April 11, 1939. V. W. MORAY 2,154,178

FLUID HEATER

Filed Sept. 21, 1935 4 Sheets-Sheet 1

Fig. 1.

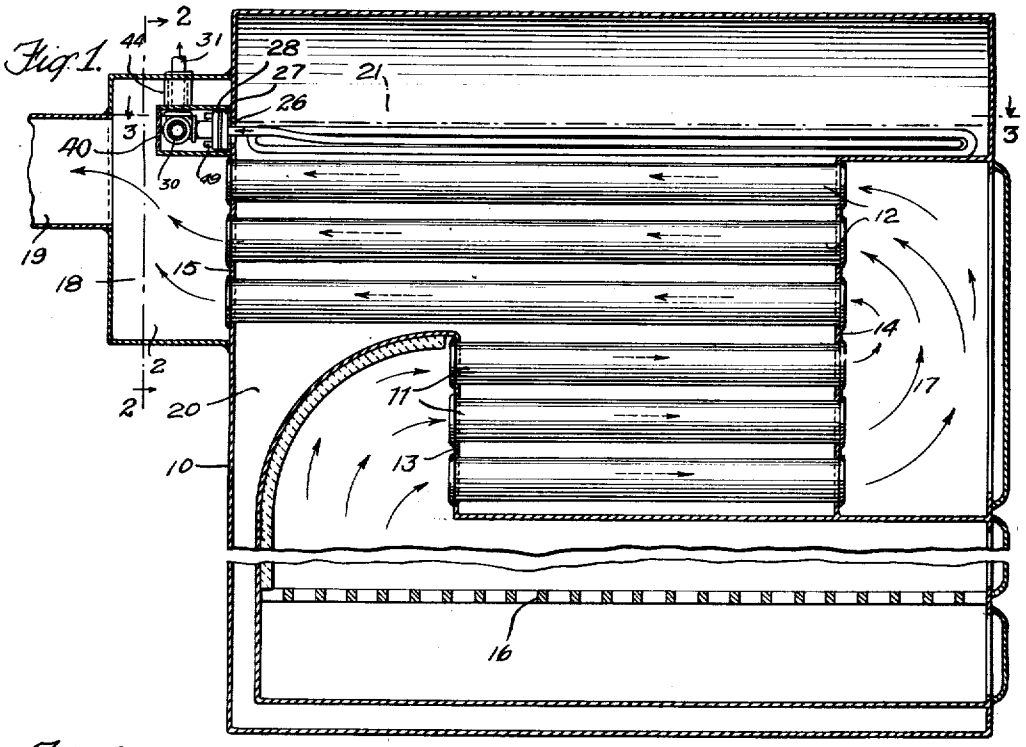
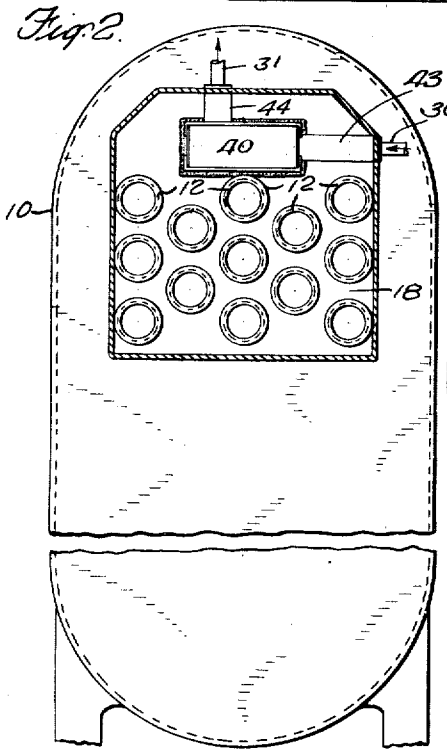



Fig. 2.



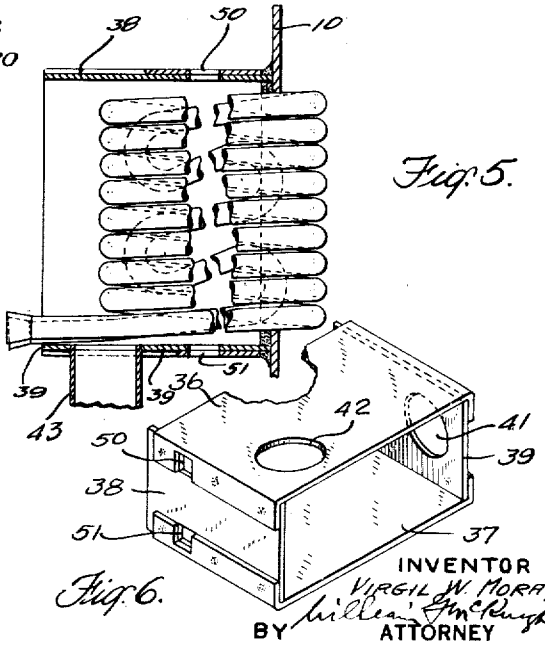




Fig. 5.

Fig. 6.

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FLUID HEATER

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Fig. 3.

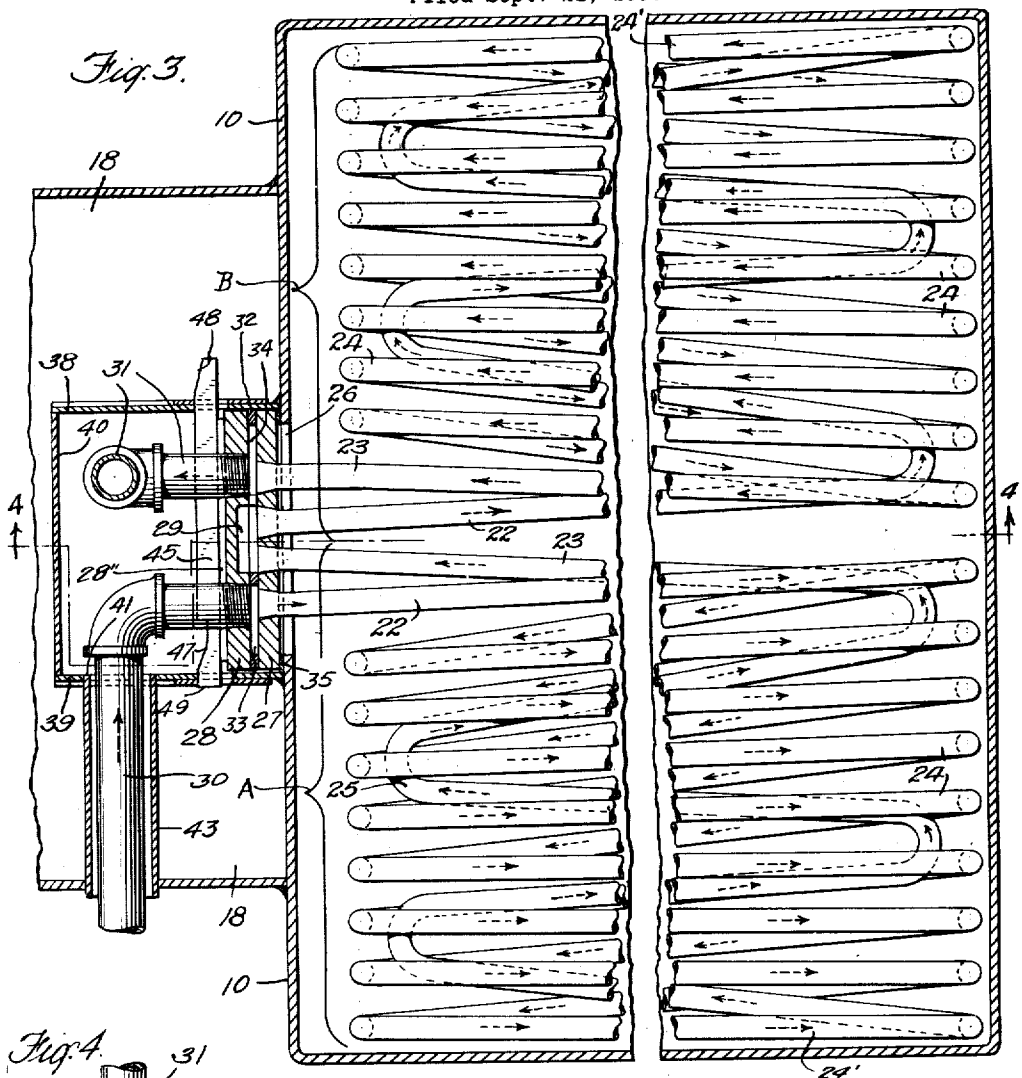
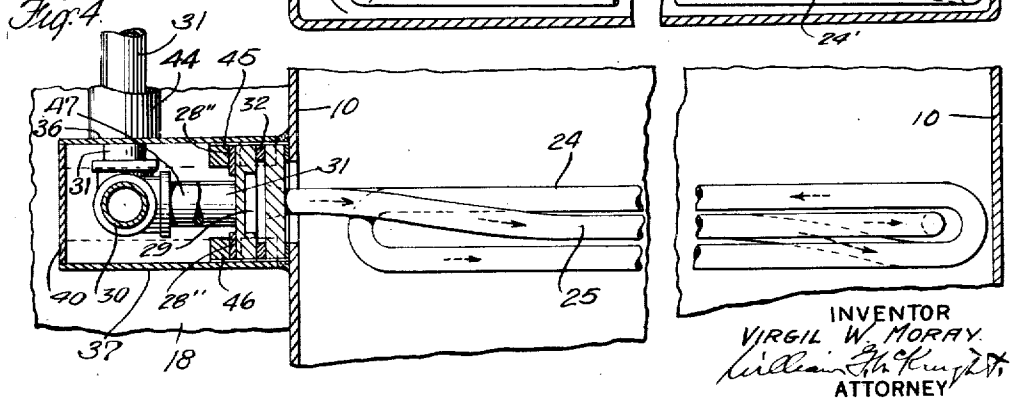



Fig. 4




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FLUID HEATER

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Fig. 7.

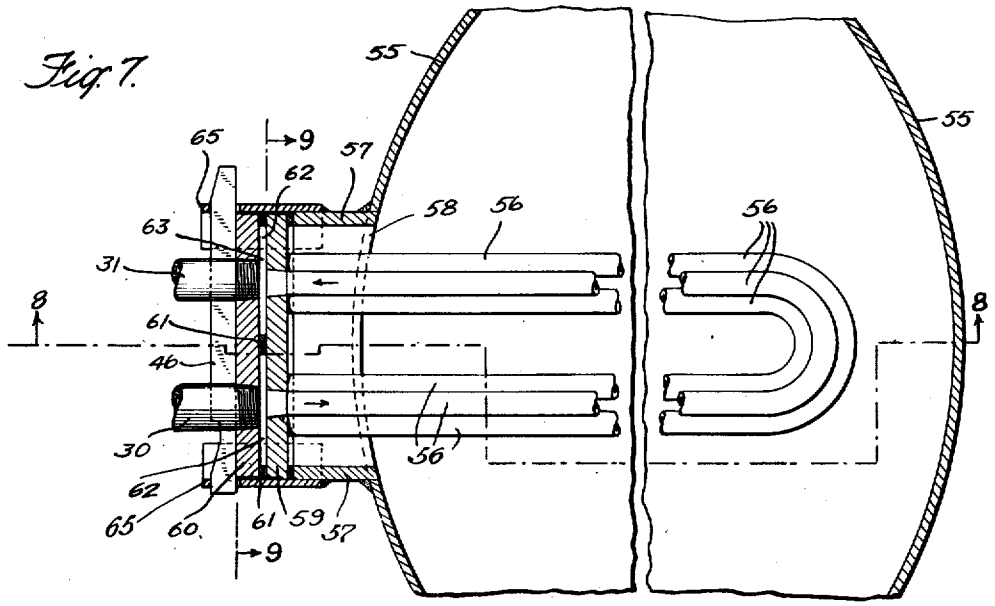
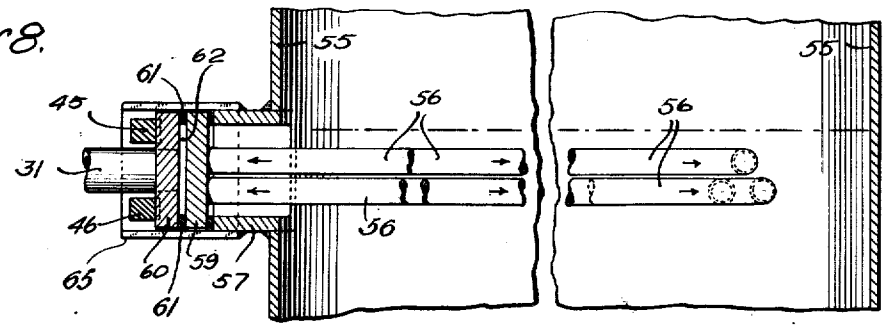



Fig. 8.



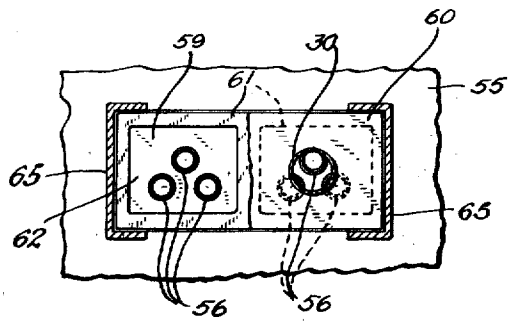




Fig. 9.

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FLUID HEATER

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Fig. 10.

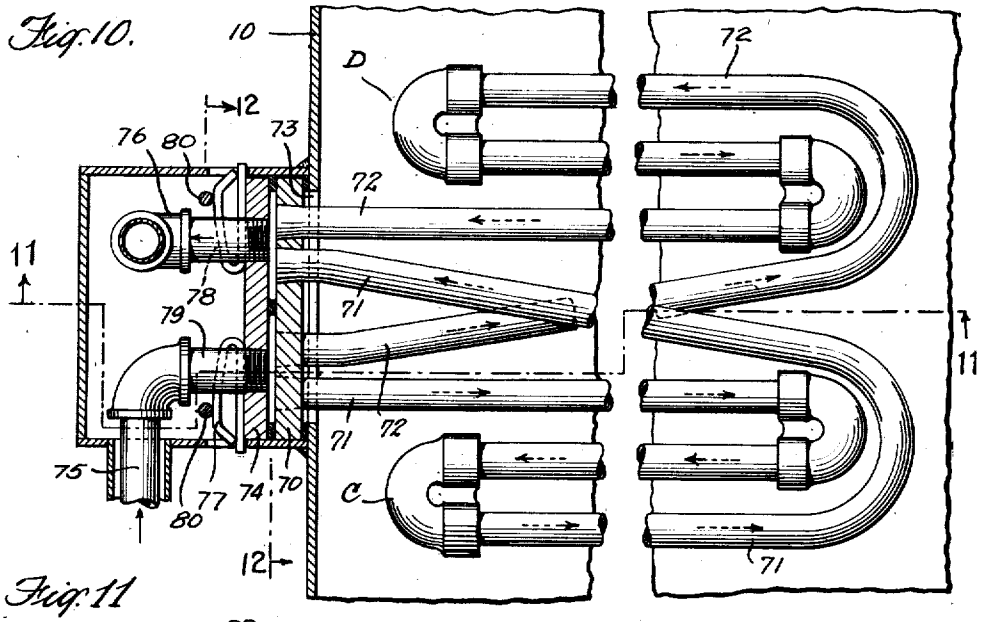



Fig. 11

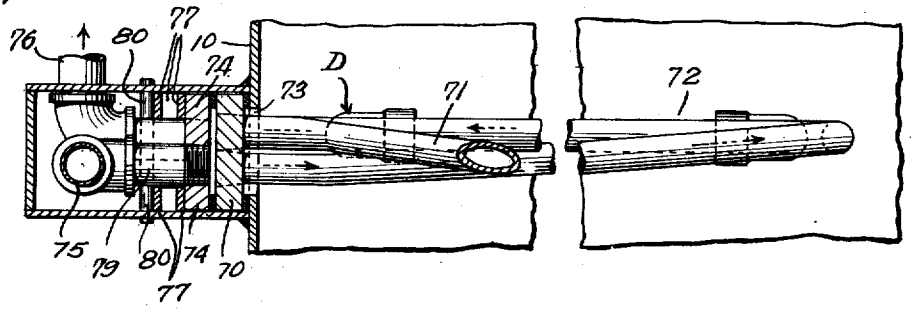



Fig. 12.

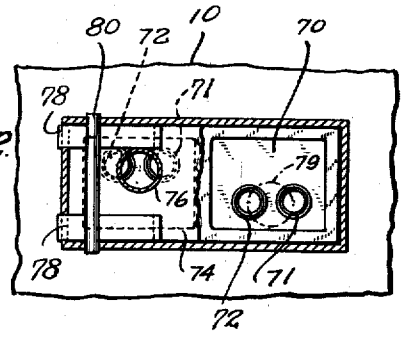
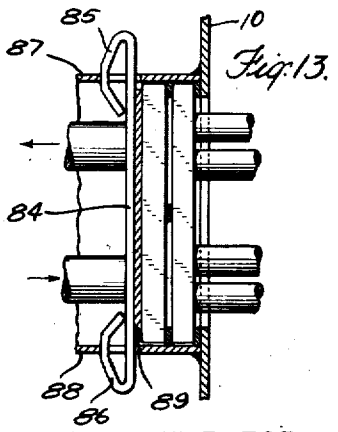



Fig. 13.




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Patented Apr. 11, 1939

2,154,178

# UNITED STATES PATENT OFFICE

2,154,178

## FLUID HEATER

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Application September 21, 1935, Serial No. 41,533

15 Claims. (Cl. 257—236)

This invention relates to heat exchange equipment and more particularly pertains to auxiliary fluid heating coils for steam boilers, water heaters or the like.

In general, fluid heating coils of this character have had but small heating surface due primarily to practical difficulties in installing the coils in the boilers and in so constructing them that they may be removed. Ordinarily, a manhole or handhole has been provided through which the coil could be inserted and removed and another hole in the boiler was required for the pipe outlets of the coil. Additionally, the coil heads have usually been of cast metal and bolts have been utilized to secure the coil head parts together. In some instances the coil pipes have been expanded into the coil heads but to provide greater heating surface, brazing has been resorted to, but this method of securing the coil pipes to the heads proved too expensive for general use.

The present invention provides novel fluid heating coils of the character referred to and also provides a novel method of installing the coils in a steam boiler, water heater or the like. The coils of my invention are characterized by a relatively large heating surface, compactness, and small coil heads of wholly novel construction. Only one small opening in the boiler is required for each coil and the coils are readily installed and removed from boilers or water heaters.

The invention further provides novel resilient means for securing the coil heads in position in boilers or water heaters.

Further features and advantages of the invention will appear from the following description when considered in connection with the accompanying drawings forming a part thereof, in which:

Fig. 1 is a vertical sectional view of a fire tube boiler having an auxiliary fluid heating coil embodying the present invention.

Fig. 2 is a combined end elevational and sectional view, the latter being taken on line 2—2 of Fig. 1;

Fig. 3 is a horizontal sectional view on an enlarged scale, taken on line 3—3 of Fig. 1;

Fig. 4 is a vertical sectional view taken on line 4—4 of Fig. 3;

Fig. 5 is a partial plan view, with parts in section, of the heating coil and the coil head casing illustrating the method of installing the coil in a boiler;

Fig. 6 is a perspective view of the coil head casing;

Fig. 7 is a horizontal sectional view of a cylindrical shell steam boiler or water heater having another form of fluid heating coil embodying the invention;

Fig. 8 is a partial vertical sectional view taken on line 8—8 of Fig. 7;

Fig. 9 is a sectional view taken on line 9—9 of Fig. 7;

Fig. 10 is a horizontal sectional view similar to Fig. 3, showing another form of coil and coil head securing means;

Fig. 11 is a sectional view taken on line 11—11 of Fig. 10;

Fig. 12 is a sectional view taken on line 12—12 of Fig. 10, and

Fig. 13 is a partial sectional view showing another form of coil head securing means.

Like characters of reference refer to the same or similar parts throughout the several views.

Referring to the drawings, reference character 10 designates the shell of a fire tube boiler having an auxiliary fluid heating coil embodying features of the invention. The boiler has a plurality of fire tubes 11 and 12 extending between tube sheets 13, 14 and 15, all arranged to provide two passes for the products of combustion through the boiler. The boiler is provided with a grate 16, a transfer chamber 17 and a smoke box 18 to which the inlet end of a flue 19 is connected. Water fills the space 20 between the tubes 11 and 12 and is maintained at the level 21. It will be understood that this particular type of boiler is not essential to the invention, but that other types of boilers may be employed if desired.

Referring particularly to Figs. 1 to 6 inclusive, the coil illustrated is made in two sections indicated A and B, and is arranged to fill substantially the entire volume of the boiler above the boiler tubes and below the water level 21. Both sections are identically arranged but when installed in a boiler, are reversed, as shown. Each section consists of a fluid inlet lead 22 and an outlet lead 23 which are connected by a plurality of tube loops the latter of which are arranged to form a relatively flat helicoidal coil. The inlet lead of each section continues into a plurality of similar and adjacent laterally disposed elongated loops 24 and the outlet lead 23 connects with the most remote loop 24' through a plurality of straight portions connected together by return bends 25 which extend through the space bounded by the loops 24.

The sections A and B of the fluid heating coil are originally formed with the several loops 24 spaced to the extent it is desired they be spaced

when installed in the boiler. Just prior to inserting the coil section in the boiler, the sections are contracted sufficiently to permit them to be passed through an opening in the tube sheet or the shell of the boiler as illustrated in Fig. 5. The coil sections are inserted in the boiler above the fire tubes through an opening 26 in the tube sheet 10, which in this instance is rectangular in configuration and is only large enough to permit one of the coil sections to be readily passed therethrough. After the coil section, for example section A, has been passed through the opening 26 into the boiler, the several loops thereof spring apart to approximately their original spaced position, due to the resiliency of the metal of the tubes. After section A has been installed, section B is contracted and then passed through the opening 26 and expands to approximately its original condition. The leads 22 and 23 are brought into horizontal alignment and are thereafter expanded into a base plate 27 which forms part of the coil head. This plate is provided with the desired number of tube holes and the ends of the leads are passed through these holes and are expanded thereinto. The tubes may be brazed to the base plate instead of being expanded thereinto, if desired.

In the form of the invention disclosed in Figs. 1 to 6, applicant's novel coil head consists of two cooperating plate-like portions, one of which is the aforementioned base plate 27 and the other of which is the cooperating outer plate 28. Plates 27 and 28, as shown, are of rectangular configuration and are of rectangular cross-sectional configuration essentially. Base plate 27 is provided with tube holes to receive the coil leads 22 and 23, and plate 28 is recessed to provide a circular transfer chamber 29 and is further threaded at opposite sides of the recess 29 to receive the ends of fluid inlet pipe 30 and outlet pipe 31. One or more gaskets 32 are employed between the plates 27 and 28 to prevent leakage of the fluid flowing through the head; to separate the inlet and outlet chambers 33 and 34 respectively from the transfer chamber 29 and to maintain the head plates in spaced relationship to provide adequate volume for the inlet, transfer and outlet chambers. A suitable gasket 35 is employed between the shell or tube sheet 10 of the boiler and the plate 27 to prevent leakage therebetween. With this arrangement it will be seen that the entire coil head consists essentially of two cooperating plates which may be bar stock from the mill and which with simple machining operations may be finished to provide parts which cooperate to form the coil head. The simplicity and economy of manufacture possible with this coil head of my invention will be apparent.

In this instance the coil head is disposed in the smoke box 18 of the boiler and protecting means are provided to prevent corrosion of the head and its connections which would result from contact of the combustion gases with the metal parts of the head and its connections. As shown, the protective casing is rectangular in cross-section. The casing is fabricated from sheet metal parts which are secured together preferably by spot welding. The upper and lower portions 36 and 37 (see Fig. 6) of the casing consist of plates having short upstanding flanges at their ends and the sides 38 and 39 are flat plates which are secured by welding or otherwise to the flanges of the upper and lower portions. The casing is secured to the tube sheet 10 of the boiler so as to surround the opening 26 by welding the inner ends of the sides 38 and 39 and the upper and lower portions 36 and 37 thereto. The casing is so formed that the inner edges of the sides 38 and 39 only, engage the tube sheet when the casing is placed thereagainst so that the casing does not have to be made exactly square. The spaces between the tube sheet and the inner edges of the upper and lower portions are filled when the casing and these portions are welded in place. A sheet metal plate 40 having dimensions such that it forms a forced fit with the inner surface of the casing provides a cover for the outer end thereof. The casing is provided with an opening 41 in the side wall 39 to permit the coil inlet pipe 30 to pass therethrough. The upper portion 36 is also provided with an opening 42 through which the coil outlet pipe 31 passes. Pipes 30 and 31 pass through ventilating sleeves 43 and 44 respectively, which have their inner ends secured to the casing at the peripheries of the openings 41 and 42 respectively, and have their outer ends passing through and extending slightly beyond the smoke box 18.

The coil head casing is also utilized to aid in securing the coil head to the tube sheet 10 or to the shell of the boiler and to secure together the several plates of the head. In the form of the invention shown in Figs. 1 to 6, the means employed are two wedge bars 45 and 46 shown more particularly in Figs. 3 and 4. These wedge bars have a rectangular cross-section and are slightly longer than the length of the coil head and the width of the coil head casing. Each wedge bar is provided with a wedging surface 47 at one end and a wedging surface 48 at the other end, both wedging surfaces being inclined in the same direction. The wedging surface 47 is disposed slightly inwardly of the end of the wedge bar, as shown in Fig. 3, to provide a surface 49 which is parallel to the surface of the wedge bar which engages wear strips 28'', comprising thin metal strips disposed between the outer head plate and the wedges. Aligned wedge openings 50 and 51 are provided at the upper and lower portions of the coil head casing of sufficient area to accommodate the wedge bars 45 and 46. After the coil head has been placed in position and the coil head casing has been secured to the tube sheet 10 of the boiler and the wear strips 28'' are in place, the wedge bars are inserted through one side of the casing until the wedge surfaces 47 and 48 engage the cooperating edges of the openings 50 and 51. In this position the wedge bars engage the wear strips and when the outer ends of the wedge bars are driven inwardly, it will be seen that the action of the wedging surface on the casing will force the coil head plates together at the same time that the coil head or the base plate 27 is forced against the tube sheet 10 or the boiler shell. When driven in place, the wedge bars 45 and 46 arch somewhat between the points at which they are supported by the casing, due to the resiliency of the material of the wedge bars.

In installing the coil in the steam generator, an opening such as 26 is made in the tube sheet or shell 10 of the generator, one of the coil sections after having been contracted as illustrated in Fig. 5, is passed through the opening with the inlet and outlet leads positioned near the opening and the other section B after having been contracted, is then passed through the opening and is rested on the uppermost row of tubes 12 of the boiler in expanded condition with its inlet and outlet leads positioned near the opening 26.

The leads of both sections (now expanded) are passed through the tube holes in the base plate 27 of the coil head and are thereafter rolled into the base plate to secure them thereto. Prior to securing the coil section leads to the base plate, the gasket 35 is placed between the shell or tube sheet 10 and the base plate. Thereafter the coil head casing is secured to the shell or tube sheet 10 by welding preferably, gasket 32 is placed in position over the base plate 27, the cooperating outer head plate 28 is then placed in position, wear plates 28'' are disposed in contact with the coil head plate 28 and the wedge bars 45 and 46 are then passed through the casing as previously described, and are driven home to wedge the cooperating parts of the coil head together and simultaneously to secure the coil head to the shell or tube sheet 10. Thereafter, the inlet and outlet pipes 30 and 31 are attached to the plate 28 of the coil head and the ventilating sleeves 43 and 44 are placed in position. Finally the casing cover 40 is forced into position in the casing. The sequence of steps set forth hereinabove may be considered as the preferred method of installing the coil and its associated equipment in the generator or water heater, but the sequence may be varied if desired.

To remove the coil or any section thereof for cleaning or repair, the sequence of steps heretofore enumerated are reversed. Before any section of the coil may be removed, it must of course, be contracted to an extent sufficient to permit it to be passed through the opening 26.

The wear strips disposed between the coil head and the wedging means assist in the placing of the wedges in coil head securing position. Additionally they function to distribute the force exerted by the wedges on the coil head and thereby serve to prevent buckling or arching of the coil head plates.

Figs. 7, 8 and 9 illustrate the application of the invention to a steam generator or hot water heating boiler having a cylindrical shell 55. In this instance also the heating coil includes a plurality of U-bend tubes 56 instead of the "accordion" coils disclosed in Figs. 1 to 6. The coil head casing is the same as the coil head casing in Figs. 1 to 6, but an adapter 57 is employed through which the casing is secured to the boiler shell. Adapter 57 is of rectangular configuration in transverse cross-section and its outside dimensions are such that the coil head casing snugly fits over the outside end of the adapter. The inside or boiler end of the adapter 57 is shaped to fit the boiler shell and to enclose the opening 58 which is made therein so that the coil tubes 56 may be passed therethrough and installed in the boiler. The adapter is preferably welded to the boiler shell but may be secured thereto by other suitable means if desired. The base plate 59 of the coil head is the same as base plate 27 in Figs. 1 to 6, excepting that the tube holes are disposed to accommodate the ends of the U-bend tubes 56. The outer section 60 of the coil head is similar to plate 28 excepting that it is not recessed to provide a transfer chamber. The outer plate 60 is merely drilled and tapped to provide threaded openings for the inlet and outlet pipes 30 and 31. An extra thick gasket 61 is utilized to space the plates 59 and 60 apart to provide inlet and outlet chambers 62 and 63.

In the form of invention illustrated in Figs. 10, 11 and 12, the coil head is similar to the coil head disclosed in Figs. 1 to 6, with the exception that the outer head plate 74 is not recessed to provide a transfer chamber. The fluid heating coil is in two sections C and D, as in Figs. 1 to 6, and each section consists generally of double U-bend tubes 71 and 72. Each of these sections has an overall width, such that it may be passed through the opening 73 in the shell or tube sheet 10 of the boiler. In this case the coil sections are rigid, that is to say they are not arranged for expansion and contraction as the coil sections of Figs. 1 to 6 are arranged. The outer or cooperating plate 74 of the coil head is simply a rectangular strip or bar having overall dimensions substantially the same as those of the base plate 70, with threaded openings therein to receive the fluid inlet and outlet pipes 75 and 76, respectively. In this instance, a different form of wedging means is utilized to secure the coil head to the shell or tube sheet 10 and to force the cooperating parts of the head together. The wedging means consists of a plurality of resilient wedges 77, each of which consists of a single loop of spring steel or other suitable resilient material with the ends of the loop disposed so that they will come in contact as illustrated, when driven into securing position. The wedges 77 are arranged to provide a wedging surface 78 adjacent the loop end of the wedge and this wedging surface continues into a securing surface 79 which will be disposed substantially parallel to the surface of the wedge which engages the coil head plate 74 when the wedges are driven home. The wedges 77 cooperate with wedge pins 80 which are driven through suitable apertures in the upper and lower portions of the coil head casing. These pins are vertically disposed as shown, and each pin cooperates with two wedges 77 adjacent the upper and lower portions of the pin. In this form of the invention no wear plates are utilized between the wedges and the coil head, but such wear plates may be utilized if desired.

In the form of the invention shown in Fig. 13, the wedging member 84 consists of two resilient wedges 85 and 86 integral with each other. The wedging member and the wedges are so arranged that they cooperate with the side portions 87 and 88 of the coil head casing. Generally two wedging members 84 will be utilized sbstantially in the manner that the wedge bars 45 and 46 of Figs. 1 to 6 are utilized, but it will be understood that a single wedging member 84 may be employed to secure the coil head to the tube sheet or shell 10 and to secure the coil head sections together. As shown, wear plates 89 which are similar to the wear plates 63 and 64 of Figs. 7, 8 and 9 are utilized.

The resilient wedges, such as shown in Figs. 10 to 13 inclusive, as well as the wedge bars 45 and 46, are advantageous for the reason that they automatically take care of the expansion and construction of the coil head and the coil head casing with the result that fluid tightness is maintained and the life of the coil head gaskets are increased by virtue of the fact that the wedges maintain gasket tightness upon contraction after expansion of the coil head and its connected parts.

From the foregoing disclosure it will be perceived that I have provided a fluid heating coil which is compact, provides a large fluid heating surface and which may be installed and removed through a single relatively small opening in a boiler shell or in a tube sheet. My novel coil head construction is characterized by great simplicity and economy of manufacture by reason of the fact that the head may be made from sec-

tions of bar stock from a mill so that casting of the head or head parts is not necessary. The bar stock from the mill need only be subject to simple machining operations to prepare the bar stock for use as coil heads. The means herein disclosed for securing the coil head to the boiler shell or tube sheet and for securing the coil head parts together is also characterized by simplicity and economy of manufacture. Threaded members such as nuts and bolts or the like are not necessary and the securing means, the wedges, automatically take care of expansion and contraction of the coil head and its connected parts so that gasket tightness is maintained under all conditions.

When the coil heads are disposed in a smoke box of a fire tube boiler, the coil head casing provides means for adequately protecting the coil head and its connected parts from the corrosive action of the combustion gases. The casing is also ventilated so that any products of combustion which may leak into the casing are removed therefrom into the atmosphere. Additionally, the casing functions as a means for cooperating with the means for securing the coil head to the shell or tube sheet of the boiler and for securing the several parts of the coil head together, and further functions to reenforce the tube sheet or boiler shell around the opening provided for the coil.

Since changes and variations in the particular combinations of elements herein disclosed may be made without departing from the principles of the invention or transcending the scope thereof, it will be understood that the invention is not to be limited except by the scope of the appended claims.

What is claimed is:

1. Heat exchange apparatus comprising a shell, a fluid heating coil having tubes extending through an opening in the shell, a coil head connected to the tubes, a coil head casing around the opening and connected to the shell and wedging means directly engaging the casing for securing the coil head to the shell.

2. Heat exchange apparatus comprising a shell, a fluid heating coil having tubes extending through an opening in the shell, a coil head connected to the tubes and having a plurality of cooperating sections, a coil head casing around the opening and connected to the shell, and wedging means engaging the casing for securing the cooperating sections of the coil head together and for securing the coil head to the shell.

3. A heat exchange coil comprising a plurality of connected and adjacent loops arranged to form a relatively flat helicoidal coil and a return bend tube connected to one of said loops and extending through the space defined by said loops.

4. Heat exchange apparatus comprising a cylindrical shell, a fluid heating coil having tubes extending through an opening in the cylindrical wall of the shell, a coil head connected to the tube, a tubular adapter secured to the shell around the opening and a coil head casing secured to the adapter.

5. Heat exchange apparatus comprising a shell having an opening therein, a fluid heating coil extending through the opening, a head for the coil, a casing for the head having an opening therein, and wedging means inserted through said opening for securing the coil head in position against the shell.

6. A heat exchange coil comprising a plurality of connected and adjacent tube loops, tubular coil leads connected to the terminal loops of the coil, one of said leads extending through the space defined by the tubes forming said loops and having a part thereof disposed in proximity to the other lead, the portion of said one lead which lies within said loops having a return bend portion which permits the coil to be laterally expanded and contracted by movement of said loops toward and from each other without substantial displacement of the end of said lead.

7. Fluid heating apparatus including fluid conducting tubes connected to a head comprising two flat plates perforated solely for tube connections to the head, said tubes being connected to one of said plates, fluid inlet and outlet leads connected to the other plate, fluid sealing means intermediate the plates to space the plates apart to provide fluid chambers therebetween, and means exterior of said plates to hold said plates together.

8. Fluid heating apparatus including fluid conducting tubes connected to a head comprising a base plate and an outer plate, fluid sealing means intermediate the plates to space them apart to provide fluid chambers therebetween, and means for imposing pressure on the outer plate and independent of penetration of the base and outer plates for securing the head in position on the member with which it is to be used and for maintaining the plates in assembled relationship.

9. Heat exchange apparatus comprising a shell having an opening therein, a fluid heating coil extending through the opening, a head for the coil, and resilient wedging means comprising a loop of resilient material for securing the coil head in position against the shell.

10. Heat exchange apparatus comprising a shell having an opening therein, a fluid heating coil extending through the opening, a head for the coil, wedging means having a plurality of connected and spaced wedging surfaces, and means secured to the shell and acted against by said wedging means to secure the coil head in position against the shell.

11. Heat exchange apparatus comprising a shell having an opening therein, a fluid heating coil extending through the opening, a head for the coil, resilient wedging means, and means secured to the shell and acted against by said wedging means to secure the coil head in position against the shell.

12. Heat exchange apparatus comprising a shell having an opening therein, a fluid heating coil extending through the opening, a head for the coil, resilient wedging means, and means secured to the shell and acted against by said wedging means to secure the coil head in position against the shell, said wedging means comprising a loop of resilient material so arranged that one end of the loop engages another portion of the loop when the wedging means is in securing position.

13. Heat exchange apparatus comprising a shell having an opening therein, a fluid heating coil extending through the opening, a head for the coil, wedging means, and means secured to the shell and acted against by said wedging means to secure the coil head in position against the shell.

14. Heat exchange apparatus comprising a shell having an opening therein, a fluid heating coil extending through the opening, a head for the coil comprising a plurality of cooperating sections, wedging means, and means secured to the shell and acted against by said wedging means

to secure the cooperating sections of the coil head together and to secure the coil head in position against the shell.

15. Heat exchange apparatus comprising a plurality of separate coil sections each consisting of a plurality of connected and adjacent tube loops arranged to form a relatively flat helicoidal coil with tubular coil leads connected to the terminal loops of the coil and with one of said leads extending through the space defined by the tubes forming said loops and being bent to provide a resilient portion whereby said lead may be contracted and expanded, said lead having a part thereof disposed in proximity to the other lead, and a single coil head for all of said coil sections to which said leads are connected.

VIRGIL W. MORAY.

CERTIFICATE OF CORRECTION.

Patent No. 2,154,178. April 11, 1939.

VIRGIL W. MORAY.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 3, second column, line 47, for "sbstantially" read substantially; line 60, for "construction" read contraction; line 67-68, for "preceived" read perceived; page 4, first column, line 64, claim 4, for "tube" read tubes; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 16th day of May, A. D. 1939.

Henry Van Arsdale

(Seal) Acting Commissioner of Patents.

to secure the cooperating sections of the coil head together and to secure the coil head in position against the shell.

15. Heat exchange apparatus comprising a plurality of separate coil sections each consisting of a plurality of connected and adjacent tube loops arranged to form a relatively flat helicoidal coil with tubular coil leads connected to the terminal loops of the coil and with one of said leads extending through the space defined by the tubes forming said loops and being bent to provide a resilient portion whereby said lead may be contracted and expanded, said lead having a part thereof disposed in proximity to the other lead, and a single coil head for all of said coil sections to which said leads are connected.

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