

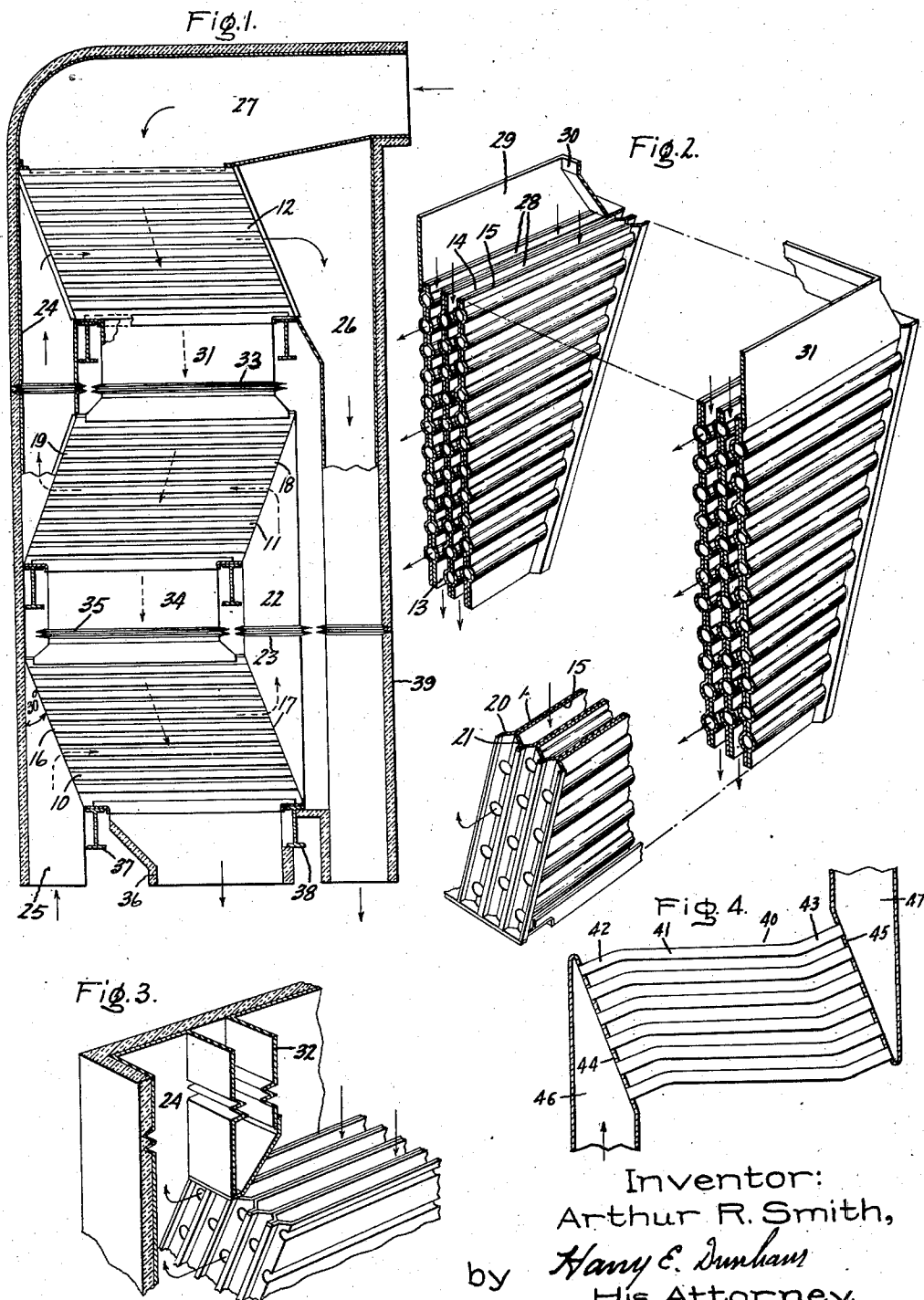
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SURFACE TYPE HEAT EXCHANGER

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SURFACE TYPE HEAT EXCHANGER

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The present invention relates to surface type heat exchangers such as are used, for example, to preheat air by means of gases discharged from a combustion chamber.

The object of my invention is to provide an improved construction and arrangement of surface type heat exchangers which is simple and compact in construction and may be produced at comparatively low cost.

For a consideration of what I believe to be novel and my invention, attention is directed to the following description and the claims appended thereto in connection with the accompanying drawing.

In the drawing Fig. 1 illustrates a sectional view of a surface type heat exchanger embodying my invention; Fig. 2 is a perspective view, partly broken away, of a part of Fig. 1; Fig. 3 is another perspective view of a detail of Fig. 1; and Fig. 4 illustrates a modification of a part of Fig. 1.

The heat exchanger comprises a plurality of banks of spaced parallel tubes. In the present example I have shown three vertically spaced banks of tubes 10, 11 and 12. Each bank has a plurality of tubes or channel members 13. In a preferred embodiment, as shown in Figs. 2 and 3, these channel members are formed by spaced pairs of oppositely corrugated sheets of metal 14, 15. Opposite corrugations form the channels or tubes 13, and the portions intermediate such corrugations are suitably sealed together such as by seam-welding. The tubes of the bank 10 have inlets 16 and outlets 17, and the tubes of the bank 11 have inlets 18 and outlets 19. The inlets and outlets of each bank are substantially located in parallel planes inclined to the tubes. In other words, in contrast to the usual arrangement in which said planes are substantially vertical to the tubes, in the arrangement according to my invention said planes are at an angle other than 90° to the tubes. In the present example the angle of inclination of the inlet and outlet planes is of the order of 30°. Portions 20 and 21 of the corrugated sheets 14, 15 near the outlets and the inlets of the tubes 13 are bent and suitably sealed to corresponding portions 21 and 20 respectively of adjacent sheets 14, 15 to form end walls for each bank of tubes. Thus, from another viewpoint, each bank of tubes comprises a plurality of parallel tubes or channel members sealed to openings of parallel end walls, which latter are inclined to the tubes.

The several banks of tubes 10, 11, 12 are connected in series. This is accomplished by the pro-

vision of conduits or header means partly formed by said end walls and connecting the outlets of one bank to the inlets of a succeeding bank. In the present example the outlets 17 of the first bank 10 are connected to the inlets 18 of the second bank 11 by a header or conduit 22 which has an intermediate portion substantially rectangular in section and provided with a bellows 23 to facilitate expansion and contraction, the end portions of the conduit being partly formed by the oppositely inclined end walls of the banks 10, 11. Said end portions have a cross section gradually decreasing towards the ends of the header 22. With this arrangement the projection of the end wall of one bank vertical to its tubes coincides with the projection of the end walls of the adjacent banks, that is, the preceding and succeeding banks, and the projection of the header 22 vertical to the tubes coincide substantially with the confines of the end walls of the respective banks, thus permitting a maximum length of tubes and requiring a minimum space for the location of the connecting headers.

The outlets 19 of the bank of tubes 11 are connected to the inlets of the bank of tubes 12 by a header or conduit means 24 arranged and constructed similar to the header 22 previously described. The inlets 16 of the bank 10 are connected to an inlet conduit 25, depending vertically from the end wall formed around the inlets 16 of the bank of tubes 10. The outlets of the bank of tubes 12 are connected to an outlet header 26, in the present example extending downward and located partly adjacent the header 22.

During operation the medium to be heated, such as air to be used to maintain combustion in a furnace, is conducted through the inlet conduit 25 into the first bank of tubes 10, whence it is conducted through the header 22, into the second bank of tubes 11, to be discharged therefrom through the header 24 into the third bank of tubes 12 and the outlet conduit 26, which latter may be connected to a consumer such as a furnace.

On its passage through the banks of tubes the air is heated by a suitable heating medium, such as gases discharged from the combustion or convection chamber of a furnace, and conducted to the heat exchanger by means including a conduit member 27. This conduit member 27 is connected to the upper end of the third banks of tubes 12. The arrangement embodies the counter-flow principle.

Adjacent pairs of metal sheets 14, 15 form sub-

stantially vertical passages 28 for receiving the heating medium. The upper ends of the passages 28 of the bank 12 are connected to the conduit member 27. The lower ends of the passages 28 of the bank 12 are connected to the upper end of the corresponding passages of the bank 11 by a channel member substantially rectangular in section and having four walls 29, 30, 31 and 32 (Figs. 2 and 3). These walls have expansible portions 33 to avoid excessive stresses during operation due to expansion and contraction. Each wall is sealed, preferably by fusion, to the edges of the outer walls of the banks 11 and 12. The spaces formed between the tubes of the banks 10, 11 are connected in series by a conduit 34 with a bellows portion 35 similar to the conduit connecting the banks 11, 12. The passages formed between the tubes of the bank 10 have lower discharge ends connected to a discharge conduit 36. Each bank of tubes 10, 11, 12 is supported by a pair of fixed I-beams 37, 38, thus fixing the lower end of each bank of tubes but leaving the upper end free to expand vertically.

The heat exchanger as a whole is enclosed in a casing 39 of heat-insulating material, which casing is partly formed by the conduits 25, 24 and 27.

In the arrangement of Figs. 1 to 3 the end portions of the tubes of each bank are at an acute angle to the respective end walls of the headers. In certain instances it may be desirable to bend the end portions of each tube in opposite directions to arrange them at right angle with respect to the corresponding end walls or bottoms of the headers in order to reduce the resistance to flow of fluid through the heat exchanger. Such an arrangement is shown in Fig. 4. It comprises a bank of parallel tubes 40. Each tube has a major, horizontally disposed portion 41 and bent end portions 42 and 43 connected to openings of parallel walls 44 and 45 respectively. The walls 44, 45 are perpendicular to the oppositely bent end portions 42, 43 but at an acute angle to the major tube portions 41. Headers 46 and 47 partly formed by the walls 44, 45 respectively are connected to the ends of the tubes.

Having described the method of operation of my invention, together with the apparatus which I now consider to represent the best embodiment thereof, I desire to have it understood that the

apparatus shown is only illustrative, and that the invention may be carried out by other means.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. Surface type heat exchanger comprising two vertically spaced banks of spaced parallel horizontal tubes, parallel walls having openings sealed to the ends of the tubes of each bank, said parallel walls being inclined to the tubes and the inclination of said walls with regard to one bank being opposite to that of the other bank and the projection of corresponding walls vertical to the tubes coinciding, conduit means connecting the banks in series and including a conduit connecting the outlets of one bank to the inlets of the succeeding bank and having a vertical projection coinciding with that of the respective walls, and vertical conduits between successive banks for connecting the passages defined between the respective tubes which conduits have a width extending substantially the entire length of the tubes.

2. Surface type heat exchanger comprising vertically spaced banks of spaced horizontal heating tubes, each bank having parallel end walls with openings connected to the ends of the respective tubes and inclined to the tubes, the inclination of the end walls of one bank being opposite to the inclination of the end walls of adjacent banks and the vertical projections of the respective end walls coinciding with each other, channels partly formed by the end walls for connecting the banks in series, and vertical conduits between successive banks for connecting the passages defined between the respective tubes which conduits have a width extending substantially the entire length of the tubes.

3. Surface type heat exchanger comprising vertically spaced banks of spaced horizontal heating tubes, each bank having parallel end walls connected to the ends of the respective tubes and inclined to the tubes, the inclination of the end walls of one bank being opposite to the inclination of the end walls of adjacent banks, and channels partly formed by the end walls for connecting the banks in series, the projection of the channels vertical to the tubes being located within the confines of the projections of the respective end walls.

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