

[54] HEAT EXCHANGER

[75] Inventor: Nobutsugu Kobayashi, Tokyo,
Japan

[73] Assignee: Shoei Kabushiki Kaisha, Tokyo,
Japan

[22] Filed: June 27, 1972

[21] Appl. No.: 266,741

[30] Foreign Application Priority Data

July 30, 1971 Japan..... 46/67259
Aug. 9, 1971 Japan..... 46/71160

[52] U.S. Cl..... 122/165, 122/177

[51] Int. Cl..... F22b 7/00

[58] Field of Search..... 122/165, 176, 177,
122/37

[56]

References Cited

UNITED STATES PATENTS

336,114	2/1886	Horn.....	122/176
1,810,642	6/1931	Carlson.....	122/165
2,664,861	1/1954	Alexander.....	122/165

Primary Examiner—Carroll B. Dority, Jr.

Assistant Examiner—Harold Joyce

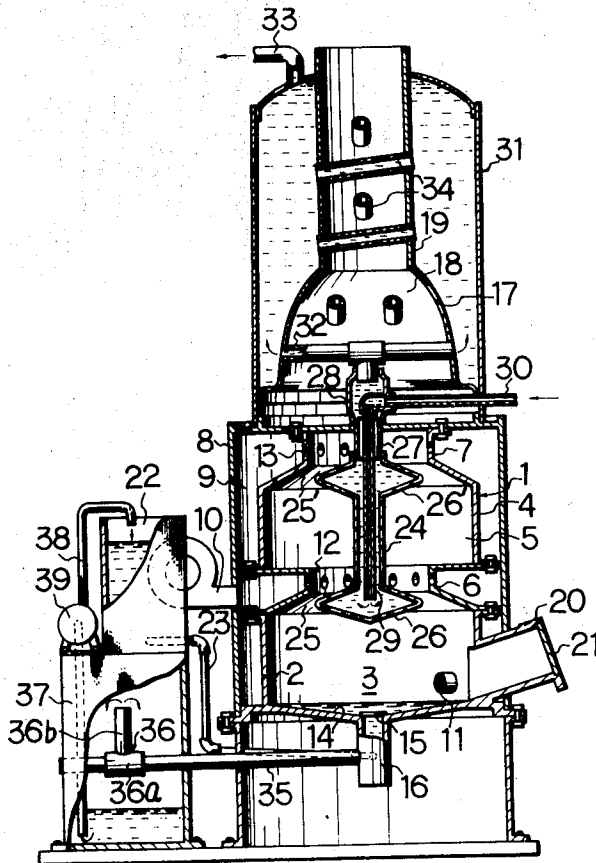
Attorney—Eric H. Waters et al.

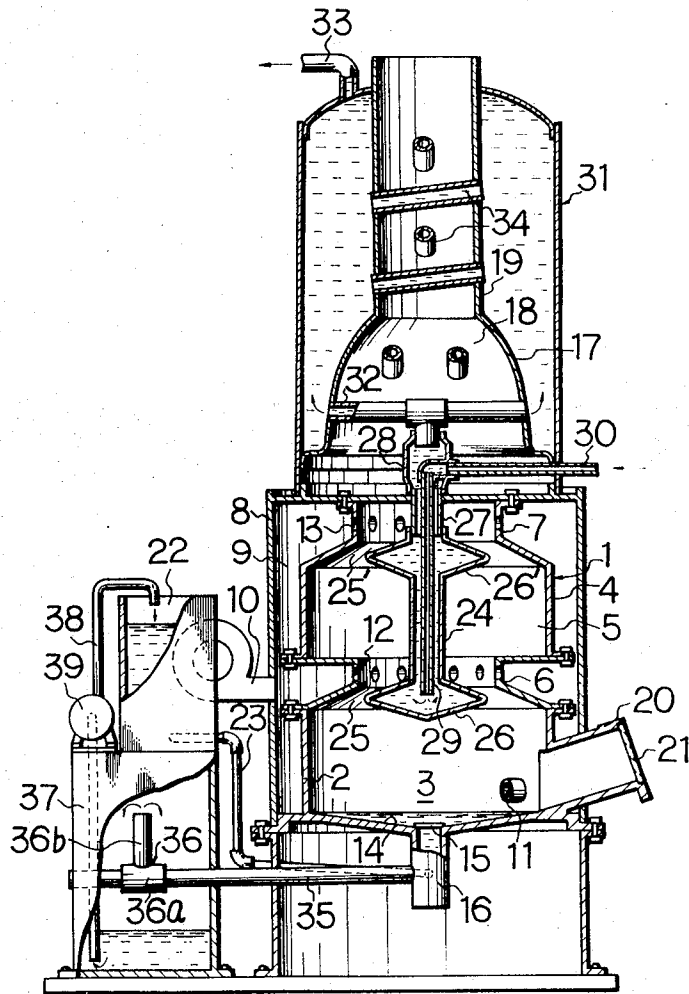
[57]

ABSTRACT

Herein disclosed is an improved heat exchanger for use in a liquid-fuel combustion furnace wherein heat exchange is effected through transfer of heat from hot water to cool water with the aid of the combustion heat in the combustion chamber of the furnace.

5 Claims, 1 Drawing Figure





HEAT EXCHANGER

This invention relates generally to a heat exchanger and, more particularly, to a heat exchanger for use in a liquid fuel combustion furnace of the vertical type.

A great amount of waste oil or slush is discharged from a variety of industrial equipment, giving rise to a serious contamination problem. Complete combustion of the waste oil is not presently achieved mainly because of its high boiling point.

It is a general object of this invention to provide an improved liquid fuel combustion furnace which is capable of burning out a liquid fuel including waste oil without emitting air-pollutant which would otherwise result from incomplete combustion of the liquid fuel.

Another important object of the invention is to provide an improved heat exchanger for use specifically in the liquid fuel combustion furnace of the above noted nature.

Still another object is to provide an improved heat exchanger of the construction adapted to efficiently exchange heat between cool water and combustion gases produced in the combustion furnace and to effect optimum secondary and tertiary air distribution.

The liquid fuel combustion furnace incorporating a heat exchanger according to this invention generally comprises an inner cylindrical housing composed of three portions respectively defining primary, secondary and tertiary combustion chambers and an outer cylindrical housing enclosing the inner housing for defining a common air distribution chamber between the two housings. The inner housing further includes two constrictions which are disposed respectively between the primary and secondary combustion chambers and between secondary and tertiary combustion chambers. A flue tube is provided at an upper extension of the inner housing.

The bottom wall of the inner housing is inclined toward its center so as to form thereon a liquid fuel reservoir. The inner housing also has a number of primary air inlet ports formed in its side or peripheral wall surrounding the primary combustion chamber. A number of secondary and tertiary air inlets are formed respectively in the side walls of the two constriction portions. These primary, secondary and tertiary air inlets provide constant communication between the combustion chamber and the air distribution chamber. A blower is associated with the air distribution chamber so that air under pressure is supplied into the over-all combustion chamber through the primary, secondary and tertiary air inlets at predetermined distribution ratios. An upper fuel storage tank is provided at an elevated level in communication with the primary combustion chamber through a central aperture formed in the bottom wall of the inner housing so that a liquid fuel is constantly supplied during operation from the fuel storage tank to the primary combustion chamber.

A heat exchanger to be incorporated in the above described combustion furnace generally comprises a construction having two hollow disc portions both disposed substantially upstream of the two constricted portions of the inner housing so that throats are formed respectively between the upper wall of the two discs and the inner wall of the two constriction portions. Thus, combustion gases are accelerated while flowing through the throat, with sufficient amount of secondary or tertiary air passed through the secondary or tertiary air inlets.

The construction also includes conduit interconnecting the two disc portions for providing fluid communication therebetween. The heat exchanger further comprises a cool water supply conduit positioned partly in the two disc construction. One end of this conduit is so arranged as to extend into the lower disc, while the other arranged to extend outside of the inner housing through the higher disc so that cool water is constantly supplied in operation into the two disc construction.

The heat exchanger further comprises a hot water flow passage having fluid communication with the higher disc for guiding or discharging outside of the particular combustion furnace hot water which has been warmed up while flowing in the two disc construction. This hot water flow passage may include a hot water housing encompassing the flue tube and/or the inner housing at the tertiary combustion chamber for defining a hot water reservoir therebetween. A horizontal conduit may also be mounted in the hot flow passage for providing fluid communication between the lower disc and the hot water reservoir. Where desired, an outlet may be formed in the uppermost wall of the hot water housing for convectively ejecting the hottest water reserved in the hot water reservoir. The hot water flow passage may preferably be provided with a plurality of slanting conduits which are arranged to slantingly extend across the tertiary combustion chamber and/or the flue tube so that additional heat exchange is effected between the combustion gases and the hot water convectively flowing therein.

Other features and advantages of the heat exchanger of the above described general nature will be more clearly understood from the following description taken in conjunction with the accompanying drawing, which shows a vertical section of the liquid fuel combustion furnace incorporating a heat exchanger embodying this invention.

Referring now to the accompanying drawing, a liquid fuel combustion furnace is shown as being of the so-called vertical type having multiple combustion stages. The combustion furnace includes an inner housing generally designated at 1 and having a first inner housing 2 defining a primary combustion chamber 3. The inner housing 1 also has a second inner housing 4 defining a secondary combustion chamber 5. These first and second housings 2 and 4, respectively, are positioned vertically and are connected to each other through a first constriction 6 which is located above the first housing 2. The second housing 4 also has a second constriction 7 merging therefrom. The combustion furnace further includes an outer housing encompassing the over-all inner housing 1 for defining a common air distribution chamber 9 between the two housings 1 and 8. A blower 10 is provided so as to feed air under pressure into the air distribution chamber 9.

The first housing 2 has formed therein a plurality of primary air inlets 11 while the first constriction 6 has formed therein a plurality of secondary air inlets 12. A plurality of tertiary air inlets 13 are formed in the peripheral wall of the second constriction 7. These primary and secondary air inlets 11 and 12 provide constant communication between the air distribution chamber 9 and each of the primary and secondary combustion chambers 3 and 5, respectively. The bottom wall 14 of the first housing 2, on the other hand, has an aperture 15 which is formed at its center toward which the bottom wall 14 is inclined, thus forming a liquid fuel reser-

voir to reserve a liquid fuel, for example, waste oil. This oil reservoir may preferably have a funnel shape and, accordingly, is provided with a central oil pan 16, as shown.

Designated at 17 is a third housing preferably of a cowl shape. This housing 17 is positioned atop the second constriction portion 7 for defining a tertial combustion chamber 18. A flue tube 19 is so arranged as to extend from the open end of the third housing 17 for discharging combustion products therefrom.

The first inner housing 2 may be provided with a mouth member 20 which leads slantingly and outwardly therefrom. This mouth member 20 has an open end so as to provide manual access to the primary combustion chamber 3 when in igniting the liquid fuel stored therein or in purging the chamber. The mouth member 20 is usually closed by a closure plate 21 which may preferably be hingedly connected to the open end of the mouth member.

A liquid fuel is supplied to the primary combustion chamber 3 from an upper fuel storage tank 22 storing the liquid fuel therein. This upper fuel storage tank 22 is positioned at a level which is suitably elevated from a desired level of the liquid fuel to be supplied to the primary combustion chamber 3. The upper fuel storage tank 22 communicates with the liquid fuel reservoir in the primary combustion chamber 3 through a fuel supply conduit 23 and the central oil pan 16. Thus, the liquid fuel in the fuel storage tank 22 is fed to the primary combustion chamber 3 by its own gravity. The construction and operation of the fuel storage tank will be explained later.

Description will now be made of a heat exchanger incorporated in the above combustion furnace for exchanging heat between combustion gases and cool water flowing in the heat exchanger and heated in the meantime. The heat exchanger generally comprises a two disc construction including a conduit 24 vertically disposed between the inner housing 1 and the outer housing 8. The two disc construction further includes first and second hollow discs 26 and 26' respectively disposed slightly upstream of the first and second constriction portions 6 and 7, respectively, and connected to the connection conduit 24 for providing fluid communication therebetween. With these arrangements, first and second throats 25 and 25', respectively, are formed between the inner wall of the first constriction portion 6 and the upper wall of the first disc 26 and between the inner wall of the second constriction portion 7 and the upper wall of the second disc 26', both for accelerating combustion gases flowing therein so that sufficient amount of additional air is passed through respective air inlets 12 or 13 into the associated combustion chamber 5 or 18.

The two hollow discs 26 and 26' may preferably have sections of generally inverted letter V. The heat exchanger further comprises a hot water flow passage including a connection conduit 27 having one end connected to the upper open end of the second disc 26' and the other end connected to a connection drum 28. The heat exchanger further comprises a cool water supply passage including an L-shaped conduit composed of two portions 29 and 30. The vertical conduit portion 29 extends downwardly into the first disc 26 while the horizontal conduit portion 30 is connected to the vertical portion 29 and to a suitable water pump, not shown.

The hot water flow passage further includes a hot water housing 31 which may preferably encompass the third housing 17 and the flue tube 19 for defining therebetween a hot water storage tank, not numbered. A horizontal conduit 32 is positioned in the hot water flow passage, horizontally extending across the tertial combustion chamber 18 for providing fluid communication between the hot water storage tank and the two disc construction through the second disc 26', connection conduit 27 and connection drum 28. A hot water outlet 33 is opened in the uppermost wall of the hot water housing 31 for convectively ejecting the hottest water stored in the hot water storage tank. The hot water flow passage may preferably include a plurality of conduits 34 slantingly extending across the tertial combustion chamber and/or the flue tube 19 so as to additionally exchanging heat between the final combustion gases and the hot water convectively flowing therein.

A fuel drain pipe 35 communicates with the oil pan 16. This pipe 35 is closed at its leading end and has a fuel level regulating valve 36 mounted thereon. This regulating valve 36 consists of a valve tube 36a rotatable on the drain pipe 35 and an angle-adjustable fuel release tube 36b which is directed generally perpendicularly to the valve tube 36a. The fuel release tube 36b is located within a lower fuel storage tank 37 positioned below the upper fuel storage tank 22. As the valve tube 36a is manually rotated on the drain pipe 35 through a suitable central angle, the fuel release tube 36b is angle-adjusted with respect to the level of the liquid fuel reserved in the primary combustion chamber 3. If, in this instance, the fuel release tube 36b is so angle-adjusted as to have its open end located on a plane lower than the reserved fuel level in the combustion chamber 3, then the excess fuel is drained into the lower fuel storage tank 37 through the drain pipe 35. On the other hand, the lower fuel storage tank 37 is connected to the upper fuel storage tank 22 through a pipeline 38 which is provided with an oil pump 39. This oil pump 39 is adapted to recirculate up to the upper fuel storage tank 22 the liquid fuel which has been drained into the lower fuel storage tank 37. The oil pan 16, interposed between the central aperture 15 and the drain pipe 35, may be provided with a valve, not shown, capable of opening the drain tube 35 for the purpose of cleaning it.

In operation, the liquid fuel stored in the upper fuel storage tank 22 is passed over to the primary combustion chamber 3 through the fuel supply conduit 23 and stored in the liquid fuel reserver on the bottom wall of the first housing 2. The liquid fuel is fired by throwing an igniter into the primary combustion chamber 3 through the mouth member 20, an example of the igniter being a lump of burning cloth immersed with kerosene. At this instant, the fuel commences to evaporate burn with the aid of the primary air supplied through the primary air inlets 11. The resultant combustion gases including unburned contents such as hydrocarbons or soots move upwardly in the primary combustion chamber 3 by virtue of convection effects. At the first throat 25, the combustion gases are throttled or accelerated and receive secondary air through the secondary air inlets 12. The secondary air is thus mixed with the combustion gases to burn the unburned contents in the secondary combustion chamber 5. The further burned combustion gases are then raised by con-

vection effects up to the second throat 25', where they are accelerated for a second time so as to receive the tertial air through the tertial air inlets 13. The tertial air is mixed with the combustion gases in the secondary combustion chamber 5 and burn them out completely. The final combustion gases leaving the tertial combustion chamber 18 are thus substantially completely cleared of an unburned content.

As is well known in the art, the temperature in the burning gases is highest in their reaction zone. Consequently, the two disc construction of the character above described can provide the hottest regions in the vicinity of the two discs 26 and 26', in which the cool water supplied thereinto transiently stays. Thus, the cool water is efficiently warmed up in the disc construction while convectively flowing therein. The once warmed water is then introduced into the hot water reservoir. Here, it should be noted that the hot water reservoir itself is provided around the hot water housing 31, thus promoting further heat conduction through the wall of the hot water housing 31. In addition, the slanting conduits 34 are expected to effect further heat exchange between the final combustion gases flowing in the third inner housing 17 and the flue tube 19 and the hot water in the hot water reservoir. On the other hand, the two disc construction having mounted therein the cool water supply conduit 29 and 30 will make it easier to anchor the conduit 29 and 30 therein without inviting any water seal problem.

What is claimed is:

1. In a combustion furnace of vertical type for burning a liquid fuel, including a first cylindrical housing defining a primary combustion chamber and having in its side wall a plurality of primary air inlets for supplying therethrough primary air into said primary combustion chamber and at its bottom a fuel reservoir for storing a liquid fuel supplied thereto, a first constriction positioned atop said first cylindrical housing and having in its side wall a plurality of secondary air inlets, a second cylindrical housing positioned atop said first constriction and defining a secondary combustion chamber, a second constriction positioned atop said second cylindrical housing and having in its side wall a plurality of tertial air inlets, a cowl-shaped housing positioned atop said second constriction and a tertial combustion chamber, and a flue tube positioned atop cowl-shaped housing for exhausting therethrough combustion gases produced in said primary, secondary and tertial combustion chambers, a heat exchanger for exchanging heat between said combustion gases and cool water flowing therein to produce hot water, said heat exchanger comprising: a two disc construction including a first hollow disc disposed in said primary combustion chamber slightly upstream of said first constriction for forming a first throat together with said first constriction to accelerate combustion gases produced in said primary combustion chamber, a second hollow disc disposed in said secondary combustion chamber slightly upstream of said second constriction for forming a second throat together with said second constriction to ac-

celerate combustion gases produced in said second combustion chamber, and a connection conduit connecting said first and second discs for providing fluid communication therebetween; a cool water supply conduit positioned partly in said disc construction and having one end downwardly extending into said first disc and the other end extending outside of said second constriction for supplying cool water into said disc construction; and a hot water flow passage in communication with said second disc for guiding outside of said combustion furnace hot water warmed while convectively flowing in said disc construction.

2. A heat exchanger according to claim 1, wherein said hot water flow passage includes a hot water housing encompassing said cowl-shaped housing and/or said flue tube for defining a hot water reservoir therebetween, a horizontal conduit having fluid communication with both said second disc and said hot water reservoir and horizontally extending across said tertial combustion chamber and a hot water outlet mounted on the uppermost wall of said hot water housing for convectively ejecting the hottest water in said hot water reservoir.

3. A heat exchanger according to claim 2, wherein said hot water flow passage further includes a plurality of slanting conduits slantingly extending across said tertial combustion chamber and/or said flue tube for further exchanging heat between said combustion gases flowing in said tertial combustion chamber and/or said five tube and said flowing therein.

4. A heat exchanger according to claim 1, wherein each of said first and second discs has an upper wall respectively facing said first and second constrictions, the section of said upper wall having a generally inverted letter V.

5. A heat exchanger according to claim 1, further comprising a fuel level regulator including an upper fuel storage tank positioned over said fuel reservoir in the bottom of said first housing for supplying a liquid fuel to said reservoir, a fuel supply conduit for providing fluid communication between said upper fuel storage tank and said fuel reservoir, a lower fuel storage tank positioned below said upper fuel storage tank, a fuel drain pipe having fluid communication with said fuel reservoir and substantially horizontally extending into said lower fuel storage tank, a fuel level regulating valve mounted on said fuel drain pipe and having a valve tube rotatable on said fuel drain pipe and an angle-adjustable fuel release tube directed substantially perpendicularly to said valve tube, said angle-adjustable tube being angle-adjusted with respect to the level of the liquid fuel reserved in said fuel reservoir as said valve tube is manually rotated on said drain pipe, a pipeline for providing fluid communication between said upper and lower fuel storage tanks, and an oil pump located halfway of said pipeline for recirculating up to said upper fuel storage tank from said lower fuel storage tank through said pipeline the liquid fuel which has been drained into said lower fuel storage tank.

* * * * *