May 6, 1930. C. D. MOSHER 1,757,327

TUBULAR AIR HEATER

Filed Dec. 31, 1927 2 Sheets-Sheet 1

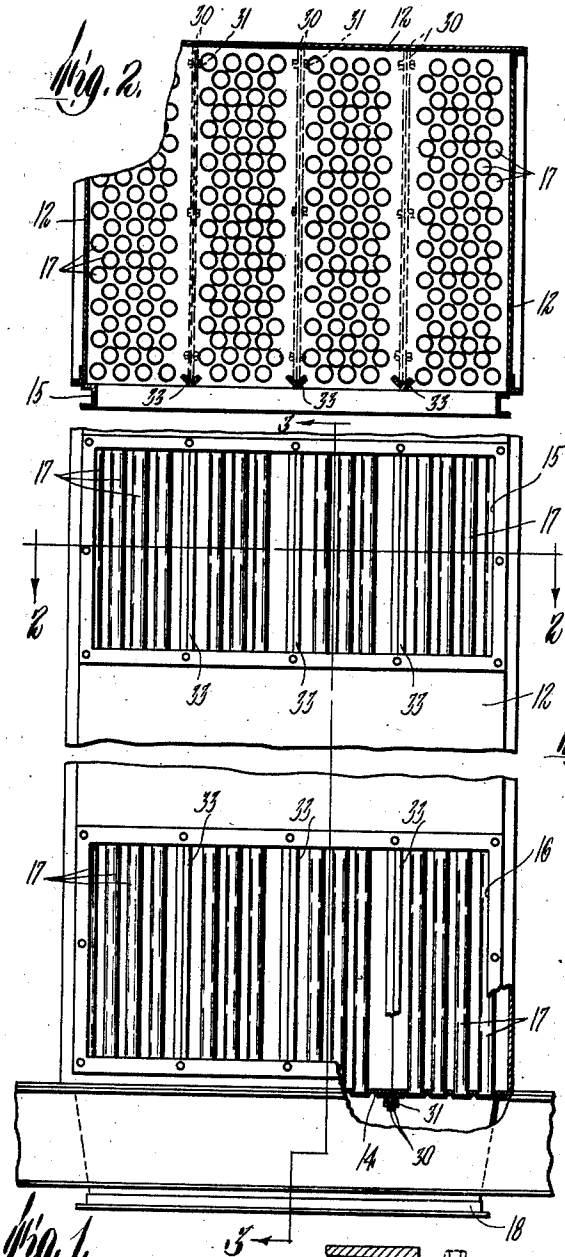


Fig. 2.

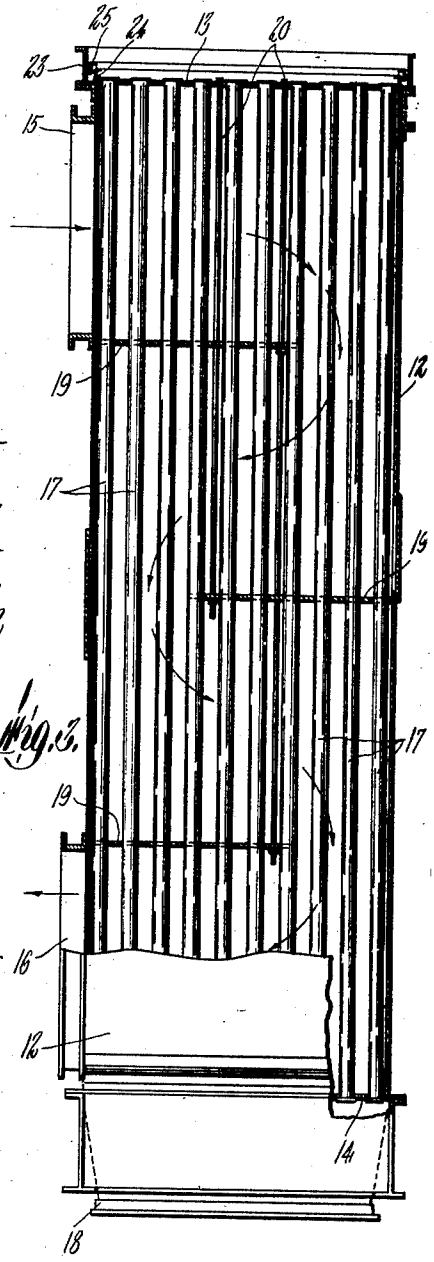


Fig. 3.

Fig. 1.

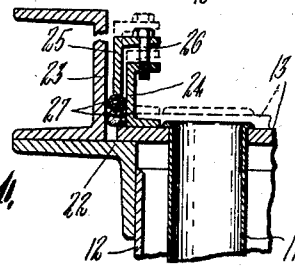


Fig. 4.

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TUBULAR AIR HEATER

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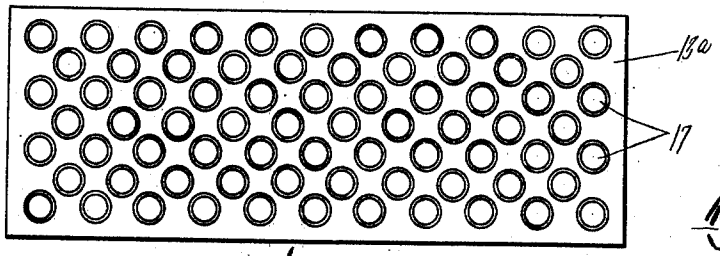


Fig. 5.

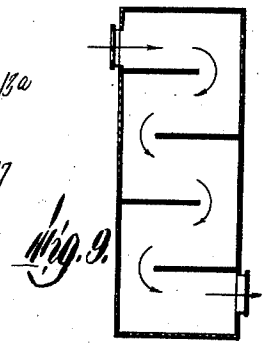


Fig. 9.

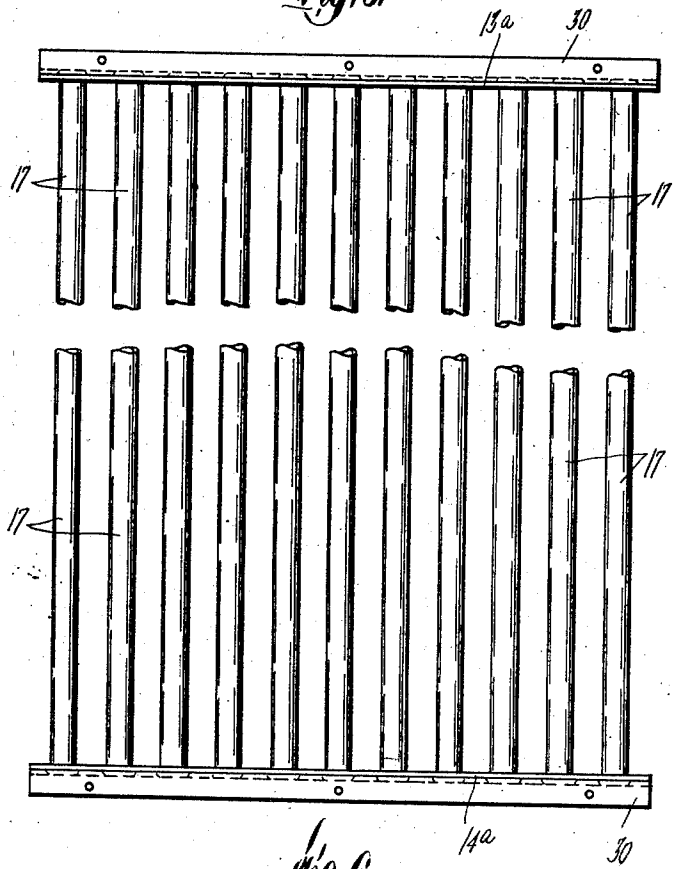


Fig. 6.

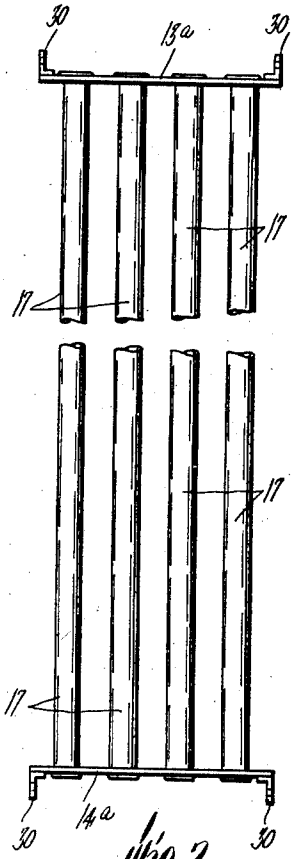


Fig. 7.

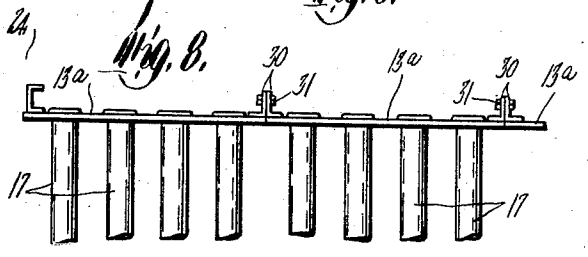


Fig. 8.

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UNITED STATES PATENT OFFICE

CHARLES D. MOSHER, OF HYDE PARK, MASSACHUSETTS

TUBULAR AIR HEATER

Application filed December 31, 1927. Serial No. 243,894.

This invention relates to air-heating structures utilizing wasted heat from a boiler furnace, or other source, to heat air for a useful purpose.

The structure in which the invention is embodied comprises an elongated air-conducting casing, composed of walls constituting the body or major portion of the casing, and tube sheets constituting the casing ends or heads, the casing body being provided at one end portion with an air intake, and at the opposite end portion with an outlet for heated air.

The structure includes also a plurality of heat-conducting tubes, fixed at their opposite ends in the tube sheets, and extending longitudinally through the casing, and baffle plates within the casing, arranged to cause air to pass in a sinuous course along and across the tubes, on its way from the intake to the outlet.

One object of the invention is to provide a construction permitting the free longitudinal expansion and contraction of the elongated heat-conducting tubes, without injurious strains on the structure, and without permitting leakage, or deviation of the heated air from its predetermined course.

Another object, of paramount importance, is to provide a sectional construction permitting the assemblage of the tube sheets and tubes in portable units of convenient size, and of not excessive weight, so that each unit may be conveniently passed through a doorway of not unusual size, and conveniently assembled with other units, and all enclosed within the casing.

Other related objects will hereinafter appear.

Of the accompanying drawings forming a part of this specification,—

Figure 1 is a front elevation of an air heater embodying the invention, parts being broken away, and parts shown in section.

Figure 2 is a transverse section on line 2—2 of Figure 1.

Figure 3 is a longitudinal section on line 3—3 of Figure 1, the entire length or height of the structure being shown.

Figure 4 is a fragmentary enlargement of a portion of Figure 3.

Figure 5 is a plan view of one of the units, looking toward the tube-sheet section, constituting the upper head of the unit.

Figure 6 is a side view; and

Figure 7 an end view of the unit shown by Figure 5.

Figure 8 is a fragmentary end view, showing portions of a plurality of units.

Figure 9 is a sectional view, showing certain modifications of the casing.

The same reference characters indicate the same parts in all of the figures.

The casing is, in this instance, vertically elongated, and is composed of vertical walls 12, constituting the body or major portion of the casing, and two tube sheets 13 and 14, at opposite ends of the body and constituting the casing ends or heads. One of the walls 12 is provided at its upper end portion with an air intake 15, and at its lower end portion with an air outlet 16, said inlet and outlet being preferably of the same size, for a purpose hereinafter stated, and bounded by suitable frames. The intake 15 may receive cool air, and the outlet 16 may discharge hot air, through suitable flues (not shown) secured to the frames. Elongated heat-conducting tubes 17 are fixed at their opposite ends in the tube sheets 13 and 14, each tube being preferably about two and one-half inches in external diameter, and having its ends expanded directly into orifices in the tube sheets. The lower ends of the tubes 17 receive hot gases passing from a furnace, or elsewhere, through a conduit section 18, fixed to the lower end of the casing, the gases rising through the tubes and escaping from their upper ends. Within the casing between the air intake and outlet are baffle-plates 19, of which there are three in this instance, each plate being provided with holes receiving some of the tubes. The baffle-plates are preferably supported by rods 20, supported by the upper tube sheet 13, as shown by Figure 3.

The baffle-plates are arranged to cause air to pass in a sinuous course along and across the tubes, as indicated by the arrows in Figure 3, the air passing downward in the casing,

and the hot gases upward in the tubes, so that the heater is of the counterflow type.

The lower tube sheet 14 is fixed rigidly to the casing below the air outlet 16, in any suitable manner. The upper tube sheet 13 is vertically movable relative to the casing, so that it permits free longitudinal expansion and contraction of the tubes. The casing is provided with an upwardly facing seat 22 (Figure 4), on which the marginal portion of the under side of the upper tube sheet 13 bears loosely, when the tubes are of normal length. When the tubes are longitudinally expanded, they raise the tube sheet 13 from the seat, as indicated by dotted lines in Figure 4.

To prevent leakage of air from the casing around the raised tube sheet, I provide packing means, preferably embodied in the slip joint elements shown by Figure 4, and on a smaller scale by Figure 3, said elements constituting a stuffing box. 23 designates a rectangular upstanding outer curb, fixed to the upper end of the casing, and preferably to the seat 22, which is angular in cross section, said curb surrounding the tube sheet. A rectangular upstanding inner curb 24, is fixed to the marginal portion of the movable tube sheet 13 and extends around the tube sheet close to the margin thereof. Said curbs have spaced apart parallel faces, between which is interposed compressible packing material, preferably composed of a strand or strands 27 of asbestos packing. 25 designates a rectangular gland, angular in cross section, one of its wings being provided with adjusting screws 26, engaged with a flange on the inner curb 24. The gland 25 projects into the space between the curbs, and bears on the packing 27, which is compressible by the gland against the opposed faces of the curbs.

To permit the convenient transportation and installation of the element of the heater which includes the tube sheets and tubes, I subdivide said element into a plurality of units, adapted to be separately handled and assembled side by side, to form an element of any desired size. One of said units is shown by Figures 5, 6 and 7, and includes two tube sheet sections, designated in said figures by 13^a and 14^a and a group of tubes 17, secured at their opposite ends to said sections. Any desired number of tube-sheet sections may be abutted together and separately connected edge to edge, as indicated by Figure 8, to form pieced or sectional tube sheets of the desired area, corresponding to the internal area of the casing.

I prefer to provide each of the tube-sheet sections, excepting those forming the ends of the pieced tube-sheet, with flanges 30, at two of their opposite edges, said flanges being abutted together and united by bolts or rivets 31, as shown by Figure 8. Each section 13^a forming an end of the upper pieced tube-sheet, has only one flange 30, the opposite edge being in the plane of the section and adapted to bear on the seat 22 (Figure 4).

It will now be seen that each of the described units may be proportioned to pass through an ordinary doorway, in transporting it to the place where the heater is to be located, and may be of relatively light weight, so that it may be conveniently transported, the sections being adapted to be quickly and conveniently set up and connected, to form a heater element. The casing may be constructed in any suitable manner, to permit the convenient installation of the heater.

The air intake and outlet may be formed, one in one wall 12, and the other in the opposite wall, as shown by Figure 9, so that the air may enter the casing at one side and be discharged at the opposite side, if convenience of installation so requires.

The tubes 17 are arranged in staggered rows and in spaced apart groups, as shown by Figure 2, and the end tubes of the alternate rows are nearer the abutting edges of the tube-sheet sections than the end tubes of the other rows, so that there is necessarily a gap of considerable width between the end tubes of any two adjacent units. To limit the volume of cold air entering said gaps and the spaces between the tube groups at the air inlet or intake of the casing, I extend across the intake opening, vertically elongated V-shaped air deflectors 33 (Figure 2), arranged to laterally deflect air entering the intake, so that the volume of air flowing through said gaps is limited.

The casing may be supported on a base below it, or suspended from a structure above it, some installations requiring a supporting base below the casing, and others an elevated support above the casing.

It is obvious that the directions of the counterflowing gases and air may be reversed, the gases flowing downward and the air upward, in which case the fixed tube sheet should be at the upper end of the casing, and the movable or floating tube sheet and the packing at the lower end.

I claim:

1. An air heater comprising a vertically elongated air-conducting casing composed of wall portions constituting the body of the casing, and tube sheets at opposite ends of the body, and constituting the ends or heads of the casing, the wall being provided at one end with an air inlet adjacent one of the tube sheets, and at its opposite end with an air outlet adjacent the other tube sheet, heat-conducting tubes extending vertically through the casing and fixed at their opposite ends to the tube sheets, means at one end of the casing for delivering hot gases to the receiving ends of the tubes, the gases passing through the tubes and ecaping from the opposite ends thereof, and baffle-plates associated with the tubes within the casing, and ar-

ranged to cause air entering the air inlet to pass in a sinuous course to the air outlet and contact with all of the tubes, one tube sheet being fixed to the casing, and the other sheet being free to rise and fall, to permit free expansion and contraction of the tubes, the casing being provided with a seat on which the margin of the movable tube sheet normally bears loosely, the casing and the movable tube sheet being provided with slip joint elements constituting a stuffing-box preventing leakage of air around the movable sheet when it is separated from said seat by longitudinal expansion of the tubes.

2. An air heater comprising a vertically elongated air-conducting casing composed of wall portions constituting the body of the casing, and tube sheets at opposite ends of the body, and constituting the ends or heads of the casing, the wall being provided at one end with an air inlet adjacent one of the tube sheets, and at its opposite end with an air outlet adjacent the other tube sheet, heat-conducting tubes extending vertically through the casing and fixed at their opposite ends to the tube sheets, means at one end of the casing for delivering hot gases to the receiving ends of the tubes, the gases passing through the tubes and escaping from the opposite ends thereof, and baffle-plates associated with the tubes within the casing, and arranged to cause air entering the air inlet to pass in a sinuous course to the air outlet and contact with all of the tubes, one of the tube sheets being fixed to the casing, and the other sheet being free to rise and fall, to permit free expansion and contraction of the tubes, the casing being provided with a seat on which the margin of the movable tube sheet rests loosely, and with an outer curb surrounding and spaced from the margin of the movable tube sheet, said sheet being provided with an inner curb surrounded by and spaced from the outer curb, and with a packing gland adjustably connected with the inner curb, packing material compressible by said gland being interposed between the two curbs.

3. An air heater comprising a vertically elongated air-conducting casing composed of wall portions constituting the body of the casing and tube sheets at opposite ends of the body constituting the ends or heads of the casing, the casing body being provided at one end with an air inlet adjacent one of the tube sheets, and at its opposite end with an air outlet adjacent the other tube sheet, heat-conducting tubes extending vertically through the casing and fixed at their opposite ends to the tube sheets, means at one end of the casing for delivering hot gases to the receiving ends of the tubes, the gases passing through the tubes and escaping from the opposite ends thereof, baffle-plates associated with the tubes within the casing and arranged to cause air entering the inlet to pass in a sinuous course to the outlet, the tube sheets and tubes being assembled to constitute a plurality of portable units, each including two tube-sheet sections, and a group of tubes fixed thereto, the tube-sheet sections being abutted together and separably connected edge to edge, to form pieced tube sheets coextensive in area with the cross-section of the casing.

4. An air heater as specified by claim 3, the tube-sheet sections being provided with flanges at opposite edges, abutted and fastened together to form pieced tube sheets coextensive in area with the cross section of the casing, the end sections of the pieced tube sheets being formed for engagement with corresponding portions of the casing.

5. An air heater comprising a vertically elongated air-conducting casing composed of wall portions constituting the body of the casing and tube sheets at opposite ends of the body constituting the ends or heads of the casing, the casing body being provided at one end with an air inlet adjacent one of the tube sheets, and at its opposite end with an air outlet adjacent the other tube sheet, heat-conducting tubes extending vertically through the casing and fixed at their opposite ends to the tube sheets, means at one end of the casing for delivering hot gases to the receiving ends of the tubes, the gases passing through the tubes and escaping from the opposite ends thereof, baffle-plates associated with the tubes within the casing, and arranged to cause air entering the air inlet to pass in a sinuous course to the outlet, the tubes being arranged in spaced apart groups, and vertically elongated air deflectors extending across the air inlet in the air-receiving portions of the spaces between said groups, and formed and arranged to laterally deflect portions of the air entering said spaces for the purpose specified.

In testimony whereof I have affixed my signature.

CHARLES D. MOSHER.