

[54] **HEAT EXCHANGE APPARATUS WITH GAS CHAMBER BELOW HEAT EXCHANGE BED**
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[30] **Foreign Application Priority Data**

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[52] **U.S. Cl.**..... 122/4 D; 165/104; 110/28 J; 23/288 S

[57] **ABSTRACT**

Heat exchange apparatus comprising first and second chambers separated by a gas-permeable plate, and a jacket for receiving liquid to be heated positioned around the first and second chambers, said first chamber being for receiving hot gases which, during use of the apparatus, pass through the plate into a heat exchange bed of particulate material positioned in the second chamber and supported on the plate.

[51] **Int. Cl.**..... **F28d 13/00**

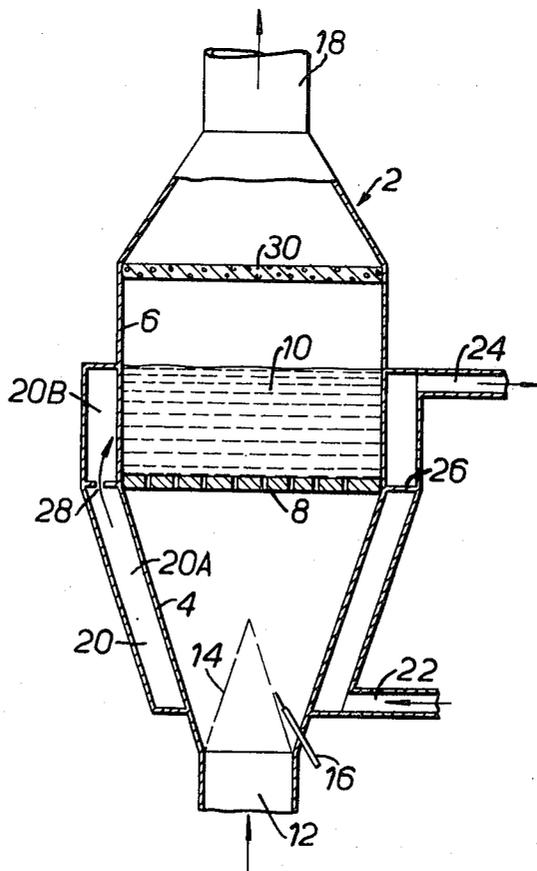
[58] **Field of Search**..... 165/104; 110/28 J; 23/288 S; 122/4 D, 176, 177; 432/15, 58; 34/57 A

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5 Claims, 2 Drawing Figures



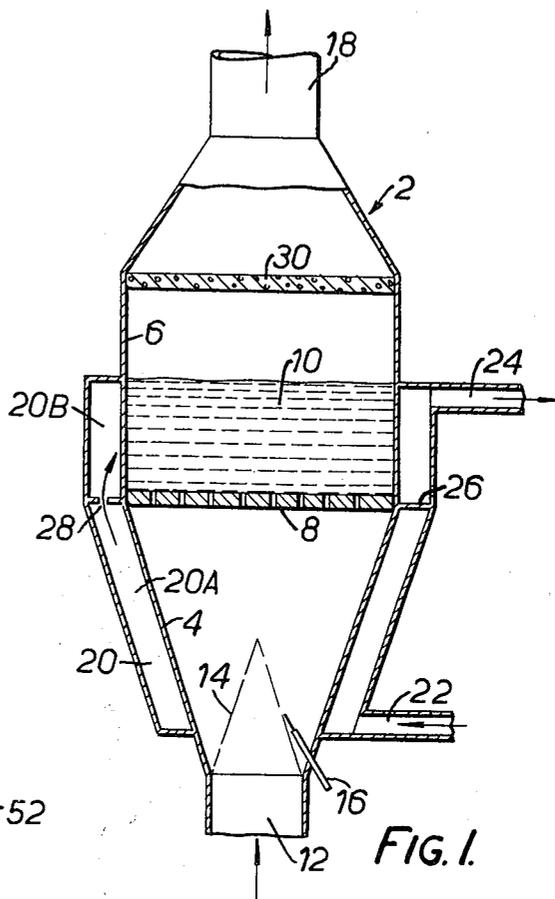


FIG. 1.

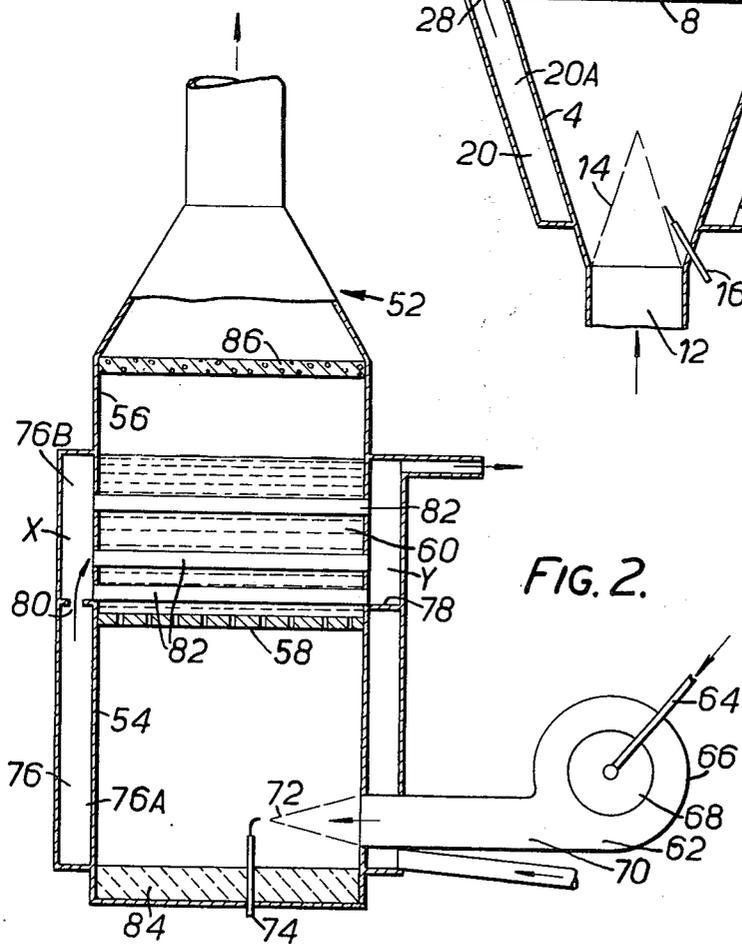


FIG. 2.

HEAT EXCHANGE APPARATUS WITH GAS CHAMBER BELOW HEAT EXCHANGE BED

This invention relates to heat exchange apparatus such for example as boilers useful in central heating systems.

Heat exchange apparatus such for example as boilers for central heating systems should desirably be small and compact to facilitate installation of the apparatus in convenient and non-obstructive positions. It is an aim of the present invention to provide such apparatus.

Accordingly, this invention provides heat exchange apparatus for use in a central-heating system, which apparatus comprises first and second chambers separated by a gas-permeable plate, and a jacket for receiving water to be heated positioned around the first and second chambers, said first chamber being provided with an igniter for igniting a gaseous medium in said first chamber to form hot gases from which, during use of the apparatus, pass through the plate into a heat exchange bed of particulate material positioned in the second chamber and supported on the plate.

In use of the heat exchange apparatus of the present invention, hot gases pass into the heat exchange bed and heat up the bed. The liquid-receiving jacket surrounds the first chamber so that heat is transferred from the hot gases to the liquid, e.g., water, over this area. The jacket also surrounds the second chamber so that further heat is transferred to the liquid from the hot particulate material. It will thus be seen that the maximum surface area is utilised for heating up the liquid.

Preferably the heat exchange bed is of the fluid type but a solid or packed bed can be employed if desired. With a solid bed, the particulate material may be, for example, metallic particles bonded together. With a fluidized bed, the particulate material may be constituted by, for example, sand, silicon carbide, silicon nitride or loose metallic particles.

If desired, further transfer of heat from the heat exchange bed to the liquid to be heated can be effected by having pipes for receiving the liquid running through the bed and being in communication with the jacket surrounding the bed. In instances where pipes or other pieces of auxiliary apparatus, e.g., electrical heating elements, are buried in a fluidized bed, we have found it advantageous to provide the plate which supports the bed with apertures arranged as described in detail in our co-pending patent application Ser. No. 330,141 entitled "Heat Exchange Apparatus." Generally speaking, as will be seen from our said co-pending application, the fluidized bed is substantially uniformly fluidized by providing the plate with less apertures (or no apertures at all) in portions of the plate positioned below the auxiliary apparatus. (See FIG. 3).

Usually, the plate will be formed of metal, for example mild steel, although other materials such as ceramic materials may in some circumstances be used. Where a fluidized bed is utilised, some of the fluidized bed particles may tend to fall through the apertures in the plate. In such circumstances, it may be desirable to place on top of the plate a metal sponge, gauze, mesh or screen with a view to stopping the particles falling through the apertures in the plate whilst at the same time allowing the hot gases to pass freely from the first chamber into the heat exchange bed. A preferred metal sponge is the Ni/Cr metal sponge sold by the Dunlop

Company under the Trade Mark RETIMET, this metal sponge being such that it allows the relatively easy passage of the hot gases through it.

In some embodiments of the present invention, and with a view to providing a large amount of heat for heating a large amount of water, it is possible to provide banks of the first and second chambers and associated heat exchange beds, and all of the chambers can, if desired, be provided with a common water jacket and can also be provided with a common flue outlet. Similarly, all of the first chambers can be fed from a common fuel source.

In some embodiments of the invention, the plate which supports the heat exchange bed can itself be a metal sponge, mesh or screen. Again, RETIMET is the preferred metal sponge.

As mentioned above, the heat exchange apparatus of the present invention can be constructed to be small and compact. For example, a boiler giving 30,000 B.T.U. need be no bigger than 10 inches high by 5 inches wide by 6 inches deep.

Two embodiments of the invention will now be described by way of example and with reference to the accompanying drawings in which:

FIG. 1 is an axial section through first heat exchange apparatus in accordance with the invention; and

FIG. 2 is an axial cross section through second heat exchange apparatus in accordance with the invention.

FIG. 3 shows in cross-section an embodiment of the invention in which a metal sponge 41 is in the form of a layer over perforated plate 8.

FIG. 4 shows in plan view heat exchange apparatus in accordance with the present invention in which a plurality of sets of first and second chambers 2 are provided with a common water jacket 120.

FIG. 5 shows the embodiment of FIG. 4 in elevation.

Referring to FIG. 1, there is shown heat exchange apparatus in the form of a boiler 2. The boiler 2 has a first chamber 4 and a second chamber 6. The two chambers 4 and 6 are separated by a gas permeable metal plate 8 which is provided with apertures (as shown) to allow gas to pass from the first chamber 4, through the plate 8 and into a fluid sand bed 10 arranged in the second chamber 6 and supported by the plate 8. The hot gases are provided in the chamber 4 by introducing a mixture of gaseous fuel and air from a centrifugal fan (not shown) into a fuel inlet 12 positioned in the bottom of the first chamber 4. The fuel/air mixture is at sufficient pressure to fluidize the bed 10. The fuel inlet 12 is provided with a flame holder 14 and the fuel is ignited in the chamber 4 in the vicinity of and on the flame holder 14 by means of an igniter 16. If liquid fuel is employed, this can be sprayed into the chamber 4 by means of an atomiser and the flame holder will then be of the well known gutter or finger type. The hot gases pass upwards through the plate 8, through the fluidized bed 10 and out through the top of the boiler 2 by means of a flue outlet 18.

Surrounding the first and second chambers 4, 6, respectively is a water jacket 20. The water jacket 20 is provided with a water inlet 22 and a water outlet 24. It will be noted that the water jacket 20 is provided with a dividing plate 26 which is apertured at 28 to allow water to pass from the lower portion 20A of the jacket to the upper portion 20B of the jacket. Also, a thermocouple may be positioned in the aperture 28 for ascertaining the water temperature. Water in the portion

20A is heated by means of the hot gases in the first chamber 4, and also heat radiated by the holder 14 and the plate 8, and water in the chamber 20B is heated by means of heat given out from the hot bed 10, the said bed 10 being heated by means of the hot gases from the chamber 4. Usually, heat will be put into the bed 10 by the gases and taken from the bed 10 by the water at such a rate that the bed will stop at substantially flue gas temperature, which is ideally about 400°F to prevent condensation within the outlet flue 18. The hot water leaving the water outlet 24 can be utilised in a normal central heating system or for other purposes as is well known.

It will be noted that the top of the second chamber 6 is provided with an apertured retaining plate or screen 30 for retaining fluidised particles thrown upward from the fluid bed 10. Care has to be taken in appropriately choosing the aperture or mesh size for the retaining plate 30 as otherwise it can become prematurely clogged. As an alternative to employing the retaining plate 30, a cyclone separator (not shown) can be employed which separates the particles thrown upwardly and returns them to the fluidized bed 10.

Referring now to FIG. 2, there is shown a somewhat similar arrangement comprising heat exchange apparatus constituted by a boiler 52. The boiler 52 is provided with a first chamber 54 and a second chamber 56 separated by a gas permeable plate 58 which is provided with apertures (as shown). These apertures allow gas in the chamber 54 to pass through the plate 58 and into a fluid bed 60. The fluid bed is thus heated by the gases. The gases are provided in the chamber 54 by means of a device 62 which includes a conduit 64 for introducing gas into a fan 66. The device 62 is also provided with an air inlet 68 so that gas and air are mixed by the fan 66 and pass along a common conduit 70. The gases then pass through a flame holder 72 and are ignited by means of an igniter 74. The flame holder prevents the ignited gas mixture from blowing back along the conduit 70.

A water jacket 76 is provided around the first and second chambers 54, 56 respectively. It will be noted that this water jacket 76 is provided with a dividing plate 78 and this dividing plate is apertured at 80 to allow water to pass from the lower portion 76A of the jacket to the upper portion 76B of the jacket. The aperture is also conveniently provided for housing a thermocouple (not shown) which can show the various temperatures of the water. The water in the lower portion 76A of the water jacket is heated by means of the hot gases in the chamber 54, and also heat radiated from the holder 72 and plate 58, and the water in the upper portion 76B of the water jacket is heated by means of heat emitted from the fluidized bed 60. Also, in order to more quickly heat up the water in the water jacket 76, water pipes 82, if desired of convolute form, have been buried in the fluid bed 60 and these water pipes communicate with the upper portion 76B of the

water jacket 76. Obviously, the use of the pipes 82 allows the water to be in heat exchange contact with a greater area of the fluid bed 60. Water can be encouraged to pass through the pipes 82 by dividing the upper portion 76B of the jacket 76 into two parts X and Y with access from part X to part Y being only attainable through the pipes 82.

The lower portion of the boiler 52 is provided with a radiant fire brick base 84. This radiant fire brick base 84 quickly heats up and assists in heating gases in the chamber 54.

If desired, the embodiment illustrated in FIG. 2 can be utilised without the pipes 82. As in the case of FIG. 1, the chamber 56 in FIG. 2 has been closed with a particle-retaining screen 86. Again, as in the case of FIG. 1, this particle-retaining screen 86 can be replaced by a cyclone separator if desired.

What we claim is:

1. Heat exchange apparatus for use in a central-heating system, which apparatus comprises first and second chambers separated by a gas-permeable plate, and a jacket for receiving water to be heated surrounding the first and second chambers, said first chamber being provided with an igniter for igniting a gaseous medium in said first chamber proximate the bottom of said jacket to form hot gases which, during use of the apparatus, pass through the plate into a heat exchange bed of particulate material positioned in the second chamber and supported on the plate to fluidize said particulate material.

2. Heat exchange apparatus according to claim 1 including conduits for the liquid to be heated running through the heat exchange bed and being in communication with the liquid-receiving jacket surrounding the heat exchange bed.

3. Heat exchange apparatus according to claim 1 in which a metal sponge is positioned on top of the gas-permeable plate.

4. Heat exchange apparatus according to claim 1 including banks of first and second chambers and associated heat exchange beds, said first and second chambers all being provided with a common water jacket.

5. Heat exchange apparatus for use in a central-heating system, which apparatus comprises first and second chambers separated by a gas-permeable metal sponge plate, and a jacket for receiving water to be heated which surrounds the first and second chambers and which is divided adjacent said plate so that said jacket is formed into two compartments which are in communication with each other, said first chamber being provided with an igniter for igniting a gaseous medium in said first chamber proximate the bottom of said jacket to form hot gases which, during use of the apparatus, pass through said plate into a heat-exchange bed of particulate material positioned in the second chamber and supported on said plate to fluidize said particulate material.

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