

Aug. 26., 1924.

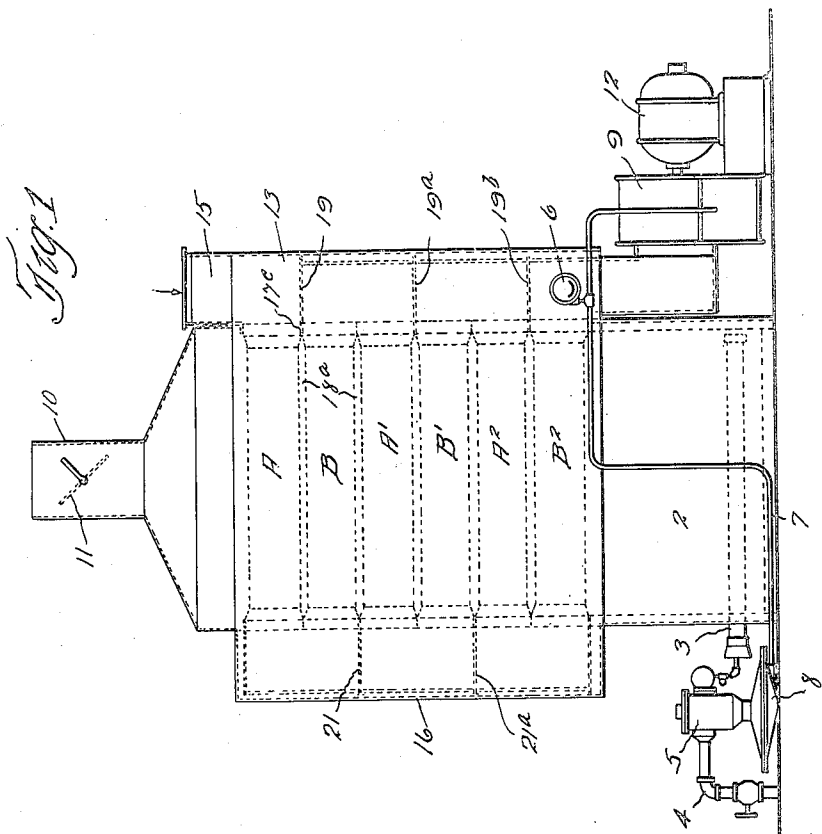
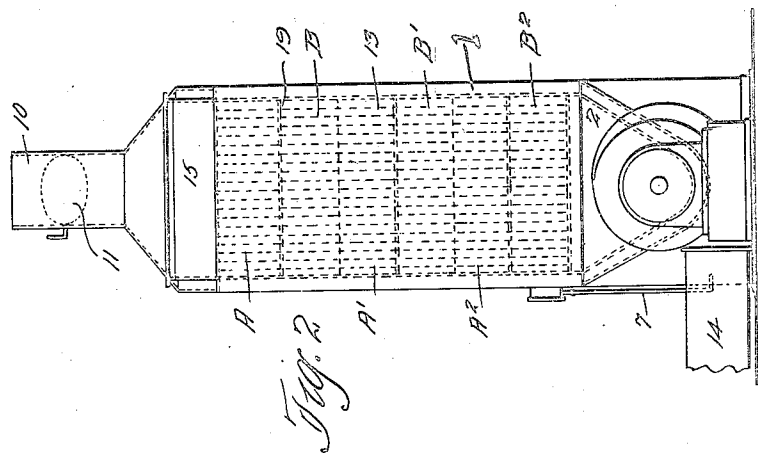
1,506,121

J. M. HARRISON

APPARATUS FOR THE EXCHANGE OF HEAT

Filed Oct. 14. 1921

2 Sheets-Sheet 1



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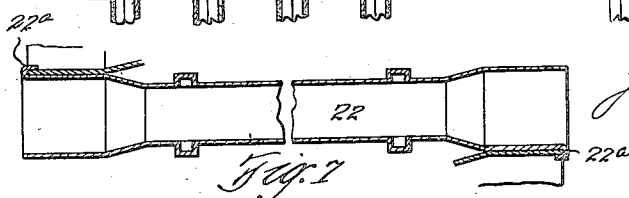
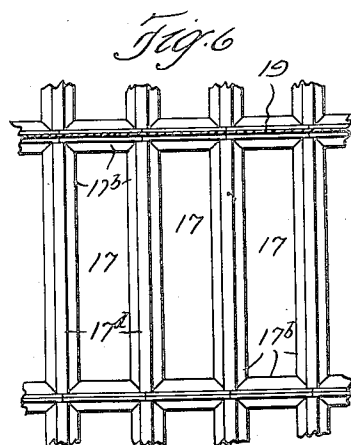
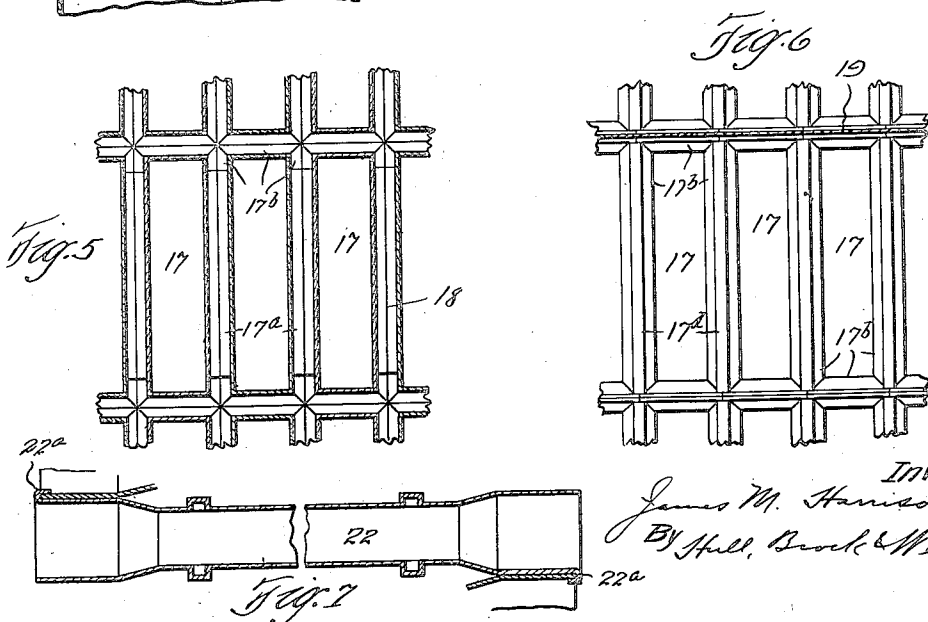
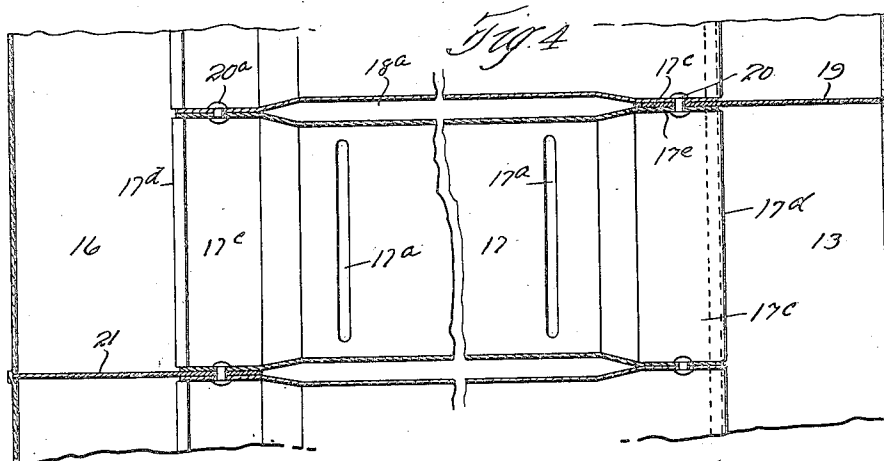
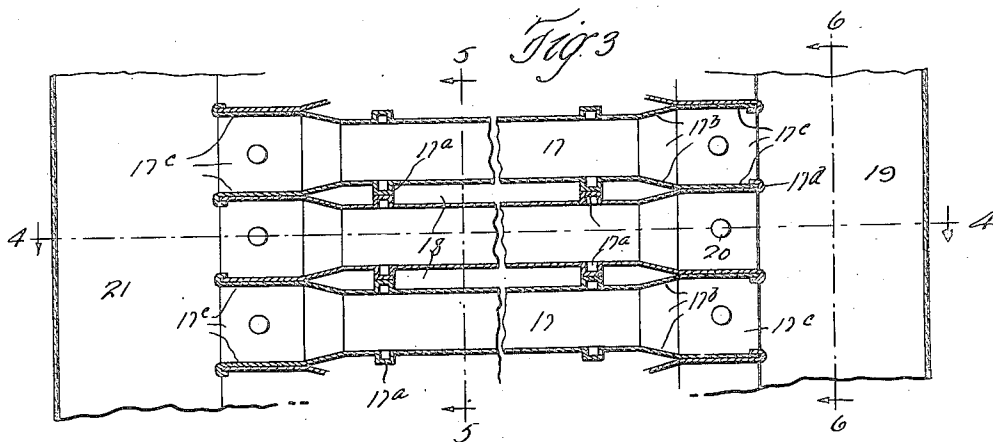
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J. M. HARRISON

APPARATUS FOR THE EXCHANGE OF HEAT

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2 Sheets-Sheet 2



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UNITED STATES PATENT OFFICE.

JAMES M. HARRISON, OF CLEVELAND, OHIO.

APPARATUS FOR THE EXCHANGE OF HEAT.

Application filed October 14, 1921. Serial No. 507,604.

To all whom it may concern:

Be it known that I, JAMES M. HARRISON, a citizen of the United States, residing at Cleveland, in the county of Cuyahoga and State of Ohio, have invented a certain new and useful Improvement in Apparatus for the Exchange of Heat, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings.

This invention relates to heat-exchange apparatus and elements therefor, and has for its general object to improve the efficiency of such apparatus and elements as well as to economize in the cost of construction thereof. Further and more limited objects of the invention will appear hereinafter in the specification and will be realized in and through the combinations of elements embodied in the claims hereto annexed.

In the drawings which embody the present preferred form of the invention, Fig. 1 represents a side elevation and Fig. 2 an end elevation of an air-heating furnace to which the invention is applied; Fig. 3 a detail in horizontal section through some of the heating elements and showing the manner of connecting the same with the air-circulating hoods or flues; Figs. 4, 5 and 6 are sectional views corresponding, respectively, to the lines 4-4, 5-5 and 6-6 of Fig. 3; and Fig. 7 a detail in section showing a modified manner of connecting the ends of adjacent heat exchanging elements.

Describing the various parts by reference characters, 1 denotes the rectangular casing of a hot air furnace to which the invention is shown as applied, the furnace comprising a combustion chamber 2 in the lower part thereof which may be heated in any approved manner, as by means of a gas burner 3 having a supply pipe 4, with a fuel-control valve 5 adapted to be operated by any approved type of thermostat 6 in a pipe 7 connected at one end to a diaphragm-chamber 8 and at its opposite end with the delivery pipe of an air blower 9. The casing 1 is provided with an outlet flue 10 having a damper 11. The blower 9 is shown as operated by a motor 12 and as connected with the bottom of a pass hood 13 projecting from one end of the casing 1 and delivering the air drawn from said pass hood into and through a discharge pipe 14.

The pass hood 13 is shown as substantially coextensive in height with the end of the furnace casing above the combustion chamber 2 and as having an inlet for cold air (indicated at 15) at the top thereof. Secured to the opposite end of the furnace casing is a pass hood 16 which is shown as closed at both the top and the bottom. Extending transversely of the casing from one of the pass hoods to the other are horizontal series of tiers of tubes or heat-exchange elements by means of which the cold air drawn through the inlet 15 is subjected in a most efficient manner to the hot gases produced by the operation of the burner 3. The construction of each element or heater tube will now be described, and the mode of connecting and supporting the same will be described hereinafter.

Each heater tube element comprises a sheet metal body which is oblong, and preferably rectangular, in section, the material of which the tubes or elements are formed being preferably sheet metal. One of these tubes is indicated generally at 17. Each of the tubes is preferably of uniform cross sectional area throughout its length (with the exception of the ends) and, in installations where the tubes or elements are of considerable length, they will each be provided with integral spacers 17^a, preferably pressed therefrom, the spacers on adjacent tubes or elements being adapted to engage each other thereby to prevent warping of the tubes or elements and to preserve substantially constant the width of the circulating spaces therebetween. Each tube or element is preferably arranged in the casing with its major axis vertical and its minor axis horizontal and, adjacent each end, is flared outwardly at the top, bottom and both sides thereof, as indicated at 17^b. From the outer ends of the expanded walls 17^b, the extreme end walls of the said elements are continued parallel with the corresponding main walls, as indicated at 17^c. The vertical side walls 17^c at one end of each tube or element project beyond the corresponding ends of the two adjacent tubes or elements, while the vertical side walls 17 at the opposite end of each of such adjacent tubes or elements project beyond the corresponding end of the first mentioned tube or element, whereby such projections are provided on the ends of alternate tubes or

elements at each end of each horizontal series. These projecting ends are bent around the ends of the contacting sides of the adjacent tubes or elements as indicated at 17^d. The sides 17^c of adjacent tubes or elements being in contact, serve, with the flared walls 17^b, to space the bodies of the tubes or elements apart, providing vertical flues or passages 18 therebetween, the width of such passages being determined by the amount of expansion given to the ends of the tubes or elements.

The tubes or elements are arranged in horizontal alternating tiers or series A, B, A', B', A², B² and the tubes or elements in each series being arranged with their major diameters or axes in a vertical direction. The uppermost series A is separated, at the end which communicates with the pass hood 13, from the series B therebeneath by means of a baffle plate 19 extending across the said pass hood and inserted between the bottom walls 17^c at the ends of the tubes of series A and the corresponding top walls 17^c at the ends of the tubes in series B, being secured in place by means of rivets 20 connecting the said plate and the said end walls of the tubes or elements. A similar baffle 21 extends across the pass hood 16 and is inserted between the bottom walls at the ends of the tubes or elements in series B and the top walls of the tubes or elements in series A' therebeneath. Baffle plates 19^a and 19^b also extend across the pass hood 13 and are inserted between and connected in like manner to the end walls of the tubes or elements comprising series A' and B' and series A² and B², respectively. A baffle 21^a, similar to baffle 21, extends across the pass hood 16, below the baffle 21, and is inserted between and secured to the end walls of the tubes or elements in series B' and in series A² therebeneath. The bottom of the pass hood 16 extends to the lower ends of the tubes or elements in series B². The ends of the top and bottom walls of the tubes in adjacent series are connected directly by means of rivets 20^a where there is no interposed baffle plate.

In Fig. 7 there is shown a modification of the manner of connecting the ends of the side walls of adjacent tubes or elements. In this case, each tube or element, indicated at 22, is constructed in substantially the same manner as each tube or element 17 but, instead of having lips formed at opposite sides of one end thereof, has one lip at each end, the lips, however, being on opposite sides of said tube or element, as indicated at 22^a.

With the parts constructed and arranged as described, the operation will be easily understood. Air drawn into the pass hood 13 will circulate through the upper hori-

zontal series of tubes or elements A, through the upper portion of the pass hood 16 and back through the tubes or elements of series B into the pass hood 13, and thus alternately and reversely through the tubes or elements A', B', A² and B², being delivered by the blower 9 through the pipe 14 to any suitable place of use. The products of combustion and the heated gases due to the action of the burner 3 will circulate around the various tubes or elements by means of the passageways 18 and 18^a.

Reference has been made hereinbefore to the particular shape of the heating tubes or elements as being oblong or rectangular in cross section. It will be observed that the longer axis or dimension of each of said tubes or elements is parallel with the general direction of the flow of the surrounding gases. The ratio of the minor axis or diameter to the major axis or diameter determines the amount of air passing through each element and the temperature to which such air is heated from and by a given volume and temperature of hot gases on the outside of the tubes, with a given velocity of air or other fluid in such tubes or elements. The smaller the minor axis or diameter is in relation to the major axis or diameter, the larger will be the ratio of the heating surface to the volume of the air passing through the interior of each tube or element and the higher will be the temperature.

The manner of constructing the tubes or elements enables them to be quickly and conveniently assembled and, when assembled, to provide a definite or pre-determined space around the body of each such tube or element for the passage of the hot gases. This construction permits the heating apparatus to be constructed of any desired height or width and with any desired number of elements, without the use of tube sheets. The construction also allows the pass hood baffles to be conveniently interposed between alternate tiers or series of tubes or elements for directing the flow of air therethrough. The number of such series or tiers has a direct relation upon the final temperature obtained in the fluid circulating through the tubes or elements.

Having thus described my invention, what I claim is:

1. An apparatus of the character described comprising a plurality of series of oblong hollow elements each having expanded ends, the ends of the elements in each series engaging one another and the bodies of adjacent elements being spaced, a pair of pass hoods communicating with opposite ends of each of said elements respectively, each of said elements having one or more end lips bent into engagement with the end or ends of adjacent elements, baffle

plates in each pass hood, each of said plates extending between the bottoms of the expanded ends of the elements of one series and the tops of the expanded ends of the elements in a subjacent series and the baffle plates in one pass hood being staggered with respect to those in the other, means connecting the tops and the bottoms of the ends of the elements in adjacent series, means for circulating a fluid through said pass hoods and the said elements, and means for circulating another fluid through the passages provided between the said elements.

2. An apparatus of the character described comprising a plurality of series of oblong hollow elements each having expanded ends, the ends of the elements in each series engaging one another and the bodies of adjacent elements being spaced, a pair of pass hoods communicating with opposite ends of each of said elements respectively, means for securing the said elements in place, baffle plates in each pass hood, each of said plates extending between the bottoms of the expanded ends of the elements of one series and the tops of the expanded ends of the elements in a subjacent series and the baffle plates in one pass hood being staggered with respect to those in the other, means for circulating a fluid through said pass hoods and the said elements, and means for circulating another fluid through the passages provided between the said elements.

3. In an apparatus of the character described, the combination of an upper and a lower series of heat exchange elements each being substantially rectangular in section and having the four walls thereof expanded outwardly at opposite ends, the bottom walls of the upper elements substantially engaging the top walls of the lower elements and the side walls of the elements in each series being in contact, each element having one or more end lips adapted to engage and interlock with the corresponding end of an adjacent element in its series, and means for securing together the bottom walls of the elements in the upper series and the top walls of the elements in the lower series.

4. In an apparatus of the character described, the combination of an upper and a lower series of heat exchange elements each being substantially rectangular in section and having the four walls thereof expanded outwardly at opposite ends, the bottom walls of the upper elements substantially engaging the top walls of the lower elements and side walls of the elements in each series being in engagement, means for securing together the bottom walls of the elements in the upper series and the top walls of the elements in the lower series, means for circulating a fluid through each series of ele-

ments in succession, and means for circulating another fluid through the spaces provided between the bodies of said elements.

5. In an apparatus of the character described, the combination of a plurality of series of elements arranged side by side and each having a body section expanded at opposite ends thereof, the corresponding side walls at the ends of adjacent elements being in engagement, each element having one or more lips adapted to engage and interlock with the corresponding end of an adjacent element in its series, the said elements being provided with intermediate projections pressed outwardly therefrom and constituting spacing means between adjacent elements, means for circulating a fluid through the series of elements in succession, and means for circulating a fluid through the spaces provided between the bodies of said elements.

6. In an air heater, the combination of a plurality of series of oblong hollow elements arranged side by side and each having widened ends and a reduced body section, the ends of the elements in each series engaging each other, whereby ducts will be provided between the body sections only of the said elements, means for circulating a heating fluid through the said ducts, and means for circulating air successively through the different series of elements.

7. In an air heater, the combination of a plurality of horizontal series of oblong hollow elements arranged side by side, each element having expanded or widened ends and a body section of less width than its ends, the ends of the elements in each series engaging each other, whereby vertical ducts will be provided between the sides of the elements, said ducts extending the full height of the assembly of such elements, means for circulating a heating fluid through said ducts, and means for circulating air successively through the different series of elements.

8. In an air heater, the combination of a plurality of horizontal series of oblong hollow heating elements arranged side by side with their major axes substantially vertical, each element having its ends widened or expanded and its body section of less width than its ends, the ends of the elements in each series engaging each other, whereby vertical ducts will be formed between the sides of the elements, said ducts extending the full height of the assembly of such elements, the said elements being provided with projections in their reduced body sections adapted to engage one another in said ducts, means for circulating a heating fluid through said ducts, and means for circulating air successively through the different series of elements.

9. In an apparatus of the character de-

- scribed, the combination of an upper and a lower series of heat exchange elements each being substantially rectangular in section and having the four walls thereof expanded outwardly at opposite ends thereof, the bottom walls of the upper elements substantially engaging the upper walls of the lower elements and the side walls of the elements in each series being in substantial engagement, means for securing the side walls of adjacent elements in each series, means for securing together the bottom walls of the elements in the upper series and the upper walls of the elements in the lower series, means for circulating a fluid through the ducts provided between said elements, and means for circulating another fluid successively through the two series of elements.
10. In an apparatus of the character described, the combination of a plurality of horizontal series of heat exchange elements each having an oblong body and provided with expanded ends, the said elements being arranged side by side in each series with their ends so shaped as to engage the corresponding ends of like elements in such series and in an adjacent series to form a closed joint therewith, means for securing the ends of said elements together, said elements being provided with outwardly pressed portions in the reduced bodies thereof constituting spacers in the vertical ducts formed therebetween, means for circulating a fluid successively through the different series of elements, and means for circulating a fluid through the vertical spaces between said elements.
- In testimony whereof, I hereunto affix my signature.
- JAMES M. HARRISON.