Jan. 20, 1970 W. E. KRAMER 3,490,420

INDUCED DRAFT OIL-FIRED WATER HEATER

Filed Dec. 13, 1967 2 Sheets-Sheet 1

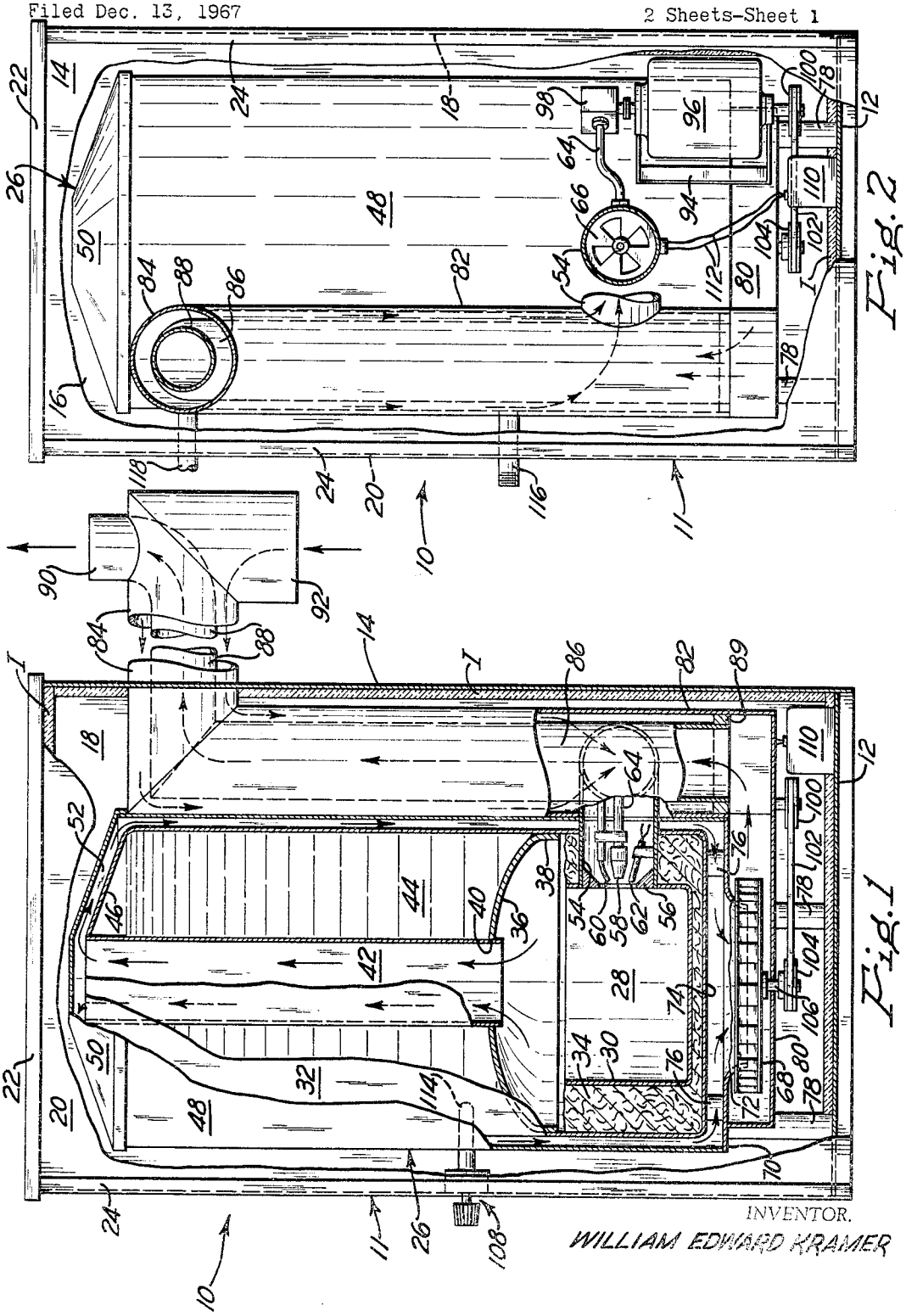


Fig. 2

Fig. 1

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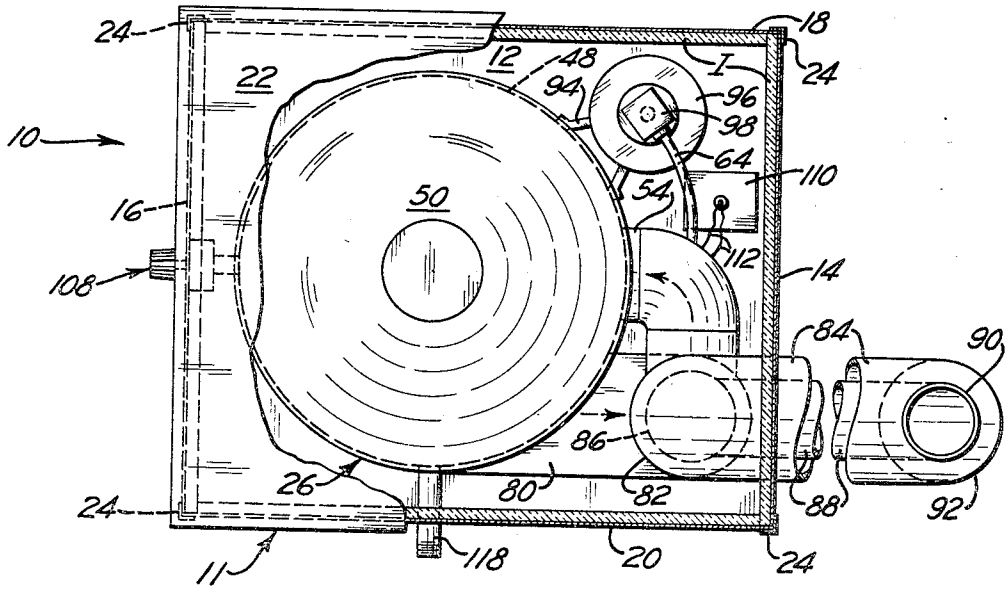



Fig. 3

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# INDUCED DRAFT OIL-FIRED WATER HEATER

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U.S. Cl. 122—17 11 Claims

## ABSTRACT OF THE DISCLOSURE

A compact oil-fired water heater utilizing a toroidal water tank positioned over a combustion chamber with a central exhaust gas passage through the tank and a narrow space leading from the top of the central passage down the outside of the water tank and the combustion chamber to a draft inducing fan located below the tank and combustion chamber which draws the exhaust gases and pushes them through an exhaust pipe which is nested within the air supply pipe.

This invention relates to water heaters, and more specifically concerns a compact, oil-fired water heater for domestic use.

In the water heater art it is desirable to provide as large a surface area as possible between the source of heat and the water tank in order to maximize the amount of heat added to the water, to thereby maximize the efficiency of use of fuel. It is also desirable to provide as small a water heater as possible, in its overall external physical dimensions, while at the same time providing sufficient hot water to the dwelling or the like supplied by the water heater. The desideratum of small physical size is particularly important where the water heater is used in small dwellings, or in house trailers, or other places where space is limited. The present invention has an advantage over prior water heaters in this regard in that its height, in the common sizes of hot water capacity, may be on the order of 34 to 38 inches, which is a comfortable counter height. Thus, the top surface of the water heater may be provided with a laminated plastic, wood block, or other useful working surface, whereby the space occupied by the water heater is usefully employed. Thus, the water heater of the invention may be easily and to advantage worked into a kitchen or other work room of a small home or the like where space is at a premium. Prior water heaters are typically large, unwieldy devices which are ordinarily located in a basement or in a closet, thus consuming space which could be utilized.

The water heater of the invention also comprises induced draft means which yields several advantages over prior known water heaters. The induced draft arrangement of the water heater of the invention permits sealed operation, i.e., no room or surrounding environment air is used to support combustion. Virtually all prior water heaters require openings or direct communication of some kind between the combustion chamber and the surrounding environment to permit the flow of air therefrom into the combustion chamber. The need to draw room air into the water heater is a serious disadvantage of these prior water heaters because the direct communication often works both ways, and in case of malfunction in the burner apparatus raw fuel, such as oil, natural gas, bottled gas, or the like, can enter the room to constitute a serious health hazard at worst and to create dirt and the like within the room at best. Further, the necessity for louvered openings, grills, or the like air communication means into the water heater restrict the positioning of the water heater since these openings must have free access to room air. Another advantage of the sealed nature of the present invention is that no oxygen is drawn



from the room into the water heater. This is important in trailers, houseboats and the like small enclosures since oxygen starvation in such a small area could be harmful to plants and animals, including human beings, therein.

The present invention achieves sealed operation and all of its attendant advantages by use of a fan and by nesting the exhaust gas condut or pipe within the air intake conduit or pipe. Since the heater of the invention is specifically intended to burn oil as a fuel, access outdoors for the exhaust gases is provided. The burner of the present invention could be adapted to burn natural gas or bottled gas, such as methane, LPG or propane, if desired, as well as other liquid fuels, such as kerosene. The induced draft construction of the present invention permits the nested exhaust and air intake arrangement since no conventional natural draft flue or chimney is required. The induced draft fan is arranged near the exit end of the exhaust gas path through the water heater, and draws exhaust gases through the combustion chamber to exert a positive suction force on the air inlet to the combustion chamber, to thereby draw outdoor air through the inlet pipe into the air inlet openings of the combustion chamber.

Another advantage is that a beneficial pre-heating effect is experienced by the air drawn in since the pipe carrying it surrounds the warm exhaust gas conduit. The length of double pipe extends for substantially the entire height of the water heater, and then from the water heater to and through an opening in an external wall, and terminates at the outside surface of said external wall.

Still another advantage resulting from nesting the exhaust gas conduit within the air supply conduit is that the water heater of the invention is quite safe in operation as far as positively pushing exhaust gases into the surrounding environment should the exhaust conduit spring a leak. Since the exhaust conduit is surrounded by an annulus of fresh air moving towards the burner, a leak in the exhaust conduit will result in exhaust gases entering the stream of fresh air. If the leak is large enough, then the reduced percentage of oxygen in the gas flow to the burner will result in oxygen starvation of the flame, which will cause it to go out. The flame-out will be sensed by the safety equipment incorporated in the apparatus of the invention, which will result in a shutdown, thereby warning the user that some attention or service is required. Restarting of the burner by operation of the re-set button will cause operation of the burner for a short time only until the flame is again extinguished due to oxygen starvation.

Another advantage flowing from the induced draft arrangement is that a relatively narrow space is provided on the outside of the water tank through which the exhaust gases are drawn by the fan at relatively high velocities. By providing a thin layer of gas around the tank, the thickness of the relatively stagnant boundary layer on the tank surface is minimized. By providing a thin, high velocity, layer of gas around the tank, turbulent flow of the gas is assured. Thus, virtually the entire outside surface of the water tank is contacted by a hot, turbulent layer of high velocity exhaust gases, and these factors improve the efficiency of heat transfer from the gases to the water.

The invention comprises a draft inducing fan which is housed within a fan scroll chamber located below the combined combustion chamber and water tank. The means to create the above mentioned narrow space surrounding the water tank lead downwardly and communicate with the fan scroll chamber. An advantage flowing from this structure, i.e., having the fan and its scroll chamber located at the lowermost point of the apparatus, is that a warm zone, as opposed to a very hot zone, is created at the lowermost point of the apparatus to thereby permit use of the water heater of the invention on virtually any

normal flooring material. Many prior water heaters had the combustion chamber located at the lowermost point of the apparatus, and this structure necessitated specially constructed noncombustible flooring, usually a concrete slab, on which the water heater was mounted. The present invention eliminates the need for any such special flooring, thereby reducing the cost of installing the water heater, and permitting virtually unlimited freedom in placing the water heater.

Another advantage of the water heater of the invention is that by provision of a toroidal water storage tank, all surfaces of the tank are exposed to hot gases to thereby increase the flow of heat into the water. The center of the toroidal tank comprises a vertical passageway having direct access to the combustion chamber for the upward flow of exhaust gases therein. The top and side cylindrical surfaces of the water tank, in combination with other wall portions, comprise a narrow space completely surrounding the top and outside surfaces of the tank through which are drawn exhaust gases exiting from the vertical center passageway to increase the flow of heat from the gases into the water. The bottom surface of the water tank is, in effect, the roof of the combustion chamber, whereby this bottom surface, which comprises a single, relatively thin sheet of metal, directly "sees" the flame, whereby heat is imparted to the water by both conduction from the hot exhaust gases, and by direct radiation from the flame.

Other advantages of the invention will be pointed out or will become evident in the following detailed description and claims, and in the accompanying drawing also forming a part of the disclosure, in which FIG. 1 is a vertical side view of a water heater embodying the invention with some parts in section and some parts broken away; FIG. 2 is a vertical end view of the water heater of FIG. 1 with some parts broken away and some parts in cross-section; and FIG. 3 is a top plan view of the heater of FIG. 1 with the top member partially broken away.

Referring now in detail to the drawing, reference numeral **10** generally designates a water heater embodying the invention. Heater **10** is mounted entirely within a cabinet or console **11** comprising a floor **12**, a back wall **14**, a front wall **16**, a left side wall **18**, a right side wall **20**, and a top member **22**. Although not specifically shown, it will be understood by those skilled in the art that either one or both of the side walls of the cabinet **11** is made so as to be easily removable for burner adjustment and service purposes. Four corner members **24** have their lower ends resting on the floor of the room or the like, and support the top member **22** at their upper ends. All inside surfaces of console **11** are provided with suitable heat insulation I, such as fiberglass batting coated with aluminum foil on the surface facing the heat. Corners **24** may comprise angle irons, and the various walls **12** through **20** may comprise sheet metal, composite board, or other suitable materials to form the external cabinet. The top member **22** is advantageously utilized in some manner, such as by being made up of laminated wood to serve as a cutting board, or being covered with a suitable plastic such as Formica to form a kitchen working surface.

Mounted within cabinet **11** are the working portions of the water heater **10**, generally designated by reference numeral **26**. Mechanical portions **26** comprise a combustion space **28** which is defined by a combustion chamber wall **30** which is generally cylindrical with a generally vertically disposed axis. Wall **30** and entire working portions **26** are generally cylindrical because such shape is the most practical for fabrication purposes. It will be understood, of course, that the invention is not limited to the generally cylindrical shape shown.

Combustion chamber wall **30** is nested within an inner water heater wall **32**, and is held in spaced relation thereto by any suitable heat insulation material **34**, such as vermiculite, mineral wool, or the like. Insulation **34** is packed within walls **30** and **32** and surrounds the combustion chamber on its lateral and bottom sides, the top of the combustion chamber being open. The upper end of the combustion space **28** is defined by a dome-like wall **36** formed with a cylindrical side flange **38** which contacts the inside surface of inner wall **32** and is joined thereto by any suitable water and air tight sealing means such as welding. Dome **36** is formed with a central opening **40** in which is sealingly fitted the lower end of an exhaust gas carrying conduit or flue **42**. The lower end of flue **42** extends slightly below dome **36**. The downwardly extending lower end of flue **42** increases the residence time of the hot gases at dome-like wall **36**. Since, as is conventional, cold water enters adjacent the bottom of the tank and exits adjacent the top of the tank, the increased residence time of the hot gases at the bottom of the tank increases the efficiency of heat transfer to the water because of the temperature differential. That is, the water is at its lowest temperature and the gases are at their highest temperature at wall **36**.

The annular, dome-like wall **36** serves as the bottom of the toroidal water tank **44** as well as the roof of the combustion space **28**. The inside wall of the tank **44** comprises flue **42**, the outside wall comprises the upper portion of inner wall **32**, and the upper end of tank **44** comprises a wall **46** which extends from the upper end of wall **32**, upwardly and inwardly to join the upper end of flue **42**.

Means are provided to create a relatively narrow space around the water tank **44** for the passage of heated gases therethrough to permit flow of heat through walls **32** and **46** into the water in tank **44**. To this end, a wall **48** surrounds wall **32** over its entire length in closely spaced relation thereto. A lid member **50** is seated upon the upper end of wall **48** in closely spaced relation to the upper open end of flue **42** and in closely spaced relation to wall **46**. Thus, a narrow space **52** is created completely surrounding the outside and upper surfaces of the water tank **44**. The lid member **50** is removable to permit access to the water tank for service and maintenance, and may be held in place by screws or other suitable means such as a snug friction fit.

Means are provided to create a flame within combustion space **28**. To this end, a tube **54** extends through suitable formed openings in wall **30**, insulation **34**, and walls **32** and **48**, terminating at a location spaced outwardly of wall **48**. The inner end of tube **54** is provided with a suitable combustion mixture swirling device **56**. As shown, the water heater **10** is intended to burn fuel oil, it being understood that other suitable fuels and attendant fuel handling means may be used. In spaced relation to swirl plate **56** is a fuel oil nozzle **58**, ignition means **60**, and flame sensing means **62**, the supports for all of which are partially omitted for the sake of clarity. Nozzle **58** is mounted on the end of a fuel oil supply pipe **64**, which is nested within tube **54**. Means are provided to adjust the amount of air which may flow into the rear or outer end of tube **54**. To this end, a double plate segment type air shutter **66** is provided at the outer end of tube **54**. Access is had to control shutter **66** via suitable openings or a remote control lever, or the like, not shown, as is conventional in the art.

Water heater **10** utilizes a sealed induced draft, i.e., no access to the surrounding environment is necessary for purposes of creating a natural draft for the exhaust gases and to supply air for combustion. It is the induced draft feature which permits the advantages of sealed operation for the present invention. The induced draft apparatus comprises a squirrel cage or other suitable type of fan **68** below the combustion chamber and in communication with narrow space **52**. Horizontally disposed wall **70** is joined to the lower end of wall **48** and is provided with a central opening defined by a downwardly and inwardly flaring portion **72** which terminates in the space within fan **68**. The bottom, horizontal portion of narrow space **52** is further defined by a horizontally disposed wall **74** which also constitutes the bottom of the chamber which holds insulation **34**. Suitable legs or sup-

ports 76 are interposed between walls 70 and 74 to support the combned combustion chamber and water tank assembly within the space defined by wall 48 and lid 50. In turn, the combined outer tank assembly defined by wall 48, lid 50, and bottom wall 70 is supported on the floor 12 of console 11 by suitable legs or supports 78. A fan scroll chamber is positioned below wall 70 and is defined by a rectangular cross-section conduit 80 which terminates at the lower end of an exhaust conduit 86. As shown in FIGS. 1 and 3, conduit 80 is partially defined by bottom wall 70 through the extent thereof wherein it is positioned under wall 70. Conduit 80, the fan scroll chamber, comprises the buffer zone which permits use of the water heater of the invention on virtually any kind of normal flooring.

Means are provided to supply air for combustion to tube 54 and to vent the exhaust gases removed from the system by fan 68, while at the same time utilizing the heat within said exhaust gases to pre-heat the fresh air. By withdrawing the heat from the exhaust gases, overall efficiency and economy are enhanced. It is possible and desirable to withdraw substantially all of the heat, above atmospheric conditions, from the exhaust gases without impairing efficiency of operation of the exhaust system of the present invention. This advantage flows directly from the induced draft arrangement of the present invention. In more conventional natural draft heating devices, a certain and often substantial amount of heat must be left in the exhaust gases in order to cause them to rise naturally up the chimney or flue. Thus, fuel cost and overall efficiency of heater 10 are improved by the induced draft apparatus. Referring to the drawing, air supply tube 54 is in communication with an air supply conduit 82, which comprises a top horizontal conduit portion 84. An exhaust conduit 86 extends upwardly from scroll 80 within supply conduit 82, and comprises a top horizontal portion 88 within conduit portion 84. At the plane of juncture between the lower ends of nested conduits 82 and 86, and scroll 80, a sealing ring 89 is provided to prevent exhaust gases from entering the annular fresh air passageway. Ring 89 may be held in place by any suitable fluid-tight sealing means such as welding.

It is the above described structure, exhaust conduits 86 and 88 nested within fresh air conduits 82 and 84, which yields the advantage of increased safety. A break anywhere in the exhaust conduits will result in exhaust gases being drawn into the fresh air flow, which will act to extinguish the flame because of oxygen starvation.

The combined nested conduits 84 and 88 extend through the back console wall 14 near the upper end of the console. The break in the nested conduits 84 and 88 shown in FIG. 1 is representative of an extent of nested conduits sufficient to extend from the rear of the heater to and through some convenient external wall or window and out to the outside environment. Beyond said outside wall, exhaust conduit 88 is provided with an upwardly opening vertical portion 90 and air intake conduit 84 is provided with a downwardly opening vertical conduit portion 92. It will, of course, be understood that all interconnections between various conduit portions throughout the water heater as well as the junctures at the places where one conduit passes through or extends into the wall of another, are provided with suitable air-tight sealing means such as gaskets, caulking, or the like.

Thus, the entire air supply and exhaust gas system is positively driven by fan 68. The fan draws gases into its center portion and then drives them outwardly through its blades. The exhaust gases pass through scroll 80, exhaust conduits 86, 88, and 90, and are positively driven upwardly upon exiting from conduit 90. Any residual heat that may be present in the exhaust gases aids them in rising in the atmosphere. The intake side of fan 68 draws gases through narrow space 52 surrounding the bottom, sides, and substantially the entire top of the combined combustion chamber and water heater. The suction in space 52 draws exhaust gases through flue 42. The suction force in flue 42 draws fresh air for combustion, the amount of which is controlled by air shutter 66, through tube 54 and conduits 82, 84, and 92. Air for combustion is drawn from below the level of the region of exhaust to thereby assure that exhaust gases will not be recirculated through the system.

Means are provided to drive fan 68 and to pump oil through supply pipe 64 to nozzle 58. To this end, a bracket 94 of any suitable type supports an electric motor 96 on the lower end of wall 48. Motor 96 has a double-ended shaft and supports an oil pump 98 at its upper end, which is held against rotation by suitable means not shown. Pump 98 draws fuel from a source not shown and supplies it under pressure through supply pipe 64. The lower end of the motor shaft carries a pulley 100 which drives a suitable drive belt 102 which in turn drives a pulley 104, which is mounted on a shaft 106 which drives the fan 68.

Means are provided to supply electrical energy to motor 96 and ignition means 60, and to interconnect flame sensing safety device 62 and suitable water temperature control means 108 into one electrical system. Since the electrical system is conventional, most of it is omitted for the sake of clarity. A high voltage transformer 110 is included in said electrical system and supplies high voltage current through electrical conductors 112 to the ignition means 60. Water temperature control 108 is conventional and is connected into the electrical system by leads not shown, and comprises a water temperature sensing probe 114.

Means are provided to supply cold water and remove hot water from water heater 10. To this end, a cold water supply pipe 116 extends from water tank 44 to the outside of the console adjacent the lower end of the water tank, and a hot water take-off pipe 118 is positioned adjacent the upper end of the water tank directly above supply pipe 116. The water supply and take-off apparatus is otherwise conventional.

While the invention has been described in detail above, it is to be understood that this detailed description is by way of example only, and the protection granted is to be limited only within the spirit of the invention and the scope of the following claims.

I claim:

1. In a water heater, the combination comprising a combustion chamber, means to supply fuel and air to said combustion chamber and to create a flame therein, a water tank above said combustion chamber, transverse wall means in said water heater defining the bottom of said water tank and the top of said combustion chamber, said water tank comprising a central passageway extending from said transverse wall means through said water tank to the top thereof to communicate said combustion chamber with the space above said water tank, said water heater comprising wall means closely adjacent to and surrounding the top and sides of said water tank to define a relatively narrow space around said top and sides of said water tank, fan means and exhaust conduit means in communication with said relatively narrow space, whereby said fan means draws air from said air supply means into said combustion chamber to support the combustion therein and causes movement of the products of combustion upwardly through said centrally disposed passageway, through said narrow space surrounding the top and sides of said water heater, and through said exhaust conduit means, said supply means including a pair of nested conduits consisting of an air supply conduit within which is nested said exhaust conduit, whereby heat in the exhaust gases passing through said exhaust conduit is utilized to pre-heat the air in said air supply means prior to combustion.

2. The combination of claim 1, said transverse wall means comprising a metal sheet having a dome-like shape

with its convex side facing upwardly into said water tank.

3. The combination of claim 2, the lower end of said central passageway extending down below said transverse wall.

4. The combination of claim 1, said nested air supply and exhaust conduits comprising means to diverge from each other in an environment from which air for combustion is drawn and into which exhaust gases are vented, said diverging means comprising an upwardly extending open-ended conduit portion of said exhaust conduit and a downwardly extending open-ended conduit portion of said air supply conduit, and said exhaust conduit passing through the wall of said air supply conduit.

5. The combination of claim 1, said water tank comprising a toroidal cross-sectional shape, the side cylindrical wall of said water tank comprising a downwardly extending portion concentric with said combustion chamber, heat insulation means interposed between said combustion chamber and said downwardly extending portion of said cylindrical wall, said wall means surrounding said water tank comprising a cylindrical wall portion around said cylindrical wall of said water tank and said downwardly extending portion thereof, and the portion of said surrounding wall means adjacent to the top of said water tank comprising a removable lid positioned on the upper end of said cylindrical surrounding wall.

6. The combination of claim 5, said surrounding wall means comprising a bottom transverse portion formed with an opening, said opening comprising an inwardly and downwardly flaring lip portion, said fan means comprising a squirrel cage fan disposed below and in spaced relation to said bottom portion of said surrounding wall means with said flaring portion of said wall means disposed in the space within said squirrel cage fan.

7. The combination of claim 5, said insulation comprising vermiculite.

8. The combination of claim 1, a closed console housing said water heater, and said console being formed with means to permit passage of said air supply means and said exhaust conduit means through the wall thereof.

9. The combination of claim 8, said console having an overall height in the range of about 34 inches to about 38 inches.

10. The combination of claim 8, said console comprising a removable top member having a counter top surface.

11. In a water heater, the combination comprising a combustion chamber, means to supply fuel and air to said combustion chamber and to create a flame therein, a water tank above said combustion chamber, transverse wall means in said water heater defining the bottom of said water tank and the top of said combustion chamber, said water tank comprising a central passageway extending from said transverse wall means through



said water tank to the top thereof to communicate said combustion chamber with the space above said water tank, said water heater comprising wall means closely adjacent to and surrounding the top and sides of said water tank to define a relatively narrow space around said top and sides of said water tank, fan means and exhaust conduit means in communication with said relatively narrow space; whereby said fan means draws air from said air supply means into said combustion chamber to support the combustion therein and causes movement of the products of combustion upwardly through said centrally disposed passageway, through said narrow space surrounding the top and sides of said water heater, and through said exhaust conduit means, said water tank comprising a toroidal cross-sectional shape, the side cylindrical wall of said water tank comprising a downwardly extending portion concentric with said combustion chamber, heat insulation means interposed between said combustion chamber and said downwardly extending portion of said cylindrical wall, said wall means surrounding said water tank comprising a cylindrical wall portion around said cylindrical wall of said water tank and said downwardly extending portion thereof, the portion of said surrounding wall means adjacent to the top of said water tank comprising a removable lid positioned on the upper end of said cylindrical surrounding wall, said surrounding wall means comprising a bottom transverse portion formed with an opening, said opening comprising an inwardly and downwardly flaring lip portion, said fan means comprising a squirrel cage fan disposed below and in spaced relation to said bottom portion of said surrounding wall means with said flaring portion of said wall means disposed in the space within said squirrel cage fan, and said bottom transverse portion of said surrounding wall means defining an extension of said narrow space disposed below said combustion chamber and extending into the space within said squirrel cage fan.


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