Oct. 18, 1938. C. C. ABBOTT 2,133,838

ELECTRIC HEATER

Filed Aug. 12, 1936 2 Sheets-Sheet 1

Fig. 1.

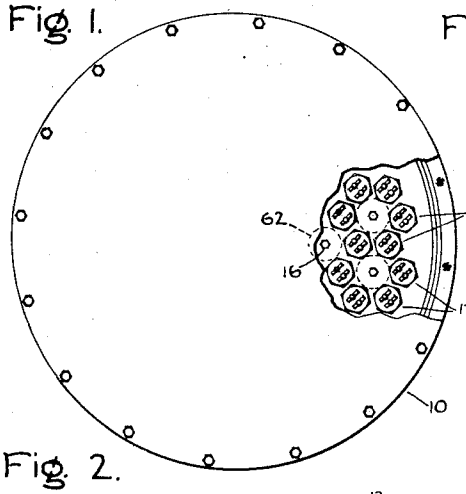


Fig. 2.

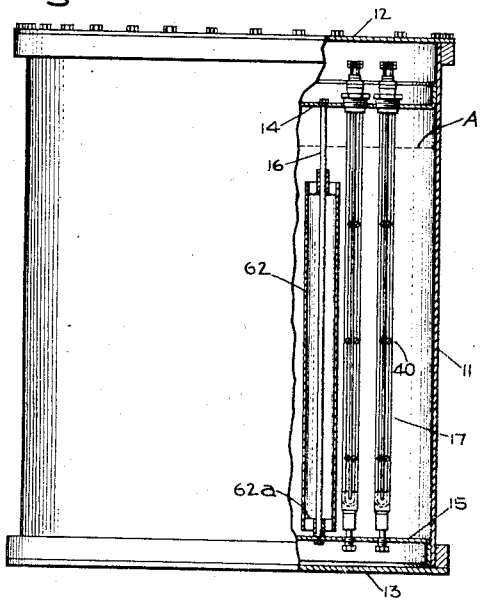


Fig. 3.

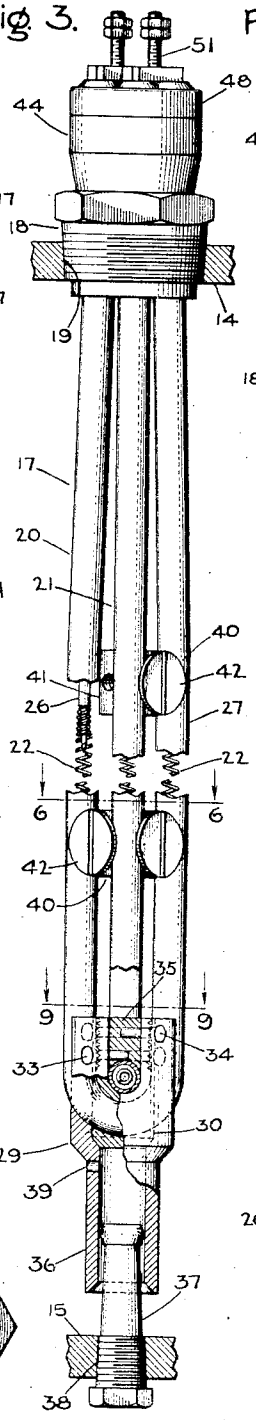


Fig. 4.

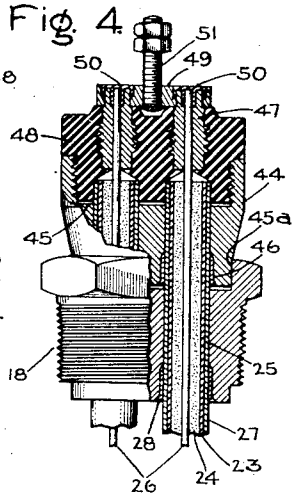


Fig. 5.

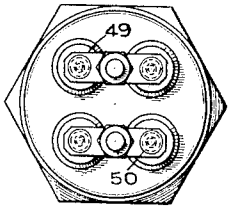


Fig. 6.

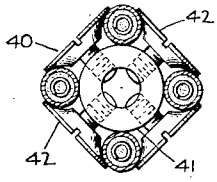


Fig. 7.

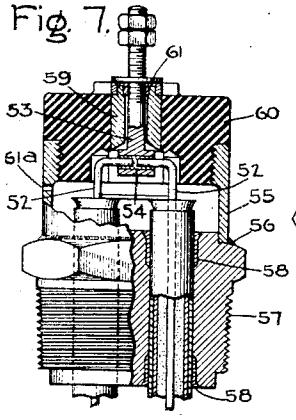


Fig. 8.

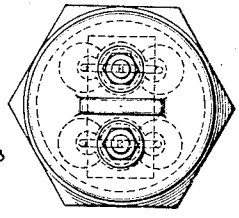
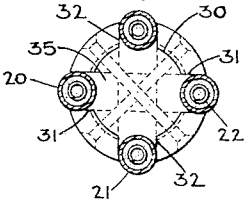


Fig. 9.



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Oct. 18, 1938. C. C. ABBOTT 2,133,838

ELECTRIC HEATER

Filed Aug. 12, 1936 2 Sheets-Sheet 2

Fig. 10.

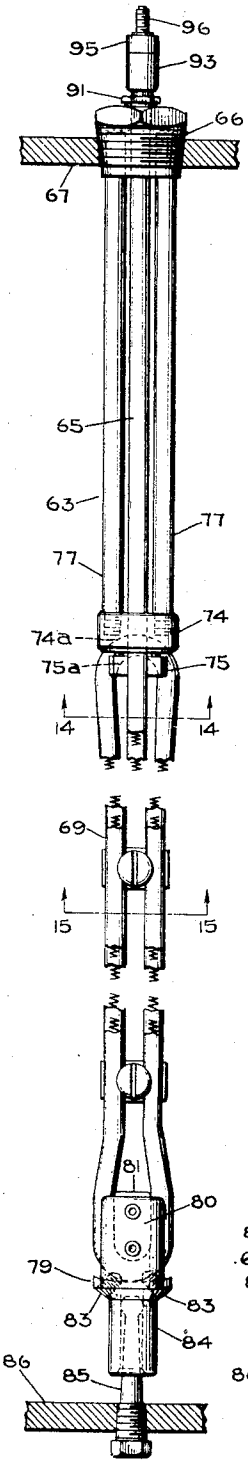


Fig. 11.

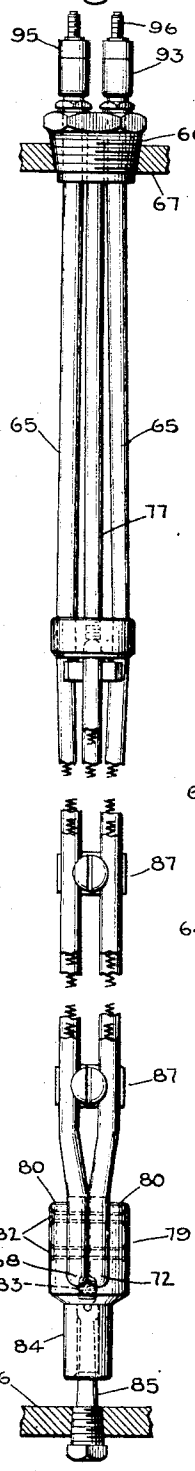


Fig. 16.

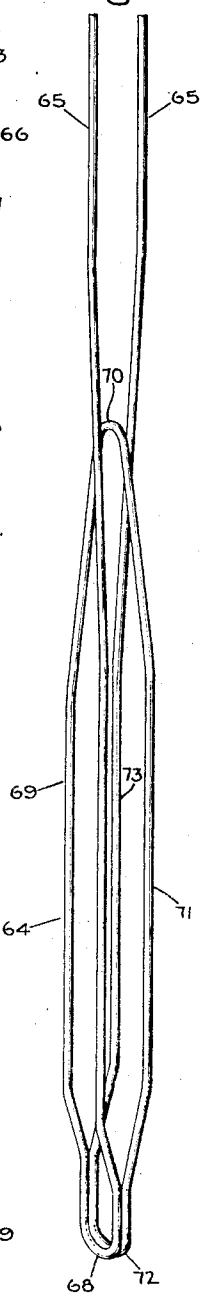


Fig. 12.

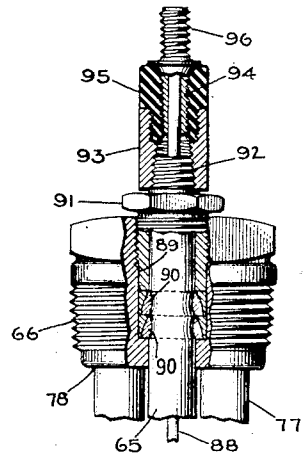


Fig. 13.

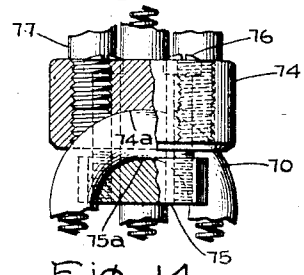


Fig. 14.

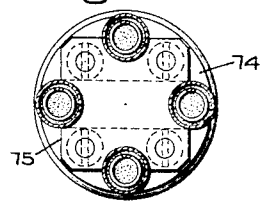
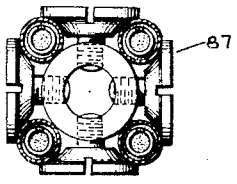


Fig. 15.



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Patented Oct. 18, 1938

2,133,838

UNITED STATES PATENT OFFICE

2,133,838

ELECTRIC HEATER

Charles C. Abbott, Pittsfield, Mass., assignor to General Electric Company, a corporation of New York

Application August 12, 1936, Serial No. 95,574

13 Claims. (Cl. 219—38)

This invention relates to electric heaters, and it has for its object the provision of an improved electric heater for steam boilers and the like.

More specifically, this invention relates to electrically sheathed heating units such as described and claimed in my United States Patent No. 1,367,341, dated February 1, 1921, and contemplates the provision of an improved heater of this character particularly useful for heating liquids in a closed container, such as water in a steam boiler.

The invention comprehends an improved heater structure of this character per se whereby a highly concentrated energy input is provided; and also improved means for sealing the terminals for the heater. Moreover, this invention comprehends the provision of an improved organization of heaters and boiler involving improved means for mounting the heaters in the boiler, and of an improved arrangement of heating elements in the boiler to effect a more efficient and satisfactory application of heat to the liquid in the boiler.

In accordance with this invention, the sheathed heaters in one form thereof are supported at their terminal ends by means of suitable metallic plugs adapted to close apertures provided for them in a wall of the boiler. The opposite ends of the heating elements are secured to suitable clamping or securing devices which in turn are secured to a wall of the boiler so as to prevent lateral displacement of the elements with reference to the boiler.

The heating elements are preferably positioned in a circle about the boiler stays. Mounted on each stay is a circulating tube providing for thermal flow of the cooler liquid at the top of the boiler down to the lower portions thereof for heating by the heating elements.

The improved terminal sealing means includes an improved organization of parts having a vitreous compound interposed between the sheath and terminal of the heater. Preferably, the vitreous compound will consist chiefly of mica and glass.

For a more complete understanding of this invention, reference should be had to the accompanying drawings in which Fig. 1 is a plan view of a boiler provided with electrical heating elements, arranged in accordance with this invention, parts being broken away so as to illustrate certain structural details; Fig. 2 is an elevation of the boiler of Fig. 1, with parts being broken away so as to illustrate certain details of construction; Fig. 3 is an enlarged fragmentary elevation of a heating element used in the boiler of Figs. 1 and 2 and arranged in accordance with this invention; Fig. 4 is an enlarged elevation mainly in section of a part of the heater of Fig. 3 illustrating the terminals and the sealing means for the terminals arranged in accordance with this invention; Fig. 5 is a plan view of the organization shown in Fig. 4; Fig. 6 is a sectional view taken through the line 6—6 of Fig. 3 and looking in the direction of the arrows; Fig. 7 is a view similar to Fig. 4 but illustrating a modified form of this invention; Fig. 8 is a plan view of the organization shown in Fig. 7; Fig. 9 is a sectional view taken through the line 9—9 of Fig. 3 and looking in the direction of the arrows; Fig. 10 is an elevation illustrating a modified form of electric heating element arranged in accordance with this invention; Fig. 11 is a fragmentary view in elevation at right angles to Fig. 10; Fig. 12 is a fragmentary elevation mainly in section of a portion of the heating element of Figs. 10 and 11 illustrating the terminal structure and sealing means therefor; Fig. 13 is a fragmentary elevation illustrating a part of the heater shown in Figs. 10 and 11, parts being shown in section so as to illustrate certain details of construction; Fig. 14 is a sectional view taken through the line 14—14 of Fig. 10 and looking in the direction of the arrows; Fig. 15 is a sectional view taken through the line 15—15 of Fig. 10 and looking in the direction of the arrows; and Fig. 16 is a fragmentary perspective view of the heating element of Figs. 10 to 15.

Referring more particularly to Figs. 1 and 2, this invention has been shown as applied to a steam boiler 10 of the vertical type intended to be used in an electric locomotive. The boiler 10, as shown, is provided with a cylindrical side wall 11 which may be closed at the top and bottom by cover members 12 and 13. Headers 14 and 15 are arranged within the boiler spaced from the covers 12 and 13 respectively, as shown in Fig. 2. The headers are provided with flanges, as shown, bearing against the inner surface of the side walls, and these flanges are secured to this surface in any suitable manner, as by welding. The headers are tied together by means of a plurality of tie rods 16.

A plurality of electrical heaters 17 are arranged in the boiler. As shown in Figs. 3 and 4, each of the heaters 17 comprises a metallic supporting member 18 in the form of a screw plug adapted to be fitted in a threaded aperture 19 provided for it in the wall or header 14 of the boiler. Two sheathed heating elements 20

and 21 are mounted on each plug 18. The elements 20 and 21 are of the sheathed type such as described and claimed in my above-mentioned Patent No. 1,367,341. The resistance conductor 22 of the heater is in helical form and is embedded in and supported in spaced relation with reference to a metallic sheath 23 by a heat refractory electrically insulating material 24 (Fig. 4) that is compacted to a hard dense mass within the sheath. Sheathed heating elements of this character can be easily formed or bent into any suitable shape. As shown, the heating elements are formed substantially in the shape of a hair-pin, the two legs of the hair-pin being received in the plug and the bends of the element being opposite the plug. Preferably, the legs of the two elements will be in planes arranged substantially at right angles to each other, as shown, and the bend of the element 21 will be placed slightly above the bend of the element 20.

The plug 18, as shown, is provided with passageways or apertures 25 therethrough through which the two end portions of the legs of the elements 20 and 21 are directed so as to project through the plug onto the opposite side, as clearly shown in Fig. 4. It is within these ends that the terminals 26 of the heater are provided. These terminals are electrically connected with the resistance conductor 22 in any suitable manner, but preferably will be provided with threads on which the end turns of the resistance conductor are wound, as shown in Fig. 3, and as described and claimed in my U. S. Patent No. 1,494,938, dated May 20, 1924.

Preferably and as shown in Fig. 4, the sheath 25 will be provided with an outer protective sheath 27 fitted tightly on the inner sheath as described and claimed in my United States Patent No. 2,036,788, dated April 7, 1936. The casing 27 will be formed of a suitable non-corrosive metal, such as a zinc-tin-copper alloy; one alloy of this character that is satisfactory is admiralty metal. The outer sheath 27 is secured to the plug 18 with a fluid-tight joint 28 formed in any suitable manner, as by brazing.

In order to prevent lateral displacement of the heater due to swaying and movement of the locomotive on which the boiler is mounted, a suitable metallic anchor member 29 is provided at the bends of the hair-pin elements 20 and 21. This member 29 has an upper hollow cylindrical portion 30 provided with oppositely arranged pairs of slots 31 and 32 in its side walls to receive the legs of the heating elements 20 and 21 respectively, as shown in Fig. 3. The bends of the two units are received in the hollow member. Directly above the inner surface of the bend of the heating element 21 is arranged a transverse pin 33 supported at its ends in the walls of the member 30. Placed somewhat above this and arranged substantially at right angles thereto is another pin 34 also supported by the walls of the member 30. The chamber 30 is filled with an expanding alloy 35, such as Babbitt metal containing a sufficient amount of antimony to cause it to expand when it cools. It will be understood that this Babbitt metal is poured into tthe chamber 30 in the liquid state and then is allowed to cool; as the metal 35 cools, it expands to fill all the cracks and crevices between the heating elements and the chamber and between the heating elements themselves. Preferably, the walls of the chamber 30 will be threaded, as shown, which will be filled with the metal 35; this arrangement firmly anchors the member 29 to the heater elements and prevents the metal 35 from expanding upwardly.

The anchor member 29 also has a tubular extension 36 in alignment with the chamber 30 and adapted to receive an anchoring pin 37 rigidly secured to the bottom header 15. The pin 37, as shown, has a threaded section 38 received in a tapped bore provided for it in the header. The extension 36 is provided with a vent hole 39 to permit air to escape when the sleeve 36 is applied to the anchor pin. The pin 37 secures the heater against swaying in the boiler, but permits longitudinal movement of the member 29 as the heater expands and contracts.

Interposed between the anchor member 29 and the plug 18 are a plurality of spacer members 40. The spacer members 40 comprise rings 41 (Fig. 6), mounted between the legs of the heater elements 20 and 21, and four set screws 42 threaded in the rings between adjacent legs, as clearly shown in Fig. 6. Preferably, the inner surfaces of the screw heads will be curved to conform substantially with the curvature of the sheath wall portions that they engage; and preferably, the portions of the heads between the legs of the heater will be bent or forced inwardly to prevent the screws from loosening. Any suitable number of spacers may be used, but it is desirable that a sufficient number be used to space the legs of the heater apart to such an extent that the water can freely circulate around and about the heating elements.

The sealing means at the terminal ends of the heater comprises a metallic cupped member 44 having a chamber 45 in the upper end thereof, and its lower end receive in a recess 45a provided in the plug 18. This member 45 is provided with apertures receiving the upper ends of the heating elements, as shown in Fig. 4, and is secured to the sheaths by fluid-tight joints 46 formed in any suitable manner, as by brazing. Surrounding each terminal 26 is a metallic core 47. Substantially filling the chamber 45 and the spaces between the metallic cores 47 and between the cores and the walls of the chamber is a substantially homogeneous mass of vitreous material 48. Preferably, this vitreous material 48 will consist chiefly of glass and mica, and preferably it will be related to the cores 47 and the wall of the casing 45 substantially as described and claimed in the United States patents to J. W. Case Nos. 1,888,071 and 1,974,298. As described in these patents, the cores and wall of the case will be provided with external and internal threads respectively. It will be understood that the sealing mass 48 electrically insulates the terminals from the sheath.

The terminals 26, as shown, project from the upper surface of the sealing material 48 and to these ends suitable connector bars 49 are electrically connected as by brazed joints 50. It will be understood that the connector members may connect the heaters in any suitable manner, but preferably they will be arranged to connect the heaters in parallel. Each connector bar 49 has a terminal stud 51 rigidly secured thereto.

In Figs. 7 and 8 there is illustrated a modified form of terminal seal. In this form, the terminals 52 are provided with portions bent substantially at right angles to the body of the terminals and toward each other, as clearly shown in Fig. 7. The ends of these bent portions are received in a passageway provided in a terminal member 53, and are rigidly secured to the terminal member in any suitable manner, as by brazing 54. Sur-

rounding the terminals is a metallic sleeve 55 which has a fluid tight joint 56 with the supporting plug 57. This joint may be formed in any suitable manner, as by brazing. The sheaths themselves are also brazed to the plug 57 to form tight joints 58. Surrounding the terminal member 53 is a metallic core or sleeve 59. Interposed between this core and the sleeve 55 is a mass of sealing material 60 similar to the mass 48 of Fig. 4. The sleeve 59 is secured to the terminal member 53 by means of a fluid-tight brazed joint 61. Generally the sleeve 55, core 59 and sealing mass 60 will be made as a unit before assembly with the heater, and will be assembled as a unit. When the sleeve 55 is brazed to the plug, the space within the sleeve is vented through an opening 61*a* which is subsequently closed by brazing material.

A relatively large number of heating units are used in the locomotive boiler 11 shown in Figs. 1 and 2 in order to provide a comparatively large energy input to the boiler. In the particular example shown in these figures, it is contemplated that the boiler will be about 5' high and 5' in diameter. Within a boiler of this size, it is contemplated that there will be approximately 140 heating units, each having a capacity of twelve kilowatts.

Where such a large energy input is introduced into a boiler, it is possible that the heating units will impart heat to the water so rapidly that the heated water will rise in large volumes and in doing so will conflict with the cooler currents attempting to flow down into the boiler with the result that there will be considerable turbulence accompanied by the formation of steam pockets. In order to avoid this, and in order to permit the cooler currents to flow downwardly separate from the heated currents of water flowing upwardly, the heating elements 17 are arranged in a circle about each of the stay bolts 16, as shown in Fig. 1. As shown in this figure, there are six heating units about each stay bolt, two units in each case being common to two circles of adjacent units. Mounted on each stay bolt within the circle of heating units is a tubular member 62. In the operation of the boiler, the water level generally will be at the line designated A. The terminals 26 will extend down substantially to the upper end of the tubes 62 so that the active heat generating positions of the heating elements extend through the full length of the tubes. The water adjacent the heating elements is heated and due to thermal head rises upwardly in paths that flow adjacent the units, whereas the cooler water flows downwardly through the tubes in paths removed from the more highly heated paths adjacent the heating units. In other words, the tubes 62 constitute return paths for the cooler water so that it can flow downwardly without interference from the heated water that flows up adjacent the units. The tubes may be secured to the stay bolts in any suitable manner, as by means of spiders 62*a*.

In Figs. 10 to 15 inclusive there is illustrated another form of heating unit. In this case, a single heating element 63 is used. The element 63 is of the sheath wire type, as described and claimed in my above-mentioned Patent No. 1,367,341. The heating element 63 is formed so as to have an elongated loop portion 64 at its lower end, and two ends 65 extending a material distance from the loop portion 64 to a supporting plug 66 which serves to mount the unit in the receptacle wall 67. As shown, the loop 64 may be traced from one of the legs 65 downwardly as viewed in Fig. 10 to the bottom of the heater where it is bent, as indicated by the numeral 68 to return upon itself and thereby define an upright length 69 of the loop; this length terminates in a bend 70 from which the element is directed downwardly to define a length 71 which in turn terminates in a lower bend 72 from which bend the element extends upwardly in a length 73 which merges in the other straight portion 65 attached to the plug.

In order to make a rigid and stabilized unit, the upper bend 70 is rigidly secured to the two straight portions 65 of the heater and also to the supporting plug 66. For this purpose, a pair of metallic clamping members 74 and 75 are provided. The clamping member 74 is positioned on the side of the bend 70 adjacent the plug, whereas the other member 75 is positioned on the opposite side of the bend. The members 74 and 75 are provided with recesses 74*a* and 75*a* conforming to the surfaces of the bends which they engage, as clearly shown in Figs. 10, 11 and 13. The two clamping members are secured in their clamping relation, as shown in Fig. 13, by means of a plurality of studs 76 directed through apertures provided for them in the clamp 74 and received in threaded engagement in the clamp 75. The clamping device 74 is rigidly secured to the plug 66 by means of a pair of rods 77 having threaded connections at their lower ends with the clamping member 74 and having their upper ends directed into apertures provided for them in the plug 66 and secured to the plug in any suitable manner, as by means of arc welded joints 78. Preferably, the parts will be so arranged that the rods 77 will lie in a plane substantially at right angles to the plane of the straight portion 66, and the loop and clamping devices will be so arranged that the plane of the bends 68, 70 and 72 will also be arranged substantially at right angles to the plane of the straight portions 65.

The bends 68 and 72 are anchored by means of an anchoring device comprising a metallic clamp 79 having legs 80 embracing opposite sides of the bends 68 and 72, as shown more clearly in Fig. 11. Positioned above the inner sides of these bends is a metallic insert 81 shaped to conform to the bends, as shown in Fig. 10. This insert is secured by means of a pair of pins 82 arranged transversely of the clamp as shown in Fig. 11. Positioned under the bends and preferably between them are a pair of set screws 83 which are turned in to draw the insert 80 tightly against the upper surfaces of the bends. The clamping device 79 is provided with a depending tubular extension 84 in which an anchoring pin 85 is received. The anchoring pin 85 is rigidly secured to a wall 86 of the boiler, which as in the first case may be the lower head of the boiler.

Suitable spacer members 87 (Fig. 15) similar to those described in the first form of this invention are interposed at spaced intervals between the clamping device 74, 75 and the anchoring means 79, 85.

In this form of the invention, the terminals 88 extend through the straight portions 65 of the heating element substantially to the clamping device 74, 75 where they are attached to the resistance conductor.

In this case, the straight lengths 65 of the heater are received in passageways 89 provided for them in the plug 66. Arranged within each passageway are two pairs of reversely arranged wedge rings 90 hammered into place in tight me-

chanical relation with the sheath and the walls of the passageway to define a fluid-tight connection between the heater and the plug, as clearly shown in Fig. 12. Threaded in the passageways 89 over the wedge members 90 are bushings 91. The upper end of the straight sections 65 project above these bushings and are provided with threaded sections 92. Threaded on each section 92 is a metallic sleeve 93. Arranged within the sleeve 93 and mounted on the terminal 88 is a metallic core 94. Arranged between the sleeve 93 and the core 94 is a mass of vitreous sealing material 95 of the same type as used in the previous forms of this invention. The core 94 is secured to the terminal 88 so as to have a fluid-tight connection with it by brazing, or any other equivalent connecting means. The core in this case has a solid metallic extension 96 that is threaded. This extension constitutes a terminal connection means for the heater.

While I have shown particular embodiments of my invention, it will be understood, of course, that I do not wish to be limited thereto since many modifications may be made, and I, therefore, contemplate by the appended claims to cover any such modifications as fall within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States, is:

1. An electric heater for steam boilers and the like comprising a resistance conductor, a metallic sheath encasing said resistance conductor, a support secured to said sheath, an anchor member receiving a portion of said sheath removed from said support, an expanding metal in said anchor member embedding the portion of said sheath in said member and means preventing lateral movement of said anchor member in said boiler.

2. An electric heater for steam boilers and the like comprising a metallic sheath of substantially hair-pin shape, a resistance conductor in said sheath, a plug support attached to the legs of said sheath, a metallic plug having a chamber in which the bend of said sheath is received, a pin arranged transversely of said chamber above said bend and an expanding metal in said chamber embedding said bend and said pin.

3. An electric heater for steam boilers and the like comprising a screw plug adapted to be threaded in an aperture provided for it in a wall of the boiler, a pair of hair-pin shaped sheathed heating elements having their legs extending through spaced apertures in said plug so that the major portions of said legs and their bends are located in said boiler, the planes of the legs of the two heating elements being substantially at right angles to each other and intersecting substantially in the central axis of said plug, and the bend of one heating element being arranged above the bend of the other, a hollow cylindrical member receiving said bends and having pairs of slots in its side walls to receive the legs respectively of said elements, pins mounted in said walls extending transversely through said chamber above said bends, an expanding metal in said chamber embedding said bends and said pins in said chamber, a hollow extension on said member, and a pin loosely fitted in said extension and adapted to be mounted in a wall of said boiler to stabilize said heating elements.

4. An electric heater comprising a heating element having a plurality of legs, a spacer ring between said legs and set screws between adjacent legs threaded into said ring and having enlarged heads engaging said adjacent legs so as to clamp them to said ring.

5. An electric heater for steam boilers and the like comprising a screw plug adapted to be threaded in an aperture provided for it in a wall of said boiler, a pair of hair-pin shaped sheathed heating elements having their legs extending through spaced apertures in said plug so that the major portions of said legs and their bends are located in said boiler, the planes of the legs of the two heating elements being substantially at right angles to each other and intersecting substantially in the central axis of said plug, and the bend of one heater being arranged above the bend of the other, spacer rings between said legs, and set screws between adjacent legs threaded into said rings and having enlarged heads engaging said adjacent legs so as to clamp them to said ring.

6. An electric heater comprising a support having apertures therein, a sheathed heating element formed into a loop and having its legs received in said apertures, means securing said legs to said support, a member secured to the legs of said loop at a point relatively removed from said support, and a rigid reenforcing rod having its opposite ends secured to said member and to said support.

7. An electric heater for boilers and the like comprising a metallic plug support adapted to close an aperture in said boiler having a plurality of spaced apertures, a sheathed heating element having parts extending into said apertures and secured to said support so that said element is supported in said boiler, a metallic member removed from said plug support having spaced apertures receiving parts of said heating element, and a plurality of rods, each having one end threaded into said metallic member and its other end rigidly secured to said metallic plug.

8. An electric heater comprising a plug support adapted to close an aperture in a container, a sheathed heater formed with an elongated loop and having a pair of legs extending from said loop, the ends of said legs being received in spaced apertures provided for them in said plug support, a clamping member on one side of the bend in said loop nearest said plug having a recess fitted to said side of said bend, rods rigidly securing said clamping member to said plug, a second clamping member on the other side of said bend having a recess receiving said side, and means rigidly securing said clamping members together.

9. An electric heater for boilers and the like comprising a plug support adapted to be fitted in an aperture in a container, a sheathed heater having an elongated loop and a pair of legs extending a material distance from said loop to said plug support where the ends of said legs are attached to said plug support, the bends of said loop lying in a plane substantially at right angles to the plane of said pair of legs, a pair of clamping members on the opposite sides of the bend of said loop nearest said plug having recesses receiving said sides, means securing said clamping members together, a pair of rods in a plane substantially at right angles to the plane of said pair of legs, each having one end threaded in said clamping member nearest said plug and its other end secured to said plug support, a clamping member at the other end of said loop clamping the bends thereof together, spacers between the ends of said loop holding the legs of said loop between the bends thereof in prede-

termined spaced relation, a resistance conductor in the loop portion of said sheath and terminals in said pair of legs connected with said resistance conductor.

10. An electric heater comprising a metallic support having an aperture therein, a metallically sheathed heater having a terminal end inserted through said aperture to project from one side thereof, a terminal projecting from said end, a metallic member in said aperture wedged between said sheath and metallic support to secure said sheath to said support with a fluid tight joint between them, a metallic sleeve secured to the end of said sheath and having a fluid-tight joint with it, a metallic core within said sleeve in spaced relation with it and secured to said terminal with a fluid-tight joint, and a vitreous compound consisting substantially of mica and glass between said core and sleeve adhering to their surfaces.

11. An electric heater comprising a metallic support having an aperture therein, a metallically sheathed heater having a terminal end inserted through said aperture to project from one side thereof, a terminal projecting from said end, a fluid-tight joint between said sheath and said support, a cupped metallic member fitted about said sheath so that said sheath extends into the chamber of said member, a fluid-tight joint between said cupped member and said sheath, a metallic core on said terminal and a mass of vitreous compound consisting substantially of mica and glass in said chamber embedding the end of said sheath and adhering to the walls of said chamber and of said metallic core.

12. An electric heater comprising a plug support, an electric heating element having sheathed terminal ends extending through apertures in said support to project from one side thereof, a metallic sleeve around said ends mounted on said support, a fluid-tight joint between said sleeve and said support, terminals projecting from said ends bent toward each other, a common terminal connector member for said terminals connected to the bent portions of said terminals, a metallic sleeve around said connector member, a fluid-tight seal between said sleeve and connector member, and a vitreous compound between said metallic sleeves adhering to their surfaces and having an internal cavity in which said bent portions of said terminals are received.

13. An electric heater comprising a resistance conductor, a metallic sheath housing the conductor, heat conducting, electrically insulating material in said sheath between the walls of the sheath and the resistance conductor, a terminal for said resistance conductor projecting from the end of said sheath, a cupped metallic member fitted about said sheath so that said sheath extends into the chamber of said member, a fluid-tight joint between said cupped member and said sheath, a metallic core on said terminal, and a mass of vitreous compound consisting substantially of mica and glass in said chamber embedding the end of said sheath and adhering to the walls of said chamber and of said metallic core.

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