 37 to lie in close contact therewith The upper sheath 40 may likewise be formed of annealed bronze, or other suitable positive metal or alloy, bent to conform at its ends, as at 40*a* and 40*b*, to the corresponding adjacent surfaces of the bar 37, but provided with an outwardly expanded and slotted intermediate portion 41. Said expanded intermediate portion 41 comprises offset lengths 41*a* and 41*b*, which lie parallel to and closely spaced from the corresponding surfaces of the bar 37 and that are themselves spaced along their adjacent edges to provide a slot 42. The offset intermediate portions 41*a* and 41*b* thus establish upwardly extending passages 43 and 44 (Fig. 3) opening upwardly through the slot 42. The contsruction of the sheaths for the cartridge 38 is identical and therefore need not be further described

In assembling the unit, the sheathed cartridge, or electrode, 38, is first placed in position to lie against the inclined plane faces of the abutment 20, and then the clamping member 28 is slipped into position with the inclined faces of the abutment 34 pressing against the sheather electrode. Next, the clamping member 27 is positioned in back-to-back relationship to the clamping member 28, the sheathed electrode 37 is positioned in place against the inclined faces of the abutment 31, and the end plate 12 threaded over the ends of the tie bolts 13. The nuts 16 are next threaded home on the threaded projected ends of the tie bolts 13 to hold the unit in tightly assembled relationship, with the conforming end portions of the sheaths in pressure contact with the bars, or cartridges 37 and 38. A quite considerable pressure is set up by tightening the nuts 16. Owing to the rather massive construction of the abutments 21, 31, 34 and 20, a very considerable pressure can be exerted to hold the sheathed ends of the electrodes in good electrical contact despite any tendency of the boiler water to corrode and insulate the contacting surfaces.

In use, the unit is mounted upon the boiler

tubes, or in any other suitable position within the boiler, fully submerged in the water of the boiler. Since the unit is preferably placed in the boiler as shown in the drawings, the intermediate spaced portions of the upper sheaths 40 provide upwardly extending passages 43 and 44 converging in the upper slot 42 for both water and steam, thereby exposing a larger area of the electrodes to the electrolytic action of the boiler water. The lower sheaths 39 serve to deflect the rising bubbles of steam to either side, so that the upper surfaces of the electrodes are exposed to hot water only. A major portion, therefore, of the electrolytic activity of the unit is due to the exposed upper surfaces of the electrodes and the closely spaced relationship of the offset sheathed portions 41*a* and 41*b*. Since the sheaths are made of bronze or other positive metal, or alloy, they form a part of the total cathode, along with the end plates 11 and 12, clamping members 27 and 28 and tie bolts 13.

The end plates 11 and 12 are apertured, as at 45 (Fig. 2) to insure a relatively free flow of water through the unit. The slots 23 and 25 and 33 and 36, also serve to reduce the amount of resistance to the passage of water through and over the assembly. It will be noted that the corner edges, as at 46 and 47 (Fig. 3), of the electrodes 37 and 38 are exposed in the slots or grooves 25, 33, and 23, 36, so as to insure the activity of the electrodes at those additional areas. The result is that the area of the anode electrode exposed to the action of the electrolyte can be sufficiently large without the necessity of exposing large end areas, thereby obviating the necessity of exposing large end areas with the accompanying danger of the ends being eaten away and dropping off into the boiler. The construction of the unit illustrated insures efficient operation of the unit from the start, regardless of whether expansion of the anode element occurs, or not. The unit will therefore operate at pressures and/or concentrations too low to activate a unit such as described in my copending application, above referred to.

I claim as my invention:

1. An electrolytic water correction device for use in water boilers, comprising a bar of rectangular cross-section formed of a negative metal, a two-part sheath of a positive metal, each part enclosing a pair of adjoining sides of said bar, one of said sheath parts conforming to and in surface contact with a substantial intermediate portion of said bar and the other of said sheath parts having end portions conforming to and in surface contact with said bar adjacent the ends thereof and having offset portions intermediate said end portions spaced from and parallel to corresponding intermediate bar surfaces, both of said sheath parts terminating short of the ends of said bar to expose the ends thereof to electrolytic action, and clamping means holding contacting portions of said sheath parts and bar in a pressure contact relationship.

2. An electrolytic water correction device for use in water boilers, comprising a bar of rectangular cross-section formed of a negative metal, a two-part sheath of relatively thin metal sheet formed of a positive metal, one part conformingly fitting against a substantial intermediate length of said bar to enclose two adjoining sides thereof, the second part having end portions conformingly fitting said bar enclosing the other two adjoining sides of said bar but offset intermediate said end portions to lie in parallel, closely spaced relation-

ship to corresponding intermediate portions of said same two bar sides, said parallel offset sheath portions and intermediate bar surfaces providing elongated passages therebetween for water, and clamps having seating faces bearing against the outer surfaces of said sheath parts to urge conforming portions of said sheath parts and said bar into tight surface engagement.

3. An electrolytic water correction device for use in steam boilers, comprising an elongated bar of rectangular cross-section formed of a negative metal and adapted to be positioned horizontally in the water of a boiler, a two-part sheath of relatively thin metal sheet formed of a positive metal, one part conforming to and fitting against a substantial intermediate length of said bar to enclose two adjacent lower sides thereof, the second part having end portions conforming to and fitting against two adjacent upper sides of said bar but offset from said upper two sides intermediate said end portions to lie in parallel closely spaced relationship to the intermediate portion of said same upper two sides, the space defined by said offset portion and said bar surfaces providing elongated water and steam passages, and clamping means

for holding fitting portions of said sheath parts and bar in a pressure contact relationship, said means including clamping elements having V-shaped seating faces adapted to be seated against sides of said bar adjacent each end thereof and bearing against each of said sheath parts to maintain the sheath parts in position on said bar, and bolt means connecting said clamping elements to maintain said elements in position.

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