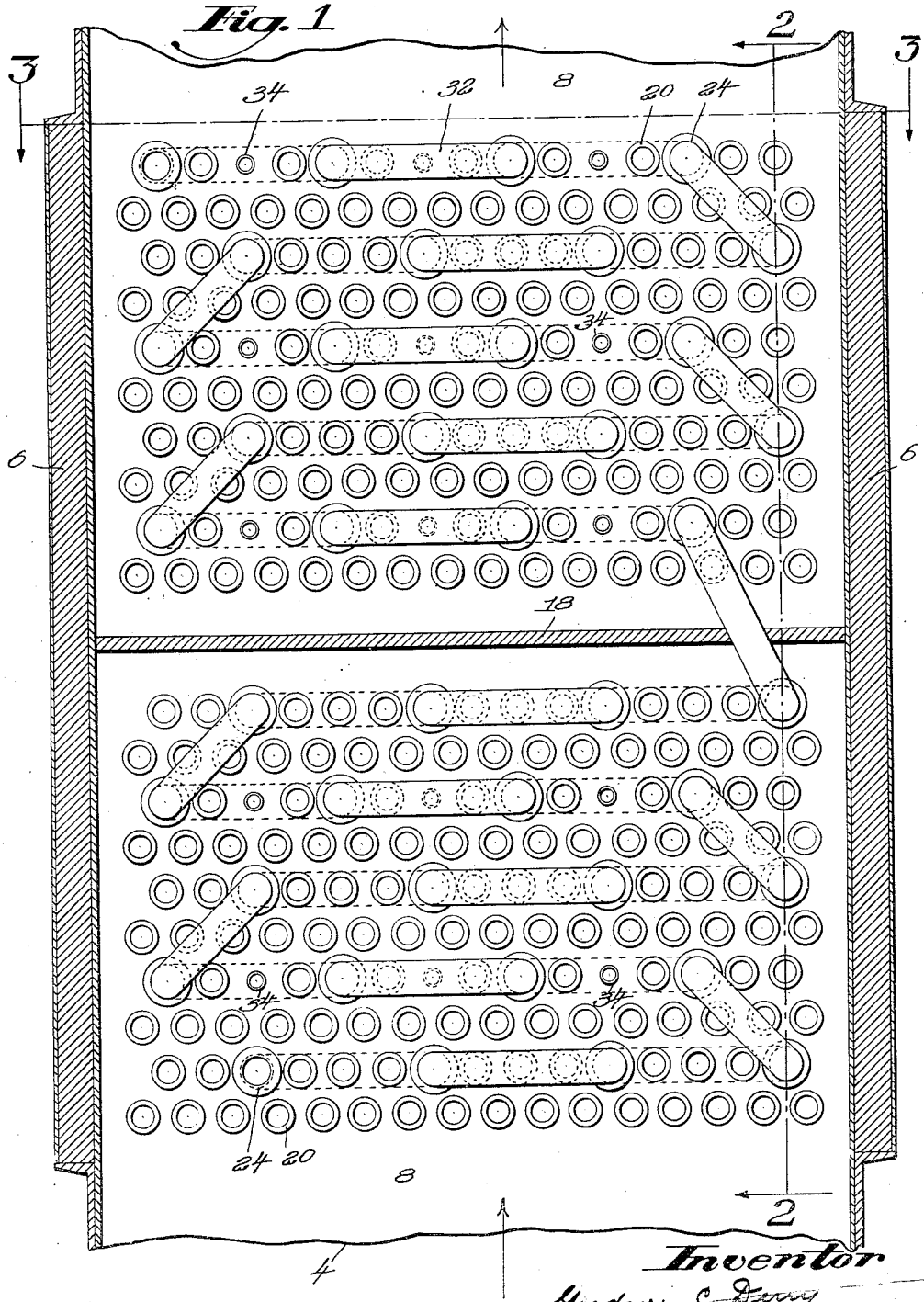
Jan. 10, 1933. G. C. DERRY 1,894,026

HEAT EXCHANGE APPARATUS

Filed Sept. 26, 1929 3 Sheets-Sheet 1

Fig. 1



Inventor

Witness

Helmar Van Dine.

Gardner C. Derry

by his attorneys

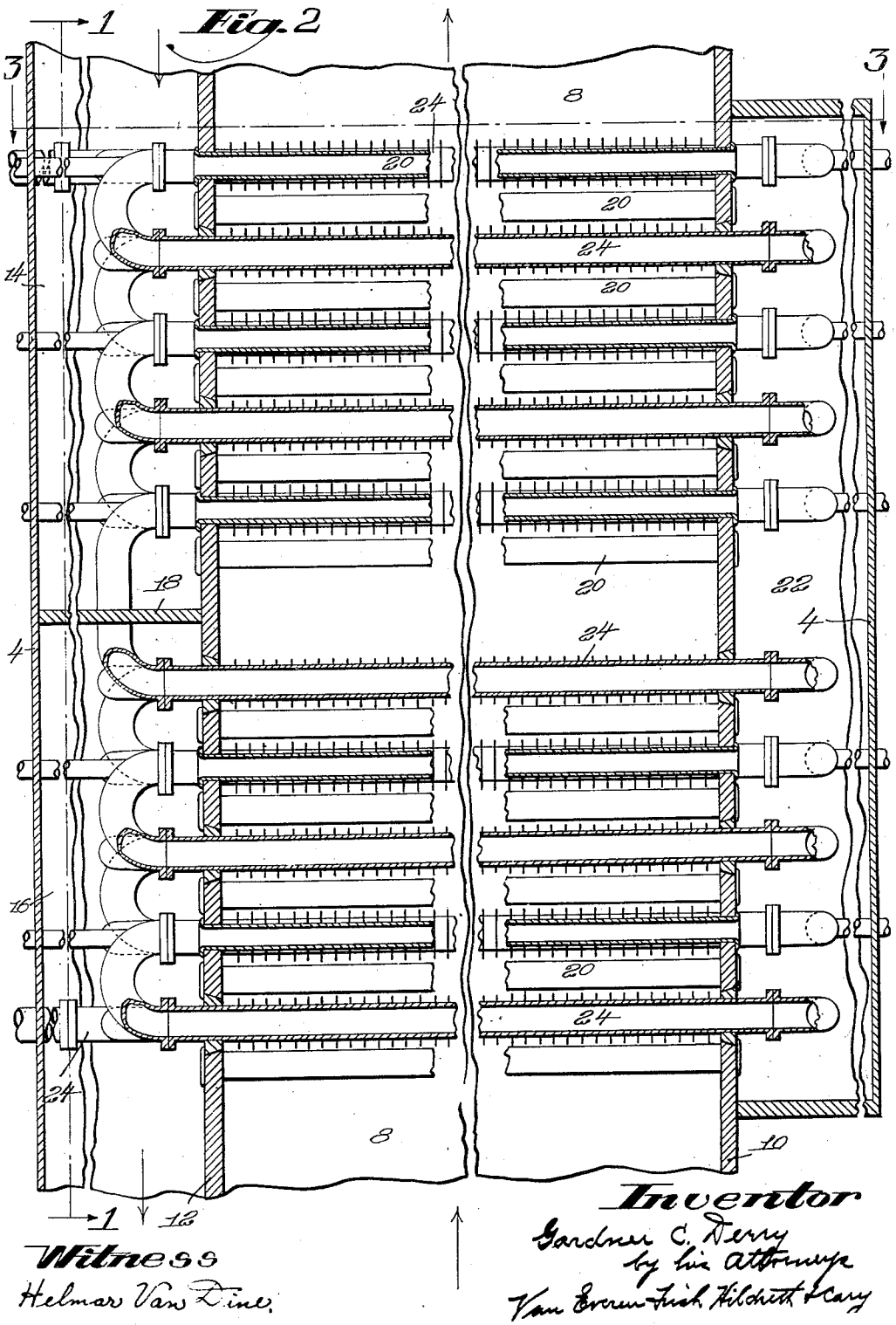
Van Dusen, Fick, Kilburn & Gray

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HEAT EXCHANGE APPARATUS

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Fig. 2



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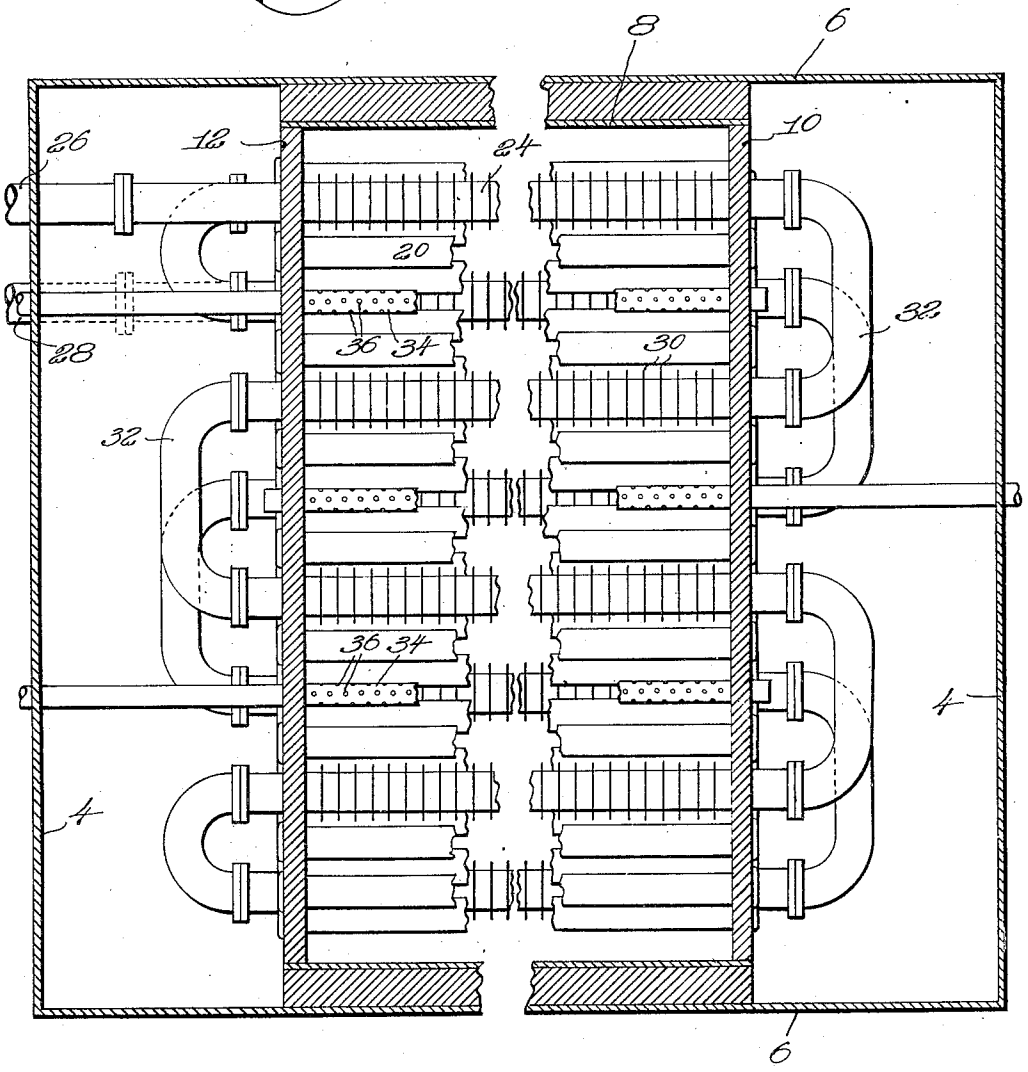
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HEAT EXCHANGE APPARATUS

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Fig. 3



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Patented Jan. 10, 1933 1,894,026

UNITED STATES PATENT OFFICE

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HEAT EXCHANGE APPARATUS

Application filed September 26, 1929. Serial No. 395,299.

The present invention relates to heat exchange apparatus and more particularly to apparatus for extracting available heat from waste gases in steam power plants, oil stills and other apparatus.

A common type of heat transfer device used for obtaining heat from the waste gases in a power plant is an economizer for heating the feed water for the boiler. In modern plants, however, wherein steam at high pressure and temperature is generated in the boiler, the temperature of the feed water entering the boiler is often so high that the full available heat from the waste gases is not extracted. This is particularly so in cases where the feed water is initially heated by so-called stage bleeding, so that it enters the economizer at temperatures as high as 300° or 350° and even higher. The capacity for heat transfer in any equipment is dependent, among other factors, upon the "heat head", that is, the difference in temperature between the flue gases and the material to be heated. With high feed water temperatures the heat head in an economizer is so far diminished that the economizer has lost much of its usefulness in high pressure plants.

In order to avoid the large stack loss brought about by the inability of the economizer to extract the available heat from the gases, air heaters are now commonly employed. These offer a higher heat head because of the fact that the temperature of the air entering the air heater is considerably lower than the temperature of the feed water entering the economizer. The air heater is not always used to the exclusion of the economizer, a small economizer being usually provided for the purpose of augmenting the temperature obtained in the stage heater. When both an economizer and heater are used, the air heater follows the economizer because of the higher heat head at the low temperature or inlet end. However, because of the fact that the economizer absorbs a considerable part of heat from the flue gases before the latter reach the air heater, there is a considerable loss of heat head at the outlet of the air heater. In other words, the air heater is not able to obtain the full benefit of high flue gas temperature.

The principal object of the present invention is to provide a heat exchange apparatus including means for heating both combustion air and feed water, and having provision for making the entire temperature drop of the waste gases available for heat transfer both to the air and water.

Another object of the present invention is to provide a heat transfer apparatus including both an air heater and a feed water heater, of simple and compact construction.

With these objects in view the principal feature of the present invention consists of a heat exchange apparatus having air and water tubes which are interspersed among one another, and adapted to be swept by the flue gases, both the air and water tubes being so disposed as to be subjected to the maximum available heat head.

The apparatus in its preferred form consists of a single casing having a large number of air tubes and a lesser number of water tubes dispersed among the air tubes.

As a further feature, the invention contemplates the provision of the water tubes with external extended surface whereby the heat absorbing capacity thereof is considerably increased over the heat absorbing capacity for plain tubes. The total external surface of the water tubes is preferably equal to the amount of surface which would be provided by plain water tubes of the same diameter, and included in the same volume with minimum practicable spacing. Thus, the extended surface water tubes are permitted to be spaced at considerable distances from one another, thereby leaving sufficient space for insertion of plain air tubes. The number of air tubes for which space is provided among the water tubes is ordinarily sufficient to maintain the proper temperature between the heat transferred to the water and the heat transferred to the air.

In the accompanying drawings Fig. 1 is an end view, partly in section, on line 1—1, Fig. 2, showing a preferred form of heat exchange apparatus embodying the features of the the present invention; Fig. 2 is a sectional side

view on line 2—2 of Fig. 1; and Fig. 3 is a horizontal sectional view on line 3—3, Fig. 2.

The illustrated embodiment of the present invention comprises a casing having ends 4 and sides 6. Internally of the casing is provided a flue 8, bounded by the tube sheets 10 and 12. One end of the casing is formed with upper and lower air inlet and outlet chambers 14 and 16, separated by the horizontal partition or baffle 18.

The apparatus is preferably constructed for counterflow between the flue gases and the air and water to be heated. In the preferred form of the invention the flue gases from the boiler ascend through the flue 8, as indicated by the arrow in Figs. 1 and 2 at the top and bottom, while the air and water, entering at the top of the apparatus, are discharged at the bottom.

Mounted in the tube sheets are a plurality of rows of air tubes which, as shown in Fig. 1, are staggered. These tubes are expanded at their ends to secure them in the tube sheets. The upper set of tubes, that is, those above the partition 18, convey the air from the inlet chamber 14 at one end of the apparatus to the reversing chamber 22 at the opposite end, where the partially heated air is turned downwardly and back through the lower set of tubes to the outlet chamber 16 from which it is directed to the combustion chamber of the furnace.

As shown in Fig. 1, a number of air tubes are omitted from alternate rows, and in these spaces are located water tubes 24. These water tubes convey feed water from an inlet 26 at the top of the casing to an outlet 28 at the bottom. Each water tube is provided with extended heat absorbing surface in the form of flanges 30 whereby the external surface of each water tube is greatly increased. The water tubes are all connected in series by return bends 32, and are staggered among themselves and the air tubes.

In the illustrated embodiment of the present invention the water tubes are provided with flanges of such size and spacing that the surface exposed to the hot gases is about seven times the surface of a plain tube of the same diameter. The use of extended surface on the water tubes, therefore, affords with only one-seventh the number of tubes the same total heating surfaces that would be afforded by plain tubes.

Preferably the water tubes are of such number and so spaced that the total external heating surface of the water tubes is approximately the same as the total amount of heating surface practicably available in an apparatus of the same size employing plain water tubes throughout. Sufficient space is thus provided in the casing for the air tubes, which, since they require no bends or other connections, may be spaced in very close proximity to one another.

The air and water tubes are kept clean and free from soot and dust by means of the soot blowers 34 which consist of steam pipes passing through the air inlet and outlet chambers and across the flue. These pipes are provided with the perforations 36 arranged to direct live steam at definite intervals onto the adjacent air and water tubes to remove any accumulation of dust or soot.

The above described construction wherein the air and water tubes are located within the same casing and may be exposed to the same heat head provides a very compact and efficient apparatus. The use of extended surface on the water tubes still further conserves space. Compactness is also secured by the close spacing of the air tubes both horizontally and vertically, and this, in conjunction with high gas velocity, results in increased rate of heat transfer and reduced accumulation of soot and dust.

While in the illustrated embodiment of the present invention the flue gases are described as ascending while the water and air have a general descending path, it is to be understood that this is not an essential feature, but if desired, the directions of flow may be changed although ordinarily the air and water will be opposite to that of the hot gases.

Nor is the present invention limited to the subjection of water and gas to the entire heat head or to any definite proportion of air and water heating surface. The conditions of the installation will determine the amount of heating surface required in the water tubes and similarly of the air tubes, and while preferably each series of tubes will be arranged so that both the air and water will be subjected to the full heat head of the flue gases, nevertheless the present invention contemplates a construction in which the water tubes or air tubes may extend through only a portion of the heating chamber.

Having thus described the invention, what is claimed is:

1. Heat exchange apparatus for extracting heat from waste gases comprising a flue, air tubes and water tubes in the flue adapted to be swept transversely by the hot gases, the water tubes being interspersed among the air tubes and exposed to flue gases of the same temperature.

2. Heat exchange apparatus for extracting heat from waste gases comprising a flue, air tubes and water tubes in the flue adapted to be swept transversely by the hot gases, the water tubes being regularly interspersed among the air tubes and being fewer in number than the air tubes and exposed to flue gases of the same temperature.

3. Heat exchange apparatus for extracting heat from waste gases comprising a flue, air tubes and water tubes in the flue, the water tubes having extended surface and being

widely spaced from each other, the air tubes being dispersed among the water tubes and exposed to the action of flue gases at the same temperatures.

4. Heat exchange apparatus comprising a flue; air tubes and water tubes in the flue, the water tubes having extended surface to make the total heating surface of the water tubes approximately equal to the external surface of the total number of plain tubes which could be practicably received in the casing, the water tubes being widely spaced apart, and a large number of air tubes regularly dispersed in the spaces between the water tubes.

5. Heat exchange apparatus for extracting heat from waste gases comprising a casing having a flue for the passage of hot gas and air chambers on opposite sides of the flue, air tubes in the flue connecting the air chambers, and water tubes in the flue exposed to flue gases and extending into the air chambers.

6. Heat exchange apparatus for extracting heat from waste gases comprising a casing having a flue for the passage of hot gas and air chambers on opposite sides of the flue, air tubes in the flue and connecting the air chambers, and water tubes in the flue exposed to flue gases and having return connecting bends in the air chambers.

7. Heat exchange apparatus for extracting heat from waste gases comprising a casing having a flue for the passage of hot gas and having an air inlet and an air outlet chamber in one side of the casing and a reversing air chamber on the opposite side of the casing, air tubes in the flue connecting the inlet and outlet air chambers with the reversing air chamber, and water tubes in the flue interspersed among the air tubes, exposed to flue gases, and having their connections located in the air chambers.

8. Heat exchange apparatus comprising a casing having partitions therein to form a flue for the passage of hot gas and air chambers at the sides of the flue, air tubes mounted in the partitions and extending transversely through the flue and having open ends in the air chambers, and water tubes mounted in the partitions, said water tubes extending transversely through the flue with their ends extending into the air chambers, said tubes being provided within the flue with extended external heating surface and having plain surface at their ends in the air chambers.

9. Heat exchange apparatus for extracting heat from waste gases comprising a vertical flue, air tubes and water tubes in the flue, the air tubes being arranged in horizontal rows and vertically staggered and the water tubes being interspersed among the air tubes and spaced apart on centers not less than the vertical spacing between the centers of alternate rows of air tubes.

10. Heat exchange apparatus comprising a vertical flue, air tubes and water tubes in the flue, the air tubes being arranged in horizontal rows and vertically staggered, the water tubes being located in alternate rows of the air tubes, and spaced apart in said rows by a plurality of air tubes.

11. Heat exchange apparatus for extracting heat from waste gases comprising a flue, air tubes and water tubes in the flue the air tubes being arranged in a plurality of groups each group providing a plurality of parallel paths of air flow in the same direction across the flue, and the water tubes being arranged in series to provide a single path of flow.

12. Heat exchange apparatus for extracting heat from waste gases comprising a flue for the waste gases, air tubes extending across the flue transversely of the flow of gases and spaced close together, and water tubes exposed to flue gases and interspersed among the air tubes.

13. Heat exchange apparatus for extracting heat from waste gases comprising a flue for the waste gases, air tubes extending across the flue and spaced close together, and water tubes having extended surface interspersed among the air tubes.

14. Heat exchange apparatus comprising a flue for the waste gases, air tubes extending across the flue, water tubes having extended surface interspersed among the air tubes, the air and water tubes being spaced close together in staggered arrangement.

15. Heat exchange apparatus comprising a flue for the waste gases, and air and water tubes extending across the flue transversely of the flow of gases and subjected to substantially the same heat head.

16. Heat exchange apparatus comprising a flue for the waste gases, and air and water tubes extending across the flue transversely of the flow of gases the water tubes being exposed to the full heat head available in the waste gases.

17. Heat exchange apparatus for extracting heat from waste gases comprising a flue having walls, air tubes extending across the flue and having open ends expanded in the walls forming tight joints therewith, water tubes extending across the flue and through said walls, and connections for the water tubes outside the walls.

18. Heat exchange apparatus for extracting heat from waste gases comprising a flue, air tubes and water tubes in the flue adapted to be swept by the hot gases, the water tubes being interspersed among the air tubes and the water and air tubes being closely spaced so as to cause high velocity of flow of the flue gases over the surfaces of the tubes.

19. Heat exchange apparatus comprising a flue for the waste gases, and air and water tubes extending across the flue transversely of the flow of gases, all of the air tubes having unobstructed interiors and being ex-

posed to the full heat head available in the waste gases.

20. Heat exchange apparatus comprising a flue for the waste gases, and air and water tubes extending across the flue transversely of the flow of gases, the water tubes being interspersed among and located exteriorly of the air tubes, and being exposed to the waste gases.

In testimony whereof I have signed my name to this specification.

GARDNER C. DERRY.