

[54] **GAS FIRED FLUID HEATING APPARATUS**
[75] Inventor: **Ralph D. Cooksley**, Waterford,
Conn.
[73] Assignee: **Tagh, Inc.**, Westbrook, Conn.
[22] Filed: **July 19, 1971**
[21] Appl. No.: **163,812**

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Primary Examiner—Kenneth W. Sprague
Assistant Examiner—James C. Yeung
Attorney—Ralph H. Chilton et al.

[52] U.S. Cl. **122/156, 122/155 C, 122/159,**
122/183, 431/90
[51] Int. Cl. **F22b 13/02**
[58] Field of Search 122/156, 155 C, 159,
122/183; 431/90; 110/97 D

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[57] **ABSTRACT**
A home hot water supply and heating system having a tankless gas fired water heater with an upstanding fire box, a mixing nozzle for directing a gas and air mixture upwardly into the fire box, and an elongated and upstanding combined exhaust stack and heat exchanger above the fire box having a plurality of elongated generally coaxial tubes providing alternate water and exhaust passageways.

7 Claims, 4 Drawing Figures

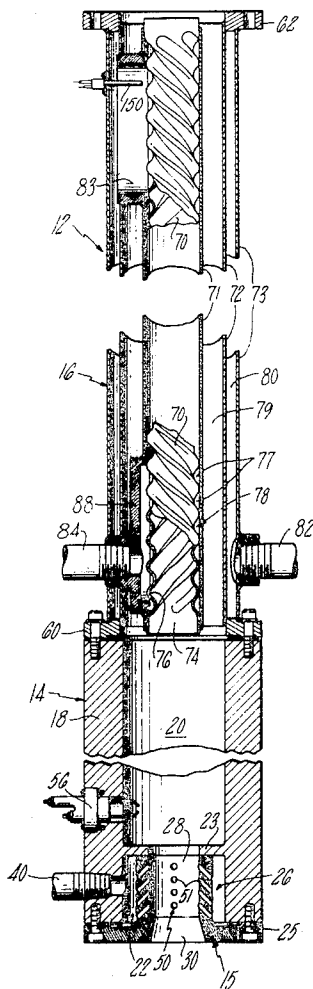
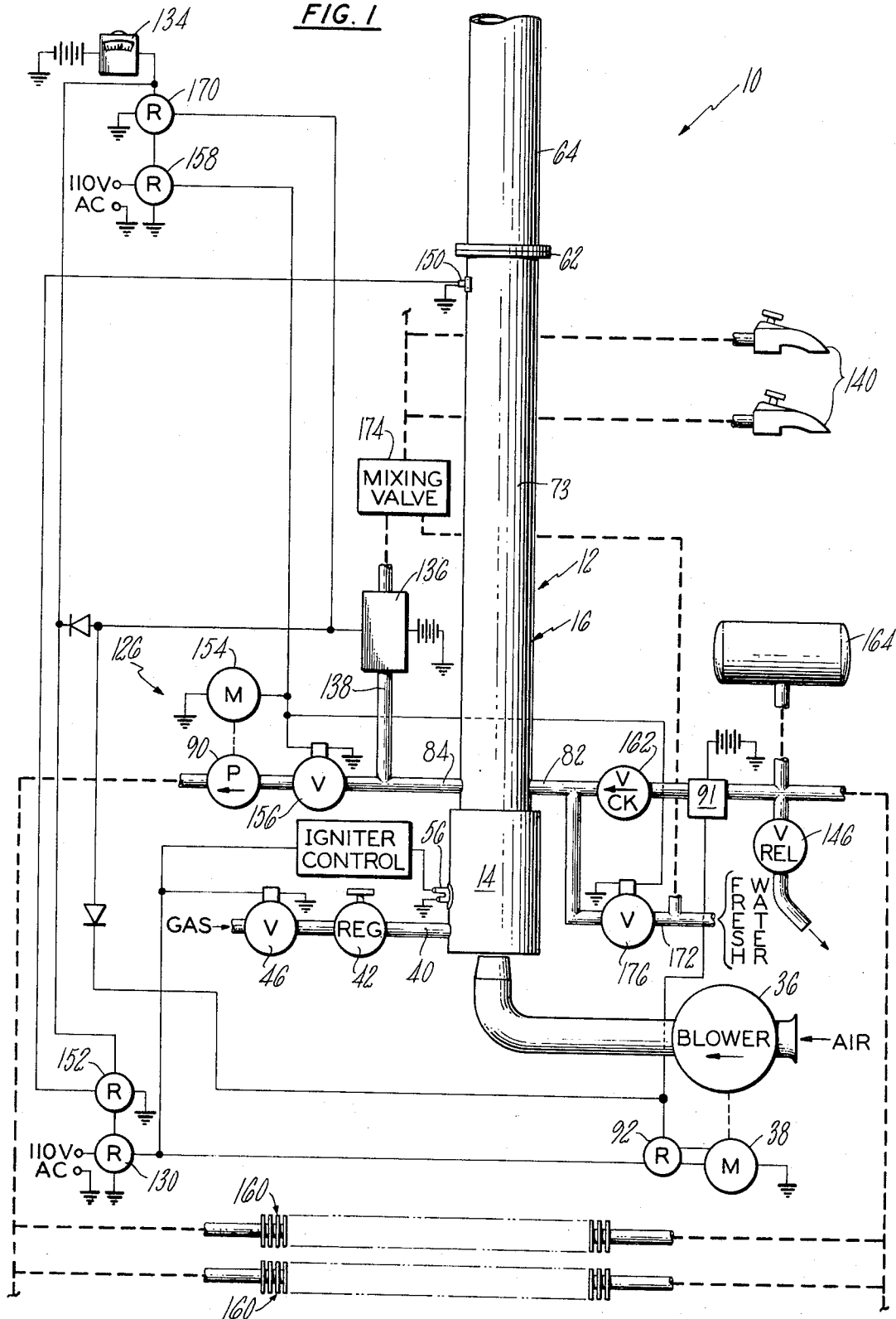


FIG. 1



INVENTOR
RALPH D. COOKSLEY
BY *Ralph H. Chilton*
ATTORNEYS

FIG. 2

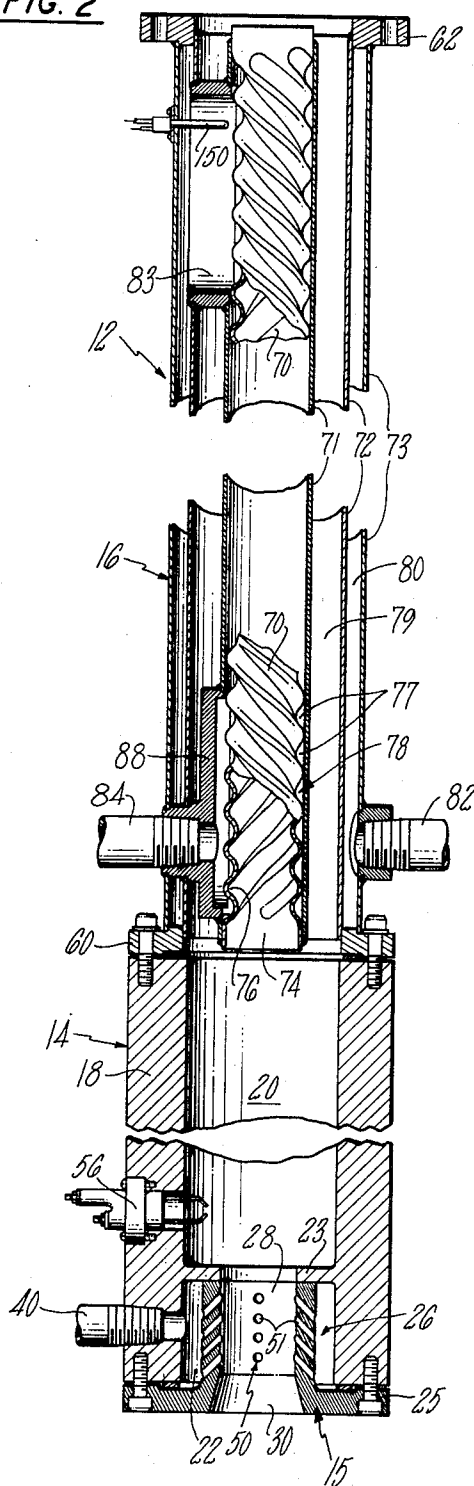


FIG. 4

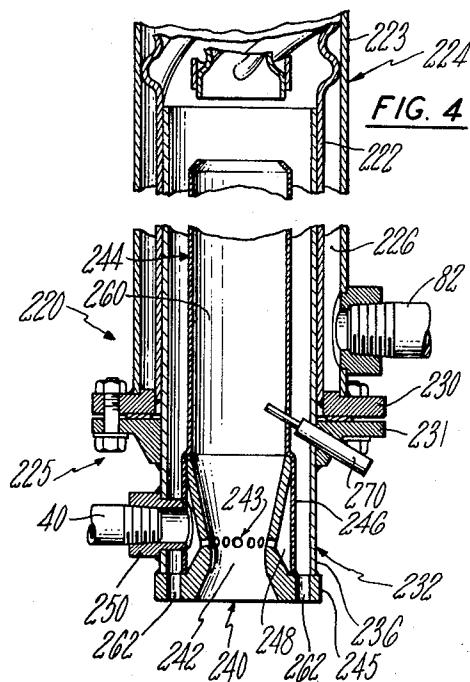
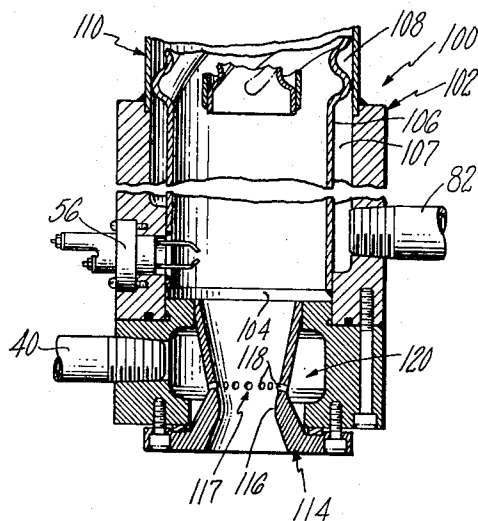


FIG. 3



INVENTOR
RALPH D. COOKSLEY
BY *Ralph H. Chilton*
ATTORNEYS

GAS FIRED FLUID HEATING APPARATUS

BRIEF SUMMARY OF THE INVENTION

The present invention relates to new and improved gas fired fluid heating apparatus useful in providing hot water on demand and having notable utility in providing hot water for home heating and other home uses.

It is a principal aim of the present invention to provide new and improved gas fired water heating apparatus capable of providing hot water for heating and/or other purposes on a continuous basis.

It is another aim of the present invention to provide a new and improved tankless gas fired water heater capable of providing hot water on demand.

It is a further aim of the present invention to provide a new and improved gas fired water heater having an economical and compact construction and useful for example in a home, apartment or other dwelling for supplying hot water and heat.

It is another aim of the present invention to provide a new and improved gas fired water heater having high thermal efficiency.

Other objects will be in part obvious and in part pointed out more in detail hereinafter.

A better understanding of the invention will be obtained from the following detailed description and the accompanying drawings of illustrative applications of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings:

FIG. 1 is a schematic illustration of a dwelling hot water supply and heating system incorporating an embodiment of the present invention;

FIG. 2 is an enlarged elevation section view, partly broken away and partly in section, of an embodiment of a gas fired water heater employed in the hot water supply and heating system; and

FIGS. 3 and 4 are partial elevation section views, partly broken away and partly in section, of two alternative embodiments of a gas fired water heater which may be employed in the hot water supply and heating system.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the drawings in detail wherein like numerals represent like parts throughout the several figures, and referring particularly to FIGS. 1 and 2, a dwelling hot water supply and heating system 10 incorporating an embodiment of the present invention comprises an elongated upstanding gas fired water heater or furnace 12 having in longitudinal alignment an elongated fire box 14, a lower upwardly opening air and gas mixing nozzle 15 and an upper elongated combined exhaust stack and fluid heat exchanger unit 16. The fire box 14 has a generally cylindrical housing 18 with an upper elongated cylindrical cavity of fire chamber 20, a lower cylindrical cavity or nozzle receptacle 22 and an intermediate radially inwardly projecting flange or separator lip 23. The air and gas mixing nozzle 15 has an outer radial mounting flange 25 for mounting the nozzle 15 centrally within the lower cavity 22 (with the flange 25 secured to the lower end of the fire box housing 18) and so as to define with the cylindrical housing 18 an annular gas plenum or supply conduit 26 surrounding the nozzle 15.

The mixing nozzle 15 has a converging-diverging nozzle opening or passageway 28 for directing air from a lower inlet end 30 thereof upwardly to the fire chamber 20. A blower 36 operated by a suitable two speed electrical motor 38 is connected for supplying air to the nozzle inlet 30 at a mass rate of flow depending upon the speed of operation of the electrical motor 38, and a gas inlet conduit 40 is connected to the housing 18 for supplying gas (e.g., natural gas or propane) to the annular gas plenum 26. A pressure regulator 42 (which is preferably adjustable) is mounted in the gas inlet conduit 40 to supply gas to the gas plenum 26 at substantially atmospheric pressure, and an electrically operated ON/OFF valve 46 is mounted in the gas inlet conduit 40 and connected to be operated with the blower motor 38 for opening the gas line to the plenum 26 when the blower 36 is in operation.

The nozzle 15 is shown having four aperture rows or sets 50, each having four generally radially extending apertures 51, for interconnecting the gas plenum 26 with the upper diverging nozzle section. The apertures 51 are located so that gas is drawn from the gas plenum 26 into the relatively low pressure converging nozzle section of the nozzle 15 as air passes upwardly through the nozzle into the fire chamber 20. Also the apertures 51 have a suitable size and upward inclination to provide for mixing the gas and air to give clean and efficient burning of the gas in the gas chamber 20. A suitable igniter 56 is mounted on the housing 18 for lighting the gas and may, as shown in FIG. 1, be connected to be operated (either temporarily or continuously) when the valve 46 and blower motor 38 are energized.

The combined stack and heat exchanger unit 16 has a lower flange or collar 60 for securing the stack to the upper end of the fire box housing 18 and an upper flange or collar 62 for securing a suitable exhaust conduit 64 to the upper end of the stack 16. The combined stack and heat exchanger 16 comprises a plurality of elongated coaxial tubes 70-73 including an inner tube 70 providing a central exhaust passageway 74, an outer cylindrical tube 73 and a pair of intermediate cylindrical tubes 71, 72.

The inner tube 70 is formed with a plurality of parallel helical convolutions (as by pretwisting the tube) providing alternate grooves and ridges which form a plurality or parallel helical passages 76, 77 within and without the tube 70 respectively. The intermediate tube 71 has a diameter for snugly receiving the inner tube 70 and to define therewith a longitudinally extending water passageway 78 provided by the plurality of individual helical passages 77. Also, the intermediate tube 71 is suitably secured to the cylindrical ends of the inner tube 70 to close off the ends of the water passageway 78. Thus, water conducted downwardly through the passageway 78 is divided into a plurality of separate parallel streams which travel helically around the tube 70 (and helically inside the tube 71). Similarly the hot exhaust passing upwardly through the central passage 74 from the fire chamber 20 is caused by the tube convolutions to swirl or twist upwardly along a generally helical path. Such upward helical movement of the hot exhaust through the tube 70 (a) increases the effective length of the heat exchanger, (b) increases the fluid pressure of the hot exhaust stream on the inside surface of the tube 70 (due to the swirling motion of the exhaust stream), and (c) increases the scrubbing action

by the hot exhaust stream on the inside surface of the tube 70.

The intermediate tubes 71, 72 define an intermediate longitudinally extending exhaust passageway 79 which is open to the fire chamber 29 at its lower end and open to the exhaust conduit 64 at its upper end. (Although the intermediate tubes 71, 72 are shown to be cylindrical, the tube 72 may preferably be formed with convolutions like the tube 70 and be associated with the tube 73 in the manner of the tubes 70, 71 as in the water heater embodiments shown in FIGS. 3 and 4.) The tubes 72, 73 provide an outer longitudinally extending water passageway 80, and a water inlet conduit 82 is connected to the lower end of the water passageway 80 to conduct inlet water to the combined stack and heat exchanger unit 16. A short transfer conduit 83 is provided at the upper end of the combined stack and heat exchanger unit 16 for connecting the upper end of the outer water passageway 80 with the upper end of the inner water passageway 78, and a water outlet conduit 84 is connected to the lower end of the inner water passageway 78 for conducting hot water from the combined exhaust stack and heat exchanger unit 16. Transfer conduit 83, collars 60, 62 and a water outlet conduit support bracket 88 provide for supporting the tubes 71-73 in coaxial relationship while permitting hot exhaust to flow upwardly through the passageways 74, 79. The outer water passageway 80 provides for maintaining the outer surface of the combined stack and heat exchanger unit relatively cool and for heating the water with the hot exhaust stream passing upwardly through the intermediate exhaust passageway 79. The water is then conducted to the inner water passageway 78 where it is conducted downwardly in a plurality of parallel streams to be heated by the hot exhaust conducted through the inner exhaust passageway 74 and intermediate exhaust passageway 79.

The combined stack and heat exchanger unit 16 therefore provides for heating the water while providing an exhaust stack for the fire chamber 20. The length and diameters of the tubes 70-73 and the length and diameter of the upright fire chamber 20 are related to provide efficient use of the available thermal energy. Also, the water flow rate provided by a circulation pump 90 (of a hot water heating system described hereinafter) is established so that the water temperature is increased a first predetermined amount (e.g., 30° F) during normal operation of the hot water heating system with the blower motor 38 operating at its lower speed. High speed blower motor operation is established so that, during operation of the hot water heating system, the water temperature is increased a second predetermined amount (e.g., 45° F) when the temperature of the inlet water to the hot water heater 12 is below a predetermined minimum temperature (e.g., 160° F). For that purpose a suitable water temperature pickup 91 is provided in the hot water heating system adjacent the water inlet conduit 82 and a motor control relay 92 is connected to be operated by the pickup 91 for connecting the blower motor 38 to be operated at its higher speed when the water temperature is below the predetermined minimum temperature.

A second embodiment 100 of a gas fired water heater or furnace is shown in FIG. 3. The water heater 100 is in general like the embodiment 12 shown in FIG. 2 and principally differs in that the fire box housing 102 has an inner annular recessed portion 104, and the inter-

mediate tube 106 is formed with convolutions (like the tube 70 shown in FIG. 2) and is lengthened to enclose the fire box housing recess 104 to provide an extension of the outer water passageway 108 and such that a major portion of the fire box housing 102 (excepting for the area around the igniter 56) is directly cooled by the water flowing through the outer passageway 108. Also, the water inlet conduit 82 is connected to the fire box housing 102 for conducting inlet water to the combined stack and heat transfer unit 110.

The gas fired water heater or furnace 100 also employs a modified converging-diverging mixing nozzle 114 having a well-defined throat 116 and a single ring 117 of a plurality of generally radially extending apertures 118 for drawing gas into the nozzle from an annular gas plenum 120 surrounding the nozzle 114. The apertures 118 are located slightly above the nozzle throat 116 and are inclined slightly upwardly to provide for drawing gas from the plenum 120 into the central relatively low pressure section of the nozzle for effectively mixing the gas with the air passing upwardly through the nozzle.

A third embodiment 220 of a gas fired water heater or furnace is shown in FIG. 4. The water heater 220 is also in general like the embodiment 12 shown in FIG. 2 and principally differs from the embodiment 12 in that the intermediate tube 222 is formed with convolutions as in the water heater embodiment 100, and the intermediate and outer tubes 222, 223 of the combined exhaust stack and heat exchanger unit 224 have lower cylindrical extensions providing a fire box housing 225 with an outer water passageway 226 and such that substantially the entire fire box housing 225 is water cooled by the water flowing through the outer water passageway 226. The water inlet conduit 82 is connected to the fire box housing 225 for conducting water to the outer water passageway 226. Also, the combined exhaust stack and heat exchanger unit 224 has a lower annular cap 230 enclosing the lower end of the outer water passageway 226 and providing a mounting flange for securing a mounting flange 231 of a mixing nozzle assembly 232 to the lower end of the combined exhaust stack and heat exchanger unit 224.

The mixing nozzle subassembly 232 comprises an outer cylindrical tube 236 adapted to be inserted into the lower cylindrical portion of the intermediate tube 222 and the mounting flange 231 is suitably secured as by welding to the tube 236. A nozzle 240 having a vertical nozzle passageway 242 and an aperture circle 243 (substantially identical to the aperture circle 117 of the mixing nozzle 114 of the embodiment of FIG. 3) has an integral annular flange 245 welded to the lower end of the outer tube 236. An inner tubular sleeve 244 having a lower enlarged portion 246 snugly receiving the upper end of the nozzle 240 provides for forming with the nozzle 240 an annular gas supply conduit 248 surrounding the nozzle. A connector 250 is inserted through openings in the outer tube 236 and the lower portion 246 of the inner sleeve 244 and is welded to the outer tube 236 for connecting the gas inlet conduit 40 to the annular gas supply circuit 248. The upper portion 260 of the inner sleeve 244 provides a flame basket defining the fire chamber, and an annular secondary air passage is provided between the flame basket 260 and the outer tube 236 for conducting secondary air upwardly from axial air inlet openings 262 in the nozzle flange 245 to combine with the gas and air exhaust

above the basket. The secondary air is drawn into the water heater 220 by the upward draft created in the combined exhaust stack and heat exchanger assembly 224 and provides for cooling the fire basket 260 and sufficient additional air for ensuring complete burning of the gas. A suitable igniter 270 is mounted on the flange 231 to extend upwardly and inwardly into the fire chamber for igniting the gas charge.

A dwelling hot water supply and heating system 126 having a gas fired water heater of the type described is schematically shown in FIG. 1. The system 126 is shown employing a relay 130 for operating the water heater or furnace (by simultaneously opening gas valve 46, operating blower motor 38 and operating igniter 56). The relay 130 is connected to be operated by a thermostat 134 or by a suitable flow responsive device 136 in a main hot water supply line 138 shown connected to a plurality of hot water outlets 140. Consequently the hot water heater is operated by the thermostat 134 when the room temperature falls below the thermostat setting or by the flow responsive device 136 when a hot water outlet 140 is operated. Also, the flow responsive device 136 is connected to the relay 92 for operating the blower motor 38 at its higher speed when a hot water outlet is opened. A thermocouple 150 is mounted at the upper end of the water heater (for example to extend into the upper water transfer conduit 83 as shown in FIG. 2) and is connected to operate a relay 152 for deactivating the water heater when the water temperature reaches a pre-determined maximum temperature.

The system 126 comprises an electric motor for the circulating pump 90 and a normally closed electrically operated valve 156 which are adapted to be operated by the thermostat 134 via a heating system relay 158 for supplying hot water from the water heater to radiator units 160. The hot water is fed through the radiator units 160 for heating the dwelling and is then returned via a one-way check valve 162 to the inlet conduit 82 of the water heater. An expansion tank 164 and pressure relief valve 146 are shown provided in the heating system in a conventional manner.

The thermostat 134 is connected to operate the heating system relay 158 and so that the water heater and water pump are simultaneously operated by the thermostat for heating purposes. The system, however, provides for supplying hot water to the hot water outlets 140 on a first priority basis, and for this purpose a relay 170 operated by the flow responsive unit 136 is provided for disconnecting the thermostat 134 from the heating system relay 158 when a hot water outlet 140 is operated to supply hot water. A fresh water conduit 172 is provided for supplying fresh water to the water heater inlet conduit 82 when hot water is supplied to a hot water outlet 140, and a suitable mixing valve 174 is preferably provided in the hot water supply line 138 and connected in the fresh water conduit for establishing the temperature of the hot water supplied to the hot water outlets 140 irrespective of the rate of flow. A normally open electrically operated valve 176 is provided in the fresh water conduit 172 and is connected to be operated with the pump motor 154 and valve 156 so that it remains closed when the heating system is in operation and so that it remains open while hot water is supplied through an outlet 140. The check valve 162 and valves 156, 176 together provide that the water

pressure in the heating system remains independent of the fresh water inlet pressure.

As will be apparent to persons skilled in the art, various modifications, adaptations and variations of the foregoing specific disclosure can be made without departing from the teachings of the present invention.

I claim:

1. Heating apparatus comprising an elongated upstanding combined exhaust stack and heat exchanger assembly having a plurality of generally coaxial elongated upstanding tubes including a first inner exhaust tube for receiving hot exhaust gases and to provide a longitudinally extending exhaust stack therefor, a second tube surrounding the first tube and defining therewith an inner longitudinally extending fluid passageway around the first tube, the first inner tube being formed with at least one helical convolution extending along a substantial portion thereof and providing corresponding helical grooves on the inner and outer surface thereof for causing generally swirling motion of the hot exhaust in the inner exhaust tube and generally helical flow of fluid around said inner exhaust tube, a third outer tube and a fourth tube intermediate the second and third tubes and defining therewith respectively longitudinally extending intermediate exhaust and outer fluid passageways.

2. Heating apparatus according to claim 1 wherein the fourth tube is formed with at least one helical convolution extending along a substantial portion thereof and providing corresponding helical grooves on the inner and outer surface thereof for causing generally swirling motion of the hot exhaust in the intermediate exhaust passageway and generally helical flow of fluid in the outer fluid passageway around said fourth tube.

3. Heating apparatus according to claim 1 further comprising a fluid inlet conduit connected to the lower longitudinal end of the outer fluid passageway, a fluid outlet conduit connected to the lower end of the inner fluid passageway and a transfer conduit for conducting fluid between the upper ends of the outer and inner fluid passageways.

4. Gas fired apparatus comprising a gas fired water heater having an elongated combined exhaust conduit and heat exchanger assembly with exhaust inlet and outlet openings at first and second opposite longitudinal ends thereof respectively, a fire box with a fire chamber connected to the inlet opening, and means for conducting air and gas into the fire chamber for burning the gas therein, the combined exhaust conduit and heat exchanger assembly comprising a plurality of generally coaxial elongated tubes including an inner exhaust tube, an outer tube and first and second intermediate tubes defining therebetween an intermediate longitudinally extending gas passage and defining with the inner and outer tubes inner and outer longitudinally extending water passages respectively, water inlet and outlet conduits connected to the outer and inner water passages respectively at said first longitudinal end of the combined exhaust conduit and heat exchanger assembly, and a transfer conduit connected to conduct water from the outer water passage to the inner water passage at said second longitudinal end of the combined exhaust conduit and heat exchanger assembly.

5. Gas fired apparatus according to claim 4 wherein the inner exhaust tube is formed with at least one helical convolution extending along a substantial portion thereof and providing corresponding helical grooves on

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the inner and outer surface thereof for causing generally swirling motion of the exhaust in the inner exhaust tube and generally helical flow of water around said inner exhaust tube along the inner longitudinally extending water passage.

6. Gas fired apparatus according to claim 5 wherein the second intermediate tube is formed with at least one helical convolution extending along a substantial portion thereof and providing corresponding helical grooves on the inner and outer surface thereof for causing generally swirling motion of the exhaust in the in-

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intermediate longitudinally extending gas passage and generally helical flow of water around said second intermediate tube along the outer longitudinally extending water passage.

5 7. Gas fired apparatus according to claim 4 wherein the outer tube and second intermediate tube have depending portions providing a housing of the fire box with a longitudinally extending water passage in communication with the outer longitudinally extending

10 water passage.

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