Aug. 27, 1963 C. C. SMITH 3,101,780

PLATE TYPE BOILER

Filed Feb. 9, 1960 3 Sheets-Sheet 1

FIG. 1

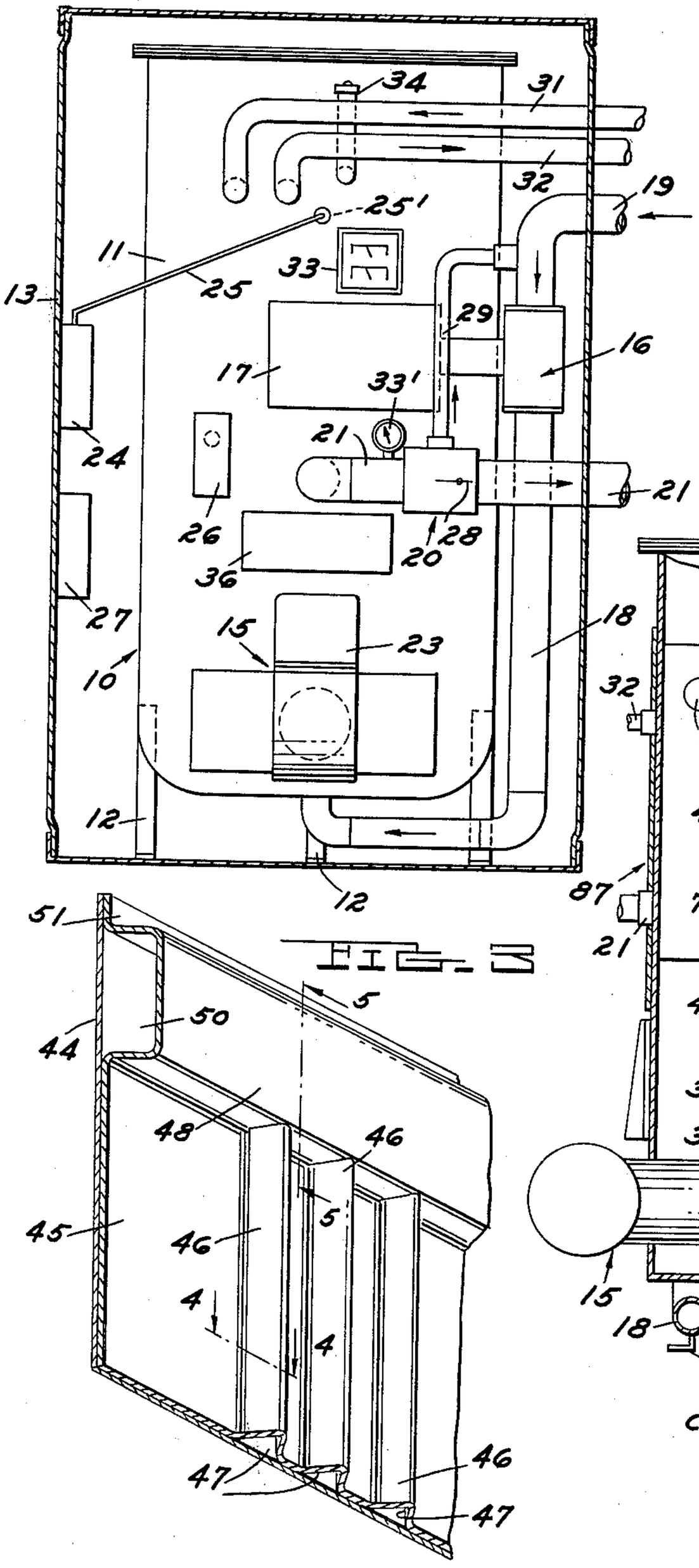


FIG. 4

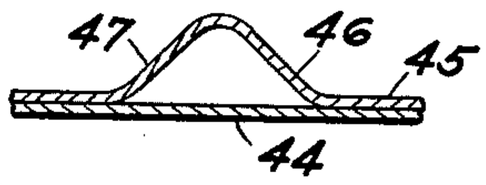


FIG. 5

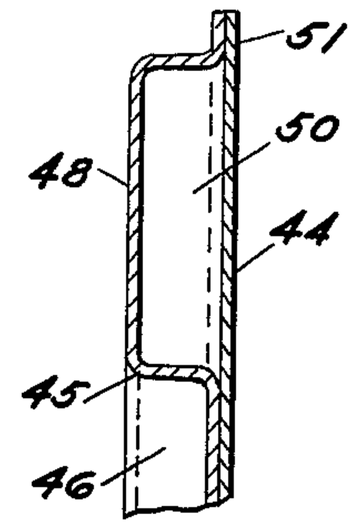


FIG. 3

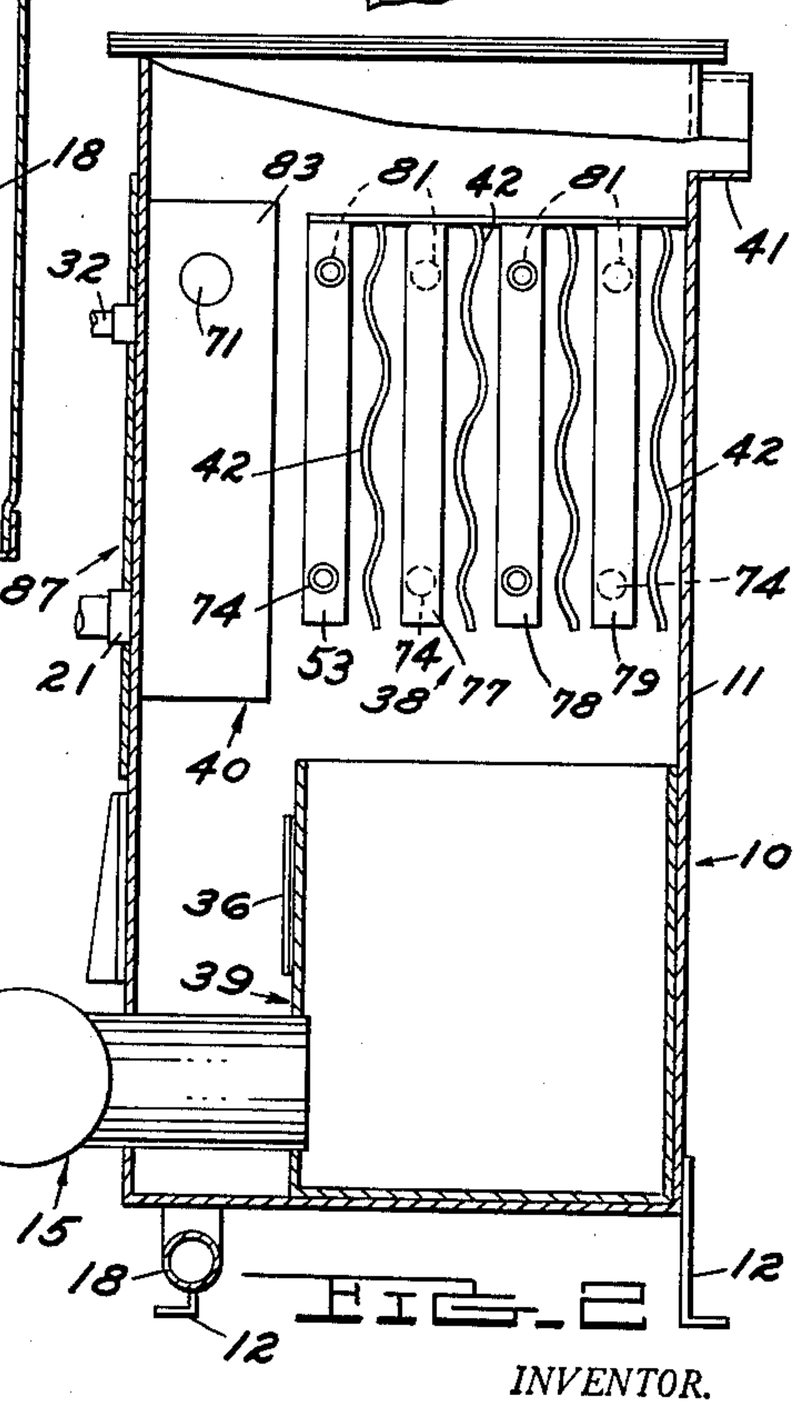


FIG. 2

INVENTOR.

CLARENCE C. SMITH

BY Whittemore Hulbert & Belknap

ATTORNEYS

Aug. 27, 1963 C. C. SMITH 3,101,780

PLATE TYPE BOILER

Filed Feb. 9, 1960 3 Sheets-Sheet 2

FIG. 6

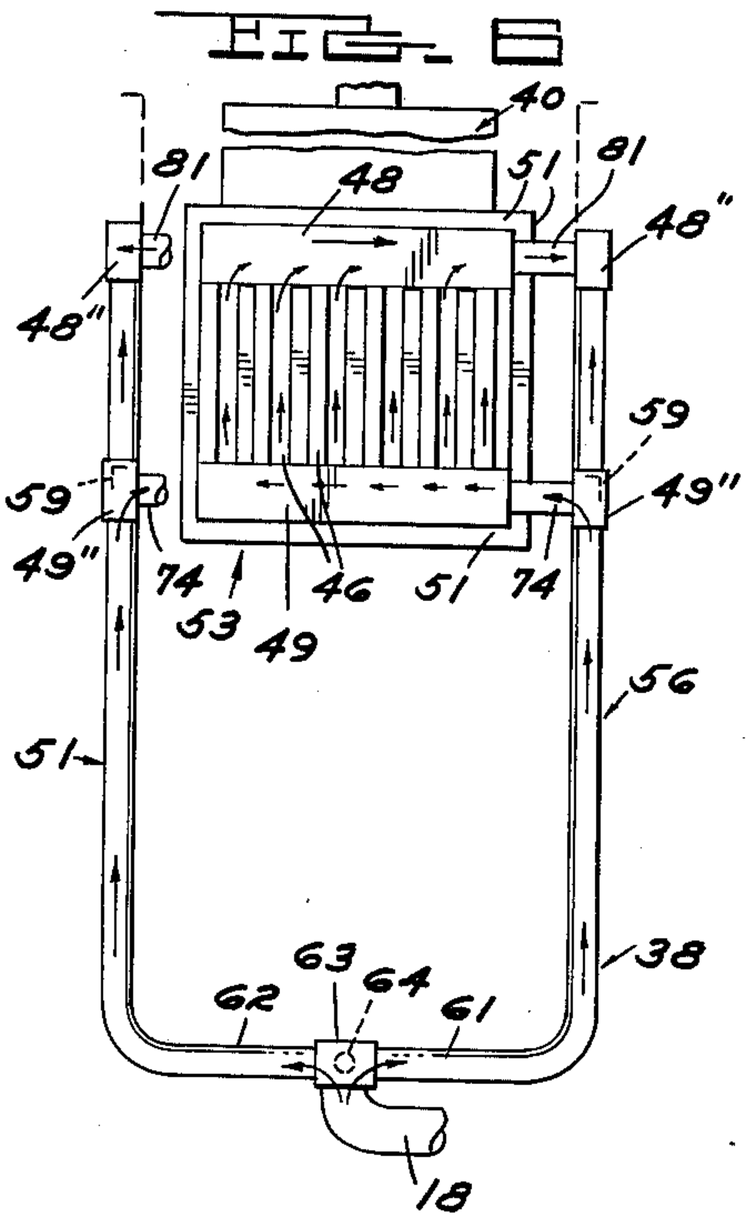


FIG. 7

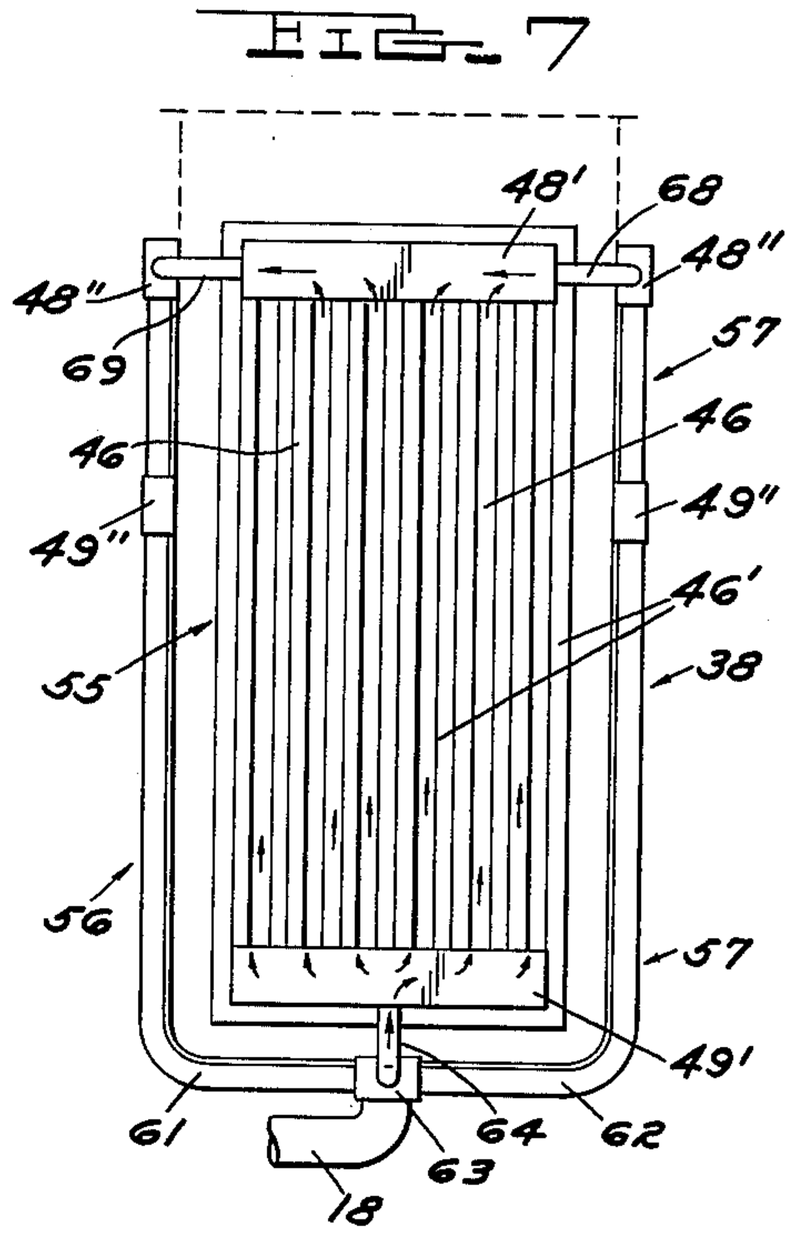


FIG. 5

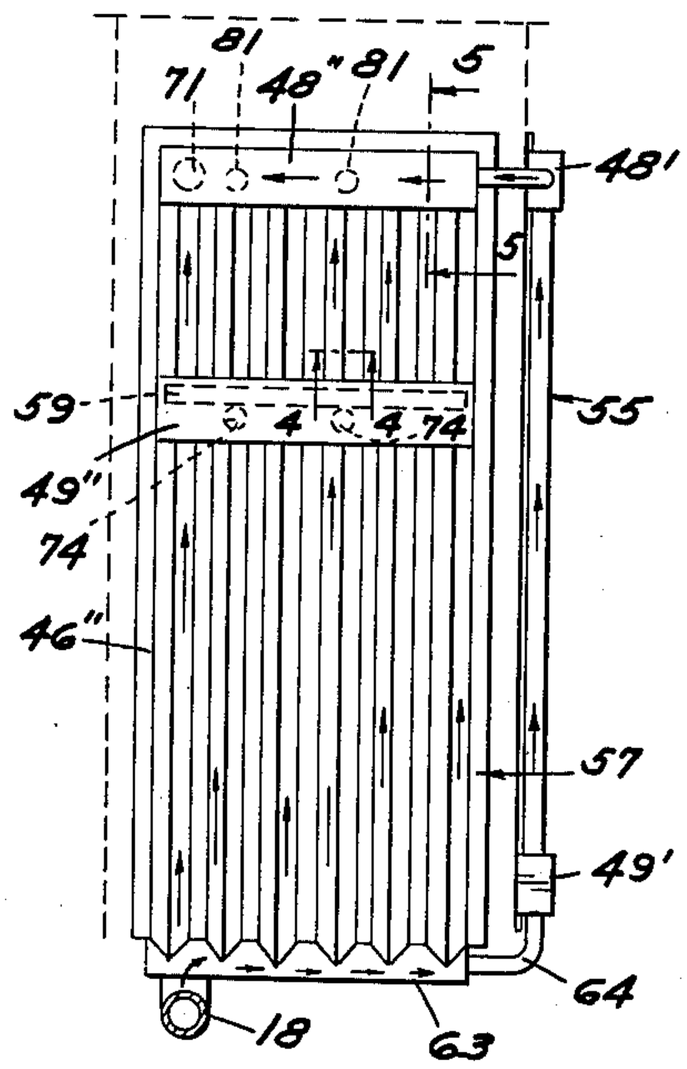
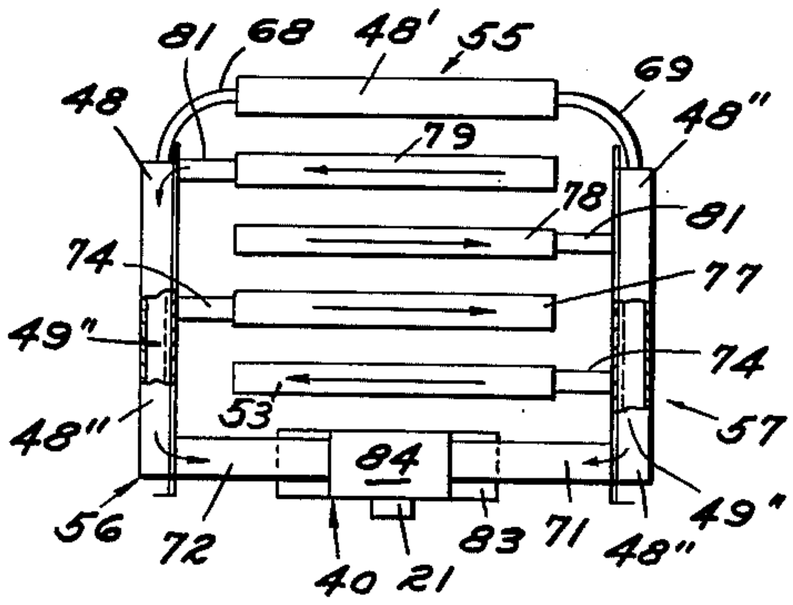


FIG. 8



INVENTOR.
CLARENCE C. SMITH
BY Whittemore, Hulbert & Belknap
ATTORNEYS

Aug. 27, 1963 C. C. SMITH 3,101,780

PLATE TYPE BOILER

Filed Feb. 9, 1960 3 Sheets-Sheet 3

Fig. 10

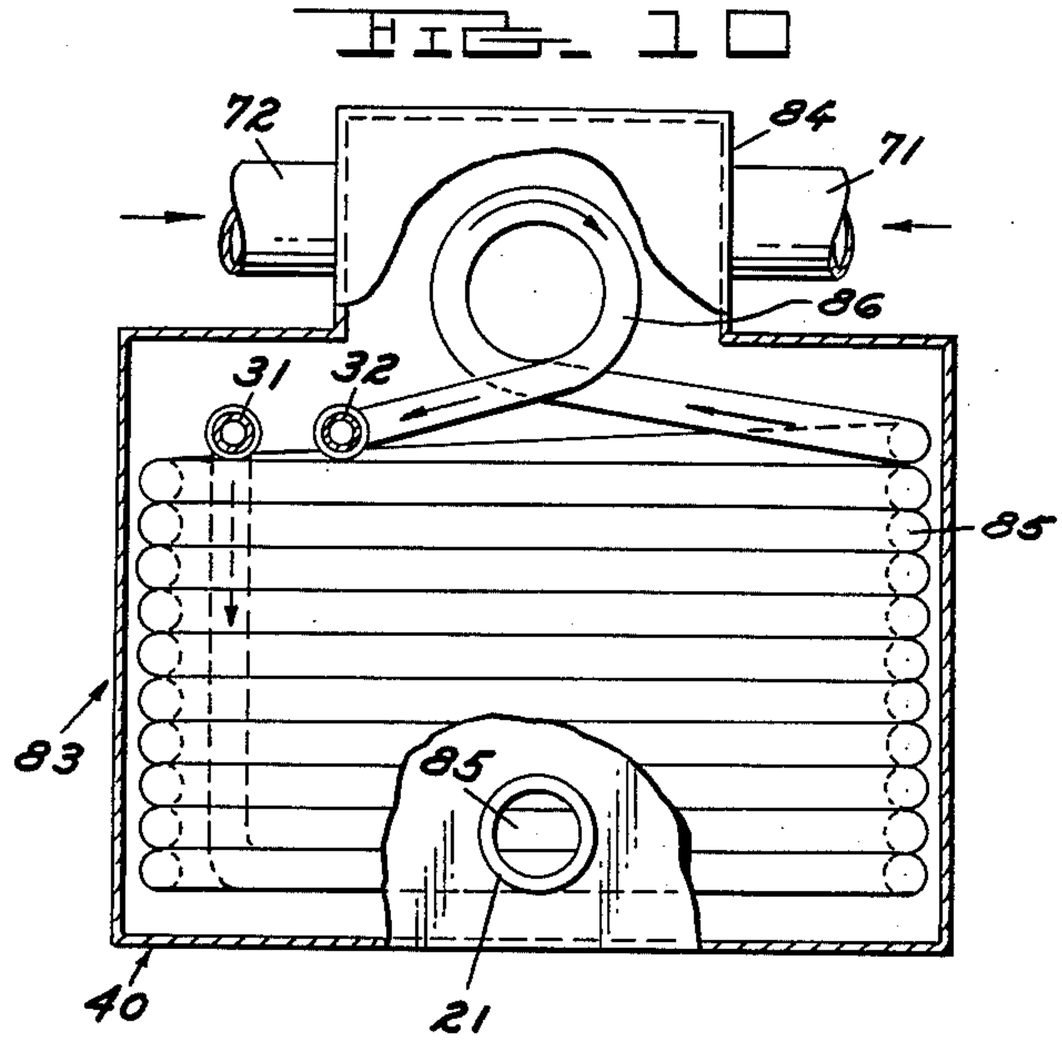


Fig. 11

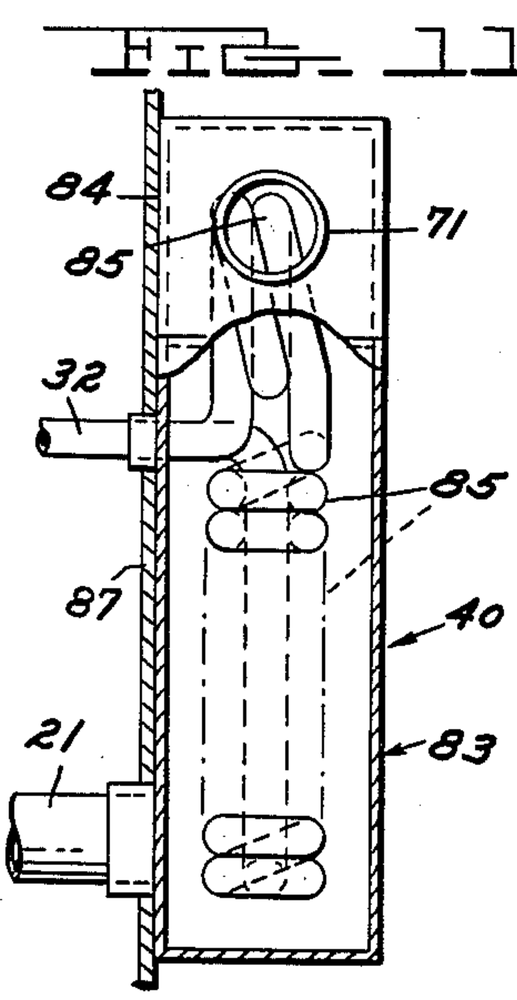
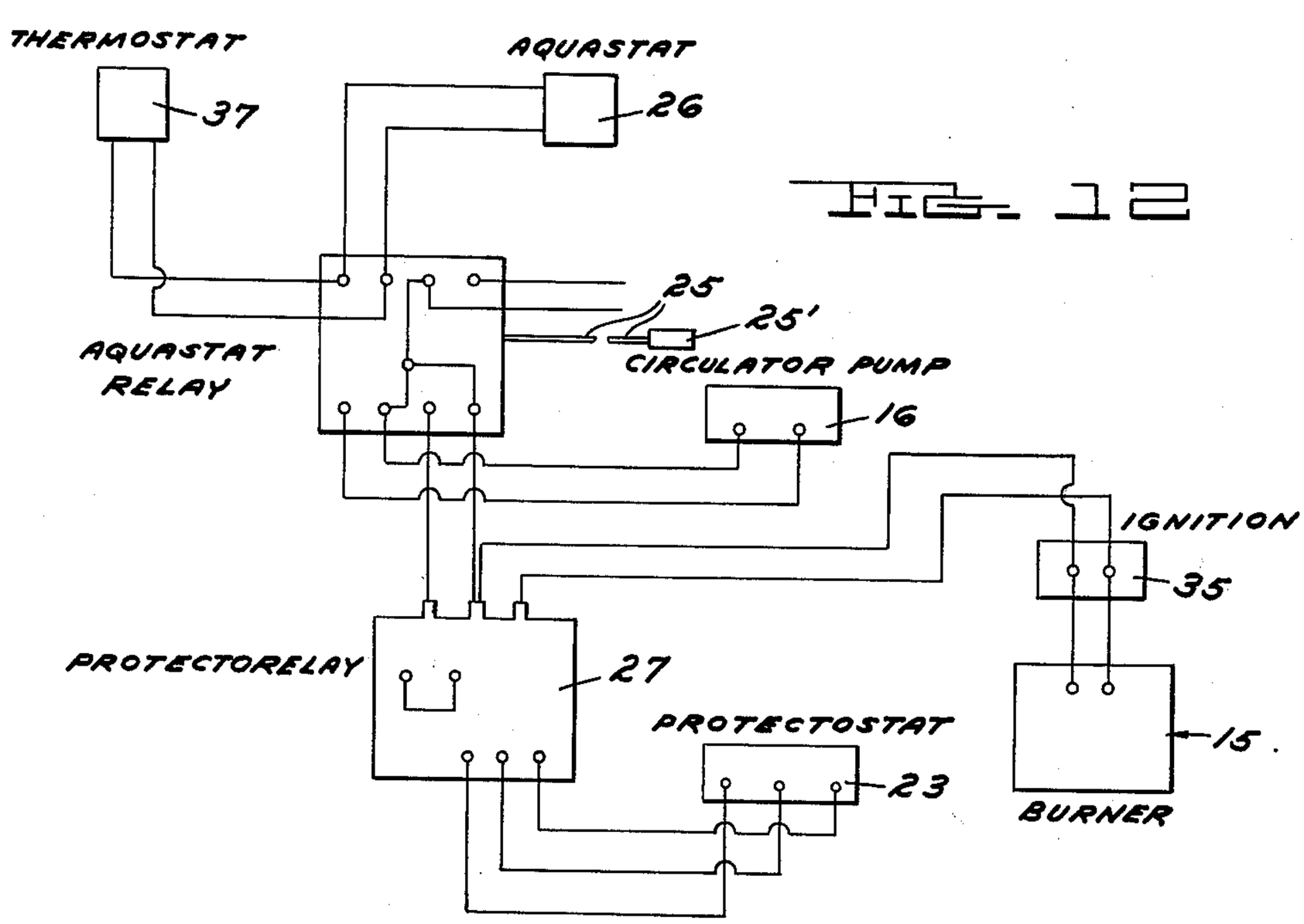


Fig. 12



INVENTOR.
CLARENCE C. SMITH
BY Whittemore, Hulbert & Belknap
ATTORNEYS

United States Patent Office

3,101,780

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3,101,780
PLATE TYPE BOILER

Clarence C. Smith, Okemos, Mich., assignor to Tranter Manufacturing, Inc., Lansing, Mich., a corporation of Michigan

Filed Feb. 9, 1960, Ser. No. 7,581
7 Claims. (Cl. 165—166)

The present invention relates to an improved plate-type hot water boiler for space heating, as through the agency of heat transferring units, which boiler is of extremely simple and inexpensive fabricated construction as regards the water circulatory and heat transfer boiler unit proper thereof. The invention also concerns an improved combination of such plate boiler unit with a further heater unit for domestic water, in which a heating coil of the last named unit is disposed in a water box or reservoir which is connected in water circulating relationship to the boiler, whereby the boiler water serves as a heating medium for a domestic water supply.

It is an object of the invention to provide a boiler unit and combination of the character referred to, in which the boiler unit is composed simply of one or more plate panels constituted alike by sheet metal plates welded, brazed or otherwise permanently bonded in face to face relation to one another and conformed to provide water circulating headers and header-connecting passages between the plates.

Another object is to provide a boiler unit in which there are a plurality of such plate panels fixedly mounted and associated relative to one another in such manner that boiler water force-fed from a circulating pump is simultaneously caused to flow through these panels, subject to maximum heat transfer from hot products of combustion impinging the large surface area of these plate panel components. The factors of large heat transfer surface and forced water circulation combine to produce maximum heating capacity for a given size boiler installation, and maximum heat transfer efficiency.

Another object is to provide a multiple panel boiler unit as described which, as associated in combination with a domestic water heater unit of the character referred to, has provisions for a maximum efficiency circulation of boiler water therethrough, as well as to and through a water box of the last named unit, within which water box a domestic water circulating coil is disposed to receive heat from the boiler water entering the box.

More specifically, it is an object of the invention to provide a plate type boiler unit fabricated of assembled and welded, brazed or otherwise permanently bonded plate panels as described, which panels are of generally similar construction in regard to the formation of intake and discharge headers and parallel connecting passages therein, whereby the invention makes possible the very expeditious and inexpensive production of more or less standard panels for different sizes or capacities.

Yet another specific object is to provide a boiler unit including water circulating and heat transfer plate panels arranged in an outline which is hollow, with cross-over plate panels of generally similar construction disposed in the hollow to receive heat from hot gaseous products of combustion of a suitable burner therebeneath.

A still further object is to provide a space and domestic water heating installation including boiler and water heating components as mentioned above, which system has a pump-forced flow of water through both the space heating and water heating units thereof for the highest possible ratio and efficiency of heat transfer; and in which, in accordance with a further improvement, thermostatically controlled by-pass means are provided to seasonally limit the flow of boiler water to the boiler unit and water box of the domestic water heater, to the exclusion of the external space heating unit. Thermostatically controlled components automatically govern such by-passing, as in the summer months, as well as automatically governing the cutting in and out of the pump and burner of the system.

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:

FIG. 1 is a schematic front elevational view showing the improved boiler and various associated pump, burner, control and other components as mounted within a suitable outer shell or housing, the front panel of which is removed;

FIG. 2 is a schematic view in vertical, front-to-rear section through the boiler, showing its basic burner, fire box and heat transfer components;

FIG. 3 is a fragmentary perspective, as viewed from the left hand and from beneath, illustrating the plate type construction of typical water-circulating, heat transfer panel means in accordance with the invention;

FIGS. 4 and 5 are fragmentary views respectively in horizontal cross section on line 4—4 of FIGS. 3 and 8, and in vertical cross section on line 5—5 of those figures;

FIG. 6 is a schematic fragmentary view in front elevation of the plate-type water circulating and heat transfer panel structure of the boiler;

FIGS. 7 and 8 are similar fragmentary views of this structure in rear and side elevation, respectively;

FIG. 9 is a top plan view of the plate boiler unit;

FIG. 10 is a fragmentary front elevational view, partially broken away and in vertical section, of a domestic water heater which is an auxiliary component of the boiler disposed at the front and top thereof;

FIG. 11 is a side elevational view, partially broken away and vertically sectioned, of this domestic water heater; and

FIG. 12 is a schematic wiring diagram for the pump, burner and controls of the boiler of the invention.

First referring to FIG. 1 of the drawings, the improved boiler is generally designated as a whole by the reference numeral **10**, being encased in an inner housing **11**, the front wall of which is of suitably rigid construction to support various valve, burner and control instrumentalities to be hereinafter described. This inner housing is in turn suitably mounted by means of uprights **12** within an outer sheet metal shell or housing **13**, so that all operating components are enclosed, although readily accessible upon removal of a front panel (not shown) of housing **13**.

Essential operating and control components associated with the boiler **10**, as shown in FIG. 1, are a suitable conventional burner **15** of the oil or gas fueled type, with which the invention is not concerned; a water circulating pump **16** adapted to be driven by an appropriate electric motor **17** mounted in front of the front wall of inner housing **11**, a boiler water inlet or supply pipe or conduit **18** leading downwardly from the discharge side of pump **16** to the intake of the boiler heat exchange and circulating plate unit, to be described, the intake side of pump **16** having connected thereto a further return pipe or conduit **19** from a radiating system of one sort or another; and a thermostatically governed water valve **20** disposed in a discharge line **21** which leads from the domestic water heater box of the invention (to be described) to the heat radiating system supplied by the boiler. A valve element **28** of the valve **20** automatically closes when boiler water temperature reaches a predetermined value, thereby by-passing the flow of water from boiler water discharge line **21** through a by-pass tube **29** to the intake side of pump **16**. Such system, although it is not shown

and is no part of the invention, may be considered to be in the form of appropriate, hot water circulating, wall baseboard radiator units or other heat transferring units. It will be understood that the supply line 19 to pump 16 receives return water from such radiator unit.

Other components which appear in FIG. 1 of the drawings are an appropriate protective unit or protectostat 23 wired (as shown in FIG. 12), for the purpose of cutting off the operation of burner 15 on ignition failure; a thermostatic relay control or aquastat relay 24 carried on a side wall of outer housing 13, and having a suitable connection 25 to a thermostatic bulb or like heat-sensing device 25', for the purpose of cutting off the operation of burner 15 at a maximum water temperature limit; a domestic water heat control unit or aquastat 26; a protective thermostatic relay control or protectorelay 27 carried by the side wall housing 13; and domestic water circulating pipes or lines 31, 32, the former a return line to and the latter a supply line from a domestic water heater unit (to be described) these lines servicing the domestic water system of a residence or the like in which the boiler is installed in the usual way.

Further shown in FIG. 1 are an appropriate pressure-temperature gauge device 33 and pressure relief valve 33', not germane to the invention, and an air vent or vent line 34 of the domestic water heater unit. The reference numeral 36 in FIG. 1 designates a suitable observation cover applied to the forward wall of the boiler 10. As appears in FIG. 12, the burner 15 is equipped with a suitable conventional, electrically controlled ignition device 35, appropriately wired therewith and with the remaining electrically controlled components of the system. Also shown in FIG. 12 is a standard room thermostat 37.

The reference numeral 38 in FIGS. 2 and 6 generally designates the improved plate type, water circulating and heat transfer boiler unit of the boiler 10 of the invention. It is constituted by plural water circulating and heat transfer panels of similar plate construction, as will be described. The reference numeral 39 designates a fire box (FIG. 2) mounted within the inner boiler housing 11 adjacent its rear wall, and directly beneath the above-mentioned heat transfer components of the boiler unit 38; and the reference numeral 40 (FIGS. 2, 10 and 11) generally designates the domestic water heater unit associated with the boiler of the invention. Products of combustion of the burner 15 discharge rearwardly and upwardly through inner housing 11, rising past the plate boiler components and exhausting rearwardly through a suitable flue 41 at the top and rear of the housing means. In transferring heat to the plate unit 38 the hot burner gases are channeled between vertical baffles 42, and a certain portion of these gases rise forwardly and upwardly past domestic water heater 40 to heat the contents of the latter.

Structural features of the improved plate-type water circulating and heat exchange unit 38 are best shown in FIGS. 3, 4 and 5 of the drawings. It is made up, as will hereinafter be described in greater detail, of front cross-over and rear and side panels, fabricated of a pair of rectangular sheet metal plates 44, 45. The former is flat throughout, while the latter is embossed to provide water circulatory passages between the plates when they are assembled in flatwise face-to-face engagement. Thus the plate 45 is shown embossed to provide elongate vertical formations 46 paralleling one another which are of triangular cross section so that, when the plate 45 is welded, brazed or otherwise permanently bonded to the plate 44 between and on opposite sides of these formations 46, water circulating passages 47 will be provided which are of generally triangular cross section.

In addition to this, the plate 45 is embossed in a direction at a right angle to the vertical formations 46 to provide further transverse or horizontal header formations of larger flow capacity, such as an upper horizontal header 48 and a similar lower header 49 (FIG. 6) paralleling it at opposite ends of the formations 46. The header formations 48, 49 are of rectangular channel-shaped outline, so that as welded, brazed or otherwise permanently bonded to the plate 44 on either side of such formations, header passages 50 are defined, into which the vertical circulatory passages 47 open at either end of the formations 46. It is to be understood that the plates 44, 45 are also welded, brazed or otherwise permanently bonded about their outer periphery, as at the marginal flange 51.

A plate-type water circulating and heat transfer panel unit 38 is thus constituted which has a large area for heat transfer from the hot products of combustion of the fire box 39. Structural plate features such as have been described in connection with FIGS. 3, 4 and 5 will, as appropriately supported within housing 11, result in the production of an upright, front cross-over plate panel, generally designated by the reference numeral 53, which is of limited height and as to which it will be observed that there are six of the vertical formations 46 providing individual circulatory passages 47.

FIG. 7 illustrates a rear plate panel generally designated by the reference numeral 55. It is constituted by component plates shaped and assembled in exactly the same manner as described above in connection with FIGS. 4 through 6, save for the fact that the rear panel 55 is of more elongated vertical dimensions than the front cross-over plate panel 53. Accordingly, its parallel passage formation and headers will be designated by reference numerals corresponding to those applied to corresponding parts and relationships in FIG. 6, but in this instance primed.

The same situation exists in reference to a pair of side plate panels, generally designated 56 and 57, which are substantially coextensive in height with the rear panel 55, paralleling and extending between opposite sides of the cross-over and rear panels 53, 55, in laterally outwardly spaced relation to the latter. Accordingly, since again structural features of the components of these panels 56, 57 are as described in connection with FIGS. 3, 4 and 5, corresponding reference numerals, double primed, will be employed to designate corresponding parts and relationships.

It will, however, be noted in FIG. 8 that the side panels 56, 57 have the respective lower headers 49'' located intermediate the vertical length of the parallel passage formations 46'', which open, therefore, into the top and bottom of the lower header 49'', and upwardly into the top header 48''. Moreover, as appears in FIGS. 6 and 8, each of the lower headers 49'' has a flow restrictor 59 extending along the length thereof, in such manner that only a portion of the liquid flow upwardly in each of the side plate panels 56, 57 will be diverted by these restrictors laterally outwardly of the headers 49'', the remainder continuing upwardly to the upper header 48'' of the side panels 56, 57.

As illustrated in FIGS. 6 and 7, the side plate panels 56, 57 are bent 90° at their lower ends to provide integral laterally inwardly directed extensions 61, 62, respectively, forming, in effect, a bottom panel for boiler unit 38, which has the same structural characteristics as the panels 56, 57, as to the passages 47 typically shown in FIGS. 3, 4 and 5. The inner ends of these bottom-forming extensions communicate with a central, front-to-rear extending, bottom distributor header 63, which is medially connected by an L-shaped fitting to a boiler intake pipe, which is the discharge pipe or line 18 of the circulating pump 16 (FIG. 1).

As shown in FIGS. 7 and 8, the rear end of bottom distributor header 63 is communicated by means of an L-shaped, tube 64 with the bottom header 49' of the back plate panel 55, so that water supplied to the header 49' will branch laterally therein and circulate upwardly through the formations 46' providing vertical passages of the panel 55. These passages discharge upwardly into the top header 48' of back panel 55; and this header is

communicated at its opposite ends through 90° laterally and forwardly extending tubes **68, 69** with the rear end of each of the top headers *48''* of the side panels **56, 57**. All boiler water received in the headers **48''** is delivered through pipes **71, 72** extending laterally inwardly from the forward ends thereof to opposite sides of the domestic water heater **40** of the installation. Such disposal includes boiler water which passes upwardly in the side panels **56, 57** past the flow restrictors **59**, water flowing upwardly through the cross-over plate panel **53** (FIG. 6), and water flowing upwardly in certain further cross-over plate panels, located in the space between panels **53, 55, 56** and **57** and now to be described.

The water which travels upwardly in the side plate panels **56, 57** and is diverted laterally inwardly by the flow restrictors **59** of lower side panel headers **49''**, passes through pipes **74** to an arrangement of upright cross-over plate panels, of which, as illustrated in FIGS. 2 and 9, there are four in the illustrated embodiment, the forwardmost being the front cross-over panel. These panels are all coextensive in height, and are shown in a front-to-rear staggered arrangement in FIG. 9, being designated **53, 77, 78** and **79**. It is to be noted that the panels **53, 78** will receive water at the bottom thereof from pipes **74** communicating with the lower header **49''** of a side plate panel **57** on one side of the boiler unit **38**; while the alternate cross-over plates **77** and **79** will be supplied at their bottom through like pipes **74** from the lower header **49''** of the side panel **56** on the opposite side of the unit. The upper ends of each of the cross-over plates **53, 77, 78, 79** charge laterally outwardly through pipes **80, 81** to the upper headers **48''** of the respective side plate panels **56, 57**, from which the flow is, as described above, through pipes **71, 72** to the domestic water heater **40**.

Thus, it is seen that the boiler unit **38** provides a very high surface area for heat transfer at its front cross-over plate panel **53**, its full height rear plate panel **55**, its full length side panels **56, 57** and their respective inward bottom extensions **61, 62**, and through the cross-over plate panels **53, 77, 78** and **79**. The sectional character of these cross-over panels is as indicated in FIGS. 3, 4 and 5, it being understood that they will be characterized by upper and lower header formations corresponding to the header formations **48, 49**, and by connecting circulating passages provided by formations corresponding to the formations **46**.

Forced water circulation through all of the plate panel components is an important feature of the invention contributing to high heat transfer capacity and efficiency. The entire boiler construction may be fabricated inexpensively of sheet metal stampings welded, brazed or permanently bonded together; and with the above described basic standardized design the boiler may be made up in a large range of sizes and capacities for use as determined by the demand.

The hot gases from the burner fire box **39** circulate upwardly past the panel components of boiler unit **38** and between baffles **42**, also forwardly past the domestic heater **40**. The water is circulated positively by pump **16** through these components, thence through pipes **71, 72** to opposite sides of the heater **40**, discharging from said heater through the pipe **21** to the radiation means of the space heating system (not shown). Return is through pipe **19** to pump **16**, and then through the line **18** back to the bottom intake at header **63** of the boiler unit **38**.

The nature of the domestic water heater **40** is illustrated in FIGS. 10 and 11. It comprises a suitably sealed water reservoir or box **83** into which the pipes **71, 72** from the side panel top headers **48''** discharge. Heater **40** further comprises a circulating coil **85** formed in a vertically flattened contour (FIG. 11) and disposed within the water box **83**, including central and upper coil portions **86** within its top extension **84**. One end of the coil is in

sealed communication with an intake line **31** from the domestic water system, and the coil portion **86** is fitted to the discharge line **32** to that system. A boiler front plate **87** is provided which is removable for the purpose of installing hot water coil **85**.

As indicated above, the improvement contemplates safety provisions controlled by the thermally responsive valve **20** in the boiler discharge line **21** to the space heating radiator (not shown) whereby as controlled by the domestic water control **26** the valve element **28** of valve **20** may be closed, causing water to be by-passed through the tube **29** to the intake side of circulating pump **16**, without traversing the radiator.

The hot water box **83** at the upper front of the boiler unit **38** acts as a collection point for all of the water going through the boiler and also houses the domestic water coil **85**. The lower part of the front boiler housing wall provides means for mounting the valve, burner, etc., and has a fire observation opening with cover **36**.

The incorporation of the domestic water unit **40** in the boiler eliminates the necessity for a hot water heater, and, in addition, makes possible the forced circulation of boiler water across its coil **85**, for a very efficient heat transfer.

The boiler may be merchandized as a complete package, which includes the controls, pump, and burner, as well as without these latter items.

The wiring for the electrically controlled components of the boiler is shown in FIG. 12, and such wiring provisions will be of a nature understood by those skilled in the art, with conventional electrical connections to the various pump, burner, thermostatically governed relay units and the like.

In operation, for example, in the wintertime, when the room thermostat **37** calls for heat, the aquastat relay control **24** is actuated, which results in electrical energization of the pump **16** and burner **15**. As the boiler water reaches a desired temperature, for example about 185° F., the thermostatic water valve **20** will be opened. Circulation through boiler unit **38**, domestic water heater **40**, its discharge line **21** and return from the space heating radiator system to the pump **16** through line **19** is maintained until room thermostat **37** is satisfied. At this time the relay control **24** is actuated to shut off burner **15**; and when the water temperature in boiler **38** drops below, say, 180° F., the thermostatic water valve **20** will close. In no event will it open unless the room thermostat is calling for heat.

If domestic hot water is being drawn from coil **85** during a period of heat demand on the part of the radiating system, the boiler water will in most cases drop below 180° F., whereupon the thermostatic water valve **20** closes, and all of the heat from the burner will go to heat the domestic water coil **85**.

In summertime operation the room thermostat does not call for heat and the thermostatic water valve **20** is always closed, by-passing water to pump **16**. When domestic hot water is drawn, the aquastat domestic water control **26** is actuated, which turns on pump **16** and burner **15**, allowing the boiler **38** to cycle on and off, thus to maintain water temperature in the boiler between limits of, say, 170° F. to 185° F.

The by-pass tube connection **29** between boiler unit **38** and thermostatically controlled water valve **20** on the discharge line **21** of the boiler, and between the radiator system and the circulating pump **16** on the inlet side of the boiler, results, when the valve **20** is closed and the burner and pump are in operation, in a definite forced circulation through boiler **38**, but not through the radiating system.

In the interest of safety, should ignition of fuel oil or gas at the burner not take place, the protectostat **23** will actuate the relay control **27** and shut off burner **15**. Whenever the water in boiler **38** reaches its maximum temperature of, say 210° F., bulb **25'** will sense it and

the aquastat relay control 24 will be actuated to shut off the burner.

What I claim as my invention is:

1. An upright plate type boiler comprising a pair of opposed upright, generally parallel, front and rear fluid circulating panel units spaced transversely from one another, a pair of opposed upright, generally parallel side panel units of a construction generally similar to said front and rear units, said front, rear and side units being arranged about the four sides of a boiler heating space, said panel units each comprising a pair of plates secured together in face-to-face sealed relation and providing therebetween a plurality of upright fluid flow passages and transversely extending, vertically spaced headers in communication with said passages adjacent vertically spaced points of the latter, the respective upper and lower headers of the respective units being in communication with one another, and at least one upright cross-over circulatory unit disposed between the opposed panel units of one of said pairs, said cross-over circulatory unit having a construction similar to said panel units, including vertically spaced headers in communication with one another through upright fluid flow passages, said headers of the cross-over unit being respectively in communication with at least one of said last named opposed panel units at the respective vertically spaced headers of the latter.

2. An upright plate type boiler comprising a pair of opposed upright, generally parallel, front and rear fluid circulating panel units spaced transversely from one another, a pair of opposed upright, generally parallel side panel units of a construction generally similar to said front and rear units, said front, rear and side units being arranged about the four sides of a boiler heating space, said panel units each comprising a pair of plates secured together in face-to-face sealed relation and providing therebetween a plurality of upright fluid flow passages and transversely extending, vertically spaced and substantially horizontal headers in communication with said passages adjacent vertically spaced points of the latter, and at least one upright cross-over circulatory unit disposed between the opposed panel units of one of said pairs, said cross-over circulatory unit having a construction similar to said panel units, including vertically spaced headers in communication with one another through upright fluid flow passages, said headers of the cross-over unit being respectively in communication with at least one of said last named opposed panel units at the respective vertically spaced headers of the latter, the respective upper and lower headers of the respective panel units being in communication with one another at the respective transverse header ends, the lower header of said front panel unit having communication with opposite ends of the lower headers of said side panel units at points substantially above the lower header of said rear panel unit.

3. An upright plate type boiler comprising a pair of opposed upright, generally parallel, front and rear fluid circulating panel units spaced transversely from one another, said rear unit being of substantially the full height of said boiler, said front unit being of lesser height, a pair of opposed upright, generally parallel side panel units of a construction generally similar to said front and rear units and of a height approximating that of the rear unit, said front, rear and side units being arranged about the four sides of a boiler heating space, said panel units each comprising a pair of plates secured together in face-to-face sealed relation and providing therebetween a plurality of upright fluid flow passages and transversely extending, vertically spaced and substantially horizontal headers in communication with said passages adjacent vertically spaced points of the latter, and at least one upright cross-over circulatory unit disposed between the opposed panel units of said first named pair, said cross-over circulatory unit having a construction similar to said panel units, including vertically spaced headers in communication with one another through upright fluid flow passages, said headers of the cross-over unit being respectively in communication with at least one of said last named opposed panel units at the respective vertically spaced headers of the latter, the respective upper and lower headers of the respective panel units being in communication with one another, the lower header of said front panel unit having communication with the lower headers of said side panel units at points substantially above the lower header of said rear panel unit, all of the upper headers having communication with one another at approximately the same level.

4. An upright plate type boiler comprising a pair of opposed upright, generally parallel, front and rear fluid circulating panel units spaced transversely from one another, said rear unit being of substantially the full height of said boiler, said front unit being of lesser height, a pair of opposed upright, generally parallel side panel units of a construction generally similar to said front and rear units and of a height approximating that of the rear unit, said front, rear and side units being arranged about the four sides of a boiler heating space, said panel units each comprising a pair of plates secured together in face-to-face sealed relation and providing therebetween a plurality of upright fluid flow passages and transversely extending, vertically spaced and substantially horizontal headers in communication with said passages adjacent vertically spaced points of the latter, and at least one upright cross-over circulatory unit disposed between the opposed panel units of said first named pair, said cross-over circulatory unit having a construction similar to said panel units, including vertically spaced headers in communication with one another through upright fluid flow passages, said headers of the cross-over unit being respectively in communication with at least one of said last named opposed panel units at the respective vertically spaced headers of the latter, the respective upper and lower headers of the respective panel units being in communication with one another, the lower header of said front panel unit having communication with the lower headers of said side panel units at points substantially above the lower header of said rear panel unit, all of the upper headers having communication with one another at approximately the same level, said side and rear panel units having means to communicate the headers thereof with a fluid circulatory line beneath the respective headers.

5. An upright plate type boiler comprising an upright fluid circulating panel unit, a pair of opposed upright, generally parallel side panel units of a construction generally similar to said first named unit and disposed in planes in substantially 90° relationship to the plane of said first named unit adjacent opposite sides of the latter to substantially define three sides of a boiler heating space, said panel units each comprising a pair of plates secured together in face-to-face sealed relation and providing therebetween a plurality of upright fluid flow passages and transversely extending, vertically spaced headers in communication with said passages adjacent vertically spaced points of the latter, the respective upper and lower headers of the respective units being in communication with one another, and a pair of upright cross-over circulatory units disposed in substantially parallel planes between said opposed side panel units, said cross-over units being respectively alternately in communication with said side panel units at the respective vertically spaced headers thereof.

6. An upright plate type boiler comprising a pair of opposed upright generally parallel, front and rear fluid circulating panel units spaced transversely from one another, a pair of opposed upright, generally parallel side panel units of a construction generally similar to said front and rear units, said front, rear and side units being arranged about the four sides of a boiler heating space, said panel units each comprising a pair of plates secured together in face-to-face sealed relation and providing

therebetween a plurality of upright fluid flow passages and transversely extending, vertically spaced headers in communication with said passages adjacent vertically spaced points of the latter, the respective upper and lower headers of the respective units being in communication with one another, and at least one upright cross-over circulatory unit disposed between the opposed panel units of one of said pairs, said cross-over circulatory unit having a construction similar to said panel units, including vertically spaced headers in communication with one another through upright fluid flow passages, said headers of the cross-over unit being respectively in communication with at least one of said last named opposed panel units at the respective vertically spaced headers of the latter, the panel unit with which said cross-over unit communicates being provided adjacent its lower header with connecting means placing said last named lower header in communication with the lower header of the cross-over unit.

7. An upright plate type boiler comprising a pair of opposed upright generally parallel, front and rear fluid circulating panel units spaced transversely from one another, a pair of opposed upright, generally parallel side panel units of a construction generally similar to said front and rear units, said front, rear and side units being arranged about the four sides of a boiler heating space, said panel units each comprising a pair of plates secured together in face-to-face sealed relation and providing therebetween a plurality of upright fluid flow passages and transversely extending, vertically spaced headers in communication with said passages adjacent vertically spaced points of the latter, the respective upper and lower

headers of the respective units being in communication with one another, and at least one upright cross-over circulatory unit disposed between the opposed panel units of one of said pairs, said cross-over circulatory unit having a construction similar to said panel units, including vertically spaced headers in communication with one another through upright fluid flow passages, said headers of the cross-over unit being respectively in communication with at least one of said last named opposed panel units at the respective vertically spaced headers of the latter, the panel unit with which said cross-over unit communicates being provided adjacent its lower header with connecting means placing said last named lower header in communication with the lower header of the cross-over unit, and with means to divert a portion of the fluid flow in said panel unit into said connecting means.

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