Nov. 2, 1965 J. J. SHOEMAKER 3,215,124

STEAM OR HOT WATER BOILER

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FIG. 1

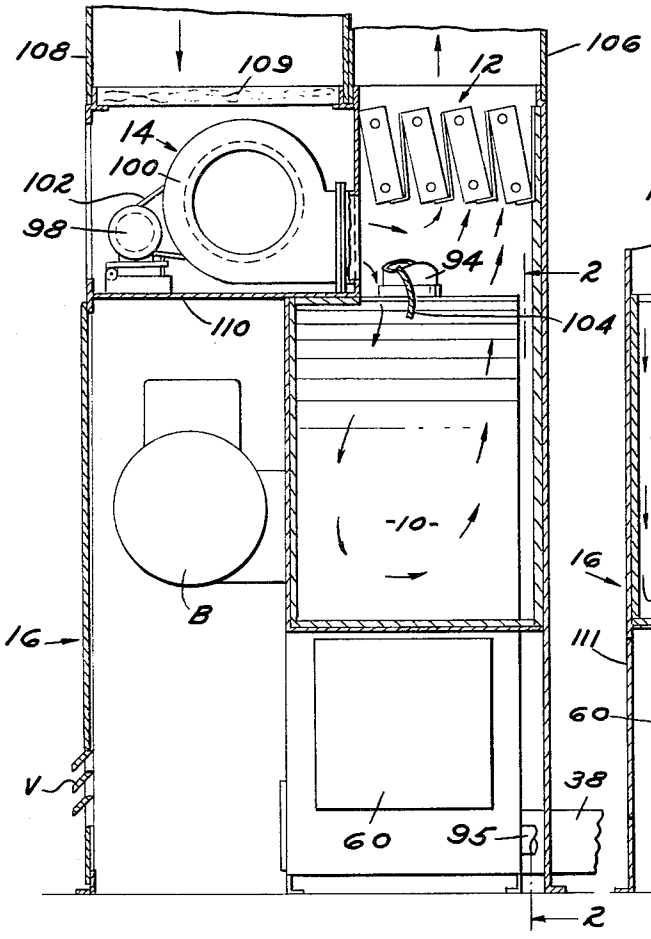


FIG. 2

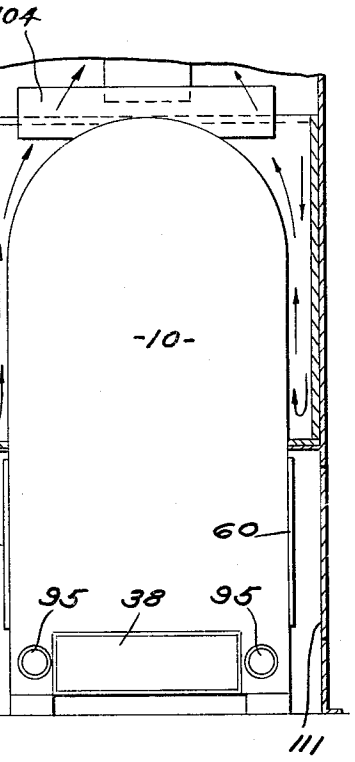
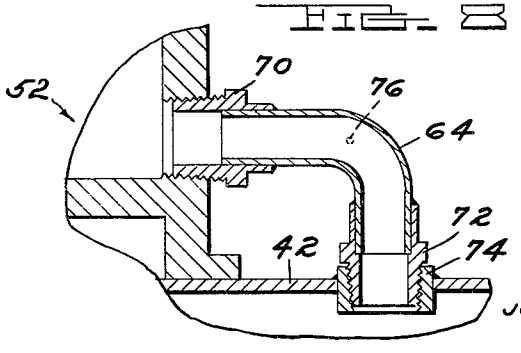


FIG. 3



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STEAM OR HOT WATER BOILER

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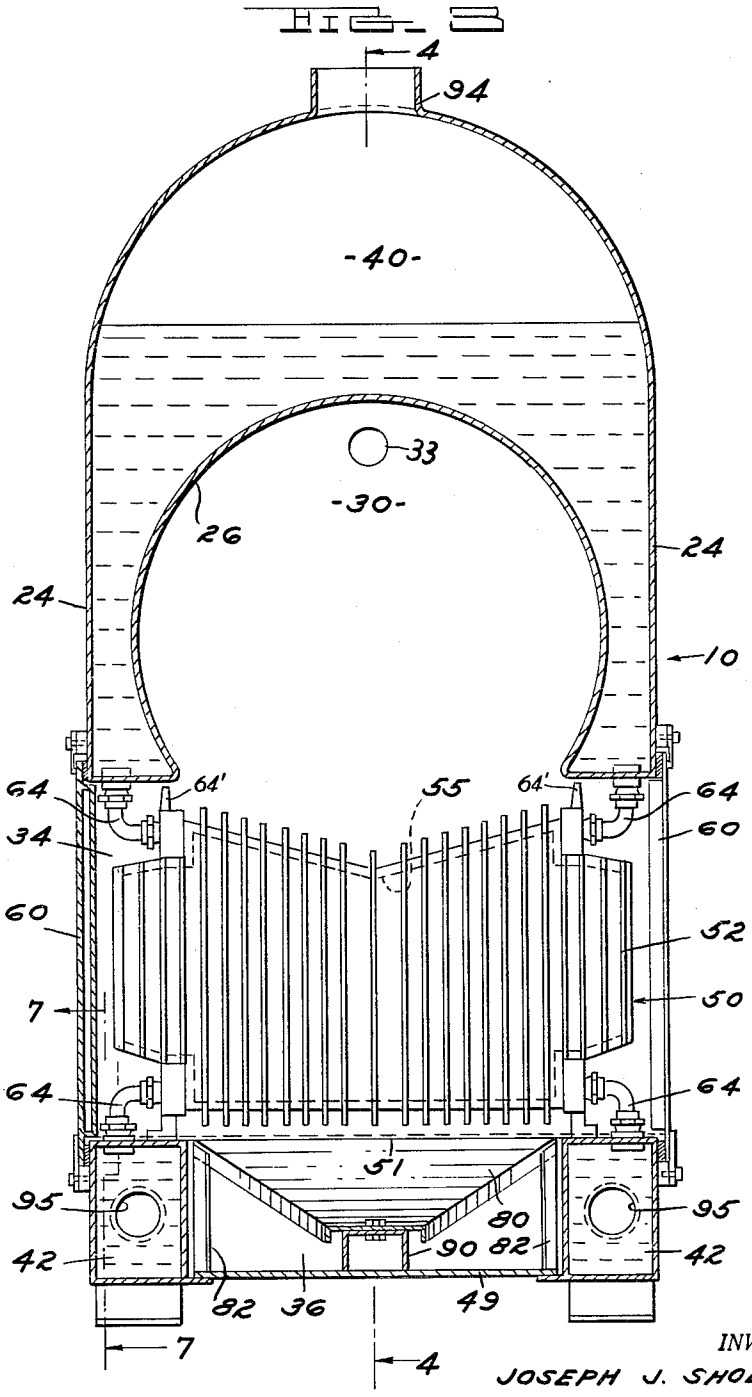
FIG. 3



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STEAM OR HOT WATER BOILER

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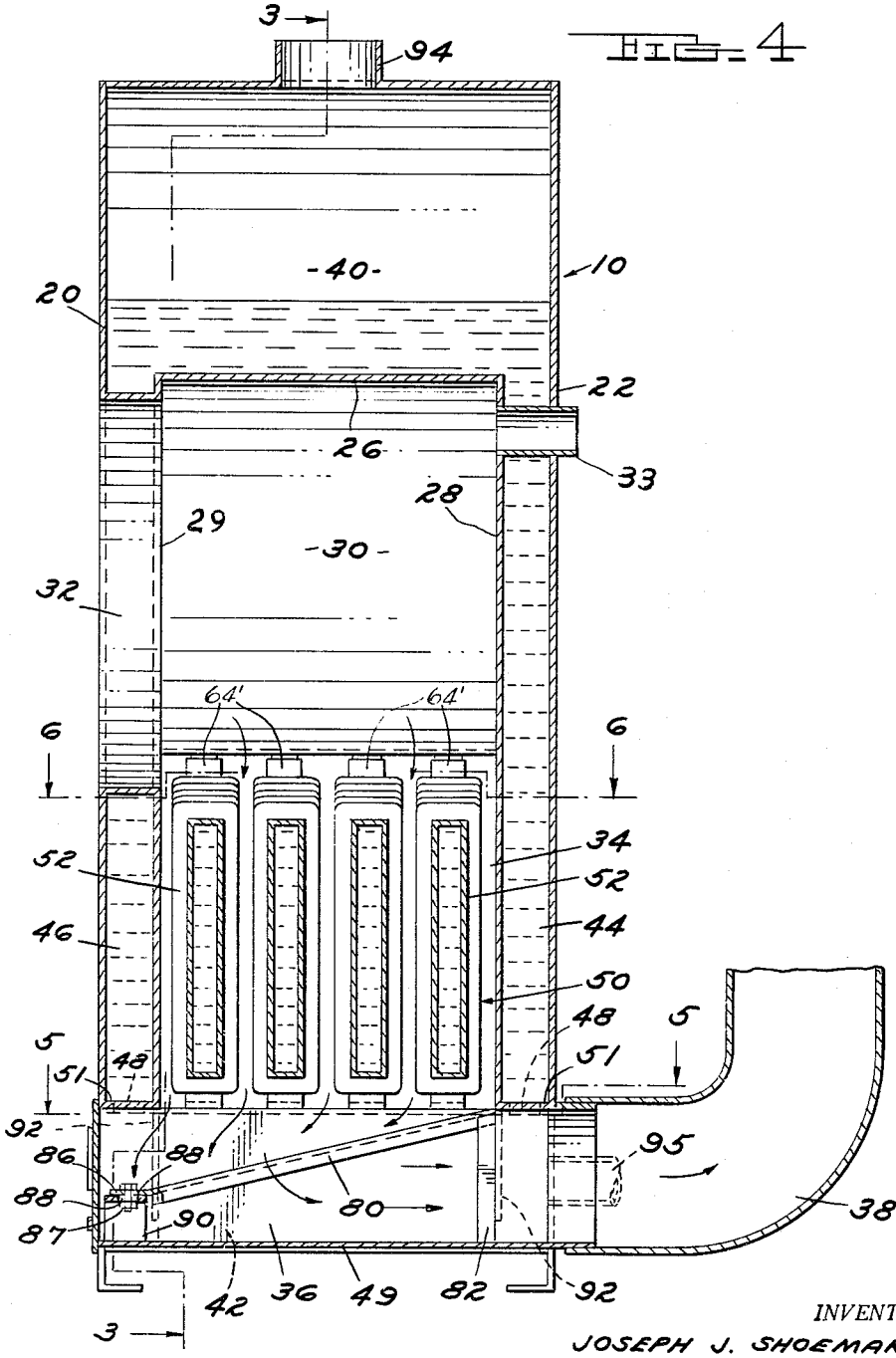
FIG. 4



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STEAM OR HOT WATER BOILER

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FIG. 5

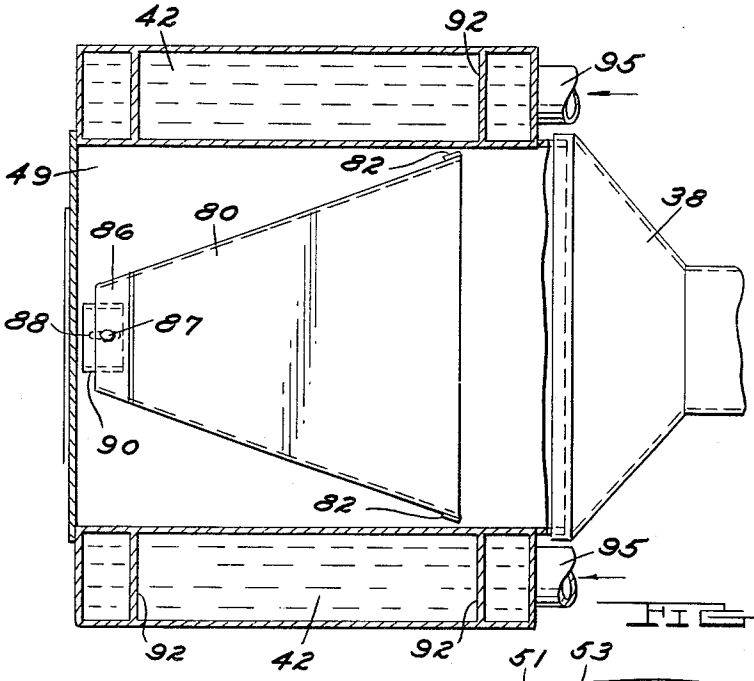

FIG. 7

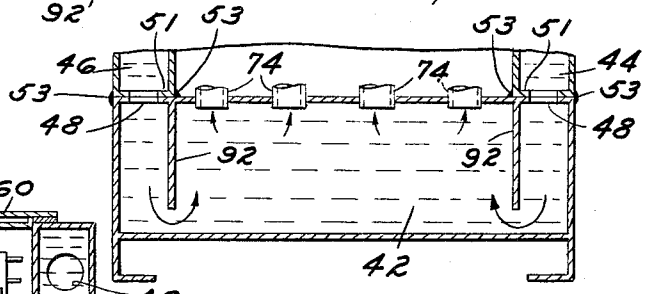

FIG. 6

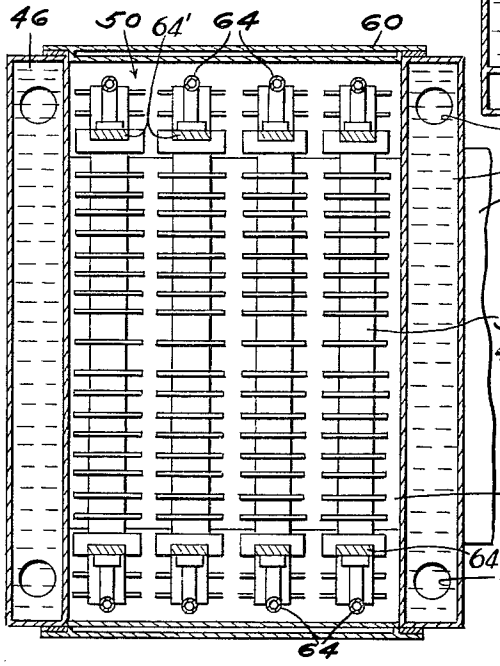

FIG. 12

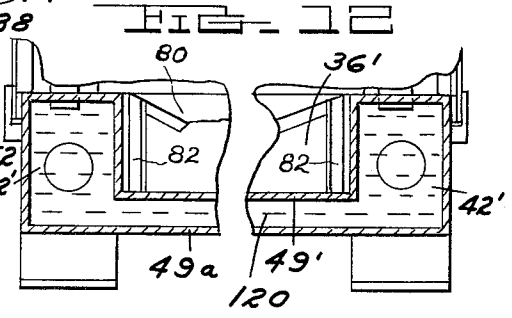

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FIG. 8

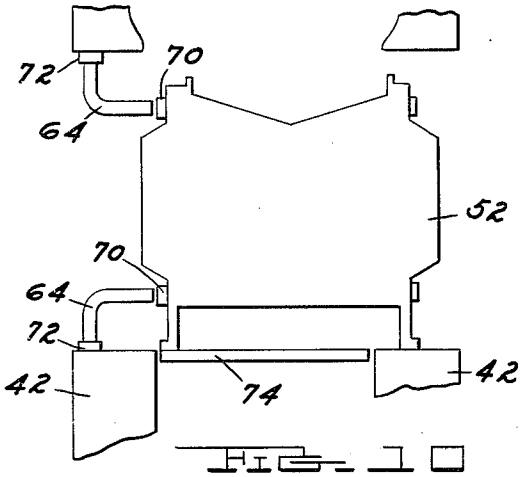
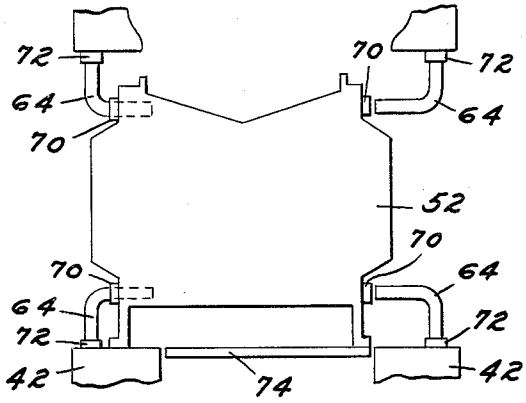


FIG. 10



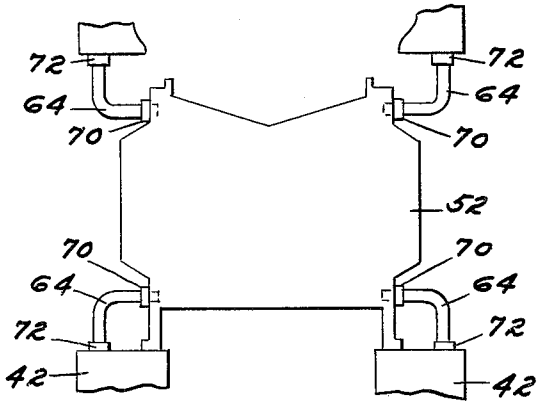


FIG. 11

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United States Patent Office

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Patented Nov. 2, 1965

3,215,124

STEAM OR HOT WATER BOILER

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Filed Mar. 28, 1960, Ser. No. 17,959
17 Claims. (Cl. 122—165)

This invention relates to a heating system and refers more particularly to a heating system of the type having a steam or hot water boiler.

One object of the invention is to provide a heating system which is compact, capable of substantially trouble-free operation, and highly efficient in performance.

The invention has for another object to provide a steam or hot water boiler which is specially constructed to operate with a high degree of efficiency.

A further object of the invention is to provide a novel boiler construction comprising upper and lower portions which are separately formed, preferably of steel plates, and then welded together. This makes it possible to test the separate boiler portions for tightness and strength before the final assembly is made.

Still another object is to provide a construction as above described in which heat exchange units are also incorporated, which are likewise formed separately from the boiler so that they may be tested before final assembly.

Another object of the invention is to provide a hot water or steam boiler of the type constructed to provide a space for water in heat exchange relation with a fire box and passage therefrom for heated gases, in which the water space has a pair of water legs on either side of the gas passage and baffle means are provided in the passage to direct the heated gases in the passage toward the water legs.

Another object of the invention is to provide a boiler constructed as in the preceding paragraph in which the baffle means is tapered and inclined with respect to the passage to effect maximum heat exchange between the gases in the passage and the water legs, and in which the baffle means is preferably adjustable to obtain optimum results under a given set of requirements.

A still further object of the invention is to provide a boiler which is capable of being readily expanded to a larger capacity.

A still further object of the invention is to provide a boiler of the type having a heat exchange unit therein, in which the heat exchange unit may be readily installed or removed.

Another object of the invention is to provide a boiler having upper and lower water sections connected in circuit for continuous movement of the water, with means provided to prevent reverse flow.

Yet another object of the invention is to provide a heating system composed of a boiler, steam coil connected to the boiler and a blower for moving air over the steam coil and over an extended surface of the boiler as well as to heat the air, and in which the boiler, steam coil and blower are preferably enclosed in an insulated housing to provide a package unit.

The foregoing as well as other objects will become more apparent as this description proceeds, especially when considered in connection with the accompanying drawings illustrating preferred embodiments of the invention, wherein:

FIGURE 1 is a vertical sectional view of a heating system including boiler, steam coil and blower, all enclosed within an insulated housing to provide a package unit according to my invention.

FIGURE 2 is a sectional view taken on the line 2—2 of FIGURE 1.

FIGURE 3 is a vertical sectional view of the boiler taken along the line 3—3 of FIGURE 4.

FIGURE 4 is a sectional view taken along a line 4—4, FIGURE 3.

FIGURE 5 is a sectional view taken on the line 5—5, FIGURE 4.

FIGURE 6 is a sectional view taken on the line 6—6 of FIGURE 4.

FIGURE 7 is a sectional view taken on the line 7—7 of FIGURE 3.

FIGURE 8 is an enlarged fragmentary sectional view showing a slip type adapter for connecting the heat exchange unit to the boiler.

FIGURES 9–11 are semi-diagrammatic views illustrating the manner of installing the heat exchange unit.

FIGURE 12 is a sectional view similar to the lower part of FIGURE 3 but showing a modification.

Referring now more particularly to the drawings, and especially to FIGURES 1 and 2, the heating system comprises an oil or a gas burner B, a boiler 10, a steam coil 12, and a blower 14, all enclosed within an insulated housing 16.

The boiler is shown more clearly in FIGURES 3–7 and has an outer shell or housing made up of the front and rear steel plates 20 and 22 and the side steel plates 24 which extend up over and define the rounded top of the shell. The end plates are welded to the plate forming the sides and top of the shell to complete the housing.

Steel plates 26, 28 and 29 are also provided within the shell to define the firebox 30 which has an opening 32 at the front for the oil or gas burner B to be inserted therewithin. A gas vent pipe 33 is provided for the firebox. The firebox 30 communicates with a chamber 34 therebeneath extending downwardly into a horizontal outlet passage 36 which is elongated from front to rear and located centrally with respect to the outer shell of the boiler. At the rear, passage 36 opens into an outlet duct or stack 38. The heated air and gases of combustion in the firebox thus pass downwardly through the chamber 34 to the outlet passage 36 and from there to the stack 38. The space for the movement of the heated gases is, of course, sealed from the water space in the boiler by the metal plate construction of the boiler. From this description and as shown in FIGURES 3–7, it is obvious that this boiler has a very large heating surface exposed to "direct" or "radiant" heat waves emitted from the fuel combustion in firebox 30. It is a well-known fact that direct or radiant heat waves emitted from the flames of the oil or gas burner, in the firebox, is much more effective in heat transfer through metal plates, than indirect heat from the hot gases after leaving the flame area of the firebox. This arrangement of parts results in more effective heating surface in a given size boiler.

The outer metal plates forming the boiler shell cooperate with the inner metal plates defining the firebox, chamber 34 and outlet passage 36 to define the space for the boiler water. This space includes an upper section 40 which embraces the top, sides and rear end of the firebox, and a lower section composed of the water legs 42. The water legs 42 are elongated from front to rear of the boiler and extend horizontally at the bottom thereof at opposite sides of the outlet passage 36. The water legs 42 are in direct communication with the upper section 40 of the water space by the connecting section 44 at the rear and the connecting section 46 at the front, the latter being centrally interrupted by the opening 32 to the firebox. As seen in FIGURES 6 and 7, the connecting sections 44 and 46 communicate with water legs 42 through holes 48.

At this point it should be mentioned that the boiler is made up of an upper portion or section and a lower portion or section, which are separately formed as indicated in FIGS. 3, 4 and 7. These portions or sections are joined together, after testing, by a continuous weld at

all four corners, as indicated in FIGURE 7. The lower portion or section consists of two water legs **42** made of steel plates connected by a plate **49** defining the bottom of passage **36**. The water legs are each formed separately and therefore can be separately tested for strength and tightness. The upper section is that portion of the boiler above the water legs which has the bottom wall **51**. This upper section is formed separately and likewise can be tested before it is welded at **53** to the lower section. The plate **49** connecting the water legs may be installed at the time of assembly. It will be noted that the bottom wall **51** of the upper section and the top walls of the legs both have the holes **48** which register for liquid communication. The bottom wall **51** is of course open centrally to provide communication between chamber **34** and passage **36**.

A heat exchanger **50** is located within the chamber **34** and is made up of a plurality of individual heat exchange units **52** which are of like construction and spaced apart from front to rear of the boiler as shown in FIGURE 4. Each unit is in the form of a flat hollow cast member of iron or aluminum or other suitable material which extends from side to side of the boiler within chamber **34** and is formed on its outer surface with the usual fins for better heat transfer. A heat exchange unit is shown in outline in FIGURES 3 and 6 and diagrammatically in FIGURES 9–11, and it will be noted that the upper edge thereof is V-shaped, and the top wall **55** of the hollow interior of the unit is likewise V-shaped as indicated in FIGURE 3. These units are separately made so that they can be tested before the final assembly. This is for a purpose to be more fully described hereinafter.

The side walls of the outer shell of the boiler are formed with access openings normally covered by doors **60**. These doors can be removed for the installation, removal or cleaning of the heat exchange units. Each heat exchange unit is connected at the bottom to a water leg by connections including the elbows **64**, and each heat exchange unit is connected at the top to the upper water section by connections including the additional elbows **64**. The heat exchange units **52** have formations **64'** which project upward from the top wall **55** at the ends of the heat exchange units, which protect the connections including the elbows **64** from the direct or radiant heat waves emitted from the flames of combustion in the fire-box **30**. These formations or shields **64'** can also be seen in FIGURES 3, 4 and 6. One of the connections including its elbow is shown in FIGURE 8. As there shown, a tubular adapter **70** is threaded into a hole at the bottom of the heat exchange unit which communicates with the hollow interior thereof, and a similar adapter **72** is threaded into a sleeve **74** secured to one of the water legs **42** in communication with the hollow interior thereof. The arms of the elbow **64** respectively extend into the adapters **70** and **72** and are welded, brazed or soldered in position in a manner forming a seal. The other connections are similarly constructed.

In order to install the heat exchange units, the adapters **70** and **72** are installed in one of the water legs, as indicated in FIGURE 9, and the portion of the upper water section directly thereabove as well as in the corresponding end of the heat exchange unit, and the elbows **64** are then inserted into the adapters **72**. The horizontal arms of the elbows are then lined up with the adapters **70** and the heat exchange unit is moved to the FIGURE 10 position in which substantially the entire length of the horizontal arms extend within the unit. During the installation, a temporary platform **74** may be employed between the water legs to support the legs of the heat exchange units as they are moved from side to side during installation.

With the heat exchange unit in the position shown in FIGURE 10, the remaining adapters **70** and **72** are installed and the elbows **64** are inserted into the adapters **72** so that their horizontal arms line up with the adapters **70**. The heat exchange unit is then centered, as in FIGURE 11, so that all of the horizontal elbow arms extend into the corresponding adapters **70**, whereupon the adapters are welded, brazed or soldered to the elbows to seal the joints. The punch marks **76** on the elbows, as indicated in FIGURE 8, may be employed to determine the amount of elbow within the adapter **70**, by measuring the distance from the punch mark to the adapter. The legs of the heat exchange units simply rest on the steel plates defining the water legs and can slide thereon as a result of expansion or contraction. The elbows should be of copper or like ductile material which will allow for expansion and contraction.

The air and gases of combustion in the fire box pass downwardly through the chamber **34** and across the heat exchange units therein to the outlet passage **36** and from there to the stack **38** as indicated in FIGURE 4. Water in the boiler moves from the upper section downwardly along the outside walls of the sides and rear of the fire-box, and, by way of the connecting sections **44** and **46**, passes into the lower water legs **42** at the ends thereof through holes **48**, as indicated in FIGURE 7. These holes keep the water in the boiler balanced at all times. The water then moves inwardly with respect to the water legs and into the heat exchange units **52** through the lower elbows **64**, as shown in FIGURE 3. The water in the heat exchange units is heated by the downwardly moving gases and flows into the upper section of the water space through the elbows **64** to complete the cycle. Steam formed by this process collects above the water level in the upper section of the boiler.

The gases moving from the chamber **34** downwardly to the outlet passage **36** are deflected for maximum heat exchange with the water legs **42** by a baffle **80**. The baffle **80** is in the form of a flat plate the side edges of which taper toward one another from the rear to the front of the boiler, so that in outline the baffle has the shape of a frustum of a cone (see FIGURE 5). The baffle extends substantially entirely from front to rear of the passage **36**, and at the rear its width is substantially equal to the width of the passage. The rear end is mounted on supporting legs **82** which engage the bottom wall **49** of the boiler shell. The baffle **80** is slanted downwardly from rear to front as seen in FIGURE 4, and at the front end is bent slightly to provide a horizontal attaching section **86** formed with a central bolt hole. The nut and bolt assembly **87** extends through the hole in the baffle plate and through an elongated slot **88** in a mounting bracket **90** to adjustably support the front end of the baffle. By loosening the nut and bolt assembly, the baffle may be moved forwardly and rearwardly within the limits of the length of slot **88** and then reclamped to secure the baffle in longitudinally adjusted position. The lower ends of legs **82** are freely slidable with respect to the bottom wall **49** of the housing. The side edges of the baffle plate are turned down to provide flanges, in the interests of strength and rigidity.

The baffle **80** is provided to secure a flow of gases somewhat as illustrated by the arrows in FIGURE 4, in which the gases are deflected forwardly and to the sides so that they will have a maximum heat exchange contact with the water legs. The gases then move in a rearward direction along the sides of the passage and beneath the baffle into the stack **38**.

It will be noted particularly in FIGURES 4, 5 and 7 that the front and rear connecting water passages **44** and **46** communicate with the water legs **42** at the ends thereof under the vertical guide plates **92**. These guide plates extend completely across the water legs from the tops thereof to a point spaced above the bottoms so that the water, as it is heated in the legs, will rise and flow up through couplings **74** to elbows **64**, FIGURE 3, to quickly supply warm water to the heat exchange units **52** and will not reverse itself and flow back up the connecting sections **44** and **46**.

A pipe **94** leads from the top of the boiler to conduct steam to an external circuit, such as the steam coil **12**.

Condensate from the external circuit is returned to the water legs **42** by conduits **95**, as indicated in FIGURE 5.

The operation of the boiler is as follows:

The flames from the oil or gas burner B provide a source of intense heat in the combustion chamber **30**. The heated gases pass from the firebox downwardly across the heat exchange units **52** in chamber **34** and into the horizontal outlet passage **36**, from whence they are discharged into the stack **38**. The water moves from the upper section downwardly through the connecting sections **44** and **46**, and from the external circuit **95**, into the water legs **42**. The water in legs **42** is heated by the gases in the outlet passage **36** and moves upwardly through the heat exchange units **52** where it is further heated by the hotter gases in chamber **34** and by the still hotter gases and radiant heat waves emitted from the flames of combustion in firebox **30** acting on the upper ends of the heat exchange units. The heated water then moves upwardly into the mid-portion of the upper water section **40** of the tank where it is further heated by the gases and the radiant heat waves emitted from the flames of combustion in firebox **30**. The baffle **80** deflects the gases moving downwardly into the outlet passage **36** forward and to the sides for maximum heat exchange contact with the water legs, and the guides **92** provide against a reverse flow of water and insure that the water heated in the legs moves up into the heat exchange units.

Referring again to FIGURES 1 and 2, the upper water section **40** of the boiler, FIGURE 3, is connected to the steam coils **12** by the pipe **94**. Thus, steam generated in the upper section of the boiler passes through the coil **12** and returns to the water legs **42** of the boiler by conduits **95**. The blower **14** is mounted to one side of the steam coils and includes a motor **98** for driving a fan **100** by means of belt **102**. The fan is arranged to blow air to the right as viewed in FIGURE 1, a portion of the air being deflected downwardly by the deflector **104** across the top and sides of the boiler to be heated by the extended surface contact therewith. The deflected air, as well as that not deflected, moves into the lower part of hot air pipe **106** where it is further heated by the steam coil **12** and in its heated condition passes upwardly through pipe **106** to heat a room of a home, for example. The blower **14** receives air from the return duct **108** through filter **109**. The blower unit is mounted on a platform **110** which is supported above and to one side of the boiler by the side walls of the heating unit housing **16**. As stated above, the heating unit including the boiler **10**, steam coil **12** and blower **14** are all enclosed in the housing **16** which preferably is completely isolated from the outside by insulation to increase the efficiency of the unit. Doors **111** normally close access openings in the housing. These openings register with the doors **60** in the boiler so that the heat exchange units **52** can be readily removed, installed, or cleaned.

A heating system of this type in which a steam boiler is provided to supply warm air from a low temperature means is very desirable. Air is heated by a steam coil with a surface temperature of approximately 220 degrees Fahrenheit to 250 degrees Fahrenheit. Part of the air is heated by the surface of the boiler shell itself, which is at a somewhat lower temperature. This is in contrast to the type of heating unit in which the furnace heats the air direct by contact with the hot iron bonnet of the fire box, which has a surface temperature of perhaps 800 degrees Fahrenheit to 1000 degrees Fahrenheit. This latter type of heating fries the air and removes substantially all of its moisture.

It might also be pointed out that the circulated air in the above described steam heating system is safe from dangerous gas leaks from the combustion gas chamber of the boiler. In the direct fired bonnet type, if cracks or leaks develop dangerous and offensive gas may be circulated directly to the rooms or space being heated.

The insulated housing enclosing the unit provides substantially an air tight enclosure, except for the air supplied to the oil or gas burner B through vent V, and the package unit shown in FIGURES 1 and 2 be factory assembled and shipped ready to be put in service with a minimum of skilled labor.

A further advantage of the boiler described is that it can be varied in wide limits by increasing the length from front to back and adding heat exchange units. This would merely require a modified side construction for the shell and firebox, etc., without changing the end construction.

Preferably, the boiler plates are joined by welding, and the heat exchange units are castings, such as cast iron. Cast units have a long life due to their ability to withstand corrosion, extreme temperature changes and rapid transfer of heat, and are quiet in operation.

The heat exchange units can be readily removed and replaced, if necessary, and all welded seams of the steel boiler are located so that they can be easily repaired in case of leakage.

FIGURE 12 shows a modification of the lower boiler section which differs from FIG. 3, the first one described, as follows. It is composed of water legs **42'**, like legs **42**, and a connecting plate **49'**. The legs are connected by a second plate **49*a*** to define a water space **120** communicating with the legs. Hence, the heated gas in space **36'** is in heat transfer relation not only with the water in the legs, but also with the water between plates **49'** and **49*a***. The layer of water extends from one end of the legs to the other to completely underlie the passage **36'**. While this construction provides more water in heat transfer relation with the gases in passage **36'**, it increases weight and means the overall height of the boiler is increased by the height of the water space between plates **49'** and **49*a***. Hence, the construction first described has its own advantages. The same baffle **80** is employed in this construction.

The drawings and the foregoing specification constitute a description of the improved steam or hot water boiler in such full, clear, concise and exact terms as to enable any person skilled in the art to practice the invention, the scope of which is indicated by the appended claims.

What I claim as my invention is:

1. A boiler comprising a housing formed of plates defining the sides, top, bottom and end walls thereof, plates within said housing defining a firebox and a chamber beneath and communicating with said firebox, an outlet passage communicating with the bottom of said chamber to permit the discharge of hot gases passing downwardly through said chamber from said firebox, said plates within said housing cooperating with said housing plates to define space for boiler water, said boiler water space including an upper portion above and about said firebox as well as a lower portion alongside said passage and a portion along said chamber connecting said upper portion and said lower portion, a water filled heat exchanger in said chamber also connecting said upper portion and said lower portion to enable an upward flow of water, and means positioned in said lower portion to cause a downward flow of water through said portion along said chamber.

2. A boiler comprising a housing formed of plates defining the sides, top, bottom and end walls thereof, plates within said housing defining a firebox and a chamber directly beneath and in open communication with said firebox, an outlet passage communicating with the bottom of said chamber to permit the discharge of hot gases passing downwardly through said chamber from said firebox, said plates within said housing cooperating with said housing plates to define space for boiler water, said boiler water space including an upper portion above and about said firebox as well as portions defining a pair of spaced water legs on opposite sides of said passage and portions

along said chamber connecting said upper portion and said water legs, baffle means in said passage for deflecting gases moving therethrough toward said water legs without any reduction in the area of gas flow, a water filled heat exchanger in said chamber also connecting said upper portion and said water legs to enable an upward flow of water, and means positioned in said water legs to cause a downward flow of water through said portions along said chamber.

3. A boiler comprising a housing formed of metal plates defining the sides, top, bottom and end walls thereof, metal plates within said housing defining a firebox and a chamber directly beneath and in open communication with said firebox, an elongated outlet passage, communicating with the bottom of said chamber to permit the discharge of hot gases passing downwardly through said chamber from said firebox, said metal plates within said housing cooperating with said housing plates to define space for boiler water, said boiler water space including an upper portion above and about said firebox as well as portions defining a pair of spaced water legs extending along opposite sides of said passage and portions along said chamber connecting said upper portion and said water legs, a baffle extending from one end of said passage to the other and constructed and arranged to deflect gases moving therethrough toward said water legs and away from the outlet end of said passage without any reduction in the area of gas flow, a water filled heat exchanger in said chamber also connecting said upper portion and said water legs to enable an upward flow of water, and means positioned in said water legs to cause a downward flow of water through said portions along said chamber.

4. A boiler comprising a housing formed of metal plates defining the sides, top, bottom and end walls thereof, metal plates within said housing defining a firebox and a chamber directly beneath and in open communication with said firebox, an elongated outlet passage communicating with the bottom of said chamber to permit the discharge of hot gases passing downwardly through said chamber from said firebox, said metal plates within said housing cooperating with said housing plates to define space for boiler water, said boiler water space including an upper portion above and about said firebox as well as portions defining a pair of spaced water legs extending along opposite sides of said passage and portions along said chamber connecting said upper portion and said water legs, a baffle extending from one end of said passage to the other end thereof for deflecting gases toward said water legs, the opposite side edges of said baffle being spaced from said water legs and said baffle being slanted downwardly in a direction away from the outlet end of said passage to deflect said gases away from the outlet end of said passage without any reduction in the area of gas flow, and a water filled heat exchanger in said chamber also connecting said upper portion and said water legs to enable an upward flow of water, and means positioned in said water legs to cause a downward flow of water through said portions along said chamber.

5. A boiler as in claim 4 in which said baffle is wider at the outlet end of said passage than at the opposite end thereof.

6. A boiler as in claim 5, in which said baffle is adjustable longitudinally of said passage, and means are provided for securing said baffle in longitudinally adjusted position.

7. A boiler comprising a housing formed of metal plates defining the sides, top, bottom and end walls thereof, metal plates within said housing defining a firebox and a chamber directly beneath and in open communication with said firebox, an elongated outlet passage communicating with the bottom of said chamber to permit the discharge of hot gases passing downwardly through said chamber from said firebox, said metal plates within said housing cooperating with said housing plates to define space for boiler water, said boiler space including an upper portion above and about said firebox as well as portions defining a pair of spaced water legs extending along opposite sides of said passage and portions along said chamber connecting said upper portion and said water legs, a baffle extending from one end of said passage to the other between said water legs and being wider at the outlet end of said passage than at the opposite end thereof to deflect gases moving through said passage toward said water legs without any reduction in the area of gas flow, and a water filled heat exchanger in said chamber also connecting said upper portion and said water legs to enable an upward flow of water, and means positioned in said water legs to cause a downward flow of water through said portions along said chamber.

8. A boiler comprising a housing formed of plates defining the sides, top, bottom and end walls thereof, plates within said housing defining a firebox and a chamber directly beneath and in open communication with said firebox, an outlet passage communicating with the bottom of said chamber to permit the discharge of hot gases passing downwardly through said chamber from said firebox, said plates within said housing cooperating with said housing plates to define space for boiler water, said boiler water space including an upper portion above and about said firebox as well as portions defining a pair of spaced water legs on opposite sides of said passage and portions along said chamber connecting said upper portion and said water legs, a water filled heat exchanger in said chamber also connecting said upper portion and said water legs to enable an upward flow of water, and guide baffles positioned within said water legs to cause a downward flow of water through said portions along said chamber.

9. A boiler as in claim 8, in which said water legs are generally horizontal, said connecting portions of said boiler space are upright and communicate with said legs at the end portions thereof, said water filled heat exchanger connects with said legs inwardly of the end portions thereof, and said guide baffles are positioned to restrict communication between said end portions of said legs and the portion thereof between said end portions.

10. A boiler as in claim 9, in which said guide baffles are in the form of vertical plates set at 90° to the heating surface of said legs and extending from the tops of said legs downwardly to a point spaced above the bottoms thereof between the points of communication of said water filled heat exchanger and said upright connecting portions of said water space with said legs.

11. A boiler comprising a housing formed of plates defining sides, top, bottom and end walls thereof, plates within said housing defining a firebox and a chamber directly beneath and in open communication with said firebox, an outlet passage communicating with the bottom of said chamber to permit the discharge of hot gases passing downwardly through said chamber from said firebox, said plates within said housing cooperating with said housing plates to define space for boiler water, said boiler water space including an upper portion above and about said firebox as well as portions defining a pair of spaced water legs on opposite sides of said passage and portions along said chamber connecting said upper portion and said water legs, a water filled heat exchanger in said chamber also connecting said upper portion and said water legs to enable an upward flow of water, said water filled heat exchanger comprising a horizontally elongated upright hollow unit connected at each lower end to said water legs and at each upper end to said upper portion of said water space, the upper wall of the hollow interior of said unit tapering in a V toward the ends thereof in order to speed the upward movement of hot water and avoid the formation of steam pockets, and means positioned in said water legs to cause a downward flow of water through said portions along said chamber.

12. A boiler comprising a housing formed of plates defining the sides, top, bottom and end walls thereof,

plates within said housing defining a firebox and a chamber beneath and communicating with said firebox, an outlet passage communicating with the bottom of said chamber to permit the discharge of hot gases passing downwardly through said chamber from said firebox, said plates within said housing cooperating with said housing plates to define space for boiler water, said boiler water space including an upper portion above and about said firebox as well as portions defining a pair of spaced water legs on opposite sides of said passage and portions along said chamber connecting said upper portion and said water legs, a heat exchanger in said chamber also connecting said upper portion and said water legs to enable an upward flow of water, means positioned in said water legs to cause a downward flow of water through said portions along said chamber, the portions of said plates defining the boiler water space comprising separate sections including a first section defining the upper and connecting portions of said boiler water space and second and third sections respectively defining said water legs, said first, second and third sections being separately formed and welded together to form an integral unit.

13. A boiler comprising a housing formed of plates defining the sides, top, bottom and end walls thereof, plates within said housing defining a firebox and a chamber beneath and communicating with said firebox, an outlet passage communicating with the bottom of said chamber to permit the discharge of hot gases passing downwardly through said chamber from said firebox, said plates within said housing cooperating with said housing plates to define space for boiler water, said boiler water space including an upper portion above and about said firebox as well as a lower portion alongside said passage and portions along said chamber connecting said upper portion and said lower portion, and a heat exchanger in said chamber also connecting said upper portion and said lower portion to enable an upward flow of water, means positioned in said water legs to cause a downward flow of water through said portions along said chamber, said plates defining the boiler water space comprising separate sections including a first section defining the upper and connecting portions of said boiler water space and a second section defining said lower portion thereof, said first and second sections being separately formed and permanently secured together.

14. The boiler defined in claim 11, wherein the upper V-shaped wall of said heat exchanger extends across and defines the lower boundary of said firebox.

15. The boiler defined in claim 1, wherein said water filled heat exchanger is formed separately from said upper and lower sections to permit testing for tightness and strength prior to assembly.

16. The boiler defined in claim 1, wherein said heat exchanger comprises a horizontally elongated, upright hollow unit, the upper wall of the hollow interior of said unit tapering in a V toward the ends thereof in order to speed the upward movement of hot water and avoid the formation of steam pockets, the upper V-shaped wall of said heat exchange unit extending across and defining the lower boundary of said firebox.

17. The boiler defined in claim 1, wherein said heat exchanger includes a horizontally elongated, upright heat exchange unit, means at each end of said unit connecting the upper portion thereof to the upper portion of said water space, means at each end of said unit connecting the lower portion thereof to the lower portion of said water space, and shields on the upper portion of said heat exchange unit adjacent opposite ends of said unit and spaced inwardly of the means connecting the upper portion of said unit to the upper portion of said boiler water space to protect said last-mentioned connecting means from the direct or radiant heat waves emitted from the flames of combustion in the firebox.

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