

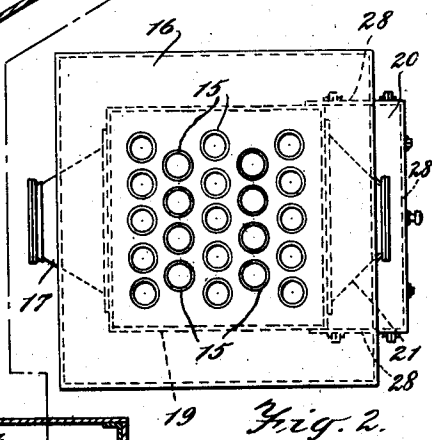
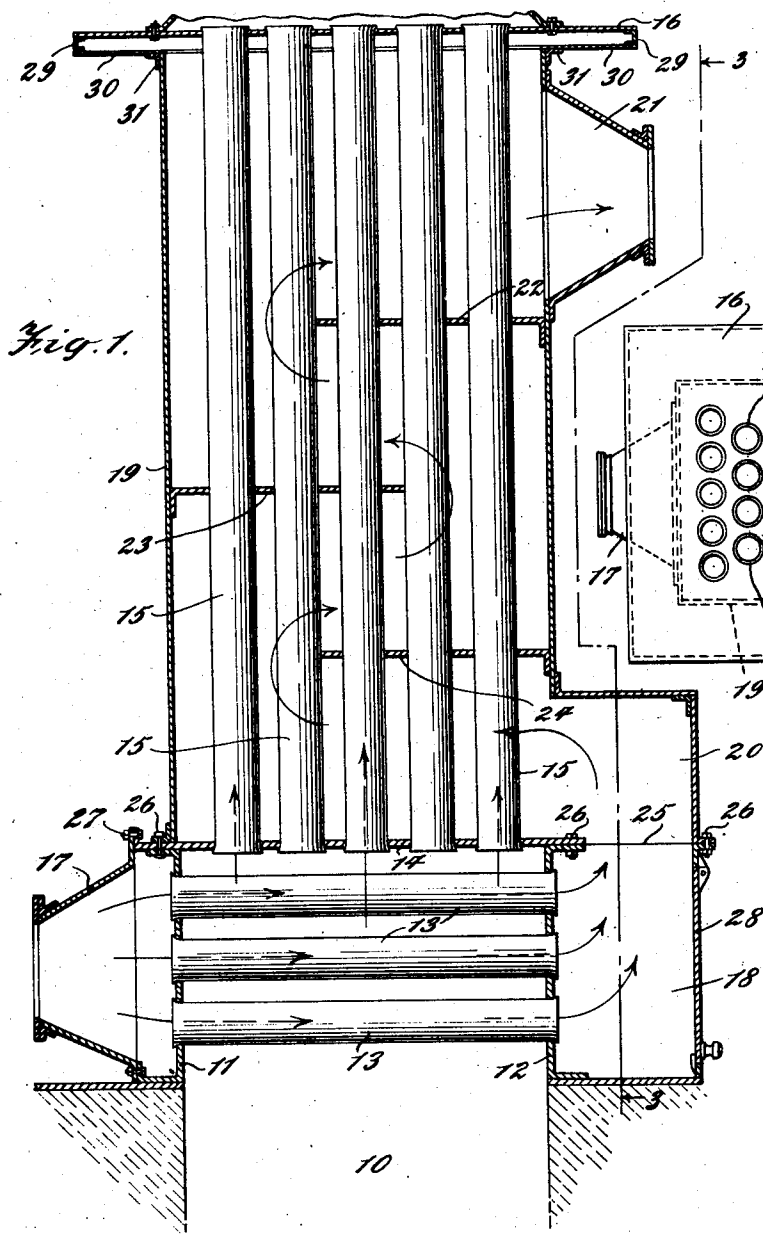
July 14, 1931.

N. L. SNOW

1,814,010

AIR HEATER

Original Filed Feb. 27, 1925 2 Sheets-Sheet 1



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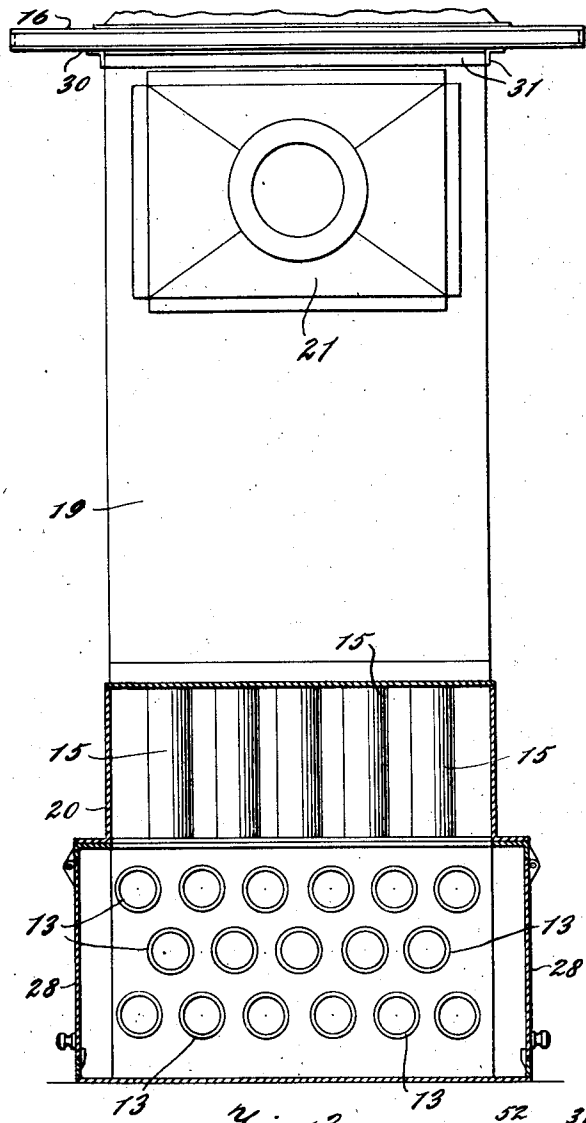


Fig. 3.

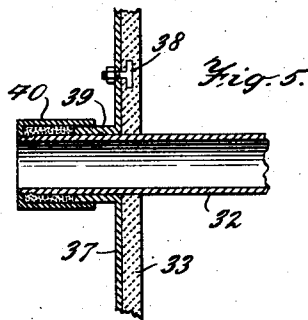


Fig. 5.

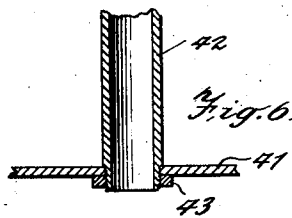


Fig. 6.

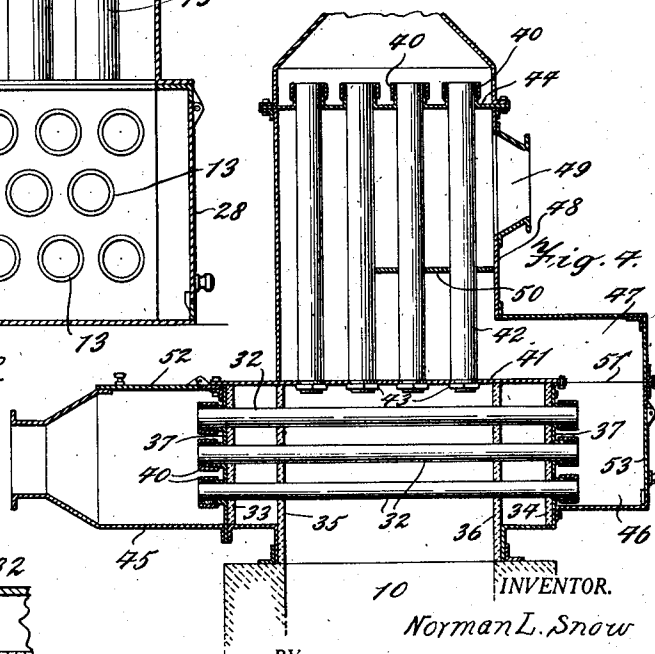


Fig. 4.

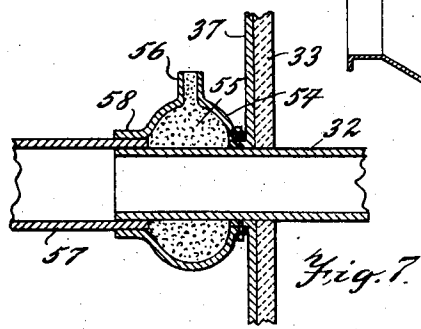


Fig. 7.

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AIR HEATER

Application filed February 27, 1925, Serial No. 12,107. Renewed February 7, 1931.

My present invention relates to heat-transfer devices, such as are commonly used for heating air or the like either by means of specially fired furnaces, from hot waste gases, or hot gases from any other source, and particularly to a form of such air heaters in which metallic materials may be used to separate the gases between which heat is being transferred.

10 My invention will best be understood from the following description and the annexed drawings in which:

Figure 1 is a vertical section of one embodiment of my invention;

15 Figure 2 is a plan view of Figure 1 on a somewhat smaller scale;

Figure 3 is a front view, partly in section, on the line 3—3 of Figure 1;

20 Figure 4 is a view similar to Figure 1, but showing a modification on a smaller scale;

Figure 5 is an enlarged view of one of the details shown in Figure 4;

25 Figure 6 is an enlarged view of another detail shown in Figure 4, and

Figure 7 is a modification of the arrangement shown in Figure 5.

Like reference characters indicate like parts in the different views.

30 In the arrangement shown in Figures 1, 2 and 3, the air heater is placed over a vertical flue 10 through which rise heated gases from any desired source. On opposite sides of the flue 10 are tube plates 11, 12 through which extend transverse air tubes 13 which, in the form shown extend horizontally and have their ends expanded to form a tight joint with the tube plates.

35 Above the tubes 13 is a horizontal plate 14 through which extend vertical tubes 15, the upper ends of the tubes 15 being expanded into a tube plate 16.

40 At the left of Figure 1 is an air inlet casing 17 and at the right an exit air casing or duct 18. Surrounding the vertical tubes 15 is an air casing 19, the lower end of which has an air inlet opening connected through a duct 20 with the upper end of the duct 18. The casing 19 is provided

with an air outlet 21 and with baffles 22, 23 and 24.

The heated gases from which heat is to be transferred to the air or other gas to be heated, flows upwardly through the flue 10 across the exteriors of the tubes 13, from thence into the interiors of the tubes 15 and from thence out of the apparatus, as to a stack or the like.

The air to be heated flows through the inlet 17 and then through the tubes 13. It then passes through the ducts 18 and 20 into the air casing 19, the baffles therein directing the air back and forth across the exterior of the tubes 15 to the air outlet 21.

45 In air heaters as they have heretofore been generally constructed, it has been necessary, if the heating gases were of a high temperature, to employ refractories for the material separating the heating gases from the gases to be heated. It has been proposed to use metallic materials to separate the two kinds of gases and such arrangement is possible where the temperatures are relatively low. When the temperatures are very high, however, it is necessary to use as such metallic material some of the expensive heat-resisting metals and alloys, and this has made the installation cost prohibitive in many cases.

50 By the arrangement which I have described, I may make the tubes first contacted by the hot gases of relatively expensive heat-resisting alloys and the remainder of the tubes, that is, the vertical set in the arrangement just described, of iron or any of the cheaper metals because the temperature of the hot gases will be lowered sufficiently before contacting with this second set of tubes to obviate danger of burning them out.

55 I preferably arrange my air heater so that it may be readily divided into two parts, whereby the parts containing the sets of tubes may be removed and replaced readily, and also whereby the tubes of the sets will be readily accessible for repair work or readily removable. Furthermore, I may arrange either set of tubes in a special manner so that they will be free to ex-

pand and contract without injury to themselves or to the headers which prevent the mixing of the two kinds of gases. Preferably this special arrangement is protected from the intense heat of the hot gases as they first enter the air heater.

In the arrangement shown in Figures 1, 2 and 3, the various flues and ducts are formed into a single casing and this casing is divided along the horizontal line 25 just below the horizontal plate 14, the two parts being held by removable fasteners 26, so that when such fasteners are removed, the two sets of tubes with their respective plates and flues or ducts may be separated, particularly so that a new portion for the lower part of the air heater may be substituted for a portion which may have become injured in use.

In Figure 1, the air inlet 17 is also arranged so that it may be detached from the plate 14 by removing the fasteners 27. In order to increase the accessibility, I preferably provide the lower portion of the casing with doors, such as 28, which may be on the front and also on the sides of the duct 18.

In the arrangement shown in Figure 1, I provide for the expansion and contraction of the tubes 15 by extending the plate 16 outward and connecting its outer edge preferably through spacing members 29 to the outer edges of a thin plate 30, the inner edges of which are fastened, as at 31, to the upper end of the air flue 19. It will be obvious that with this arrangement, if the tubes 15 expand, the plate 16 can move upward bodily with the tubes, such motion being permitted by the flexibility of the plate 30, such plate bending without causing any leakage from the interior of the air flue 19.

In the arrangement shown in Figure 4, the air heater is in general the same as that shown in Figure 1, except that the lower tubes 32 are supported in headers 33, 34 which are spaced at a considerable distance outside of the flue 10, walls 35 and 36 continuing the flue 10 upward, these walls being placed closely adjacent the inner walls of the flue 10. The walls 35 and 36 may be made of refractory material, if desired, and the tubes 32 extend through openings in these walls so as to be free to slide therein. The headers 33 and 34 may be made up partly of metal and partly of refractory material, the metal being arranged in the form of a plate 37 on the outside of the header and attached by fasteners, such as 38, to the refractory material. In the arrangement illustrated in Figure 4 and on a larger scale in Figure 5, the tubes 32 are free to slide longitudinally through the headers 33 and 34 and are provided on the ends outside of these headers with a sealing device to prevent leakage of gases or air through the clearance spaces between the tubes and the head-

ers. One such form of sealing device is illustrated on a large scale in Figure 5, the plate 37 having outwardly extending portions 39 relatively close to the walls of the tubes 32 and the tubes 32 having their outer ends threaded to be engaged by a gland nut 40, the skirt of which extends over the projection 39. The spaces between the nut 40 and tubes 32 may be filled with any desired form of packing, the tightening of the nut 40 pressing this packing between the projection 39, the tube 32 and nut 40 to provide a tight joint, while, at the same time permitting the tube 32 to move freely longitudinally through the header.

The horizontal header 41 has the lower ends of the vertical tubes 42 extending there-through and, in the form shown in Figure 4, these lower ends are connected to the header 41 as best shown on a large scale in Figure 6, the end of the tube being reduced and inserted through the header 41 and held therein by a nut 43 engaging threads on the tube 42. The upper ends of the tubes 42 extend through the upper header 44 and, in the form shown in Figure 4, are provided with sealing devices similar to that just described and as shown in Figure 5, the tubes 42 being freely slidable through the header 44.

The gases from the flue 10 pass across the exteriors of the tubes 32 and through the interiors of the tubes 42 to the gas outlet. Similarly, air through the air inlet 45 passes through the tubes 42, and then through the ducts 46 and 47 to the interior of the air casing 48 and then to the air outlet 49, a baffle 50 serving to direct the gases back and forth across the tubes 42.

The casing constituting the several flues and ducts of the air heater is divided along the line 51 in the manner described in connection with the arrangement shown in Figure 1. The air inlet 45 is provided with a door 52 and the duct 46 with a door 53. Since the gland nut 40 may be removed from each end of the tubes 32, it will be obvious that any of these tubes 32 may be withdrawn and a new tube substituted, access to the tubes for this purpose being obtained through the doors 52 and 53.

In the arrangement shown in Figure 7, the tube 32 extends through the header 33, the metal plate 37 of which is provided with a member 54 formed either integrally therewith, or separable therefrom, said member surrounding the tube 32 but arranged to form a space 55 which may be filled with any suitable granular material, such as fine carbon, to form a seal between the tube 32 and the header. This granular material may be fed to the space 55 to maintain it filled by pouring such material through a tube 56 which may be extended to any appropriate point. In the arrangement shown in Figure 7, the air is delivered to the

tube 32 through a tube 57 which enters the space between the member 54 and the tube 32. If desired, however, the tube 57 may be omitted, in which case the outer end 58 of the member 54 will be brought down into relatively close relation to the tube 32 to prevent the granular material from working out.

It will be noted that in the arrangement which I have shown in Figure 4, the sealing devices are located so that they are not directly contacted by the hot gases, so that packing or the like may be used without serious danger of its destruction. Moreover, by the use of the refractory walls 35 and 36, the circulation of the hot gases close to these sealing devices is further prevented.

Preferably where the tubes are subjected to very great differences in temperature at their two ends, I locate the sealing device at the cooler end of the tube. Thus in the set of tubes 42, it will be clear that the lower ends will be very hot while the upper ends will be relatively cool because of the transfer of the heat from the gases to the air. Similarly, the left-hand end of the tubes 32 in Figure 4 will be cooler than the right-hand end of the tubes, but since the right-hand end of these tubes will in most cases not be subjected to extremely high temperatures because the air has not been heated to its full temperature at that point, I may utilize the sealing at either or both ends of the tubes 32, as desired.

In the arrangement which I have described, I have shown the sealing devices at both ends in order to permit the removal of the tubes, but it will be understood that only one flexible connection is necessary and that any fixed form of attachment between the right-hand end of the tubes 32 and the headers 34 may be used.

It will be understood that, if desired, the hot gases may be caused to flow horizontally instead of vertically in other words, that the arrangement which I have shown may be operated in other positions than the vertical one which I have shown.

It will also be understood that the arrangements which I have described are merely illustrative and that the separate features of my invention may be used alone or in combination with other features.

In this application it will be understood that where the word "air" is used it means either ordinary air or any other gas.

What I claim as my invention is:—

1. An air heater having a first set of ducts and a second set of ducts extending at right angles to the first set, a flue to conduct air from the interiors of said first set to the exteriors of said second set, a flue to conduct hot gases over the exteriors of the first set and to the interiors of the second set, a casing forming said flues, said casing being di-

vided on a plane between the two sets, and removable fasteners to hold the two parts of the casing together, whereby the sets and their respective flues may be separated without disturbing the mountings of said ducts in their respective casing portions.

2. In an air heater, a flue for the hot gases, a first set of tubes extending across the flue, tube plates for the ends of said tubes, a second set of tubes arranged to receive and conduct hot gases from said flue after the gases have passed over the exteriors of the tubes of said first set, tube plates for the tubes of said second set, and a casing forming said flue and also flues to conduct air from the interiors of said first set of tubes to and over the exteriors of the tubes of said second set, said casing being divided on a plane between the two sets of tubes, and removable fasteners to hold the two parts of the casing together, whereby the sets of tubes with their respective tube plates and flues, may be separated without disturbing the mountings of said tubes in their respective portions of said casing.

3. In an air heater, a vertical flue for the hot gases, a first set of tubes extending across the flue, tube plates for the ends of said tubes on opposite sides of said flue, a horizontal tube plate at the top of said flue, a second set of tubes extending vertically through and above said horizontal tube plate, a header at the upper ends of said second set of tubes, a casing surrounding all of said tubes and forming said vertical flue and also flues to conduct air from the interiors of the tubes of said first set to and over the exterior of the tubes of said second set, said casing being divided on a plane below said horizontal tube plate and above said first set of tubes, and removable fasteners connecting the two parts of the casing, whereby the sets of tubes with their respective tube plates and flues may be separated without disturbing the mountings of said tubes in their respective portions of said casing.

4. In an air heater, a vertical flue for the hot gases, a first set of tubes extending across the flue, tube plates for the ends of said tubes on opposite sides of said flue and outside the wall of said flue, a horizontal tube plate at the top of said flue, a second set of tubes extending vertically through and above said horizontal tube plate, a header at the upper ends of said second set of tubes and a casing surrounding all of said tubes and forming said vertical flue and also flues to conduct air from the interiors of the tubes of said first set to and over the exterior of the tubes of said second set.

5. In an air heater, a pair of tube plates spaced apart, tubes extending between and through said tube plates, each of said tubes being attached at one end to one of said

tube plates and being free to slide through the other of said tube plates, and a sealing device at the free end of each tube to maintain a tight joint between the tube plate and the tube while permitting free longitudinal movement of the tube through the tube plate, said sealing device including a gland nut carried by said tube, a skirt formed on said gland nut and packing between said skirt and tube.

6. In an air heater, a pair of tube plates spaced apart, tubes extending between and through said tube plates, each of said tubes being attached at one end to one of said tube plates and being free to slide through the other of said tube plates, said tube plate having a portion projecting from the same and formed integral therewith and surrounding the tube, and a gland nut movable relative to said projection and arranged to compress packing between the nut, the tube and the projecting portion of the tube plate to form a seal while permitting free longitudinal movement of the tube through the tube plate.

7. In an air heater, a pair of tube plates spaced apart, tubes extending between and through said tube plates, each of said tubes being attached at one end and to one of said tube plates and being free to slide through the other of said plates, a sealing device at the free end of each tube to maintain a tight joint between the tube plate and the tube while permitting longitudinal movement of the tube through the tube plate, means to admit a gas to be heated to one end of said tubes, said sealing devices being located at the gas inlet ends of said tubes whereby the same are maintained at a relatively low temperature.

8. An air heater having a first set of ducts of relatively high heat resisting material, and a second set of ducts, of relatively low heat resisting material, extending transversely to the first set, a flue to conduct air from the interiors of said first set to the exteriors of said second set, a casing forming said flue, said casing being divided on a plane between the two sets, and removable fasteners to hold the two parts of the casing together, whereby the two sets and their respective flues may be separated without disturbing the mountings of said ducts in their respective casing portions.

9. An air heater, having a first set of ducts of relatively high heat resisting material constituting the high temperature section of said air heater, and a second set of ducts of relatively low heat resisting material extending transversely to the first set and constituting the low temperature section of said air heater, a flue to conduct air from the interiors of said first set to the exteriors of said second set, and means whereby hot gases may be directed to flow

over the exteriors of the first set of ducts and through the second set.

10. An air heater having a first set of ducts and a second set of ducts extending transversely to the first set and mounted closely adjacent thereto, a flue to conduct air from the interiors of said first set to the exteriors of said second set, and means whereby hot gases may be directed to flow over the exteriors of the first set of ducts and through the second set.

11. In an air heater, a flue for hot gases, a first set of tubes extending across said flue, a second set of tubes mounted closely adjacent said first set and extending lengthwise of said flue whereby one end of said tubes is heated more than the other, and a duct to lead air from the first set of tubes to a point adjacent the hotter ends of said second set of tubes.

12. In an air heater, a vertical flue for hot gases, a first set of horizontal tubes extending across said flue, a second set of tubes in said flue extending vertically above said first set and mounted closely adjacent thereto, tube plates for each of said sets of tubes, and a duct to lead air from said first set of tubes to the lower ends of said second set of tubes.

13. An air heater including in combination a plurality of sets of ducts, a casing for said ducts, said casing being divided between the said sets of ducts into a plurality of parts, and fasteners for detachably securing the parts of the said casing adjacent each other whereby the said sets of ducts may be readily separated from each other.

14. An air heater including in combination a plurality of units, each unit being provided with passages for the medium to be heated and passages for the heating medium and means for detachably mounting such units adjacent each other.

15. An air heater including in combination a pair of units, each unit being provided with passages for the air to be heated and with an inlet and outlet for hot gases and means for detachably mounting such units adjacent each other with the hot gas inlet of one unit in communication with the hot gas outlet of the other unit.

16. An air heater including in combination a casing forming a flue for hot gases, means forming passages across said flue to conduct air to be heated transversely of the flow of hot gases through said flue, a second casing adapted to receive hot gases from the first mentioned casing, means for detachably mounting said second mentioned casing adjacent said first mentioned casing, and means for conducting the air from the passages of said first mentioned casing to the said second mentioned casing.

17. An air heater including in combina-

tion a pair of units, each unit being provided with an inlet and outlet for hot gases and an inlet and outlet for air to be heated, means for detachably mounting such units adjacent each other and means for conducting the air to be heated from the air outlet of one unit to the air inlet of the other unit.

18. In an air heater, the combination of an elongated casing, means for flowing a heating fluid longitudinally through said casing, and means including a series of tubes arranged within said casing for conducting a fluid to be heated transversely of said casing and also longitudinally thereof in heat exchange relation to the flow of heating fluid but out of contact therewith.

19. In an air heater, the combination of an elongated casing, means for flowing a heating fluid longitudinally through said casing, and means including a series of tubes extending transversely of said casing for initially conducting a fluid to be heated transversely of said casing and then longitudinally thereof in heat exchange relation to the heating fluid but out of direct contact therewith.

20. In an air heater, the combination of an elongated casing, a series of tubes extending transversely of said casing, a second series of tubes extending longitudinally of said casing, means for flowing a heating fluid longitudinally of said casing and around certain of said tubes, and means for flowing a fluid to be heated transversely and longitudinally of said casing and through certain of said tubes.

21. In an air heater, the combination of an elongated casing, and means for flowing a heating fluid longitudinally through said casing and a fluid to be heated initially transversely of said casing and then longitudinally thereof in heat exchange relation to the heating fluid but out of direct contact therewith, said means including a series of tubes extending transversely of said casing and a second series of tubes extending longitudinally of said casing.

In testimony whereof I affix my signature.
NORMAN L. SNOW.

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