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C. M. ASHLEY

2,229,032

HEATING APPARATUS

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2 Sheets-Sheet 2

Fig. 3.

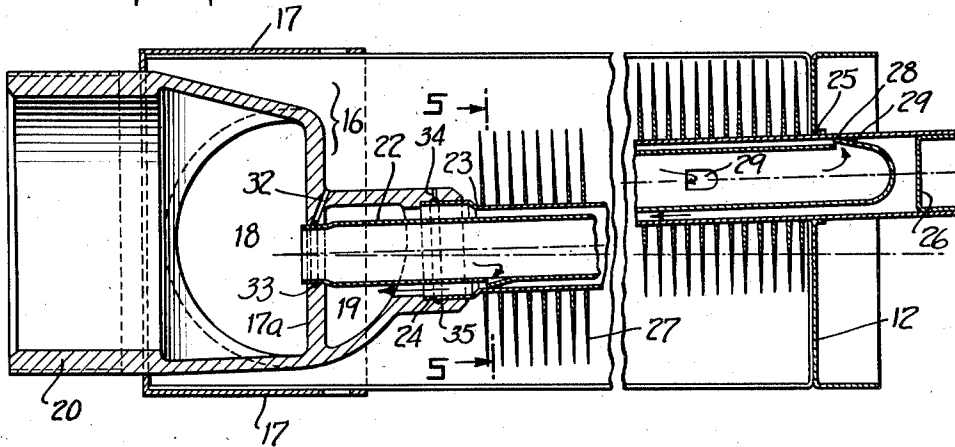


Fig. 4.

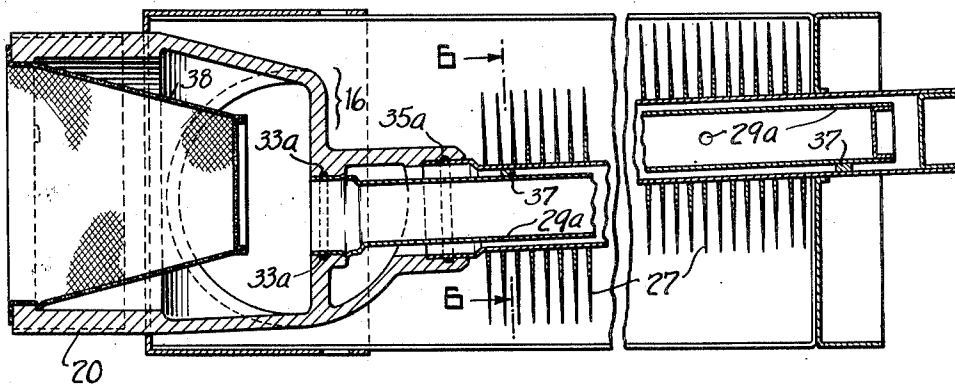


Fig. 5.

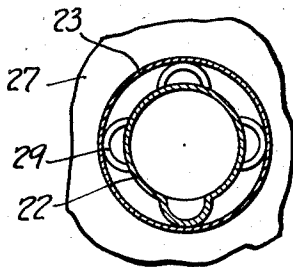
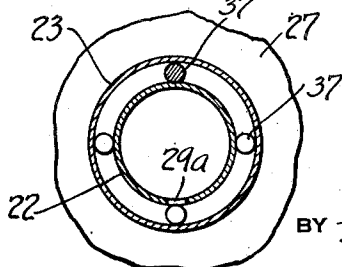


Fig. 6.



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HEATING APPARATUS

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2 Claims. (Cl. 257—146)

This invention relates to heat exchange apparatus, and more particularly to heat exchange apparatus of the type in which a fluid such as steam is utilized to heat a fluid such as air.

5 The general object of the invention is to provide an improved device for heating air or the like by heat exchange with steam or similar fluid, in which freezing due to low temperatures of the entering air is effectively prevented.

10 In various types of air heaters heretofore known, the efficiency of the heaters has been considerably reduced by the presence in the heaters of quantities of air locked therein. Efficiency losses of 15% or more due to such "air-binding" have not been uncommon. It is an object of the present invention to substantially completely eliminate "air-binding," to insure a relatively high heat transfer efficiency.

15 It is another object of the invention to provide an improved air heater particularly well adapted to be installed in duct-work or the like comprising a part of an air conditioning or ventilating system.

20 It is another object of the invention to provide a heating apparatus in which the supply of heating medium such as steam may be throttled, if desired, without danger of freezing condensate resulting from cooling of the steam, and with the assurance that all portions of the air stream contacting the heater will be tempered substantially uniformly.

25 Still another object of the invention is to provide a steam heating device for heating air or the like which is relatively simple and inexpensive to construct, and which is highly reliable and effective in operation.

30 A feature of the invention resides in the provision of an apparatus for heating air or the like by means of steam or the like, which comprises a plurality of outer tubes each containing an inner tube provided with a series of orifices spaced intermediate the extremities of the inner tube, each inner tube being spaced from its surrounding outer tube, steam being supplied to each inner tube and condensate being withdrawn from each outer tube at the same side of the apparatus.

35 Another feature of the invention resides in the provision of an air heating apparatus as referred to in the preceding paragraph in which steam passing through the orifices formed in each inner tube is discharged back toward the steam inlet end of the apparatus through a plurality of nozzle formations or the like, whereby to entrain and remove from the apparatus any air which may

tend to be trapped therein, thus to prevent air-binding of the apparatus.

40 Another feature of the invention resides in the provision of an apparatus as referred to above, in which the steam supply header and condensate return header are at the same side of the apparatus, and in which the fluid in said supply header is in heat exchange relation with fluid in said return header.

45 Another feature of the invention resides in the provision of a header structure comprising a steam supply portion and a condensate return portion, both of said portions forming part of an integral structure and being separated by a partition adapted to promote heat exchange between fluids contained in said respective portions.

50 Other objects, features and advantages of the invention will be more apparent from the following description, to be read in connection with the accompanying drawings in which:

Fig. 1 is a side elevational view, partly in section, of a heating apparatus embodying the invention in a preferred form;

Fig. 2 is an end elevational view of the structure of Fig. 1, partly broken away, and with a portion of the surrounding casing removed;

Fig. 3 is a view, in section, taken on the line 3—3 of Fig. 1;

Fig. 4 is a view similar to Fig. 3, of a modified form of the invention;

Fig. 5 is a fragmentary detail view, taken on the line 5—5 of Fig. 3, and

Fig. 6 is a fragmentary detail view, taken on the line 6—6 of Fig. 4.

Referring to the drawings, the numeral 10 designates the end wall of a casing structure including top wall 11, a second end wall 12, and a bottom wall 13. The casing thus formed is generally of rectangular shape, and is relatively shallow. The casing may be so positioned in an air duct or the like, that the top wall 11 and bottom wall 12 are substantially horizontal and so that air flows through the casing in substantially horizontal direction, as indicated generally by arrows 14 in Fig. 2. However, the heater may also be used advantageously in a variety of other positions permitting the return of condensate by gravity.

Suitably mounted within the outer casing, as by bolts 15 or in any other desired manner, is a header structure generally designated 16, situate adjacent the end wall 11. Header structure 16 is preferably shrouded by casing plates 17, so that it is protected from direct contact with the air or other gas to be heated which is caused to flow through the casing under the influence of a fan or the like.

The header structure 16 includes a partition 17a which is preferably cast or otherwise formed integral with the outer portion of the header structure, and which is formed of any suitable material having a relatively high heat conductivity. Partition 17a extends substantially throughout the length of the header structure, thus providing an inlet header 18 for steam or similar heating medium and a return header 19 for condensate. Inlet header 18 is provided with an inlet connection 20 through which steam is supplied to header 18, and header 19 is provided with a return connection 21, through which condensate may be drained therefrom.

Extending outwardly from the header 18 through suitable openings formed in partition 17a are a plurality of steam tubes 22, each steam tube being positioned within an outer or return tube 23 which is received within an extension 24 of the header structure and which communicates with return header 19. Each outer tube extends throughout the length of the outer casing and extends through openings 25 formed in the end wall 12, which constitutes, in effect, a tube sheet supporting the outer tubes. The far end of each outer tube is sealed, as by plugs 26. The outer tubes are approximately horizontally disposed one above the other, but are inclined downwardly toward the return header 19 at a slight angle to promote the return of condensate, by gravity, to the return header 19. The outer tubes 23 are provided with extended surface, generally designated 27, of any desired type, such as spiral fins, to promote heat transfer from the tubes to air passing through the heater.

The inner tubes 22 extend substantially completely throughout the length of the outer tubes 23 and are preferably concentric therewith. The far ends of the inner tubes 23 are preferably closed, but the tubes are provided with a plurality of apertures or orifices 28 spaced lengthwise of the tubes and preferably arranged peripherally therearound. These orifices serve to deliver steam from within the inner tubes 22 into the annular spaces between the inner tubes and the outer tubes. Preferably the orifices 28 are provided with nozzle or deflector formations arranged to discharge the steam delivered from within the tubes 22 back toward return header 19 at relatively high velocity. While any desired nozzle or deflector arrangement may be used, it is preferred to form these by punching out portions of the inner tubes 22, as indicated at 29, whereby the orifices 28 and nozzle discharge formations may readily be provided in a single simple operation. The nozzle formations 29 may serve, if desired, as spacer members for maintaining the inner tubes 22 in desired spaced relationship with the surrounding tubes 23. Due to the manner in which steam is discharged from within the inner tubes, there occurs an ejector action whereby the steam tends to entrain any air which may be in the tubes of the heater. This air is removed from the tubes and delivered to the return header 19, from which it may be relieved in any suitable manner.

Further to insure the elimination of air from the tubes, the orifice 28 which is nearest the header 18 is spaced from the header at a greater distance than the distance between successive or adjacent orifices. This increased distance results in the formation of a relatively low pressure in the return tube near the return header, due to the greater cooling of the steam, and this lower pressure causes air to flow toward the header from all parts of the tubes. Removing air from the

tubes of the heater renders all of the heat transfer service available for effective heat transfer, so that highly efficient operation of the heater is obtained.

To prevent bypassing air around the heater tubes, the outer casing is preferably provided with baffles 30 and 31, located, respectively, at the top and bottom of the casing structure and extending substantially completely thereacross.

To facilitate fabrication of the apparatus, the header structure 16 is preferably provided with a plurality of solder channels 32, adapted to provide communication between the exterior of the header structure and a plurality of annular solder grooves 33 formed in the partition 17a, one of such grooves extending around each tube 22 introduced within partition 17a. In this manner the tubes 22 may be soldered to partition 17a with great facility. Similarly, solder holes 34 formed in header extension 24 communicate with solder grooves 35 extending around each outer tube 23, so that these tubes also may readily be soldered to the header structure.

In air heaters heretofore known, much difficulty has been experienced due to freezing of condensate because of the low temperature of the air passed into contact with the heater. The construction herein described, however, renders freezing of condensate virtually impossible. It will be appreciated that all condensate returning to the header 19 through tubes 23 is in heat exchange relation with steam being supplied within tubes 22. Further, since the outer tubes are thermally bonded to the header structure 16 and hence to the steam supply header 18, the outer tubes are heated by the steam contained within the supply header. The fact that the outer tubes are thus heated further tends to prevent the temperature of the condensate from falling below the freezing point. Again, the condensate within header 19 is heated by steam in the header 18, this heat being transmitted through partition 17a. The condensate in header 19 is also heated by heat transmitted through the outer walls of the header structure from steam in supply header 18. Thus, freezing of condensate is prevented in both the tubes and in the return header, so that at all times during operation of the apparatus unimpeded flow of steam and condensate therethrough is maintained.

If it is desired to throttle the supply of steam to the heater, in order to reduce the heating effect on the air passing therethrough, this may be done without danger of freezing. Thus, if the pressure at which steam is supplied is reduced to such a point that steam is contained within, for example, only half of the length of the inner tubes, all of the returning condensate will still be in good heat exchange relation with the steam being supplied within the inner tubes, and freezing will be effectively prevented as above indicated. The remaining portions of the tubes, under such operating conditions, will be inert and inactive, but this fact in no way interferes with the free and continuous circulation of steam and condensate through the apparatus.

Moreover, the supply of steam may be throttled very considerably without affecting the substantially even heating of air throughout all portions of the heater.

The provision of the discharge or nozzle formations 29 serve to facilitate the return of condensate to return header 19.

While a single bank of heating elements has been illustrated it will be understood that any

desired number of banks may be provided. Also, while it is preferred to have but a single steam tube 22 within each outer tube 23, two or more steam tubes may be provided within each outer tube, if desired.

To insure effective contact between the air being heated and the fins 27 of the heat exchanger, there preferably are provided V-shaped baffles 36 at the air outlet side of the heat exchanger, one of these baffles being nested between and in contact with each pair of finned tubes. Such location of the baffles routes the air in contact with the fins in a devious course and hence for a longer time, and thus increases the rate of heat transfer.

Fig. 4 illustrates a modified form of the invention which embodies the same basic design as described above. However, it will be observed that in this embodiment of the invention, the solder channels 32 and the solder holes 34 are eliminated. To effect desired soldering of the tubes 22 and 23, the solder grooves 33a and 35a are prefilled with suitable soldering material, and after the tubes have been inserted in desired position heat is applied, as by means of a gas torch or the like, to melt the solder and effect the desired soldering of the tubes within the header structure.

In Fig. 4 the orifices 29a, through which steam is discharged from the inner tubes 22, are distributed along and around the tubes 22 as above described. However, in this embodiment, the directional nozzle formations are dispensed with. To provide for maintained concentric spacing of the tubes 22 within the tubes 23, there are provided a plurality of spacers 37. These spacers may comprise short lengths of copper wire or the like, preferably soldered or otherwise firmly secured to the inner tubes 22 and extending axially therealong. Preferably a spacer 37 is positioned diametrically opposite each orifice 29a, to insure minimum interference with the flow of steam and condensate.

If desired, the spacers may be eliminated by "bumping out" the tube at different points, the bumps thus formed serving to maintain the desired spaced relationship of the tubes.

If desired, a suitable strainer or filter may be provided in connection with the steam inlet to prevent particles of boiler scale and other foreign

matter from entering the tubes. Such a filter is indicated at 38 in Fig. 4, and is preferably of the type which may be snapped into and out of desired position at the steam inlet connection 20.

Since many changes may be made in the invention without departing from its scope, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense, applicant limiting himself only as indicated in the appended claims.

I claim:

1. A heating apparatus comprising a header structure, means for supplying steam to an inlet portion of the header structure and for removing steam and condensate from an outlet portion thereof, steam distributing tubes connected to said inlet portion of the header structure, steam and condensate return tubes surrounding each of said distributing tubes and connected to said outlet portion, said distributing and return tubes being closed at their ends remote from the header structure, said distributing tubes having perforations spaced substantially throughout the length thereof, said tubes being inclined so that condensate from steam supplied to a portion of the distributing tubes will flow back to the header structure and not proceed in a direction from the header structure beyond the points where condensation occurs in the tubes.

2. A heating apparatus comprising a header structure, means for supplying steam to an inlet portion of the header structure and for removing steam and condensate from an outlet portion thereof, steam distributing tubes connected to said inlet portion of the header structure, steam and condensate return tubes surrounding each of said distributing tubes and connected to said outlet portion, said return tubes being closed at their ends remote from the header structure, said distributing tubes having perforations spaced substantially throughout the length thereof, said tubes being inclined so that condensate from steam supplied to a portion of the distributing tubes will flow back to the header structure and not proceed in a direction from the header structure beyond the points where condensation occurs in the tubes.

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