

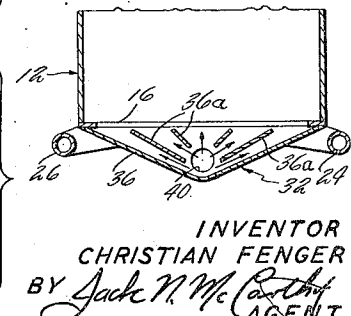
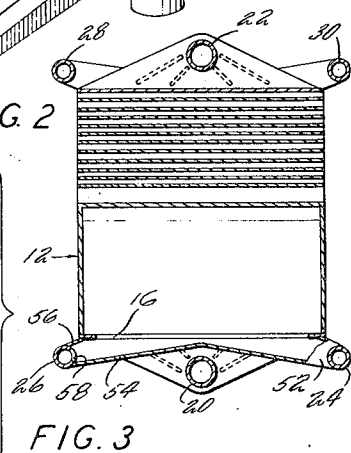
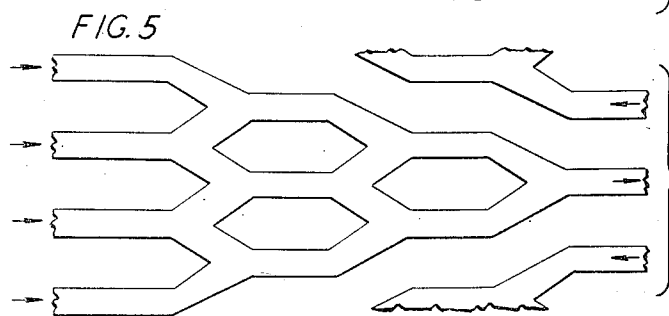
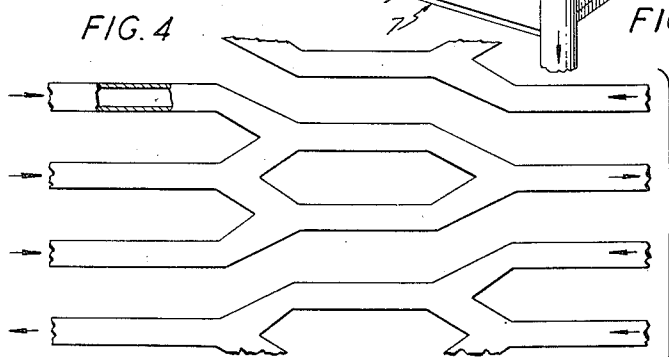
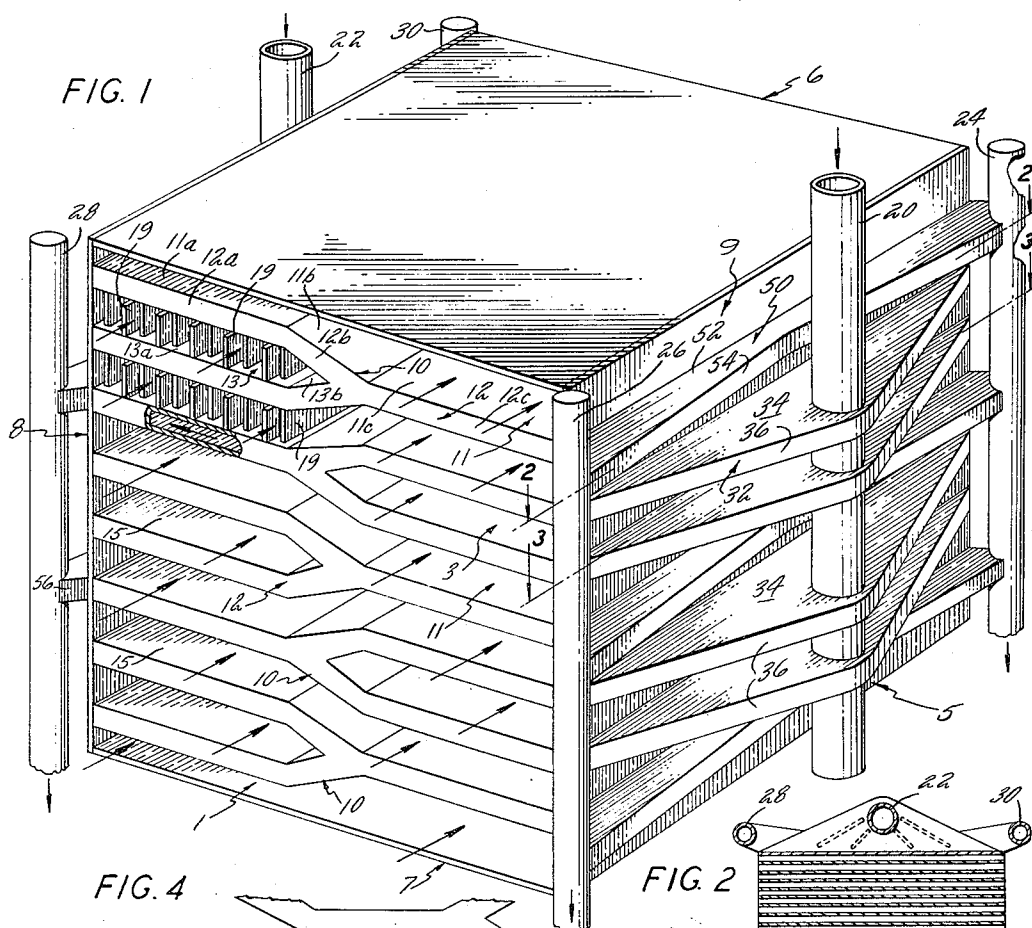
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2,813,701

CROSS-FLOW HEAT EXCHANGER

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CROSS-FLOW HEAT EXCHANGER

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This invention relates to a condenser or surface type heat exchanger.

An object of this invention is to provide a condenser or heat exchanger which will reduce the friction pressure drop for the condensing fluid of a finned-plate type of cross-flow condenser or heat exchanger without increasing the outside dimensions and without changing the inlet and outlet temperatures of the two fluids or reducing their respective flow rates.

Another object of this invention is to provide a condenser or heat exchanger in which the condensing fluid occupies successively decreasing numbers of interplate spaces as it traverses therethrough.

A further object of this invention is to provide a condenser or heat exchanger in which the condensing fluid is introduced from both sides of the unit.

Further objects and advantages will be apparent from the following specification and drawing:

Fig. 1 is a perspective view of a condenser or heat exchanger of a finned-plate cross-flow type having successively reduced free flow areas extending in the direction of condensing fluid flow.

Fig. 2 is a figure taken along the line 2—2 of Fig. 1.

Fig. 3 is a figure taken along the line 3—3 of Fig. 1.

Fig. 4 is a modification of the invention showing the condensing fluid conduit assemblies being reduced from three conduits to one.

Fig. 5 is a modification of the invention showing the condensing fluid conduit assemblies being reduced from four conduits to one.

Referring to the figures, the invention is shown embodied in a fluid-to-gas condenser or heat exchanger 1. This heat exchanger is a finned-plate, cross-flow type of one-pass arrangement and comprises a main gas flow duct or chamber 3 and a condensing fluid header system 5. The gas flow duct or chamber 3 is formed rectangular in shape having a top 6, a bottom 7, and sides 8 and 9. Top 6 and bottom 7 are formed as a solid plate while the sides 8 and 9 are each formed as a plate having rectangular openings 16 therein extending from one end to the other of the heat exchanger. The sides 8 and 9 are also connected by the plates forming the condensing fluid conduit assemblies 10 through the gas flow duct or chamber 3. Sides 8 and 9 need not be formed from two plates with rectangular openings, the sides could be comprised merely of rectangular strips attached between adjacent open ends of the fluid conduit assemblies.

Each condensing fluid conduit assembly 10 is formed in a like manner. As viewed in Figs. 1, 2 and 3, it comprises two end plates 12 of Y-shape having parallel tines 12a, a short V section 12b, and a base leg 12c. Two outside plates 11 connect the outer sides of the two end plates of Y-shape. Each plate 11 has three sections, 11a connects the outer edges of tines 12a, 11b connects the outer edges of the V-section 12b, and 11c connects the outer edges of the base leg 12c. An inner U-shaped plate 13 connects the inner sides of the two end plates of Y-shape. Each plate 13 has four sections,

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two sections 13a connect the inner edges of tines 12a and two sections 13b connect the inner edges of the V-section 12b. The free ends of the base legs 12c and the two upper free ends of the tines 12a are not connected by a plate thereby forming rectangular openings. These condensing fluid conduits 10 are fixed in the gas flow duct or chamber 3 extending from side to side with the rectangular openings being positioned each over a rectangular opening 16 of the sides. The condensing fluid conduits 10 are stacked alternately with the base leg of one facing in one direction, then in the other (see Fig. 1). While five condensing fluid conduit assemblies are shown any number desired may be used. Further, fins 19 are provided on plates 11 and 13. Only a few of these are shown at the upper left corner so that the arrangement of the condensing fluid conduit assemblies 10 may be clearly viewed. These fins aid heat transfer and strengthen plates 11 and 13. Fins may be installed inside the fluid conduit assemblies, each fin having the shape of end plates 12.

The condensing fluid header system 5 has two main inlet headers, 20 and 22, and four main outlet headers, 24, 26, 28 and 30. Main inlet header 20 is located on the side of the heat exchanger numbered 9 and the main inlet header 22 is located on the side of the heat exchanger numbered 8. Each main inlet header is positioned away from its side and approximately halfway between the ends. The main outlet headers are located each at approximately one corner edge of the heat exchanger.

Each inlet header is connected to the gas flow duct or chamber 3 around the rectangular openings 16 of the side on which it is located, which cooperate with the rectangular openings of the free ends of the tines 12a by an inlet header adapter 32. Each inlet header adapter comprises two triangular plates 34 spaced apart and an end strip 36 which connects the two triangular plates together along the two sides located away from the heat exchanger. This construction leaves a long rectangular opening which is a little larger in each dimension than a rectangular opening 16. Inlet header adapters 32 are fixed to the heat exchanger on each side, one for each rectangular opening 16 which cooperates with the rectangular openings of the free ends of the tines 12a. The rectangular opening of each inlet header adapter is positioned over its respective opening 16 (see Fig. 3).

Each inlet header is attached to its adapters 32 at the apex of the triangular shape away from the heat exchanger. Each inlet header, 20, 22, can be formed as a series of conduit sections attached to the plate 34 at each end and between the plates 34 in the center section with holes 40 in the plates connecting the conduit sections together and to each adapter, or it can be formed as a single conduit extending through holes in the adapters with openings in the conduit connecting the interior of the conduit with the interior of the adapter. Baffles 36a are also provided in each inlet header adapter 32 extending between the two triangular plates for distributing a fluid more evenly from the point of entry into the adapter to the rectangular opening.

The outlet headers are connected in pairs to the gas flow duct or chamber 3 around the rectangular opening 16, of the side of the gas flow duct or chamber 3 on which they are located, which cooperate with the rectangular openings of the free ends of the base legs 12c by an outlet header adapter 50. Each outlet header adapter comprises two side plates 52 spaced apart, an end strip 54 which connects the ends of the plates 52 located away from the heat exchanger together and a front and back plate 56 which connects the plates 52 together at their front and back ends of the heat exchanger. This construction leaves

a long rectangular opening which is a little larger in each dimension than rectangular opening 16. Outlet header adapters 50 are fixed to the heat exchanger on each side, one for each rectangular opening 16 which cooperates with the rectangular openings of the free ends of the base legs 12c. The rectangular opening of each outlet header adapter is positioned over its respective opening 16 (see Fig. 2).

One outlet header is attached to one end of the outlet header adapter 50 and another outlet header is attached to the other end of the outlet header adapter. As viewed in Fig. 1, plates 54 and 56 of each adapter abut their respective outlet headers and the associated side plates 52 are contoured to the shape of the pipe to abut therewith. At the point where each outlet header 24, 26, 28 and 30, is connected to an adapter 50, a hole 58 is provided in the header to connect the interior of the outlet header with the interior of the adapter.

In this condenser or heat exchanger arrangement the gas passing therethrough enters at the front of the gas flow duct or chamber 3 as viewed in Fig. 1 and passes over the surfaces of the condensing fluid conduit assemblies 10 and fins 19. This gas flow exits from the other end of the gas flow duct or chamber 3. The flow of gas may be directed into the heat exchanger gas flow ducts or chamber 3 in any manner desired and it may be collected or exhausted at the other end by any desirable means. The fluid passing through the condensing fluid header system 5 enters the open ends of the main inlet headers 20, 22 (as indicated by the arrows in Fig. 1) and passes through the header adapters 32 to the rectangular openings 16 of the sides 8 and 9 of the heat exchanger which cooperate with the rectangular openings of the free ends of the fins 12a of the condensing fluid conduit assemblies. The condensing fluid then passes through the condensing fluid conduit assemblies to the opposite side of the condenser or heat exchanger to the rectangular openings of the free ends of the base legs 12c. From there the condensing fluid is received in an outlet header adapter and conducted to two outlet headers. The fluid then passes out the open ends of the main outlet headers (as shown by the arrows in Fig. 1).

An important feature of this invention resides in the condensing fluid conduits which, as viewed from the ends of the gas flow chamber, define horizontal Y-shaped passageways, or ducts, which produce a single passage at one side and a double passage at the opposite side of the chamber, all of which passages lie in different horizontal planes. It will be noted that the inlet headers 20 and 22 have twin header adapters 32 which connect with the double passages only of the fluid conduits on their respective sides, whereas the outlet headers 24, 26 and 28, 30 at the corners connect with the single passages of the fluid conduits on their respective sides.

As a result of this construction, fluid entering the conduits 10 from either inlet header 20 or 22 first flows through the parallel inlet passages of the conduits 10, wherein it is in contact with maximum condensing surface. As the fluid traversing the conduit 10 condenses and becomes reduced in volume, however, it enters the single outlet passage of conduit 10 wherein the initial high rate of condensation is continued irrespective of the decreased volume of fluid since the reduced cross section of the duct maintains the initial high velocity.

The modification shown in Fig. 4 and Fig. 5 of the condensing fluid conduit assembly may be used when a greater reduction of free flow area through a condenser is desired. Figure 4 shows a reduction of three conduits to one and Fig. 5 shows a reduction of four conduits to one.

Although a specific heat exchanger has been shown and described herein for the purpose of illustration, it will be evident to those skilled in the art that this invention is capable of various modifications and adaptations within the scope of the appended claims.

I claim:

1. In combination, a gas flow chamber, a plurality of fluid conduit assemblies, each fluid conduit assembly comprising two inlet conduits connected to one outlet conduit, said inlet and outlet conduits lying in different horizontal planes, two opposite sides of said gas flow chamber having openings therein lying in different horizontal planes, one fluid conduit assembly having its two inlet conduits cooperating with two openings of one side of said chamber and its one outlet conduit cooperating with one opening of the other side of said gas flow chamber, another fluid conduit assembly having its two inlet conduits cooperating with two openings of said other side of said chamber and its one outlet conduit cooperating with one opening of said one side.

2. In combination, a gas flow chamber, a plurality of fluid conduit assemblies, each having conduits at one end lying in vertically spaced planes merging into a single conduit at the other end thereof, two opposite sides of said gas flow chamber having vertically spaced openings therein, one fluid conduit assembly connecting two spaced openings of one side of said chamber to one opening of the other side of said chamber; another fluid conduit assembly connecting two spaced openings of said other side to one opening of said one side, a main inlet header extending along one side of said gas flow chamber, two inlet header adapters, one inlet header adapter connecting said main inlet header to one of said two openings of said one side, the other inlet header adapter connecting said main inlet header to the other of said two openings of said one side, a second main inlet header extending along the other side of said gas flow chamber, two inlet header adapters, one inlet header adapter connecting said second main inlet header to one of said two openings of said other side, the other inlet header adapter connecting said second main inlet header to the other of said two openings of said other side.

3. In combination, a gas flow chamber, a plurality of fluid conduit assemblies, each having two vertically spaced conduits at one end connected to a single conduit at the other end, two opposite sides of said gas flow chamber having openings therein, one fluid conduit assembly connecting two adjacent openings of one side to one opening of the other side, another fluid conduit assembly connecting two adjacent openings of said other side to one opening of said one side, a first main inlet header extending along one side of said gas flow chamber, two inlet header adapters, one inlet header adapter connecting said first main inlet header to one of the two openings of said one side, the other inlet header adapter connecting said first main inlet header to the other of the two openings of said one side, a second main inlet header extending along the other side of said gas flow chamber, two inlet header adapters, one inlet header adapter connecting said second main inlet header to one of the two openings of said other side, the other inlet header adapter connecting said second main inlet header to the other of the two openings of said other side, four main outlet headers, one extending along each side of said first and second main inlet headers, two outlet header adapters, one outlet header adapter connecting the two main outlet headers extending along each side of said first main inlet header to the one opening of said one side, the other outlet header adapter connecting the two main outlet headers extending along each side of said second inlet header to the one opening of said other side.

4. In combination, a gas flow chamber, a plurality of fluid conduit assemblies, each fluid conduit assembly comprising two vertically spaced inlet conduits connected to one outlet conduit, two opposite sides of said gas flow chamber having vertically spaced openings therein, one fluid conduit assembly having its two inlet conduits cooperating with two adjacent openings of one side and its one outlet conduit cooperating with the one opening of the other side within said gas flow chamber, another

fluid conduit assembly having its two inlet conduits cooperating with two adjacent openings of said other side and its one outlet conduit cooperating with one opening of said one side of said gas flow chamber, a main inlet header extending along one side of said gas flow chamber, two inlet header adapters, one inlet header adapter connecting said main inlet header to one of said two openings of said one side, the other inlet header adapter connecting said main inlet header to the other of said two openings of said one side, a second main inlet header extending along the other side of said gas flow chamber, two inlet header adapters, one inlet header adapter connecting said second main inlet header to one of said two openings of said other side, the other inlet header adapter connecting said second main inlet header to the other of said two openings of said other side, four main outlet headers, one extending along each side of said first and second main inlet headers, two outlet header adapters, one outlet header adapter connecting the two main outlet headers extending along each side of said first main inlet header to said one opening of said one side, the other outlet header adapter connecting the two main outlet headers extending along each side of said second inlet header to said one opening of said other side.

5. In combination, a gas flow chamber, said gas flow chamber having two opposing sides, each side of said gas flow chamber having a series of rectangular openings extending from the top to the bottom, a plurality of fluid conduit assemblies, each having two vertically spaced ducts at one end merging into a single duct at the other end thereof, one fluid conduit assembly connecting two vertically spaced rectangular openings of one side to one rectangular opening of the other side, another fluid conduit assembly connecting two vertically spaced rectangular openings of said other side to one rectangular opening of said one side.

6. In combination, a gas flow chamber, said gas flow chamber having two opposing sides, each side of said gas flow chamber having a series of rectangular openings extending from the top to the bottom, a plurality of fluid conduit assemblies, each fluid conduit assembly including two vertically spaced inlet conduits connected to one outlet conduit, one fluid conduit assembly having its two inlet conduits cooperating with two adjacent rectangular openings of one side and its one outlet conduit cooperating with one rectangular opening of the other side, another fluid conduit assembly having its two vertically spaced inlet conduits cooperating with two adjacent rectangular openings of said other side and its one outlet conduit cooperating with one opening of said one side.

7. In combination, a gas flow chamber, said gas flow chamber having two opposing sides, each side of said gas flow chamber having a series of rectangular openings extending from the top to the bottom, a plurality of fluid conduit assemblies, each fluid conduit assembly including two vertically spaced rectangular inlet conduits connected to one rectangular outlet conduit, one fluid conduit assembly having its two inlet conduits cooperating with two adjacent rectangular openings of one side and its one outlet conduit cooperating with one rectangular opening of the other side, another fluid conduit assembly having its two inlet conduits cooperating with two adjacent rectangular openings of said other side and its one outlet conduit cooperating with one opening of said one side, a first main inlet header extending along one side of said gas flow chamber, two inlet header adapters, one inlet header adapter connecting said main inlet header to one of the two openings of said one side, the other inlet header adapter connecting said main inlet header to the other of the two openings of said one side, a second main inlet header extending along the other side of said gas flow chamber, two inlet header adapters, one inlet header adapter connecting said sec-

ond main inlet header to one of the two openings of said other side, the other inlet header adapter connecting said second main inlet header to the other of the two openings of said other side.

8. In combination, a rectangular gas flow chamber, two opposing sides of said gas flow chamber having a series of rectangular openings extending from the top to the bottom of each side, a plurality of fluid conduit assemblies, each fluid conduit assembly comprising two vertically spaced inlet conduits of rectangular cross section connected to one outlet conduit of rectangular cross section, said two inlet conduits extending in a parallel relationship for their length, the two inlet conduits being connected to the one outlet conduit by a V-shaped conduit member, one fluid conduit assembly having its two inlet conduits connected one each around one of the adjacent rectangular openings of one side and its one outlet conduit connected around one rectangular opening of the other side, another fluid conduit assembly having its two inlet conduits connected one each around one of the adjacent rectangular openings of said other side and its one outlet conduit connected around one rectangular opening of said one side.

9. In combination, a gas flow chamber, a plurality of fluid conduit assemblies, each fluid conduit assembly comprising two vertically spaced inlet conduits connected to one outlet conduit, two opposite sides of said gas flow chamber having vertically spaced openings therein, one fluid conduit assembly having its two inlet conduits cooperating with two adjacent openings of one side and its one outlet conduit cooperating with one opening of the other side of said gas flow chamber, another fluid conduit assembly having its two inlet conduits cooperating with two adjacent openings of said other side and its one outlet conduit cooperating with one opening of said one side, a main inlet header extending along one side of said gas flow chamber, two inlet header adapters, one inlet header adapter connecting said main inlet header to one of said two openings of said one side, the other inlet header adapter connecting said main inlet header to the other of said two openings of said one side, a second main inlet header extending along the other side of said gas flow chamber, two inlet header adapters, one inlet header adapter connecting said second main inlet header to one of said two openings of said other side, the other inlet header adapter connecting said second main inlet header to the other of said two openings of said other side, each inlet header adapter having baffles therein for more evenly distributing a fluid as it passes from an inlet header to an opening in a side.

10. In combination, a gas flow chamber, said gas flow chamber having two opposing sides, each side of said gas flow chamber having a series of rectangular openings extending from the top to the bottom, a plurality of fluid conduit assemblies, each fluid conduit assembly including two vertically spaced inlet conduits connected to one outlet conduit, each fluid conduit assembly having its two inlet conduits connected to two adjacent rectangular openings of a side and its one outlet conduit connected to one rectangular opening of the other side, said fluid conduit assemblies being alternately positioned from the top to bottom of said gas flow chamber, one having its two inlet conduits connected to one side and the next having its two inlet conduits connected to the other side.

11. In combination, a gas flow chamber, said gas flow chamber having two opposing sides, each side of said gas flow chamber having a series of rectangular openings extending from the top to the bottom, a plurality of fluid conduit assemblies, each fluid conduit assembly including two vertically spaced inlet conduits connected to one outlet conduit, one fluid conduit assembly having its two inlet conduits cooperating with two adjacent rectangular openings of one side and its one outlet conduit cooperating with one rectangular opening of the other side, another fluid conduit assembly having its two inlet conduits co-

operating with the two adjacent rectangular openings of said other side and its one outlet conduit cooperating with the one opening of said one side, a first main inlet header extending along one side of said gas flow chamber, two inlet header adapters, one inlet header adapter connecting said main inlet header to one of the two openings of said one side, the other inlet header adapter connecting said main inlet header to the other of the two openings of said one side, a second main inlet header extending along the other side of said gas flow chamber, two inlet header adapters, one inlet header adapter connecting said second main inlet header to one of the two openings of said other side, the other inlet header adapter connecting said second main inlet header to the other of the two openings of said other side, each inlet header adapter having baffles therein for more evenly distributing a fluid as it passes from an inlet header to an opening in a side.

12. In combination, a rectangular gas flow chamber, two opposing sides of said gas flow chamber having a series of rectangular openings extending from the top to the bottom of each side, a plurality of fluid conduit assemblies, each fluid conduit assembly comprising two vertically spaced inlet conduits of rectangular cross section connected to one outlet conduit of rectangular cross section, said two inlet conduits extending in a parallel relationship for their length, the two inlet conduits being connected to the one outlet conduit by a V-shaped conduit member, a first fluid conduit assembly having its two inlet conduits connected one each around one of the rectangular openings of one side and its one outlet conduit connected around one rectangular opening of the other side, a second fluid conduit assembly having its two inlet conduits connected one each around one of the rectangular openings of said other side and its one outlet conduit connected around one rectangular opening of said one side, a main inlet header extending along one side of said gas flow chamber, two inlet header adapters, one inlet header adapter connecting said main inlet header to one of said rectangular openings connected to one of the two inlet conduits of the first fluid conduit assembly,

another inlet header adapter connecting said main inlet header to the other of said rectangular openings connected to the other of the two inlet conduits of the first fluid conduit assembly, a second main inlet header extending along the other side of said gas flow chamber, two inlet header adapters, one inlet header adapter connecting said second main inlet header to one of said rectangular openings connected to one of the two inlet conduits of the second fluid conduit assembly, another inlet header adapter connecting said second main inlet header to the other of said rectangular openings connected to the other of the two inlet conduits of the second fluid conduit assembly.

13. In combination, a gas flow chamber, a plurality of fluid conduit assemblies, each having two vertically spaced conduits at one end merging into a single conduit at the other end thereof, two opposite sides of said gas flow chamber each having at least three vertically spaced openings therein, one fluid conduit assembly having its vertically spaced conduits connected to the upper two openings in one side of said chamber, and having its single conduit connected to the upper opening in the other side of said chamber, and another of said conduit assemblies having its vertically spaced conduits connected to the lower two of said three openings at said other side of said chamber and having its single conduit connected to the lower of said three openings at said one side of said chamber.

14. In combination, a gas flow chamber closed at the top and bottom and on two opposite sides, a plurality of vertically spaced openings in said closed sides, and a plurality of fluid conduit assemblies each having two vertically spaced inlet conduits which register with adjacent openings in one side of said chamber and merge into a single outlet conduit which registers with an opening in the opposite side of said chamber.

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