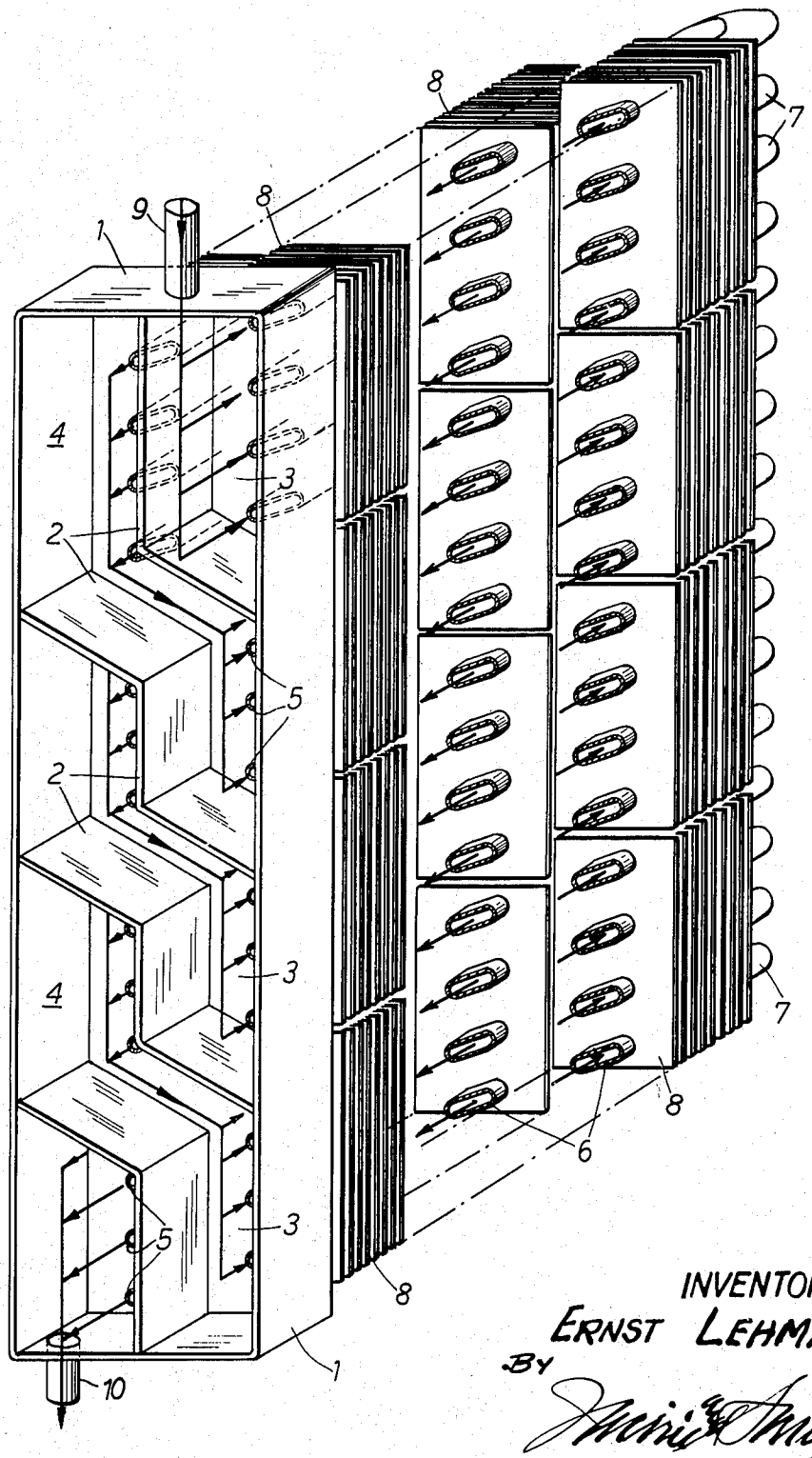
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AIR HEATER

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AIR HEATER

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The present invention relates to an air heater, and more particularly to an air heater of the kind comprising a plurality of pipe members each having a pair of legs connected by a U-shaped bend and provided with fins, said pipe members being connected to a hollow casing having inlet and outlet connections for a heating fluid and arranged to distribute such fluid from the inlet connection to said pipe members and to collect the fluid from the latter for delivery through said outlet connection. Preferably, though not exclusively, the invention applies to air heaters of the said kind in which a plurality of such pipe members are connected in parallel to form a group, and a plurality of such groups are connected in series between the inlet and the outlet.

One object of the present invention is to provide an air heater in which the heating fluid circulates in the same direction through like legs of the said pipe members.

Another object of the invention is to provide an arrangement in which the said pipe member legs through which the fluid circulates in one direction are in the same plane and the said pipe member legs through which the fluid circulates in the opposite direction are in another plane parallel to the first one, so that at all points the air is heated on the equiflow principle when traversing the heater in one direction, and on the counter-flow principle when traversing it in the opposite direction substantially perpendicular to the said planes. By "equiflow principle," it will be understood that heat is yielded from the heating fluid to the air traversing the heater first in a portion of the fluid circuit where the fluid has a higher temperature and thereafter in a portion of the fluid circuit where the fluid has a lower temperature, and by "counterflow principle" it will be understood that heat is thus yielded to the air first in a portion of the fluid circuit where the fluid has a lower temperature and thereafter in a portion of the said circuit where the fluid has a higher temperature.

A further object of the invention is to provide a heater in which the legs of each pipe member are so positioned as to permit unshielded access of the current of air to be heated to each leg of such pipe member.

Still another object of the invention is to provide a heater in which the legs of the pipe members are so shaped in cross-section and so arranged that they cause all parts of the air current to come into contact with the pipe members and their fins and that the contact surfaces of the pipe members with the air are large in comparison with the cross-section of these members.

Further objects and advantages will become apparent from the description now to follow, of a preferred embodiment of the invention, shown by way of example in the accompanying drawing.

This drawing schematically represents the said preferred embodiment in perspective view, with certain parts cut away for the sake of clarity.

In the drawing, 1 indicates a vertically elongated casing of rectangular cross-section, the front wall of which is cut away to show the interior which is subdivided into

compartments 4 by a series of partitions 2. The rear wall 3 of the casing is provided with two parallel, spaced, vertical rows of inlet and outlet openings 5, each of which openings is of flatly ovate form and has its major axis inclined from the horizontal, each opening of one row having its major axis in alinement with a corresponding and similar opening of the other row. The air heater further comprises a series of pipe members of similar flatly ovate cross-section as the openings 5 and having two parallel horizontal legs 6 connected at their rear ends by a U-shaped bend 7. The two legs 6 of each pipe member have their front ends inserted into a pair of corresponding openings 5 and are welded to the rear wall 3 of the casing at their said ends.

The casing 1 is provided at its upper end with an inlet connection 9 and at its lower end with an outlet connection 10 for the heating fluid; although these connections are shown to be arranged in the top and in the bottom wall, respectively, of the casing 1, it will be understood that they could be arranged in the uppermost and in the lowermost portion, respectively, of the front wall of the casing which is not shown in the drawing, or in a lateral wall of the casing.

Each of the partitions 2 extends across the interior of the casing 1 from the front wall (not shown) to the rear wall 3 and from one lateral wall to the other, the uppermost partition extending, however, from the top wall to one lateral wall and the lowermost partition extending from the opposite lateral wall to the bottom wall. Each partition 2 comprises a vertical portion which joins the rear wall 3 between four inlet openings 5 registering with one set of legs 6 and the corresponding four outlet openings 5 registering with the other set of legs 6 communicating with the first set through bends 7. Considered together, these vertical portions of the various partitions do not form an uninterrupted wall but they separate all the inlet openings 5 in one row from their corresponding outlet openings in the other row. Also, the vertical portion of the uppermost partition 2 separates the inlet connection 9 from the row of outlet openings 5 and the vertical portion of the lowermost partition 2 separates the outlet connection 10 from the row of inlet openings 5. With its remaining portions, each partition joins the rear wall 3 between two adjacent inlet openings 5, on one hand, and between two adjacent outlet openings 5, on the other hand, except that the uppermost partition which joins the top wall of the casing has no portion joining the rear wall across the row of outlet openings 5, and that the lowermost partition similarly joining the bottom wall of the casing has no portion joining the rear wall across the row of inlet openings. It will thus be seen that the partitions 2 divide the interior of the casing 1 into a series of compartments 4 the uppermost of which communicates with the inlet connection 9 and with the four uppermost inlet openings 5 of the vertical row of inlet openings; the second compartment connects the four uppermost outlet openings 5 of the vertical row of outlet openings to the second group of four inlet openings 5 of the vertical row of inlet openings, and each subsequent compartment connects a group of four outlet openings 5 in the vertical row of outlet openings to a further, non-corresponding group of four inlet openings 5 in the adjacent vertical row of inlet openings; finally, the lowermost compartment 4 connects the lowermost group of outlet openings to the outlet connection 10.

The legs 6 of the pipe members connected to the openings 5 are connected to each other by a number of vertical heat transfer fins 8 forced on the said legs in known manner. Preferably, each of these fins may have four tubular flanges not shown in the drawing, each tightly embracing one of the pipe member legs 6 so as to provide good transmission of heat between the said leg and

the said fin, such flanges also serving to space the several fins from each other at the pipe member leg.

The described disposition of the openings 5 in the rear wall 3 of the casing results in that the inlet leg 6 of each pipe member is vertically offset upwardly in relation to the outlet leg 6 of the member, so that the current of air, if circulating from right to left in a direction perpendicular to the common plane of the legs of all the pipe members, is not prevented by the inlet legs from directly striking the outlet legs. Inversely, if a current of air circulates from left to right perpendicularly to the said common plane, the air will not be prevented by the outlet (inlet in this example) legs of the pipe members from striking their inlet (outlet in this example) legs directly. Moreover, due to the flatly ovate cross-section of the legs of the pipe members and due to the fact that the major axis of this cross-section is inclined from the direction of flow of the air current, the heat transfer from the pipe members to the air is greatly improved.

At their bends 7, the pipe members are not retained so that they are free to expand and contract without being subject to stresses which might cause their rupture. However, these bends 7 could be protected by a cover (not shown).

The operation of the heater will be readily understood from the preceding description. As shown by the arrows in the drawing, the heating fluid such as hot water or superheated steam is adducted through the inlet connection 9 into the uppermost compartment 4, from which it proceeds through the inlet legs 6 of the four uppermost pipe members and returns through the outlet legs 6 thereof to the second compartment 4. Through the latter, the fluid reaches the second group of inlet openings 5 in the vertical row of inlet openings, where it is admitted to the second group of inlet pipe members. From their opposite ends, it is delivered to the third compartment 4, and so on. Finally, the fluid enters the lowermost compartment 4 through the lowermost outlet opening 5 in the vertical row of outlet openings and from this compartment is discharged through the outlet connection 10. Thus it is evident that in all the pipe members, the fluid circulates in the same direction, namely, from the vertical row of inlet openings 5 to the bends 7 in all the inlet legs 6 of these members, and back from these bends to the vertical row of outlet openings 5 through all the outlet legs 6.

If the air to be heated is circulated from left to right through the heater, heat exchange between the heating fluid and the air takes place on the counter-flow principle. In fact, the heating fluid circulates first through the inlet legs 6 and thereafter through the outlet legs 6 of the pipe members and moreover from top to bottom through the various groups of pipe members. The air first strikes the utlet row of pipe member legs 6 and their fins 8 and thereafter the inlet row of legs 6 and their fins 8 and also flows upwards due to its deflection by the inclined cross-section of the pipe member legs and due to its becoming specifically lighter when heated. Therefore, each particle of air is heated first by the fluid in those portions of the fluid circuit in which the fluid has already yielded some of its heat, and only thereafter reaches pipe member legs in which the heating fluid is comparatively fresh and has yielded but little of its heat. Heat transfer between the fluid and the air is further improved by the staggered arrangement of the pipe member legs and by the inclination of the broad faces of such legs.

It will be understood that, although each group of openings 5 in the vertical inlet and outlet rows and each group of pipe members connected in parallel comprises four openings or pipe members in the embodiment shown, any such group could comprise one, two, three or more than four openings and pipe members, respectively.

I claim:

1. In an air heater, a closed casing having a longitudinal wall provided with two spaced rows of longitudinally alined openings, a fluid inlet connection at one end of said casing, a fluid outlet connection at the opposite end of said casing, a series of partitions in said casing dividing its interior into a series of compartments one of which communicates with said inlet connection and with a number of said openings in one row, another of which communicates with said outlet connection and with a number of said openings in the other row, and the remaining ones of which communicate each with a number of said openings in one row and with a number of said openings in the other row, a series of pipe members each having a pair of legs connected by a U-shaped bend, said pipe members conforming in cross-section to said openings and each member having one of its legs connected to said wall at one of said openings in one row communicating with one of said compartments and having the other of its legs connected to said wall at one of said openings in the other row communicating with another of said compartments, and a series of vertical fins extending in parallel between like legs of the pipe members and connecting said like legs in groups each constituted by a plurality of such legs.

2. In an air heater, an elongated closed casing having a longitudinal wall provided with two spaced rows of longitudinally alined openings, each opening in one row corresponding to one opening in the other row, a fluid inlet connection at one end of said casing, a fluid outlet connection at the opposite end of said casing, a series of partitions extending across the interior of said casing, each partition joining said wall between a number of openings in one row and their corersponding openings in the other row and each opening in one row being thus separated from its corresponding opening in the other row by one of the said partitions, one of the said partitions also joining said wall between two adjacent openings in said one row and between said inlet connection and said other row of openings, another of the said partitions also joining said wall between two adjacent openings in said other row and between said one row of openings and said outlet connection, and the remaining partitions also joining said wall between two adjacent openings in each of the said rows, a series of pipe members each having a pair of legs connected by a U-shaped bend, said pipe members conforming in cross-section to said openings and each member having its legs connected to said wall at corresponding openings in the said two rows, and a series of fins extending in parallel between a plurality of said pipe member legs connected to said wall at openings in the same row.

3. In an air heater, a vertically elongated closed casing having a substantially vertical plane wall provided with two spaced rows of vertically alined openings, each opening in one row corresponding to one opening in the other row and being vertically offset against the other, a fluid inlet connection at the upper end of said casing, a fluid outlet connection at the lower end of said casing, a series of partitions extending across the interior of said casing, each partition joining said wall between a number of openings in one row and their corresponding openings in the other row and each opening in one row being thus separated from its corresponding opening in the other row by one of the said partitions, one of the said partitions also joining said wall between two adjacent openings in said one row and between said inlet connection and said other row of openings, another of the said partitions also joining said wall between two adjacent openings in said other row and between said one row of openings and said outlet connection, and the remaining partitions also joining said wall between two adjacent openings in each of the said rows, a series of pipe members each having a pair of substantially horizontal legs connected by a U-shaped bend, said pipe members conforming in cross-section to said openings and each member having its legs connected to said wall at correspond-

ing openings in the said two rows, and series of substantially vertical fins each extending between a plurality of said pipe member legs connected to said wall at openings in the same row.

4. In an air heater, a vertically elongated closed casing having a substantially vertical plane wall provided with two spaced rows of vertically alined openings each being of flatly ovate form and having its major axis inclined from the horizontal, each opening in one row having its major axis in alinement with a corresponding opening in the other row, a fluid inlet connection at the upper end of said casing, a fluid outlet connection at the lower end of said casing, a series of partitions extending across the interior of said casing, each partition joining said wall between a number of openings in one row and their corresponding openings in the other row and each opening in one row being thus separated from its corresponding opening in the other row by one of the said partitions, one of the said partitions also joining said

wall between two adjacent openings in said one row and between said inlet connection and said other row of openings, another of the said partitions also joining said wall between two adjacent openings in said other row and between said one row of openings and said outlet connection, and the remaining partitions also joining said wall between two adjacent openings in each of the said rows, a series of pipe members each having a pair of substantially horizontal legs connected by a U-shaped bend, said pipe members conforming in cross-section to said wall at corresponding openings in the said two rows, and series of substantially vertical fins extending in parallel between a plurality of said pipe member legs connected to said wall at openings in the same row.

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