United States Patent

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[15] **3,645,251**

[45] **Feb. 29, 1972**

[54] WATER HEATER

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[21] Appl. No.: **24,206**

[52] **U.S. Cl.** **126/359**
[51] **Int. Cl.** **F24h 1/10**
[58] **Field of Search** 126/350, 359

[56] **References Cited**

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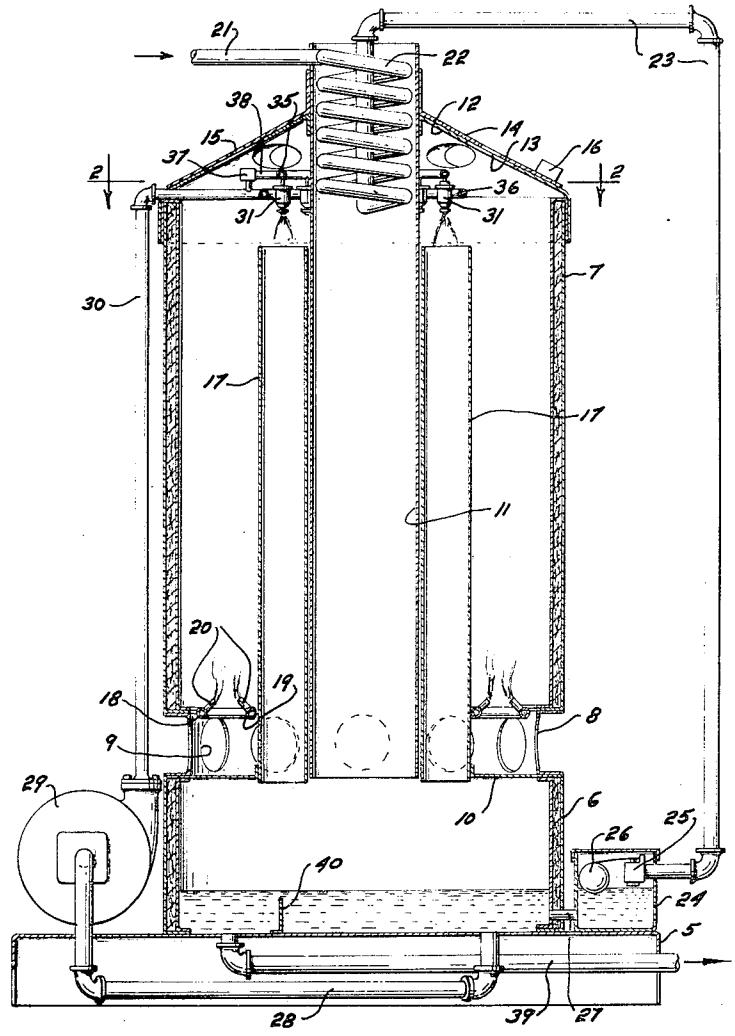
[57] **ABSTRACT**

A water heater of the type in which spray particles of the water to be heated are brought into contact with the products of combustion of the fuel used for heating the water, the heater including a burner, a stack, and means providing a flow path having runs extended in different directions from the burner to the stack, and an accumulating chamber for heated water below the stack. Means are also provided for circulating water from the accumulating chamber to water spray nozzles delivering water spray into a run of the flow path extended downwardly into the water accumulating chamber, for preheating the feed water by bringing it into heat exchange relation with the products of combustion, and for passing the water through a water jacket for the combustion chamber after the water has been heated by contact with the products of combustion.

A water spraying nozzle is also provided having a chamber with two water inlets, one arranged axially of the water spray delivered from the nozzle and the other arranged tangentially, with control means for regulating the portion of water introduced axially and tangentially.

14 Claims, 6 Drawing Figures



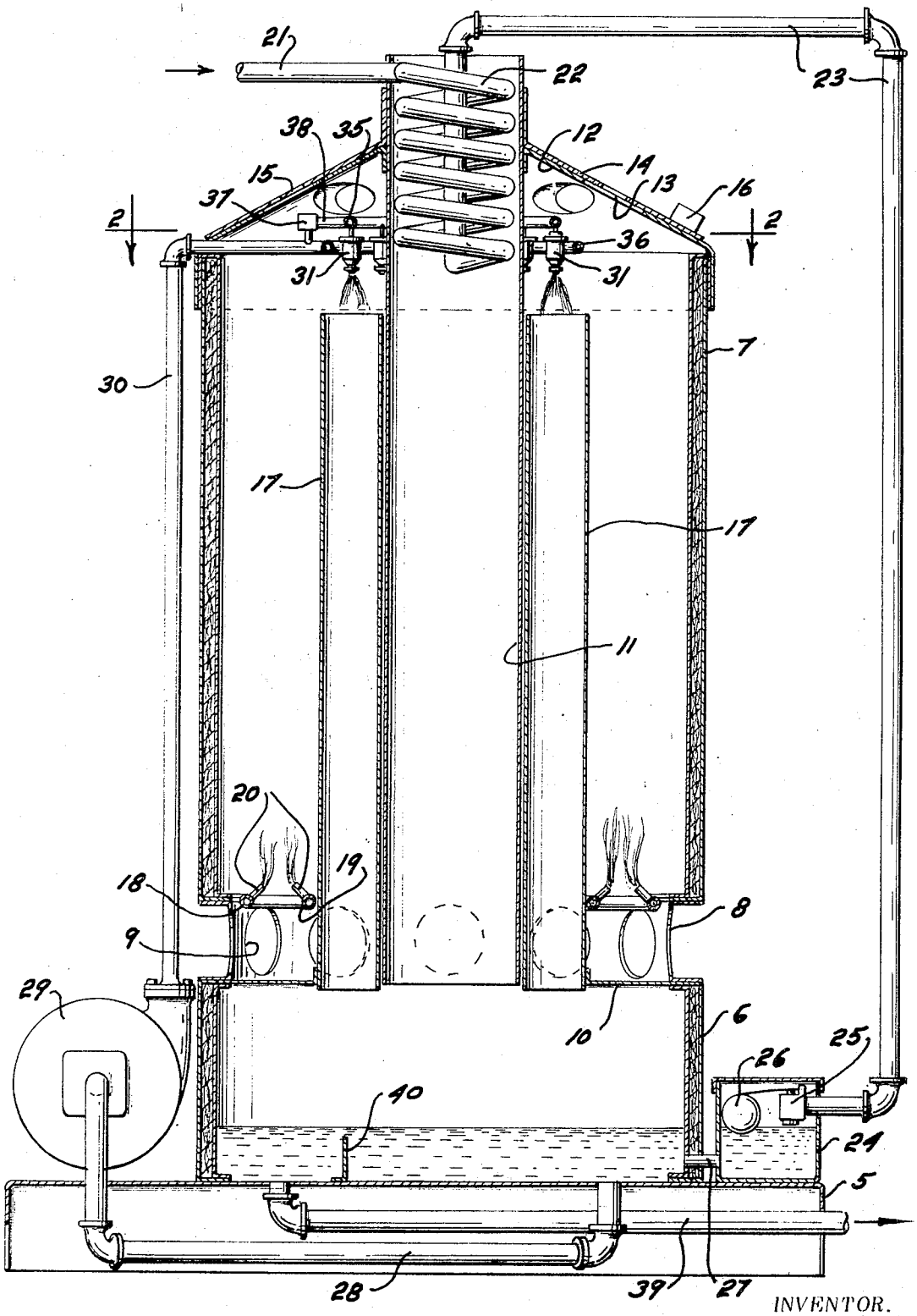


Fig-1

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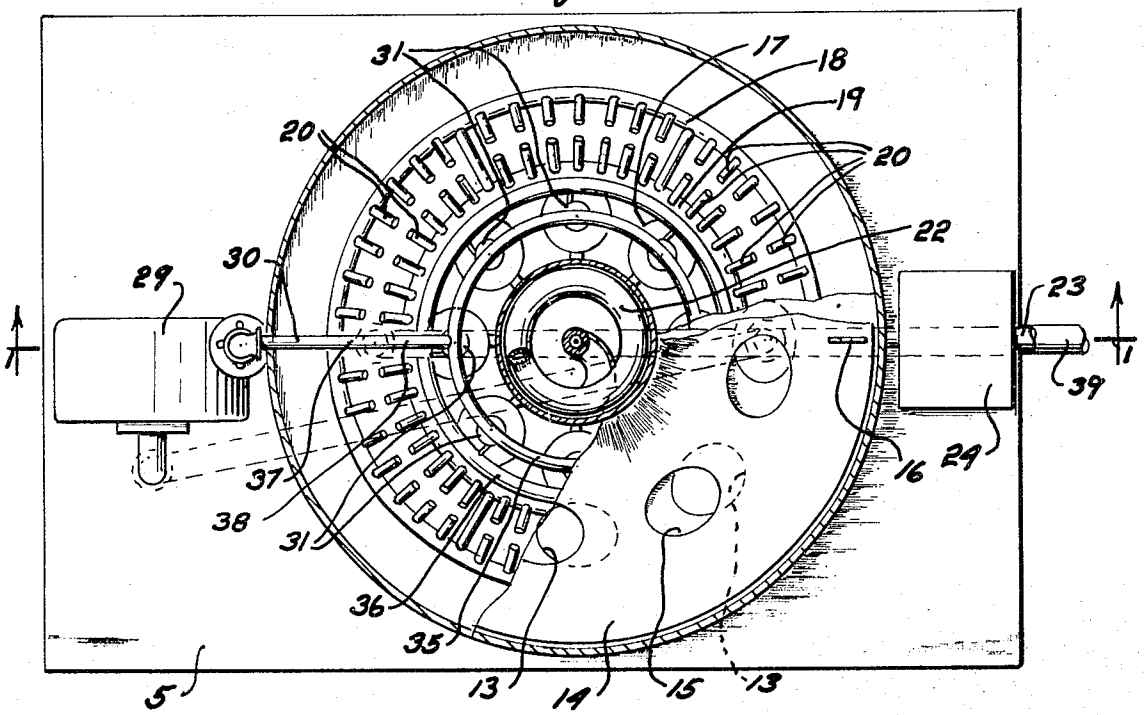
Fig-2



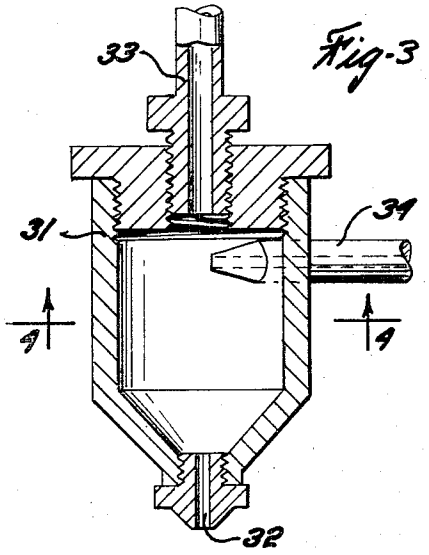


Fig-3

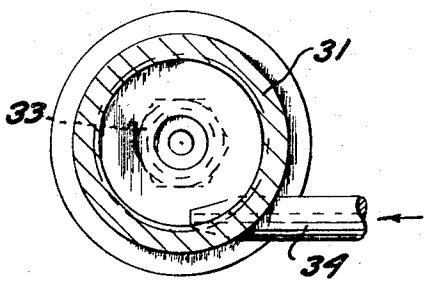


Fig-4

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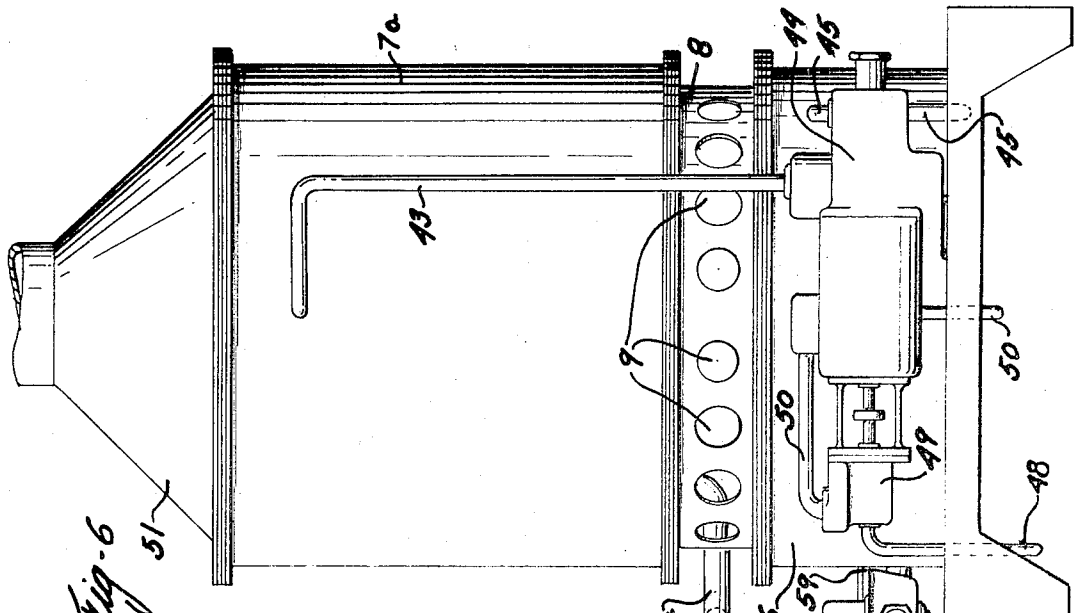

Fig. 6

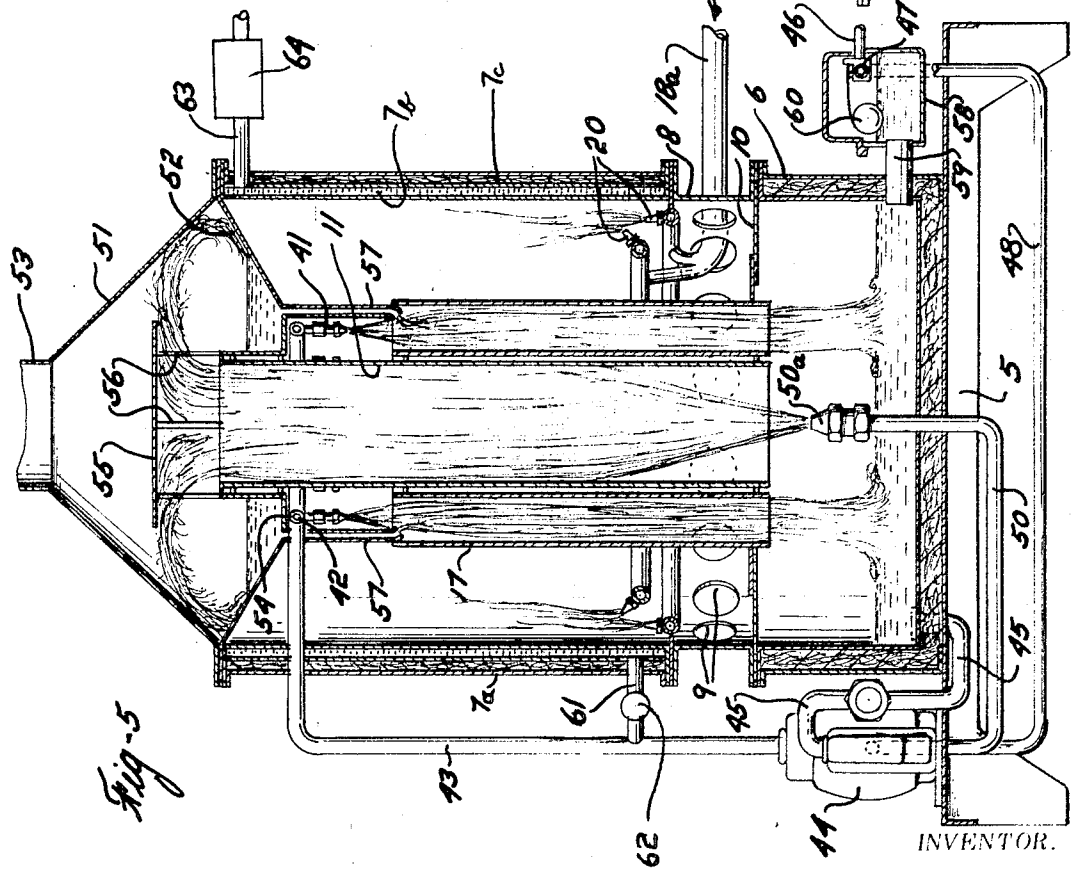

Fig. 5

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WATER HEATER

This invention relates to water heaters and is especially concerned with water heaters of the type in which sprayed particles of water are brought into direct contact with products of combustion for the purpose of heating the water.

One of the primary objectives of the invention is to provide a water heater of the kind referred to having large capacity and being capable of rapidly raising the temperature of a considerable volume of water from normal water supply line temperature up to a temperature of the order of 180° to 200° F., thereby providing a water heater unit adapted to many types of uses, especially industrial cleaning, for instance in meat and poultry processing plants, fishing boats and canneries and the like.

Although water heaters providing for direct heat exchange between sprayed water particles and products of combustion are known, they have not been widely used because they have been subject to one or another of numerous disadvantages or deficiencies. It is an objective of the invention to provide a water heater of this type having greatly increased efficiency and thus capacity, and having an improved system of controls in relation to both the combustion of the fuel used and also in relation to the spray mechanism by which the water is sprayed into the flow stream of the products of combustion.

In accordance with another aspect of the invention, provision is made for preheating the feed water introduced into the heater and bringing the feed water into heat exchange relation with the products of combustion, in one embodiment, this being accomplished by direct spray of the feed water into the stream of combustion products, followed by separation of the preheated particles and introduction thereof into the circulation system.

In considering still another object of the invention, it is mentioned that the heating of water by direct contact of a water spray with the products of combustion has a tendency to cause extensive vaporization of the water if the temperature of heating is carried up above 160° F. This is not desired where the end product sought is heated water, rather than water vapor. With this factor in mind, the invention contemplates employment of a water jacket for the combustion chamber and the establishment of a circulation system which first brings the water into direct contact with the products of combustion (in the form of a water spray), and which thereafter passes the water through the water jacket for further heating. In this way, the efficiency of the direct contact of the water with the products of combustion can be utilized to elevate the temperature of the water to a substantial extent, for instance up to about 160° F., and the subsequent heating in the water jacket may then serve to further elevate the water temperature, for instance up to about 200° F. In this way the relatively high output temperature of the water (about 200° F.) can be attained without encountering extensive vaporization, such as would result from elevation of the water to that temperature by direct contact of the water with the products of combustion.

Since the improvements of the invention are important in making it practicable to heat water by the method of direct heat exchange between the sprayed particles and the products of combustion, the invention therefore is of importance in eliminating the necessity for certain of the prior known indirect heat transfer devices, notably the heating coil heretofore frequently used.

Still further the invention has in view the construction of a water heater of the kind mentioned which while of exceedingly simple form is at the same time highly effective for the achievement of the above purposes, thereby providing a water heater unit which may readily be employed in many situations where more complicated and expensive equipment has heretofore been used.

Another object of the invention is to provide a spray nozzle of improved construction, together with means providing for adjustment of the spread of the spray in order to maximize the surface contact of the spray particles with the products of combustion.

According to another feature of the invention, provision is made for recirculation of heated water through the spray nozzles in order to further enhance the heating action.

How the foregoing and other objects and advantages are attained will appear more fully from the following description referring to the accompanying drawings, in which:

FIG. 1 is a vertical sectional view through a water heater constructed according to the present invention;

FIG. 2 is a plan view, partly in horizontal section taken on the line 2—2 of FIG. 1;

FIG. 3 is a greatly enlarged vertical sectional view through one of the specially constructed spray nozzles employed in accordance with the invention;

FIG. 4 is a horizontal sectional view taken as indicated by the line 4—4 of FIG. 3;

FIG. 5 is a view similar to FIG. 1 but illustrating a modified arrangement; and

FIG. 6 is an elevational view of the equipment shown in FIG. 5, but taken from the left of FIG. 5.

In the embodiment shown in FIGS. 1 and 2, the water heater is provided with a base 5 upon which is arranged a double walled circular structure 6 providing a chamber for accumulating water heated in the unit. Heat insulation is desirably positioned within the double wall structure 6.

Another double wall insulated structure 7 is mounted above the structure 6, for instance by means of the annulus or ring 8 having apertures 9 therein providing for entrance of combustion air, as will further appear.

A horizontal wall or partition 10 divides the water accumulating chamber 6 from the overlying combustion space within the double walled structure 7.

A stack or offtake 11 is arranged centrally within the unit with its lower end extended through the horizontal partition 10 and communicating with the top of the water accumulating chamber. The upper end of this stack is extended through and beyond the upper conical top wall 12 which is supported at the upper edges of the wall structure 7. This top wall is provided with apertures 13, and a conical damper 14 having apertures 15 cooperating with the top wall 12 to control the amount of opening provided at the top of the combustion chamber within the unit. By rotation of the cone damper 14, for instance by means of the projecting control element 16, the amount of overlap of the openings 13 and 15 may be regulated.

A cluster of ducts or tubes 17 is arranged around the stack 11 within the annular chamber provided between the wall structure 7 and the stack 11. These tubes also pass through the horizontal partition 10 and communicate with the upper portion of the water accumulating chamber 6.

The unit illustrated is adapted to be heated by gas burners and for this purpose annular gas supply pipes 18 and 19 are provided in the lower portion of the annular chamber formed between the ring of tubes 17, on the one hand, and the wall structure 7, on the other hand. These supply pipes 18 and 19 may be connected with any suitable valved supply line (not shown) and each of the annular pipes 18 and 19 is desirably provided with a multiplicity of gas burner nozzles 20 so as to provide relatively high combustion capacity. The combustion air is introduced through the apertures 9 in the ring 8 just below the burner nozzles 20.

The feed water or water supply and circulation system includes a pressure water supply line indicated at 21 which delivers water to a preheater coil 22 positioned in the upper portion of the stack 11 and providing for counterflow of the water in relation to the gas offtake flow within the stack. The preheated water is delivered through pipe 23 into a supply chamber 24 under the control of a valve 25 adapted to be operated by a float 26 so that a water level is automatically maintained in the supply chamber. This chamber is in communication with the interior of the water accumulating chamber 6 through the connection 27.

With the system as illustrated, including the stack 11 which is open to atmosphere, the water in the chamber 24 and also in the accumulating chamber 6 is under atmospheric pressure.

Water is drawn from the chamber 6 through a pipe 28 by means of a pressure pump 29 the delivery line 30 of which is extended to the spray nozzle system. The nozzles are indicated at 31 and it will be seen that there is a nozzle 31 positioned above the upper end of each of the tubes or ducts 17.

By reference to FIGS. 3 and 4 it will be seen that each nozzle has a chamber therein with a discharge orifice 32 at the bottom. A water inlet connection 33 is arranged to deliver water into the chamber of the nozzle in a direction axially of the discharge through the orifice 32. In addition, a second water inlet connection 34 is provided in a position delivering water into the chamber of the nozzle in a direction tangentially of the inlet 33 and orifice 32.

As seen in FIGS. 1 and 2, all of the inlet connections 33 for the series of nozzles are supplied from the annular water supply ring 35, and all of the inlet connections 34 are supplied from the annular ring 36. Pipe 30 delivers directly to the ring 36, and the ring 35 is supplied with water through valve 37 and connection 38. Valve 37 comprises a shutoff or choke valve which is adjustable, thereby providing for regulation of the amount of water introduced into each nozzle through its inlets 33 and 34. By this means the amount of water delivered axially and tangentially into the chambers of the nozzles may be varied and this in turn can be used to regulate the extent of spreading of the spray delivered from the nozzles and the axial velocity of the spray delivered therefrom. In a typical setting, the valve 37 is positioned to provide for delivery of most of the water through the tangential inlets 34 of the nozzles, so that the water particles are effectively spread out and thus delivered downwardly throughout most of the cross-sectional area of each of the ducts 17.

The water chamber 6 serves as a separating or accumulating chamber for the water, and heated water may be withdrawn from the chamber 6 by means of the offtake connection 39 which, as seen in FIG. 1, is connected with the chamber 6 at the bottom thereof at a point remote from the water inlet 27. A baffle 40 is preferably positioned between the inlet 27 and the outlet 39 so as to avoid short circuiting of water from the inlet to the outlet.

It will be understood that a pump will be provided in the outlet line 39, in order to develop a suitable pressure to deliver the heated water to the point of use.

With the system essentially under atmospheric pressure, it will be noted that the level of the water in the chamber 6 will automatically be maintained in consequence of the action of the float control valve 25.

In operation, the water heater as described above may operate continuously, with continuing recirculation of water from the accumulating chamber 6 through the pump to the spray nozzles. The delivery of the water spray directly into the stream of the combustion products passing downwardly through the ducts 17 provides extensive surface area contact between the particles of the water and the hot products of combustion and thereby efficiently heats the water.

Since the exterior surface of the tubes 17 are directly exposed to the burner flames and the products of combustion, the contact of water with the interior surfaces of the tubes further enhances the heating of the water. Because of the interconnection of the lower ends of the ducts 17 with the lower end of the stack 11, there is an automatic action controlling the operation of the heater. This results from the fact that the system operates at atmospheric pressure, so that there is freedom for excess vapor and steam to escape through the stack, thereby preventing build up of pressure and thus of temperature in the system, as might occur in systems which operate at superatmospheric pressure. In this way settings of the gas burners, damper 14 and spray nozzles may be established at values providing for the heating of sufficient water to the desired temperature to meet a given approximate operation load or demand. If the demand is temporarily reduced, the excess heating of water will merely result in some evaporation, with the excess steam being discharged through the stack.

The action of the water spray delivered from the nozzles 31 actually establishes a forced draft or forced circulation with respect to the combustion products themselves, serving to draw air into the air inlets 9 in the region of the burners 20 and also to deliver the products of combustion upwardly through the stack and over the feed water heater 22 for discharge to atmosphere.

Control of the burner action is also obtained by adjustment of the damper 14. For example, if the damper is opened, air will be drawn into the upper ends of the ducts 17 and this will diminish the air drawn into the inlets 9.

The arrangement of the stack having its lower end in communication with the water accumulating chamber 6 is of still further advantage in connection with the disposition of the feed water heater 22 within the upper portion of the stack. Actually this feed water heater thereby serves not only to preheat the incoming water, but also to condense moisture carried in the stream of combustion products prior to delivery of those products from the top of the stack, and since the lower end of the stack is in direct communication with the accumulating chamber 6, the condensate developed on the surface of the coils of the feed water heater 22 is delivered directly downwardly into the body of hot water being produced in the chamber 6.

Certain of the features of the arrangement shown in FIGS. 5 and 6 are similar to those described above, and those features will be described only briefly. As in the first arrangement, the arrangement of FIGS. 5 and 6 also is supported by a base 5, the principal components comprising a water accumulating chamber 6, a cylindrical structure 7*a* surrounding the combustion chamber and supported by an annulus 8 having apertures 9 for introduction of air for combustion. A partition 10 here also serves to divide the water accumulating chamber at the bottom from the combustion chamber within the structure 7*a*.

A cylindrical stack 11 is also employed in the embodiment of FIGS. 5 and 6, and a cluster of ducts or tubes 17 surrounds the stack, the lower ends of both the stack and the ducts passing through the partition 10 and being in communication with the interior of the water chamber 6.

Gas burner nozzles 20 are also provided in the combustion chamber within the structure 7*a* in the region just above the air inlet openings 9. These gas burners may be supplied with gas from a supply line indicated at 18*a*. In this arrangement the flow path of the products of combustion is similar to that described above in connection with the first embodiment, i.e., the products of combustion rise from the burner nozzles 20 and then turn inwardly and pass downwardly through the ducts 17, and then again reverse their direction of flow and pass upwardly through the central stack 11.

As in the embodiment of FIGS. 1 and 2, water is sprayed downwardly into the upper ends of the ducts 17, and this spraying action is relied upon to induce forced circulation of the products of combustion downwardly through the duct 17 and then upwardly in the stack. However, in the embodiment of FIGS. 5 and 6 the water spray nozzles are indicated at 41, and these nozzles are supplied from the supply ring 42 with which the pressure supply line 43 is connected. Pump 44 having an inlet line 45 communicating with the bottom of the water chamber 6 draws water from the water accumulating chamber 6 and delivers it under pressure through the line 43 to the discharge nozzles in the general circulation pattern described above with reference to FIGS. 1 and 2.

The nozzles 41 may be any of several known types of spray nozzles, but are advantageously of a type which will provide for spreading of the spray in a manner to distribute the sprayed particles substantially throughout the cross-sectional area of the ducts 17 into which the water spray is being delivered.

A water nozzle system of the type described above with reference to FIGS. 3 and 4 may be employed in the embodiment of FIGS. 5 and 6.

In the embodiment of FIGS. 5 and 6 a different feed water or water supply system is illustrated, being characterized in general by an arrangement providing for preheating of the feed water by bringing the feed water into direct heat transfer contact with the products of combustion, instead of by employing an indirect heat transfer coil as shown at 22 in the first embodiment.

The direct heat transfer water supply system of the embodiment of FIGS. 5 and 6 includes a water supply line 46 having a valve 47 therein delivering to the line 48 which is extended to the pump 49 (see FIG. 6). The pump discharges into the line 50 which is extended upwardly through the bottom wall of the water accumulating chamber 6 and discharging through the nozzle 50*a*, the water spray from this nozzle being directed centrally upwardly through the stack 11 for the products of combustion.

The upper end of the stack 11 is enclosed within the upper and lower conical walls 51 and 52, the wall 51 having an offtake 53 at its upper apex and representing the discharge outlet for the products of combustion from the entire system. A wall element 54 closes the lower side of the chamber surrounding the upper end of the stack 11 and within this chamber a baffle plate 55 is positioned above the upper end of the stack 11, being supported by spaced supports 56 so that the products of combustion and the entrained particles of feed water are caused to be deflected radially outwardly from the zone immediately over the stack and into the chamber surrounding the upper end of the stack. The products of combustion then rise around the edges of the baffle plate 55 and are ultimately discharged through the offtake 53. The water particles, on the other hand, accumulate in the lower portion of the chamber adjacent to the walls 52 and 54, this body of water representing preheated feed water which is to be introduced into the system.

A series of annularly spaced supply tubes 57 extend downwardly from the body of preheated feed water and serve to deliver the feed water into the upper ends of the ducts 17, to be carried downwardly therethrough under the action of the pressure spray discharged from the nozzles 41.

A suitable nozzle to be employed as nozzle 50*a* is identified as No. ¾ G3050, manufactured by Spring System Co., Bellwood, Illinois. This nozzle will provide for distribution of the feed water particles or droplets substantially throughout the cross-sectional area of the stack, thereby enhancing the surface contact of the feed water particles with the products of combustion. Any other nozzle providing this type of distribution of particles or droplets may be employed.

In FIG. 5 a water chamber 58 is illustrated adjacent to the hot water accumulating chamber 6 and is interconnected therewith by means of the pipe 59. This chamber accommodates the float 60 which is connected with the valve 47 and serves to regulate the opening of that valve in accordance with the water level in the chamber 58 and thus also in accordance with the water level in the chamber 6.

In contrast to the first embodiment, however, the water supply valve 47 does not deliver the supply water into the float chamber, but delivers this supply through the line 48 to the pump 49 for direct delivery through the spray nozzle 50*a*, in order to effect preheating of the feed water by direct contact with the products of combustion.

As in the first embodiment, insulating material is desirably provided between the two walls of the double walled water chamber 6. However, in the embodiment of FIGS. 5 and 6 the wall structure 7*a* surrounding the combustion chamber is of different construction. Here a water jacket 7*b* surrounds the combustion chamber, and another insulating layer or jacket 7*c* is provided around the water jacket.

The water jacket space is provided with an inlet or supply connection 61 formed as a branch of the supply line 43 extended to the nozzles 41. The branch 61 is provided with a shunt valve 62, for example of gate type, which may be adjustable but which ordinarily will not require regulation. The water jacket 7*b* is also provided with an offtake or outlet connection 63 which serves as the ultimate delivery line for the hot water developed by the system. A positive displacement pump diagrammatically indicated at 64 is preferably provided in the discharge line 63 and this serves to establish the rate of delivery of water from the system. In a typical system this pump may operate at the rate of 6 gallons per minute.

From the foregoing it will be seen that in the arrangement of FIGS. 5 and 6 substantial efficiency is added to the system as a result of a feed water heater system in which the feed water is heated by direct contact with the products of combustion in the central stack 11. Additional heating of the water under conditions of high efficiency is effected as a result of the spray of the water downwardly through the ducts 17, and the rate of water feed and the rate of combustion are advantageously regulated so that the preheating or feed water heating and the heating within the ducts 17 is sufficient to raise the water temperature to a level in the neighborhood of 160° F., which represents about the upper end of the range over which high efficiencies are obtainable by direct contact of water spray with the products of combustion.

The embodiment of FIGS. 5 and 6 has the further advantage that results from the use of the water jacket 7*b* surrounding the combustion chamber as the final stage of heating of the water before it is discharged through the outlet 63. This jacket, being immediately adjacent to the high temperature zone in the combustion chamber, may be employed to elevate the water temperature up to 200° F. or even higher under conditions which are not subject to the difficulty of evaporation, and in this way quite a high discharge temperature can be obtained without encountering inefficiencies resulting from vaporization.

According to the foregoing the arrangement of the invention is of great importance in eliminating the necessity for employing the heating tube or coil which forms the heart of most prior art hot water systems adapted to the heating of large quantities of water. Such heating coils are not only heavy, bulky and expensive, but tend to become clogged with minerals which are present in most municipal water supply systems. Such minerals not only interfere with efficient heat transfer between the combustion products and the water, but must be removed periodically, usually by acid treatment, in order to prevent permanent damage to the coil. In accordance with the embodiments of FIGS. 5 and 6, the coil type of indirect heating device is not even employed in the feed water heating system.

In a typical prior art system employing a heating tube, the tube comprises a steel pipe wound into several layers in order to present extensive heat transfer surface area. Although its efficiency when new may approximate 80 percent, this rapidly decreases with use because of mineral deposits outside of the tube.

In providing a truly practical direct heat transfer system for use in the heating of water, the invention thus eliminates may serious disadvantages of prior systems, including the elimination of the conventional water heating coil. This in turn eliminates the thermal inertia intrinsically associated with the water heating coil, the heating system of the present invention having quick heating characteristics, even from a cold start.

The arrangement of the invention also substantially reduces the bulk and weight of a heater of given capacity, as compared with the prior system incorporating a heating coil and still further the invention provides equipment which is comparatively free from maintenance and upkeep problems, such as the periodic shutdowns required to clean a heating coil.

From the foregoing it will be seen that the present invention is of great importance wherever large quantities of hot water are needed.

I claim:

1. A water heater comprising a combustion chamber having an air inlet, means for introducing fuel into the chamber, a plurality of ducts extended downwardly from an upper part of said chamber, a stack positioned intermediate the ducts for delivering products of combustion upwardly, a second

chamber interconnecting the lower ends of said ducts and stack, and for each duct a spray nozzle for spraying water under pressure downwardly into the upper end of the duct and thereby establish extensive surface area contact of the water with the hot products of combustion and provide for accumulation of heated water in said second chamber.

2. A water heater as defined in claim 1 in which the ducts are positioned around and parallel to the stack and in which the combustion chamber surrounds the group of ducts.

3. A water heater as defined in claim 1 in which the air inlet for the combustion chamber and also the stack are open to atmosphere and thereby maintain substantially atmospheric pressure in the combustion chamber, duct, second chamber and stack, and means for pumping water under pressure from the second chamber to the spray nozzle.

4. A water heater comprising a casing defining a combustion chamber, a stack arranged centrally of the combustion chamber and having its inlet end at a level near the bottom of the combustion chamber, a plurality of ducts surrounding the stack with their upper ends in communication with the upper portion of the combustion chamber, a second chamber interconnecting the lower ends of the ducts and the lower end of the stack, means for introducing fuel and air into the lower portion of the combustion chamber, and means for spraying water under pressure downwardly into the upper ends of the ducts and thereby effect extensive surface area contact of the water with the products of combustion and thus effect rapid heating of the water.

5. A water heater comprising a combustion chamber having an air inlet, means for introducing fuel into the chamber, a duct extended downwardly from an upper part of said chamber, a stack for delivering products of combustion upwardly, a second chamber interconnecting the lower ends of said duct and stack, means for spraying water under pressure downwardly into the upper end of said duct and thereby establish extensive surface area contact of the water with the hot products of combustion and provide for accumulation of heated water in said second chamber, and combustion control means comprising a controllable damper in an upper part of the combustion chamber.

6. A water heater comprising a fuel burner, an upright offtake or stack for the products of combustion, means establishing a flow path from the burner to the stack having a downwardly extending run, a chamber interconnecting the lower end of the stack and said run, means for spraying water downwardly into said run for heating by contact with combustion gas and for delivery of heated water into said chamber, and means for preheating water to be sprayed into said run including a heat exchanger one side of which is exposed to the water to be sprayed and the other side of which is exposed to combustion gas in the stack and providing for condensation of water and for flow of condensate downwardly through the stack into said chamber.

7. A water heater comprising a fuel burner, an offtake or stack for the products of combustion, means establishing a flow path from the burner to the stack having a plurality of runs extended in different directions, and means for spraying water under pressure into one of said runs of the flow path in the direction of gas flow therein including a pressure pump, a nozzle having a chamber therein with a discharge opening presented toward the entrance end of said run, connections between the pump and the nozzle including a pressure line having two branches, a first of which enters the nozzle chamber in a direction axially of the discharge opening and the other of which is arranged tangentially of the first, and a controllable valve in said first branch.

8. A water heater comprising a fuel burner, an offtake or stack for the products of combustion, means establishing a flow path from the burner to the stack including a plurality of generally upright ducts, a chamber interconnecting the lower ends of said ducts with the stack, for each duct a spray nozzle for delivering water spray into the upper end of the duct, each nozzle having a chamber with a discharge opening directed into the upper end of the duct, water connections for the nozzles including a supply pipe having two branches, connections from a first of said branches extending to the nozzle chambers axially of the discharge openings thereof and connections from the other of said branches extended to the nozzle chambers tangentially of the first connections, and a controllable valve in the first branch of the supply pipe.

9. A water heater comprising a fuel burner, an upright offtake or stack for the products of combustion, means establishing a flow path from the burner to the stack having a downwardly extending run, a chamber interconnecting the lower end of the stack and of said run, means for spraying water downwardly into said run for heating by contact with combustion gas and for delivery of heated water into said chamber, and means for bringing feed water into heat exchange relation with the products of combustion in said stack to preheat the water before delivery to the means for spraying the water, the means for preheating the water comprising means for spraying the feed water into products of combustion in the offtake.

10. A water heater comprising a combustion chamber having an air inlet, means for introducing fuel into the chamber, a duct extended downwardly from an upper part of said chamber, a stack for delivering products of combustion upwardly, a second chamber interconnecting the lower ends of said duct and stack, means for spraying water under pressure downwardly into the upper end of said duct and thereby establish extensive surface area contact of the water with the hot products of combustion and provide for accumulation of heated water in said second chamber, and means for preheating feed water comprising a spray device for bringing the feed water into heat exchange relation with the products of combustion in said stack and means for delivering the preheated feed water downwardly through said duct.

11. A water heater comprising a fuel burner, an offtake or stack for the products of combustion, means establishing a flow path from the burner to the stack having a plurality of runs extended in different directions, an inlet for combustion air in the region of the burner, means for establishing forced circulation of air into said inlet and of gases out of said stack and for bringing water to be heated into contact with the products of combustion comprising means for spraying water under pressure into one of said runs of the flow path in the direction of gas flow therein, a water chamber at the discharge end of the run of the flow path into which the water is sprayed, and a feed water supply system including means for introducing feed water into one of said runs of the flow path and means controlled by the amount of water in the water chamber for regulating the quantity of feed water introduced.

12. A water heater comprising a combustion chamber, an offtake for the products of combustion, means establishing a flow path from the combustion chamber to the offtake having a plurality of runs extended in different directions, means for bringing water to be heated into contact with the products of combustion comprising means for spraying water under pressure into one of said runs of the flow path, a water chamber at the discharge end of said run of the flow path, a water jacket for the combustion chamber, and means for withdrawing water from the water chamber and for circulating the withdrawn water through said water jacket.

13. A water heater comprising a combustion chamber having a fuel burner, an upright offtake or stack for the products of combustion, means establishing a flow path from the burner to the stack, means for spraying water into the products of combustion in said flow path, a water collecting chamber receiving the sprayed water, a water jacket for the combustion chamber, and means for delivering water from the collecting chamber into and through the water jacket.

14. A water heater comprising a casing defining a combustion chamber, means establishing a flow path for products of combustion, a water jacket for the combustion chamber, means for spraying water into said flow path for direct contact of the sprayed water with the products of combustion, and

means for separating the sprayed water from the products of combustion and for passing the separated water through the water jacket for further heating.

* * * * *

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,645,251 Dated February 29, 1972

Inventor(s) Robert B. Black

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

In the abstract, line 19, "portion" should be --proportioned--

Col. 6, line 52, after "deposits" insert --inside of the tube and also because of soot deposits--

Col. 7, line 46, after "and" insert --of--

Col. 8, line 3, "extending" should be --extended--.

Signed and sealed this 11th day of July 1972.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents

FORM PO-1050 (10-69)

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