Jan. 15, 1957 R. H. ASHLEY 2,777,194

METHOD OF FORMING FLUID PRESSURE SEAL BETWEEN ELEMENTS OF A CONTAINER HAVING AN INTERIOR COATING OF PORCELAIN ENAMEL

Filed Aug. 9, 1954 2 Sheets-Sheet 1

FIG. 2.

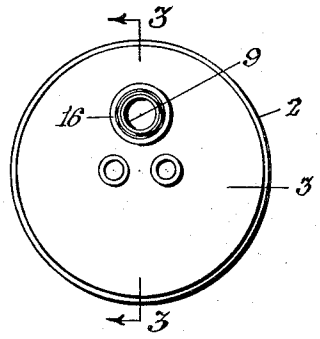


FIG. 1.

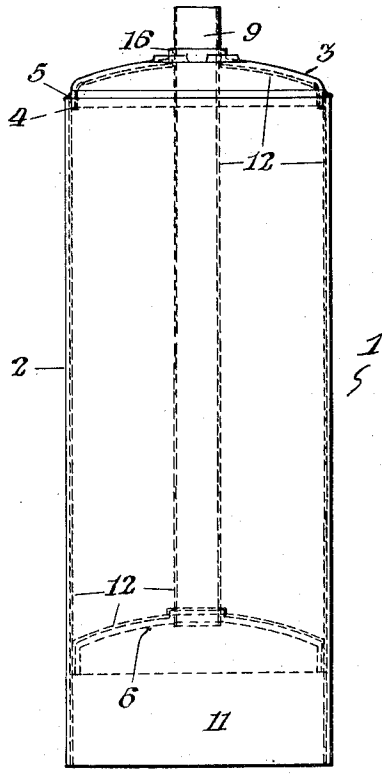


FIG. 6.



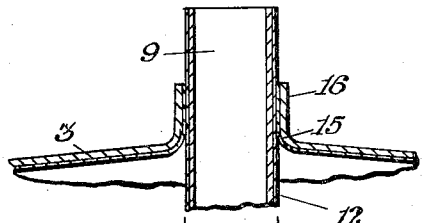
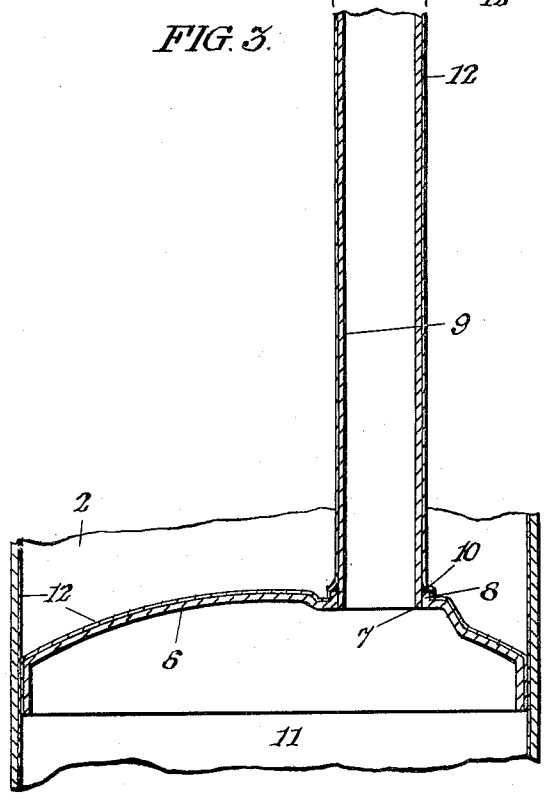


FIG. 3.



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FIG. 4.

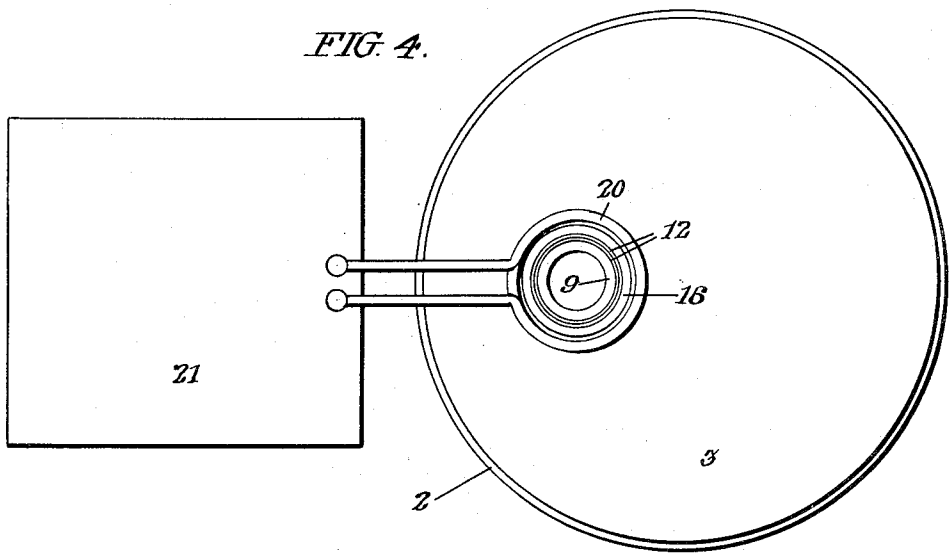


FIG. 5.

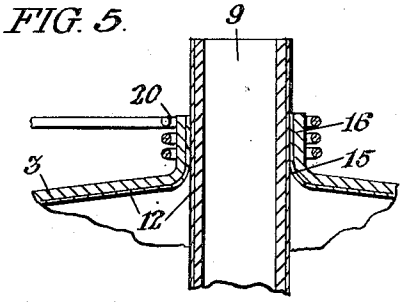


FIG. 7.

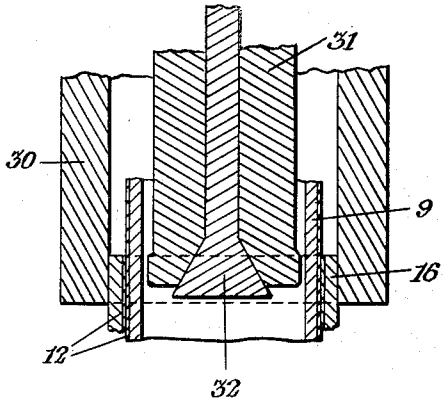
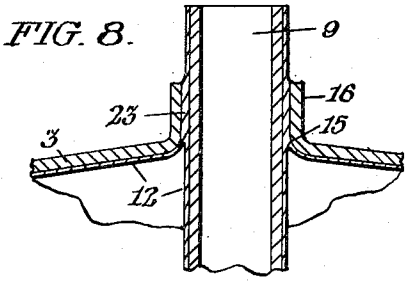


FIG. 8.



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2,777,194

METHOD OF FORMING FLUID PRESSURE SEAL BETWEEN ELEMENTS OF A CONTAINER HAVING AN INTERIOR COATING OF PORCELAIN ENAMEL

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Application August 9, 1954, Serial No. 448,723

11 Claims. (Cl. 29—458)

My invention relates generally to containers, and is particularly applicable to the production of water heater tanks which are coated on the interior surface with porcelain enamel, and to the production of other types of procelain enamel coated tanks, etc.

Most of the commercial domestic water heaters manufactured today either include a steel water tank which after fabrication is completely galvanized to provide the water tank with a corrosion resistant coating on its interior and exterior surfaces, or include a steel water tank which is provided with a corrosion resistant interior coating of porcelain enamel.

A relatively limited number of water heater tanks are made from non-ferrous metals, such as copper, or alloys such as Everdur or Monel metal, or from steel provided with a corrosion resistant cladding, or a steel tank with a non-ferrous liner. However, the cost of water tanks formed from such non-ferrous metals, clad steels, etc. is a very high as compared with the cost of a galvanized water tank or a water tank provided with an interior coating of porcelain enamel.

It is well known in the art that one of the difficulties encountered when the interior surfaces of a steel water tank are coated with an interior coating of porcelain enamel after the water tank has been completely fabricated is that it is impossible practically to properly inspect the interior procelain enamel coating to determine whether there are any defects in the coating. If the porcelain enamel coating be defective, when the water heater is put in use, electrolytic corrosion of the steel will set in where the coating is defective.

In order to overcome the difficulties encountered when the interior porcelain enamel coating is applied to the steel water tank after the water tank has been completely fabricated, it is now rather common practice to weld together the water tank steel head closure and the outer cylindrical steel shell as one subassembly; and the steel bottom closure and the steel cylindrical flue pipe as another subassembly. The two subassemblies, separately, are then provided with procelain enamel coatings on their surfaces which will be interior surfaces when the two subassemblies are welded together to form a water tank. The porcelain enamel coatings on such subassemblies may be inspected readily, before assembling them together, to determine whether there are any defects in the porcelain enamel coatings.

Said porcelain enamel coated subassemblies are assembled together by pressing the subassembly of the bottom closure and the flue tube into the shell, until a top portion of the flue tube extends through an outwardly flanged opening in the head closure. The flue tube and the top of the flanged opening are then circumferentially welded together by any of the well known electric or gas metal welding processes. The difficulty encountered is that the necessary welding heat conducted through the steel at and about the weld point will partially or wholly destroy the contacting porcelain enamel coatings on the interior of the outwardly extending flanged opening

in the head and on the exterior of the flue tube at, and for a certain distance away from, the point of weld. This is due to the fact that the metal welding temperatures for steel are considerably in excess of the melting point of the porcelain enamel coatings, which usually have a melting point around 1550° F. to 1600° F.

The porcelain enamel coated bottom closure also is circumferentially welded to the interiorly porcelain enamel coated shell, the weld point usually being at the lower part of the depending flange of the bottom closure. The necessary heat of welding conducted through the steel at and about this weld point also will partially or wholly destroy the contacting porcelain enamel coating on the interior of the shell and on the exterior of the depending flange of the bottom closure at, and for a certain distance away from, the point of weld. However, the depending flange of the bottom closure is of sufficient length and diameter that the weld heat usually will be dissipated sufficiently as to leave an impervious porcelain enamel coating without defects at the area contacted by water within the tank.

It is now rather common practice to include an anode of a metal more active than steel, such as magnesium, connected to the steel water tank to maintain the steel structure electrically negative to protect from corrosion the steel base which might be exposed to the water in the tank because of defects in the interior porcelain enamel coating of the water tank.

The anode is suspended from an anode holder screwed into an opening formed in the head closure, and the anode depends therefrom to a point near the bottom closure. Such an anode affords cathodic protection for the steel at any defective point in the procelain enamel coating which might have developed by reason of the metal welding of the flange of the bottom closure to the outer shell, or at any other porcelain enamel coated portion, except in the vicinity of the area where the flue tube enters the flanged opening in the head closure. Because it is necessary to suspend the anode from the head closure, as the anode must be so located that it can be replaced if and when used up, the anode, as is well known in the art, affords little or no cathodic protection at any defective point in the porcelain enamel coating subjected to water at the junction of the inner side of the flanged opening in the head closure and the flue tube.

The water heater industry has expended large sums of money and time in research in an endeavor to find a commercially practical solution to this long existing and well known problem of the destruction of the porcelain enamel coatings caused by the metal welding operations. Many solutions to the problem have been considered and tried with more or less unsatisfactory results, such as the interposing of heat insulating gaskets between the contacting porcelain enamel surfaces in the vicinity of a point of weld; use of inverted head closures to extend flanges so that the point of weld would be more remote from the interior porcelain enamel coating of the water tank exposed to water; etc.

Some water heater manufacturers have even located the flue at the less desirable position at the outside of the shell of the tank, instead of passing the flue tube through the tank, to avoid having to make a circumferential metal weld at the point where the internal flue tube projects through a flanged opening in a closure, such weld having to be made after the parts have been provided with a porcelain enamel coating.

Heretofore, it has been uniformly thought and believed by the industry that such a metal weld was an absolute necessity to assure that the water tank be fluid tight when subjected to usual water pressures and pulsations.

One object of my invention is to provide a method of

forming a fluid pressure tight seal between elements of a container which have coatings of porcelain enamel thereon and without a metal welding together of such elements after the porcelain enamel has been applied.

Another object of my invention is to provide a method of fusing together previously coated, dried and fired contacting porcelain enamel surfaces on elements of a container by means of a high frequency electrical current induced at a limited area and for a very limited period of time.

Another object of my invention is to provide a method of heating by a high frequency electrical current the contacting porcelain enamel coatings only to a temperature sufficient to fuse the coatings together and to continue to be bonded to the respective steel bases, with the temperature of the coatings not being permitted to rise to a temperature as would cause defects in the porcelain enamel coated surface.

Other features of my invention and a complete understanding thereof may be had by reference to the following detailed description with reference to the accompanying drawings.

In said drawings:

Fig. 1 is a somewhat diagrammatic elevation view of an assembled porcelain enamel lined water tank ready to be joined together by the use of my improved method.

Fig. 2 is a top plan view of the structure shown in Fig. 1.

Fig. 3 is a fragmentary vertical sectional view, on a larger scale, taken on the line 3—3 in Fig. 2.

Fig. 4 is a fragmentary plan view, on a larger scale, of the head closure and flue pipe as indicated in Fig. 2, and with apparatus used in practicing the invention, the induction coil and oscillation generator being shown diagrammatically.

Fig. 5 is a fragmentary sectional view of the structure shown in Fig. 4.

Fig. 6 is an elevation view of an open-ended single turn helical glass ring.

Fig. 7 is a somewhat diagrammatic vertical sectional view of a form of means for expanding the top of the flue tube shown in Fig. 3.

Fig. 8 is a fragmentary sectional view, on a larger scale, showing the two porcelain enamel coatings fused together to form a fluid pressure seal between the elements and without metal welding.

Referring more particularly to Figs. 1 to 3, inclusive, the water tank indicated generally at **1** includes a cylindrical shell body member **2** which is provided with a top closure member **3**. The top closure member **3**, conveniently, has a circumferential flange **4** which is adapted to be push fitted into the top of the shell member **2**. The head member **3** and shell **2** are integrally welded together, conveniently, by a circumferential weld, as indicated at **5**.

The bottom closure member **6** has a circular opening **7** formed therein, conveniently with a circumferential upturned flange **8**. The lower end of the flue tube **9** is fitted into the flanged opening **7**. The flue tube **9**, conveniently, is integrally circumferentially welded to the bottom member **6** by a circumferential weld as indicated at **10**. The lower end of the flue tube **9** is in open communication with the combustion chamber **11** formed in the shell **2** below the bottom closure member **6**, and in which combustion chamber a gas burner (not shown) is located.

The shell member **2** with the head closure **3** integrally welded thereto, forming a subassembly, is then provided on the inner surfaces thereof with a porcelain enamel coating **12**.

Porcelain or vitreous enamel is a glass of a special composition, and well known as an article of commerce. The porcelain frit is mixed with water and other materials to a paint-like consistency and applied in a wet state, conveniently by spraying or dipping, to the interior surfaces of the subassembly composed of the head member **3** and shell member **2**. After the frit mixture has been dried, the subassembly is subjected to a heating operation in a furnace in which the shell and head assembly is heated to approximately 1550° to 1600° Fahrenheit to fuse the porcelain enamel coating to the head member **3** and shell **2**.

The bottom closure member **6** and the flue tube **9** integrally welded together, forming a subassembly, is also provided on the outer surfaces thereof with a porcelain enamel coating **12** in the same manner as heretofore described with reference to the subassembly comprised of the shell member **2** and head closure **3**.

The subassembly comprised of the shell member **2** and head closure **3** and the subassembly comprised of the bottom closure **6** and the flue tube **9** are then assembled together by pressing the bottom closure **6** into the shell member **2** with the flue tube **9** projecting through an opening **15**, conveniently having an upturned flange **16**, formed in the head member **3**.

Thus, the entire interior surface of the tank **1**, including the outer surface of the flue tube **9**, is provided with a porcelain enamel coating at all of the interior surface areas of the tank which will be in contact with water, or other fluid, when the tank is filled.

The porcelain enamel coating **12** on the flanged opening **15** in the head member **3** and the porcelain enamel coating **12** on the outside of the flue tube **9** are in contact with each other throughout the area where the flue tube extends through the head member.

The limited area where the flue tube **9** and flanged opening **15** are in contact with each other is then heated with an induced high frequency current by positioning such limited area within the effective field of an induction heating coil **20**, connected to the output of a suitable electrical oscillation generator indicated at **21**. Sufficient high frequency energy is then transferred by induction from the oscillation coil to induce electrical currents within the steel which will heat the contacting porcelain enamel surfaces **12** at said area to such a degree that the porcelain enamel coatings will be fused together and provide a continuous porcelain enamel seal **23** fused to both the metal of the flue tube and the metal of the flanged opening.

As is well known in the art, the size and number of turns of the coil are governed by the frequency of the oscillation generator, with due consideration being given to the dimensions of the assembly to be placed within its effective field.

Although it would be possible to use a current having a frequency from above 60 cycles to upward of 5 megacycles, I have found that it is commercially practical with presently developed apparatus to use a high frequency current of the order of 140 kilocycles to 400 kilocycles, and for a period of time between 30 seconds and 60 seconds. Of course, the period of time required to fuse the porcelain enamel coatings together depends upon the frequency of the induced electrical current and the thickness of the steel.

I have found that it is preferable, although not essential, to add additional fusable material at the top of the flange **16** where the flue tube **9** projects therethrough before subjecting the assembly to the high frequency electrical current. Such additional material may be in the form of porcelain enamel frit from which the previously fired porcelain enamel coatings **12** were formed, or may be in the form of a glass ring, as indicated at **25** in Fig. 6, the glass ring **25** being slipped over the upper end of the flue tube **9** and coming to rest on the upper surface of flange **16**. Although a solid glass ring may be used, I have found that it is preferable to use an open-ended single turn helical glass ring.

My improved method produces an interfusion of the porcelain enamel coatings free from defects at the joinder. The parts are bonded together with a fluid tight joint therebetween having a tensile strength of the order

of at least 6000 pounds per square inch, and without any metal welding together of the parts. The tensile strength of the joinder is well in excess of any pressures to which such water heater tanks are subjected, and well in excess of the maximum test pressures which such water tanks must withstand under the regulations of any of the various authorities.

If the flue tube **9** and flanged opening **15** in the head closure should not be truly circular when formed and porcelain enameled due to commercial manufacture, it may be found desirable to use an internal expander means in the flue tube **9** at the location of the induction heating coil **20**. The use of an internal expander would assure that the porcelain enamel surfaces **12** will be in contact with each other and fused together free from defects at the joinder surfaces when the porcelain enamel coatings are heated to the melting point by the induction heating coil **20** and fused.

Fig. 7 shows somewhat diagrammatically one of a number of well known types of expander means which may be utilized. An outer supporting ring **30** is positioned around the flange **16** of the opening in the head closure **3**. An expanding segmental mandrel **31**, of a type well known in art, is inserted in the top of the flue tube **9**. The mandrel **31** is expanded by means of a draw bar **32** which may be actuated by an air cylinder (not shown), operatively connected to the upper end of the draw bar **32**. As the draw bar **32** is moved upwardly, as in Fig. 7, the segmental mandrel **31** is expanded to expand the flue tube **9** to the dregree desired.

The porcelain enamel coatings **12** on the flange of the bottom closure **6** and on the cylindrical shell body member **2** at the area where in contact with each other, as best shown in Fig. 3, may also be heated with an induced high frequency current, by the same method as heretofore described, to produce an interfusion of said porcelain enamel coatings **12** at this area. These parts, correspondingly, will be bonded together with a fluid tight joint therebetween having a tensile strength well in excess of any required maximum test pressures, and without any metal welding together of the parts.

I do not desire to limit myself to the specific details of the method as herein set forth, as it is obvious that various modifications may be made therein without departing from the essential features of my invention as defined in the appended claims.

I claim:

1. The method of joining, without metal welding, fired porcelain enamel coated steel elements of a container in fluid pressure tight relationship comprising assembling said elements with their respective fired procelain enamel coatings in direct contact at a limited area; subjecting only the immediate vicinity of said limited contact area to an induced high frequency electrical current for a period of time sufficient to raise the temperature of said fired porcelain enamel coatings at said limited contact area to cause an interfusion of said porcelain enamel coatings at said limited contact area; and cooling the assemblage to harden the interfused porcelain enamel coatings bonded at opposite sides to the respective steel elements.

2. The method of joining, without metal welding, fired porcelain enamel coated steel elements of a container in fluid pressure tight relationship comprising assembling said elements with their respective fired porcelain enamel coatings in direct contact at a limited area; subjecting only the immediate vicinity of said limited contact area to an induced high frequency electrical current of the order of 140 kilocycles to 400 kilocycles for a period of time sufficient to raise the temperature of said fired porcelain enamel coatings at said limited contact area to cause an interfusion of said porcelain enamel coatings at said limited contact area; and cooling the assemblage to harden the interfused porcelain enamel coatings bonded at opposite sides to the respective steel elements.

3. The method of joining, without metal welding, fired porcelain enamel coated steel elements of a container in fluid pressure tight relationship comprising assembling said elements with their respective fired porcelain enamel coatings in direct contact at a limited area; subjecting only the immediate vicinity of said limited contact area to an induced high frequency electrical current for a period of time sufficient to raise the temperature of said fired porcelain enamel coatings at said limited contact area only to such a degree as to cause an interfusion of said porcelain enamel coatings at said limited contact area; and cooling the assemblage to harden the interfused porcelain enamel coatings bonded at opposite sides to the respective steel elements.

4. The method of forming porcelain enamel lined water heater tanks composed of a cylindrical steel shell member, head and bottom closures, said head closure having an outwardly flanged circular opening, and a cylindrical tubular flue member extending longitudinally within said shell member and connecting said end closures, comprising welding said shell member and said head closure together as a first subassembly; welding said flue member and said bottom closure together as a second subassembly; separately porcelain enamel coating said first and second subassemblies on their surfaces, including the interior surface of said flanged opening, which will be interior surfaces when said subassemblies are assembled together after porcelain enameling to form a water heater tank; separately firing said first and second subassemblies to fuse said coatings; cooling said subassemblies to harden their respective fired porcelain enamel coatings; assembling said first and second subassemblies together with said end closure, respectively, at opposite ends of said shell and with said flue tube projecting through said flanged opening in said head closure; subjecting only the immediate vicinity of the limited contact area where the fired porcelain enamel coating on said flanged opening and the fired porcelain enamel coating on said flue member are in contact with each other to an induced high frequency electrical current for a period of time sufficient to raise the temperature of said fired porcelain enamel coatings at said limited contact area to cause an interfusion of said porcelain enamel coatings at said limited contact area; and cooling the assemblage to harden the interfused porcelain enamel coatings bonded at opposite sides to the respective steel elements; whereby, a fluid pressure tight seal is formed between the elements without a metal welding together of such elements after the fired porcelain enamel coatings have been applied.

5. The method of forming porcelain enamel lined water heater tanks composed of a cylindrical steel shell member, head and bottom closures, said head closure having an outwardly flanged circular opening, and a cylindrical tubular flue member extending longitudinally within said shell member and connecting said end closures, comprising welding said shell member and said head closure together as a first subassembly; welding said flue member and said bottom closure together as a second subassembly; separately porcelain enamel coating said first and second subassemblies on their surfaces, including the interior surface of said flanged opening, which will be interior surfaces when said subassemblies are assembled together after porcelain enameling to form a water heater tank; separately firing said first and second subassemblies to fuse said coatings; cooling said subassemblies to harden their respective fired porcelain enamel coatings; assembling said first and second subassemblies together with said end closures, respectively, at opposite ends of said shell and with said flue tube projecting through said flanged opening in said head closure; subjecting only the immediate vicinity of the limited contact area where the fired porcelain enamel coating on said flanged opening and the fired porcelain enamel coating on said flue member are in contact with each

other to an induced high frequency electrical current of the order of 140 kilocycles to 400 kilocycles for a period of time sufficient to raise the temperature of said fired porcelain enamel coatings at said limited contact area to cause an interfusion of said porcelain enamel coatings at said limited contact area; and cooling the assemblage to harden the interfused porcelain enamel coatings bonded at opposite sides to the respective steel elements; whereby, a fluid pressure tight seal is formed between the elements without a metal welding together of such elements after the fired porcelain enamel coatings have been applied.

6. The method of forming porcelain enamel lined water heater tanks composed of a cylindrical steel shell member, head and bottom closures, said head closure having an outwardly flanged circular opening, and a cylindrical tubular flue member extending longitudinally within said shell member and connecting said end closures, comprising welding said shell member and said head closure together as a first subassembly; welding said flue member and said bottom closure together as a second subassembly; separately porcelain enamel coating said first and second subassemblies on their surfaces, including the interior surface of said flanged opening, which will be interior surfaces when said subassemblies are assembled together after porcelain enameling to form a water heater tank; separately firing said first and second subassemblies to fuse said coatings; cooling said subassemblies to harden their respective fired porcelain enamel coatings; assembling said first and second subassemblies together with said end closures, respectively, at opposite ends of said shell and with said flue tube projecting through said flanged opening in said head closure; subjecting only the immediate vicinity of the limited contact area where the fired porcelain enamel coating on said flanged opening and the fired porcelain enamel coating on said flue member are in contact with each other to an induced high frequency electrical current for a period of time sufficient to raise the temperature of said fired porcelain enamel coatings at said limited contact area only to such a degree as to cause an interfusion of said fired porcelain enamel coatings at said limited contact area; and cooling the assemblage to harden the interfused porcelain enamel coatings bonded at opposite sides to the respective steel elements; whereby, a fluid pressure tight seal is formed between the elements without a metal welding together of such elements after the fired porcelain enamel coatings have been applied.

7. The method of forming porcelain enamel lined water heater tanks composed of a cylindrical steel shell member, head and bottom closures, said head closure having an outwardly flanged circular opening, and a cylindrical tubular flue member extending longitudinally within said shell member and connecting said end closures, comprising welding said shell member and said head closure together as a first subassembly; welding said flue member and said bottom closure together as a second subassembly; separately porcelain enamel coating said first and second subassemblies on their surfaces, including the interior surface of said flanged opening, which will be interior surfaces when said subassemblies are assembled together after porcelain enameling to form a water heater tank; separately firing said first and second subassemblies to fuse said coatings; cooling said subassemblies to harden their respective fired porcelain enamel coatings; assembling said first and second subassemblies together with said end closures, respectively, at opposite ends of said shell and with said flue tube projecting through said flanged opening in said head closure; applying pressure to maintain the fired porcelain enamel coatings on said flanged opening and said flue member in contact with each other at the area of said flanged opening; subjecting only the immediate vicinity of the limited contact area where the fired porcelain enamel coating on said flanged open and the fired porcelain enamel coating on said flue member are in contact with each other to an induced high frequency electrical current for a period of time sufficient to raise the temperature of said fired porcelain enamel coatings to cause an interfusion of said porcelain enamel coatings at said limited area at said limited contact area; and cooling the assemblage to harden the interfused porcelain enamel coatings bonded at opposite sides to the respective steel elements; whereby, a fluid pressure tight seal is formed between the elements without a metal welding together of such elements after the fired porcelain enamel coatings have been applied.

8. The method of forming porcelain enamel lined water heater tanks composed of a cylindrical steel shell member, head and bottom closures, said head closure having an outwardly flanged circular opening, and a cylindrical tubular flue member extending longitudinally within said shell member and connecting said end closures, comprising welding said shell member and said head closure together as a first subassembly; welding said flue member and said bottom closure together as a second subassembly; separately porcelain enamel coating said first and second subassemblies on their surfaces, including the interior surface of said flanged opening, which will be interior surfaces when said subassemblies are assembled together after porcelain enameling to form a water heater tank; separately firing said first and second subassemblies to fuse said coatings; cooling said subassemblies to harden their respective fired porcelain enamel coatings; assembling said first and second subassemblies together with said end closures, respectively, at opposite ends of said shell and with said flue tube projecting through said flanged opening in said head closure; expanding said flue member at the area of said flue opening to maintain the porcelain enamel coating on said flue member in contact with the porcelain enamel coating on the area of said flanged opening; subjecting only the immediate vicinity of the limited contact area where the fired porcelain enamel coating on said flanged opening and the fired porcelain enamel coating on said flue member are in contact with each other to an induced high frequency electrical current for a period of time sufficient to raise the temperature of said fired porcelain enamel coatings at said limited contact area to cause an interfusion of said fired porcelain enamel coatings at said limited contact area; and cooling the assemblage to harden the interfused porcelain enamel coatings bonded at opposite sides to the respective steel elements; whereby, a fluid pressure tight seal is formed between the elements without a metal welding together of such elements after the fired porcelain enamel coatings have been applied.

9. The method of forming porcelain enamel lined water heater tanks composed of a cylindrical steel shell member, head and bottom closures, said head closure having an outwardly flanged circular opening, and a cylindrical tubular flue member extending longitudinally within said shell member and connecting said end closures, comprising welding said shell member and said head closure together as a first subassembly; welding said flue member and said bottom closure together as a second subassembly; separately porcelain enamel coating said first and second subassemblies on their surfaces, including the interior surface of said flanged opening, which will be interior surfaces when said subassemblies are assembled together after porcelain enameling to form a water heater tank; separately firing said first and second subassemblies to fuse said coatings; cooling said subassemblies to harden their respective fired porcelain enamel coatings; assembling said first and second subassemblies together with said end closures, respectively, at opposite ends of said shell and with said flue tube projecting through said flanged opening in said head closure; subjecting only the immediate vicinity of the limited contact area where the fired porcelain enamel coating on said flanged opening and the fired porcelain enamel coating on said flue mem-

ber are in contact with each other to an induced high frequency electrical current for a period of time sufficient to raise the temperature of said fired porcelain enamel coatings at said limited area to cause an interfusion of said fired porcelain enamel coatings at said contact area; subjecting only the immediate vicinity of the limited area where the fired porcelain enamel coating on said shell member and the fired porcelain enamel coating on said bottom closure are in contact with each other to an induced high frequency electrical current for a period of time sufficient to raise the temperature of said fired porcelain enamel coatings at said limited area to cause an interfusion of said fired porcelain enamel coatings at said limited contact area; whereby, a fluid pressure tight seal is formed between all the elements without a metal welding together of such elements after the fired porcelain enamel coatings have been applied.

10. The method of forming porcelain enamel lined water heater tanks composed of a cylindrical steel shell member, head and bottom closures, said head closure having an outwardly flanged circular opening, and a cylindrical tubular flue member extending longitudinally within said shell member and connecting said end closures, comprising welding said shell member and said closure together as a first subassembly; welding said flue member and said bottom closure together as a second subassembly; separately porcelain enamel coating said first and second subassemblies on their surfaces, including the interior surface of said flanged opening, which will be interior surfaces when said subassemblies are assembled together after porcelain enameling to form a water heater tank; separately firing said first and second subassemblies to fuse said coatings; cooling said subassemblies to harden their respective fired porcelain enamel coatings; assembling said first and second subassemblies together with said end closures, respectively, at opposite ends of said shell and with said flue tube projecting through said flanged opening in said head closure; subjecting only the immediate vicinity of the limited contact area where the fired porcelain enamel coating on said flanged opening and the fired porcelain enamel coating on said flue member are in contact with each other to an induced high frequency electrical current of the order of 140 kilocycles to 400 kilocycles for a period of time sufficient to raise the temperature of said fired porcelain enamel coatings at said limited area to cause an interfusion of said fired porcelain enamel coatings at said limited contact area; subjecting only the immediate vicinity of the limited area where the fired porcelain enamel coating on said shell member and the fired porcelain enamel coating on said bottom closure are in contact with each other to an induced high frequency electrical current of the order of 140 kilocycles to 400 kilocycles for a period of time sufficient to raise the temperature of said fired porcelain enamel coatings at said limited area to cause an interfusion of said fired porcelain enamel coatings at said limited contact area; whereby, a fluid pressure tight seal is formed between all the elements without a metal welding together of such elements after the fired porcelain enamel coatings have been applied.

11. The method of forming porcelain enamel lined water heater tanks composed of a cylindrical steel shell member, head and bottom closures, said head closure having an outwardly flanged circular opening, and a cylindrical tubular flue member extending longitudinally within said shell member and connecting said end closures, comprising welding said shell member and said head closure together as a first subassembly; welding said flue member and said bottom closure together as a second subassembly; separately porcelain enamel coating said first and second subassemblies on their surfaces, including the interior surface of said flanged opening, which will be interior surfaces when said subassemblies are assembled together after porcelain enameling to form a water heater tank; separately firing said first and second subassemblies to fuse coatings; cooling said subassemblies to harden their respective fired porcelain enamel coatings; assembling said first and second subassemblies together with said end closures, respectively, at opposite ends of said shell and with said flue tube projecting through said flanged opening in said head closure; subjecting only the immediate vicinity of the limited contact area where the fired porcelain enamel coating on said flanged opening and the fired porcelain enamel coating on said flue member are in contact with each other to an induced high frequency electrical current of the order of 140 kilocycles to 400 kilocycles for a period of time sufficient to raise the temperature of said fired porcelain enamel coatings at said limited area only to such a degree as to cause an interfusion of said fired porcelain enamel coatings at said limited contact area; subjecting only the immediate vicinity of the limited area where the fired porcelain enamel coating on said shell member and the fired porcelain enamel coating on said bottom closure are in contact with each other to an induced high frequency electrical current of the order of 140 kilocycles to 400 kilocycles for a period of time sufficient to raise the temperature of said fired porcelain enamel coatings at said limited area only to such a degree as to cause an interfusion of said fired porcelain enamel coatings at said limited contact area; whereby, a fluid pressure tight seal is formed between all the elements without a metal welding together of such elements after the fired porcelain enamel coatings have been applied.

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