Dec. 5, 1950 A. F. HUBBARD 2,532,550

STEAM HEATING SYSTEM

Filed May 21, 1948 2 Sheets-Sheet 1

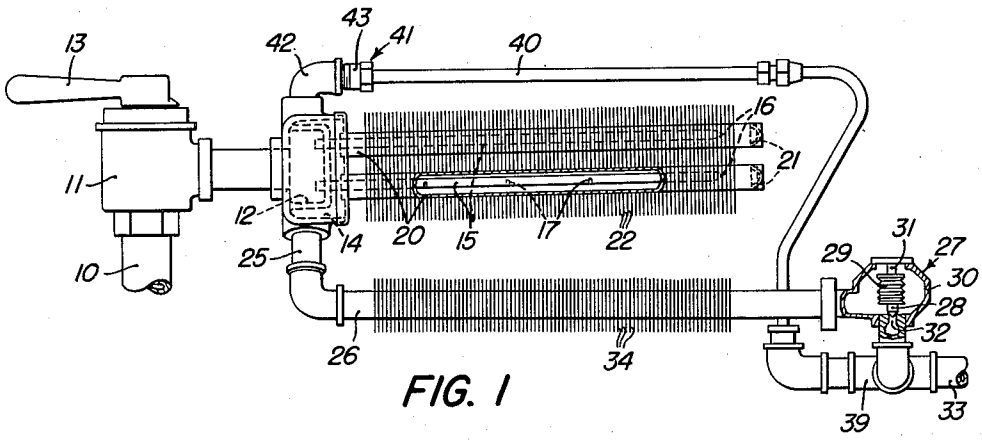

FIG. 1

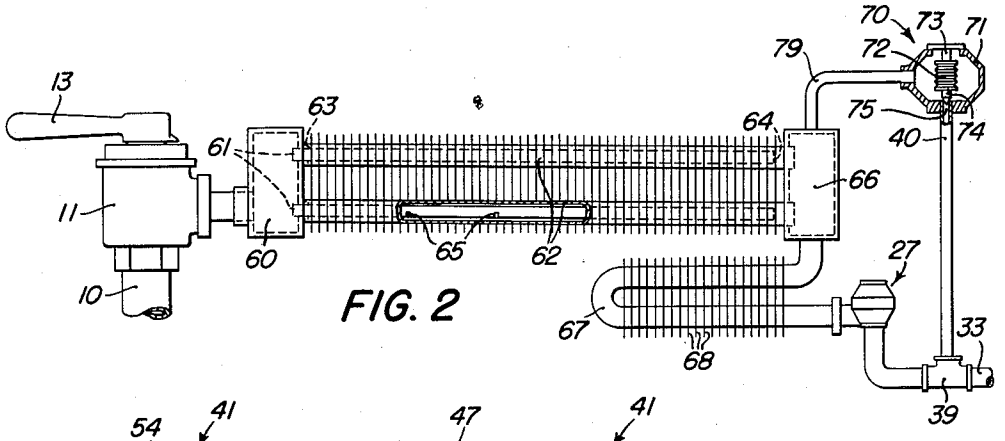

FIG. 2

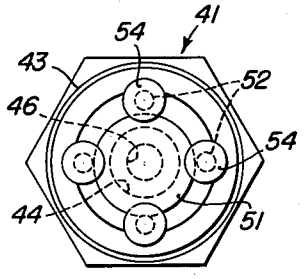

FIG. 4

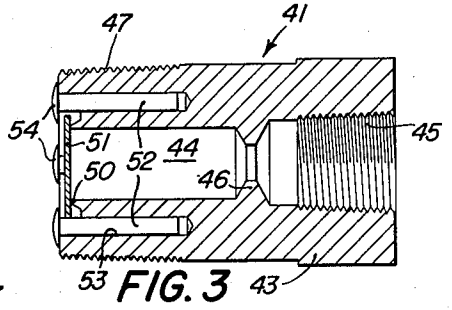

FIG. 3

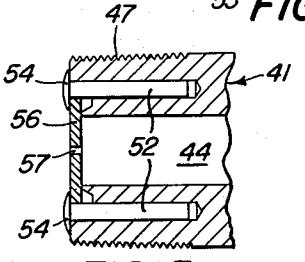

FIG. 5

INVENTOR.
ARTHUR F. HUBBARD
BY C. T. Parker
ATTORNEY

Dec. 5, 1950 A. F. HUBBARD 2,532,550

STEAM HEATING SYSTEM

Filed May 21, 1948 2 Sheets-Sheet 2

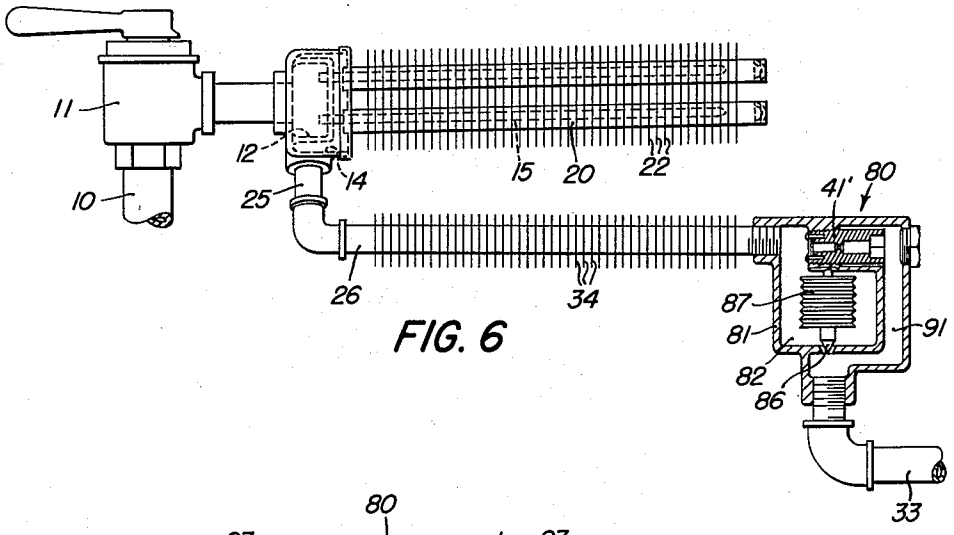

FIG. 6

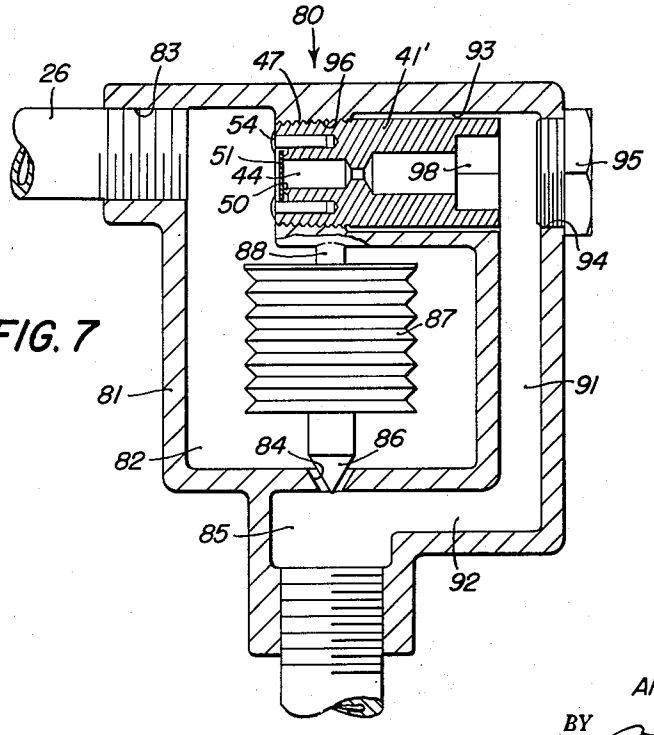

FIG. 7

INVENTOR.
ARTHUR F. HUBBARD
BY C. T. Parker
ATTORNEY

Patented Dec. 5, 1950 2,532,550

UNITED STATES PATENT OFFICE

2,532,550

STEAM HEATING SYSTEM

Arthur F. Hubbard, Moline, Ill., assignor to The Herman Nelson Corporation, Moline, Ill., a corporation of Illinois

Application May 21, 1948, Serial No. 28,322

15 Claims. (Cl. 237—9)

1

The present invention is related generally to vapor heat transfer systems and more particularly to steam heating systems. The principal object of my invention relates to the provision of a novel and improved steam heating system in which the temperature distribution in the heating elements is more uniform than has been heretofore commercially attained. Another object relates to the provision of a heating system which operates without noise due to water hammer or to air gurgling through the condensate.

A steam heating system of this type now known in the art is provided with a thermostatically operated condensate return trap connected between the exhaust header and the return line. The trap valve is closed responsive to the heat of the steam passing through and opens responsive to the cooling action of the accumulated condensate. When the main supply valve is open, steam condenses in the heating element at a rapid rate, flooding the lower portion of the element before the condensate is sufficiently cooled to cause the trap to open and drain off the condensate. This results in uneven heating of the element and also unequal expansion and contraction of the heating tubes, and the intermittent flooding causes disturbing noises.

When the steam supply is throttled, condensation of the steam in the element results in a substantial pressure drop across the throttle valve. Frequently the pressure in the element has dropped to a value lower than that of the return line. Upon subsequent opening of the trap, the greater pressure in the return line prevents free draining of the condensate. As the water drains from the trap, air must flow in from the return line, resulting in disturbing noise.

A specific object of my invention, therefore, relates to a provision for collecting and cooling the condensate below the heating element to prevent flooding of the latter.

Still another object has to do with a provision for equalizing the pressure between the exhaust header and the return line to permit free draining of the condensate. A further object relates to a provision for preventing escape of steam through the pressure equalizing means when the exhaust header is at a higher pressure than the return line.

A further object relates to the provision of a novel and simplified check valve, which is more economical to manufacture but is more efficient and less subject to operating difficulties due to rust, scale and other impurities than those of the prior art.

2

Another object relates to the provision of an improved heating element comprising heating tubes within which the distributing tubes are offset upwardly from the axes of the outer tubes to provide additional space for condensate.

Still another object relates to the provision of a condensate trap having a provision for equalizing the pressure above and below the valve to facilitate draining, the equalizing means being built into the trap itself.

These and other objects and advantages of my invention will be apparent to those skilled in the art after a consideration of the following description, reference being had to the drawings appended hereto, in which

Figure 1 is a diagram of a steam heating system embodying the principles of my invention;

Figure 2 is a diagram showing a modified form of the invention;

Figure 3 is an enlarged sectional view taken along an axial plane through the check valve;

Figure 4 is an end view of the check valve;

Figure 5 is a fractional sectional view of the check valve but with a fixed orifice in place of the check valve element;

Figure 6 is a diagram showing still another modified form; and

Figure 7 is an enlarged sectional view of a condensate trap embodying the principles of the present invention.

Throughout the drawings and in the following description, like numerals refer to like parts.

Referring now to the drawings and more particularly to Figure 1, the heating element is supplied with steam under any suitable pressure by means of a steam supply line 10 extending from a conventional steam generator (not shown). A control valve 11 of any suitable design is connected to the supply line for throttling the steam flowing to the supply header 12 and is provided with a handle 13 for convenience in manual adjustment, although any suitable automatic control device may be employed for regulating this valve.

The supply header 12 is combined with an exhaust header 14 in a unitary casting wherein the supply header is within or partially surrounded by the exhaust header. A number of steam distributing tubes 15 project from the supply header 12 and communicate therewith. The outer ends 16 are closed and the tubes are provided with axially spaced openings 17 through which the steam is distributed to the outer tubes 20 which enclose the distributing tubes 15. The outer tubes 20 of the heating element communi-

cate at their inner ends with the exhaust header 14 and their outer ends are closed by plugs 21. Heat dissipating fins 22 are mounted on the outer tubes 20 to provide a large heat transfer surface over which the air for ventilation is circulated in a manner well known to those skilled in the art. The tubes 20 are disposed on a slight incline with their outer ends higher than their inner ends to drain the condensate into the exhaust header 14, and the axes of the distributing tubes 15 are spaced above the axes of the associated outer tubes to increase the space for condensate in the bottom of the tubes 20.

A condensate duct 25 communicates with the bottom of the exhaust header 14 and extends downwardly therefrom for draining the header 14 and tubes 20 to prevent flooding with condensate. The condensate tube 25 has a portion 26 extending nearly horizontally but inclined slightly downwardly toward a condensate trap 27, preferably, but not necessarily, of the thermostatic type. The thermostatically operated trap includes a valve member 28 suspended inside a casing 30 by a bellows 29 which is carried on a support 31 from the top of the casing 30 and is filled with a suitable expansible medium as is well known to those skilled in the art. The valve member 28 is shifted by expansion and contraction of the bellows 29 into and out of closed relation with an orifice 32 in the bottom of the casing 30.

The condensate duct 26 communicates with the interior of the casing 30 for delivering the condensate thereto. The orifice 32 discharges the condensate into a return line 33 which returns the condensate to the steam generator. An exhaust pump (not shown) may be provided to maintain a subatmospheric pressure in the line 33 as is well known to those skilled in the art. The duct 26 is provided with suitable fins 34, over which ventilating air is blown, thereby cooling the condensate. The trap orifice 32 is disposed at a lower elevation than the heating tubes 20 to maintain a head of condensate above the orifice to facilitate draining when the valve 28 opens.

The upper end of the exhaust header 14 is connected with the return line, by-passing the valve orifice 32 of the trap, by means of a pressure equalizing duct 40, which communicates with the header 14 through a control device 41 having a tapered threaded end portion 47 which screws into a pipe elbow 42. While the equalizing duct 40 is preferably connected to the top of the exhaust header 14, it is feasible to make the connection with the condensate duct 25, 26, at any point between the trap 27 and header 14, the essential consideration being the by-passing of the valve orifice 32. The other end of the equalizing duct 40 is connected to the return line 33 through a T 39 which is also coupled to the trap beneath the valve orifice 32.

Referring to Figures 3 and 4, the control device in the preferred embodiment of my invention comprises a metal block or body 43, preferably of bronze, having an axially extending aperture 44 therein. One end of the aperture 44 is threaded at 45 to receive the cooperatively threaded end of the equalizing duct 40. A restriction 46 is provided within the aperture 44 to restrain rust, scale or other impurities from passing from the duct 40 through the aperture 44. The other end of the aperture 44 has a sharp annular peripheral edge 50 forming a seat for a valve disk 51 of suitable corrosion resistant metal, such as Monel metal. The disk 51 is retained in front of the opening by a plurality (four) of pins 52 disposed in axially extending, peripherally spaced recesses 53 in the end of the body 43 and preferably soldered therein, although they could be threaded into the recesses 53. The pins 52 serve as bearing supports for the edge of the disk 51 and are provided with heads 54 which overlap the edge of the disk to retain the latter in position over the end of the opening 44. The edge of the seat 50 is spaced axially inwardly from the end of the body 43 to provide for a limited amount of axial movement of the loose disk 51 toward and away from the seat 50.

Pressure on the outer side of the disk 51 forces the latter against the seat 50 and thus closes the valve while pressure applied to the inner side of the disk urges the latter away from the seat 50 into engagement with the overlapping heads 54, permitting flow of fluid out of the aperture 44 around the edge of the disk 51.

The operation of the embodiment of Figure 1 is explained as follows:

When the main valve 11 is opened, steam from the supply line 10 flows through the header 12 into the inner tubes 15 and is distributed from the openings 17 into the outer tubes 20. Heat is transferred from the steam to the air through the fins 22 and the condensed steam runs inwardly through the tubes 20 to the exhaust header. The water runs down through the condensate duct 25 and is further cooled by air passing over the fins 34 on the cooling duct 26.

Assuming a surplus of steam being delivered to the element, a certain amount of steam flows into the trap casing 30 with the condensate, thereby heating the bellows 29 and causing the latter to expand. This forces the valve member 28 to be moved downwardly into closing relation with the orifice 32, preventing further escape of condensate. The condensate collects in the cooling duct 26 beneath the heating element as the steam in the latter condenses, until the condensate is sufficiently cooled to contract the bellows 29, thereby withdrawing the valve member 28 from the orifice 32 and draining the casing 30 and duct 26, whereupon steam enters the casing 30 once more, closing the trap valve as before.

Inasmuch as a presure differential is maintained in the heating element and exhaust header relative to the return line, the check valve disk 51 is held against the valve seat 50 thus preventing steam from escaping through the equalizing line 40 to the return line 33.

When a lower rate of heating is desired, the control valve 11 is partially closed, throttling the steam flowing into the heating unit. Condensation of the steam in the tubes 20 lowers the pressure therein. When the pressure in the exhaust header 14 tends to drop below that in the return line 33, air from the return line flows through the equalizing line 40 and the check valve 41 into the exhaust header, where it mixes with the steam and displaces the condensate which is drained from the trap. This action is noiseless, for it eliminates the necessity for air to flow into the trap through the orifice 32. The heating element is uniformly heated, since there is no flooding of the tubes with condensate, and experience has proved that there is no water hammer noise at any time.

Instead of connecting the pressure equalizing

line 40 to the return line 33, it may be opened to the atmosphere and a plug installed in the connection to the T 39. Air is then drawn from the atmosphere through the check valve 41, but constitutes an additional load on the return line exhaust pump (not shown), if used.

The check valve in the pressure equalizing line 40 can be replaced by a fixed orifice, if desired. Figure 5 shows one means for accomplishing this by replacing the loose disk 51 with a disk 56 having a small aperture 57 serving as a restrictive orifice between the equalizing line 40 and the exhaust header 14. The apertured disk 56 is appreciably thicker than the check valve disk 51 and can be held firmly against the seat 50 by the heads 54 of the bolts or pins 52.

This embodiment operates in a manner similar to that of Figure 1, except that there is a continuous leakage of steam through the aperture 57 to the return line when the pressure in the header 14 is higher than in the return line 33. However, the steam is condensed in the equalizing line 40 and is discharged into the return line as condensate. Obviously, other equivalent means may be used for providing a restricted orifice in the pressure equalizing line.

Figure 2 shows another embodiment of my invention in which the check valve 41 in the pressure equalizing line is replaced by a thermostatic valve. In this embodiment another form of conventional heating element is illustrated. Steam from the supply line 10 flows through the control valve 11 to a steam supply header 60 at one end of a heating element comprising inner steam distributing tubes 61 communicating with the header 60 and extending through respective outer tubes 62, the ends of the latter being sealed around the distributing tubes at 63 adjacent the header 60. The opposite ends 64 of the distributing tubes are closed by suitable plugs and have a series of longitudinally spaced openings 65. The outer tubes communicate with an exhaust header 66.

Condensate is discharged from the exhaust header 66 through a cooling duct 67 to the trap 27, the cooling duct 67 having heat dissipating fins 68. The pressure equalizing duct 40 is connected between the T 39 in the return line 33 and a thermostatic vent valve 70. The valve 70 comprises a casing 71 connected by a duct 79 with the top of the exhaust header 66, a bellows 72 within the casing suspended from the top by a support 73, and a valve member 74 suspended below the bellows and movable by expansion and contraction of the latter into and out of closing relation in a valve orifice 75 which communicates with the return line 33 through the equalizing line 40.

The operation of this form of the invention is similar to that of the embodiment of Figure 1, except that steam under pressure in the exhaust header escaping through the duct 79 warms the bellows 72 causing them to expand and shift the valve member 74 into closed position, stopping the flow of steam through the orifice 75 and equalizing line 40. When the pressure in the exhaust header drops during throttled operation of the control valve 11, the bellows in cooling, raise the valve member 74 away from the orifice 75, permitting air from the return line 33 to flow through the equalizing line 40 into the header 66.

Thus, it is now evident that flooding of the tubes of the heating element is prevented by

providing the cooling duct 26 (or 67) beneath the heating element, while free drainage is assured by the pressure equalizing line which conducts air into the exhaust header when the pressure therein drops below that of the trap. The check valve 41 (or thermostatic valve 70) prevents escape of steam during full steam operation.

Referring now more particularly to Figures 6 and 7, this embodiment of my invention is similar to that of Figure 1, but differs therefrom in that the pressure equalizing line is built into the condensate trap itself and merely by-passes the discharge valve in the trap. The trap 80 in this embodiment comprises an upright casing 81 within which is a condensate receiving and collecting chamber 82 having an intake opening 83 in the upper portion to which the condensate duct 26 connects for delivering condensate into the trap chamber 82.

A discharge orifice 84 is provided in the bottom of the chamber 82, through which the condensate flows into the discharge duct 85 beneath the chamber. The discharge duct 85 communicates with the return line 33. A valve member 86 is adapted to seat in the orifice 84 and is controlled by a conventional bellows 87 on which the member 86 is mounted. The top of the bellows has a support 88 attached to the top of the casing 81. The bellows is filled with a suitable heat expansible medium and operates to shift the valve member 86 up or down to open or close the orifice 84 in a well known manner.

A by-pass duct 91 is provided in the trap casing, preferably formed in the wall thereof as by drilling, or cored therein, although it can be made of a separate tube. The by-pass duct 91 extends vertically and has a lower horizontal portion 92 which communicates with the discharge duct 85 beneath the discharge orifice 84. The by-pass duct 91 also has a horizontal upper portion 93 communicating with the upper portion of the chamber 82. Thus, the duct 91 communicates between the upper portion of the trap chamber and the discharge duct 85 beneath the orifice 84, thereby by-passing the orifice and its controlling valve member 86.

In the by-pass duct, preferably in the upper portion 93 as shown, is disposed a control device 41' which is generally simillar to the control device 41 shown in Figure 3. It has a tapered threaded portion 47 which engages threads 96 in the inner end of the duct 93. An opening 94 is provided in the outer wall of the casing 81 to provide for installation or removal of the control device. The opening 94 is normally sealed by a plug 95. The outer end of the axially extending aperture 44 is formed as a square opening 98 to permit a tool to be inserted therein for unscrewing the device from the threads 96.

The valve disk 51 is held in closed position against the seat 50 whenever the pressure in the chamber 82 is higher than the pressure in the return line 33, thereby preventing escape of steam or condensate through the by-pass duct 91. Hot condensate or steam in the trap chamber 82 expands the bellows to close the valve member 86 into the orifice 84, thus retaining the condensate in the trap and condensate duct 26 until the condensate cools sufficiently to contract the bellows to open the orifice 84 and drain the chamber 82 into the return line 33.

However, when the pressure in the exhaust header 14, condensate duct 26 and trap chamber 82 is lower than that in the return line 33, air

from the latter flows upwardly through the by-pass duct 91 through the control device past the disk 51 into the upper portion of the trap chamber 82, from which it can bubble up through the head of condensate in the duct 26 into the header 14. Equalizing the pressures in the trap chamber 82 and discharge duct 85 in this manner permits free flow of condensate downwardly through the orifice 84 when the valve is opened.

The check valve disk 51 can be replaced by an apertured disk 56 in this embodiment as in the embodiment of Figure 1, and the control device 41' can be replaced by a thermostatic valve for controlling the by-pass duct as in Figure 2.

I do not intend my invention to be limited to the particular details shown and described herein, except as limited by the claims which follow. Although I have described my invention as embodied in a steam heating system, it is understood that the principles may be employed in other vapor heat transfer systems, as will now be apparent to those skilled in the art.

I claim:

1. In steam heating apparatus comprising a steam supply header, a heating element connected thereto, an exhaust header communicating with said element and a condensate return line, the improvement which comprises a condensate trap disposed at a lower elevation than said heating element and connected to said return line, a condensate cooling duct below said exhaust header interconnecting said trap and said exhaust header, and a pressure equalizing line connecting said exhaust header directly with said return line, said equalizing line including valve means arranged and constructed to prevent steam from flowing from said exhaust header to said return line but permitting air to flow from said return line into said exhaust header.

2. In steam heating apparatus comprising a heating element, supply and exhaust headers connected thereto, a condensate trap connected to receive condensate from said exhaust header and a return line connected to said trap to receive the condensate discharged therefrom, the improvement which comprises means including a pressure equalizing duct connecting said exhaust header with said return line independent of said trap, and valve means in said duct arranged and constructed to permit air to flow from said return line to said exhaust header but restricting flow of steam in the reverse direction.

3. In steam heating apparatus comprising a heating element, supply and exhaust headers connected thereto, a steam supply duct connected with said supply header and having a throttle valve therein for throttling the steam supplied to said header, a condensate trap connected to receive condensate from said exhaust header and a return line connected to said trap to receive the condensate discharged therefrom, the improvement which comprises means including a pressure equalizing duct connecting said exhaust header with said return line by-passing said trap, and valve means in said duct arranged and constructed to permit steam from flowing therethrough to said return line when said throttling valve is substantially open to maintain steam pressure in said header but permitting air to flow into said exhaust header from said return line when said throttling valve is partially closed and the pressure in said exhaust header tends to drop below the pressure in said return line.

4. The combination set forth in claim 3, including the further provision that said valve means in said duct is a check valve including an orifice and a gate movable into closed position over said orifice by steam pressure on one side of the gate, said gate being movable away from said orifice by air pressure on the other side of said gate.

5. The combination set forth in claim 3, including the further provision that said valve means in said duct is a thermostatic type valve including means responsive to flow of steam through said duct for closing said valve.

6. In steam heating apparatus comprising a heating element, supply and exhaust headers connected thereto, a steam supply duct connected with said supply header and having a throttle valve therein for throttling the steam supplied to said header, a condensate trap connected to receive condensate from said exhaust header and a return line connected to said trap to receive the condensate discharged therefrom, the improvement which comprises an air intake duct connected with said exhaust header, and valve means in said duct so arranged and constructed as to prevent steam from flowing therethrough when said throttling valve is substantially open to maintain steam pressure in said supply header but permitting air to flow into said exhaust header when said throttling valve is partially closed and the pressure in said exhaust header tends to drop below atmospheric pressure.

7. In steam heating apparatus comprising a heating element, supply and exhaust headers connected thereto, a steam supply duct connected with said supply header and having a throttle valve therein for throttling the steam supplied to said header, and a condensate return line, the improvement which comprises a condensate trap disposed at a lower elevation than said heating element and connected to said return line, a condensate cooling duct below said exhaust header interconnecting said trap and said exhaust header for collecting and retaining condensate until the latter is discharged from said trap into said return line, a pressure equalizing duct connecting said exhaust header with said return line independent of said trap, and valve means in said duct so arranged and constructed as to automatically prevent steam from flowing therethrough to said return line when said throttling valve is substantially open to maintain steam pressure in said header but permitting air to flow into said exhaust header from said return line when said throttling valve is partially closed and the pressure in said exhaust header tends to drop below the pressure in said return line.

8. In heat transfer apparatus, a heating element comprising a heating tube and a distributing tube disposed within said heating tube, said distributing tube being provided with axially spaced discharge apertures and positioned with its axis spaced above the axis of said heating tube to provide an enlarged space in said heating tube below said distributing tube for passage of condensate.

9. In heat transfer apparatus, a supply header, an exhaust header, a heating tube communicating with said exhaust header, a distributing tube communicating with said supply header and extending into said heating tube, said distributing tube being provided with axialy spaced discharge apertures and positioned in said heating tube with the axis of the distributing tube spaced above the axis of said heating tube to provide an enlarged space below said distributing tube for

passage of condensate through said heating tube into said exhaust header.

10. In heat transfer apparatus comprising a heating element, supply and exhaust headers connected thereto, a condensate trap casing including a trap chamber having a connection with said exhaust header to receive condensate therefrom and a return line connected to said trap casing to receive the condensate discharged therefrom, the improvement which comprises an air intake duct communicating with said connection between said chamber and said exhaust header, and check valve means associated with said air intake duct for restricting the flow therein away from said chamber while permitting flow toward said chamber.

11. The combination set forth in claim 10, including the further provision that said air intake duct is connected to said return line, thus by-passing said trap chamber.

12. In heat transfer apparatus comprising a heating element, supply and exhaust headers connected thereto, a condensate trap connected with said exhaust header to receive condensate therefrom, and a return line connected to the bottom of said trap to receive the condensate discharged therefrom, said trap comprising a chamber for receiving and collecting condensate and a valve in the bottom of said chamber for controlling the flow of condensate into said return line, the improvement which comprises a by-pass duct connecting the upper portion of said chamber with said return line, by-passing said valve, and means disposed in said by-pass duct for restraining flow of fluid therethrough toward said return line.

13. The combination set forth in claim 12, including the further provision that said restraining means comprises a check valve preventing flow of steam or condensate from said chamber toward said return line but permitting a pressure-equalizing flow of air from the return line into said chamber.

14. In a condensate trap comprising a chamber for receiving and collecting condensate having an intake opening in the upper portion and a discharge duct communicating with the bottom of said chamber, and a valve in said discharge duct for controlling the flow of condensate through said discharge duct, the improvement which comprises a by-pass duct communicating between said chamber above said valve and said discharge duct below said valve, and means disposed in said by-pass duct for restraining flow of fluid therethrough out of said chamber.

15. The combination set forth in claim 14, including the further provision that said restraining means comprises a check valve preventing flow of steam or condensate from said chamber toward said discharge duct but permitting a pressure-equalizing flow of air from the discharge duct into said chamber.

ARTHUR F. HUBBARD.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
731,776	Hamilton	June 23, 1903
1,441,449	Rich	Jan. 9, 1923
1,957,867	Rike	May 8, 1934
1,993,832	Durdin	Mar. 12, 1935
2,041,282	Brooks	May 19, 1936
2,060,844	Adlam	Nov. 17, 1936
2,213,053	Russell	Aug. 27, 1940
2,346,590	La Rocque et al.	Apr. 11, 1944
2,366,332	Harrison et al.	Jan. 2, 1945
2,402,610	Deverall	June 25, 1946

Certificate of Correction

Patent No. 2,532,550 December 5, 1950

ARTHUR F. HUBBARD

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows:

Column 7, line 67, for the word "permit" read *prevent*;

and that the said Letters Patent should be read as corrected above, so that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 6th day of February, A. D. 1951.

[SEAL]

THOMAS F. MURPHY,
Assistant Commissioner of Patents.