

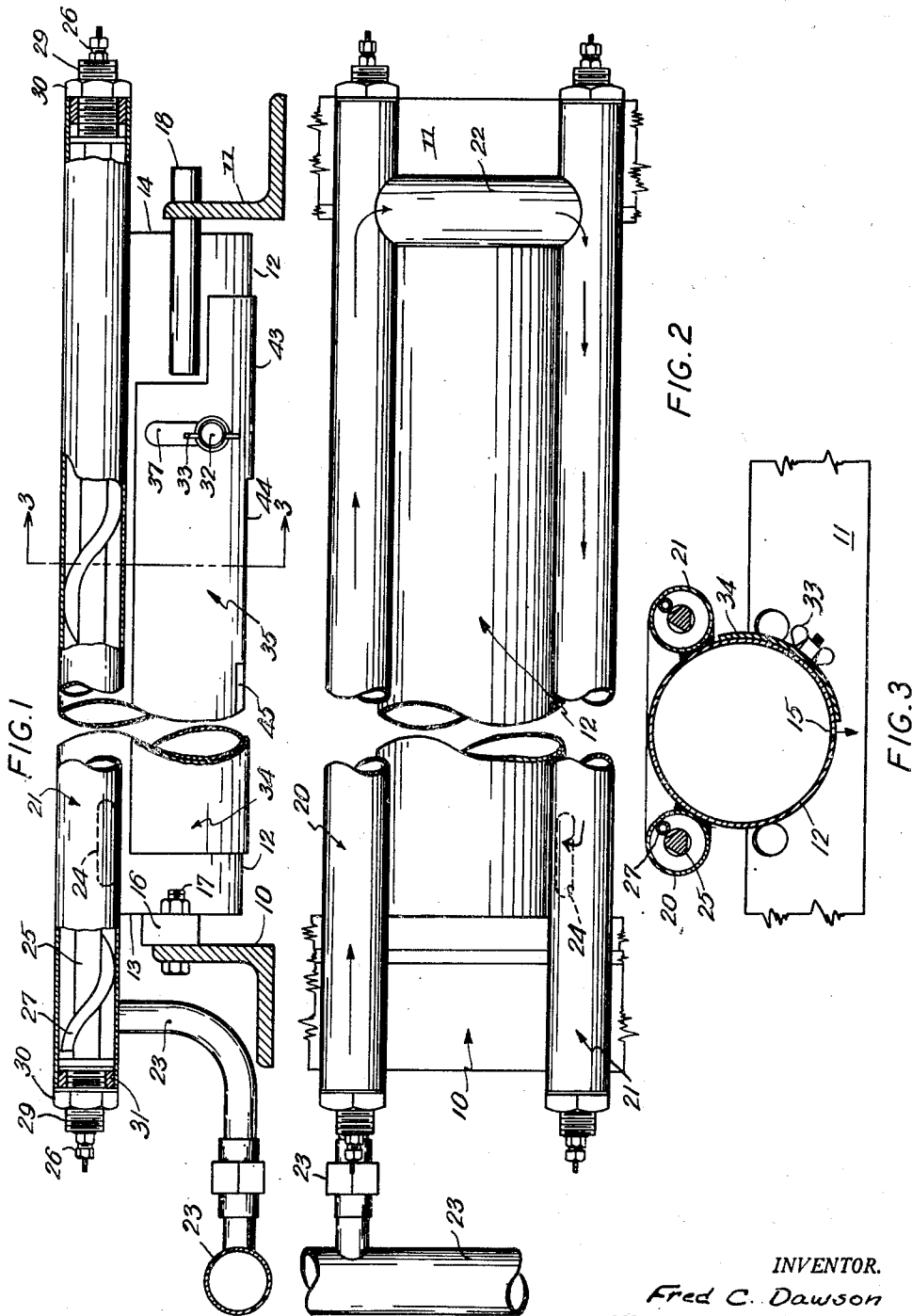
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HEAT EXCHANGER

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2 SHEETS—SHEET 1



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HEAT EXCHANGER

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This invention relates to heat exchangers, and relates more particularly to heat exchangers utilizing electric heaters for superheating steam, which is used for duties such as drying of printed sheets and the fusing of plastics.

My Patent No. 2,464,119 which issued March 8, 1949 discloses a dryer in which superheated steam is projected within a hood upon the upper surface of a sheet having printing thereon of moisture setting ink. This invention provides an improved heat exchanger for superheating and applying the superheated steam to the surfaces of materials to be heated by the steam, and which may be used not only for drying, but for heating, aside from drying, as for the fusing of plastics.

A feature of the invention resides in the effective use of electric heaters for the superheating of steam. This is accomplished, in one embodiment of the invention, by not only passing the steam to be superheated, longitudinally of a pipe around a centrally disposed electric heating element, but by providing a tube wound spirally around the heating element in contact therewith and with the interior of the pipe, whereby not only is extended heat exchange surface provided, but turbulent steam flow as well, the latter breaking up the insulating films which tend to form on heat exchange surfaces.

An object of the invention is to provide an improved heat exchanger particularly suited for the superheating of steam.

Another object of the invention is to provide an improved heat exchanger utilizing electric heating elements for the heating of a gas such as steam.

Another object of the invention is to provide an improved thermostatic control for the regulation of heat applied by an electric heater to the heating of a gas such as steam.

The invention will now be described with reference to the drawing, of which:

Fig. 1 is a side elevation, partially in section, of a heat exchanger embodying this invention;

Fig. 2 is a plan view looking downwardly upon the heat exchanger of Fig. 1;

Fig. 3 is a sectional view along the lines 3—3 of Fig. 1;

Fig. 4 is a partial plan view, partially in section, and partially broken away to show the location of a thermostat bulb in one of the heat exchangers;

Fig. 5 is a section along the lines 5—5 of Fig. 4;

Fig. 6 is a side elevation of another heat exchanger embodying this invention, and differing

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from that illustrated by Figs. 1 and 2 in that a single tube containing an electric element, instead of a pair of tubes containing electric heating elements, is used, and

Fig. 7 is a partial side elevation of one of the heat exchangers and illustrates one of the stepped, rotary plates which is used for adjusting the steam flow to suit different widths of sheets being treated.

My said patent may be referred to for the illustration of a hood and its accessories, for placement over a surface to be heated. Such a hood would be used over the heat exchangers illustrated by the present drawing.

Referring first to Figs. 1, 2 and 3, the heat exchanger illustrated is supported from the structural angles 10 and 11 which extend above and on opposite sides of a surface to be heated.

The heat exchanger comprises the steam distributing pipe 12 having closed ends 13 and 14, and having a narrow slit or spaced nozzles 15 (Fig. 3) in its lower center and through which, superheated steam is projected upon a surface to be heated. The metal bar 16 extends horizontally across the end 13 of the pipe 12 and is attached thereto as by welding. The bar 16 is attached to the angle 10 by the bolts 17. The rods 18 are attached as by welding, to the pipe 12 adjacent its other end, and are slidably fitted with circular openings in the angle 11 for providing expansion movement when heat is applied.

The pipe 12 has attached to the opposite sides of its upper portion, as by welding, the two tubes 20 and 21 which are interconnected at their ends adjacent the end 14 of the pipe 12, by the tube 22 extending transversely therebetween. Steam from a conventional source is supplied through the piping 23 into the interior of the tube 20. The tube 21 and the pipe 12 have a common interconnecting slot 24 adjacent the left hand end of the tube 21 for supplying superheated steam from the tube 21 into the pipe 12.

Each of the tubes 20 and 21 contains a centrally extending, cylindrical, electric heating element 25 having the connection 26 at its ends for the supply of electric energy. A tube 27 is wound spirally around each element 25 in contact with its outer surface, and in contact with the inner surface of the tube 20 or 21 in which it is placed.

The tubes 20 and 21 preferably are flattened where they touch the tubes 27 as illustrated by Fig. 3 of the drawing, for providing better contact with the tubes 27. The tubes 27 also serve to support and center the heating elements 25 in the tubes 20 and 21.

The ends of the elements 25 are held in the threaded rods 29 on which the nuts 30 are threaded against the ends of the tubes 20 and 21, for securing the elements in place within the ends of the tubes. An assembly consisting of an element 25 and a tube 27 wound thereon can be slid into a tube 20 or 21 through one of its ends. The rods 29 have the sleeves 31 threaded thereon inside the end portions of the tubes 20 and 21 and which serve to space the rods 29 and the elements 25 from the walls of the tubes 20 and 21, and since they are slidably fitted in the ends of the tubes 20 and 21, they provide for outward movement of the ends of the elements when they expand on being heated.

Each distributing pipe 12 has two pairs of circular openings in one lower side, one pair adjacent each end, and through which extend the bolts 32 having the wing-nuts 33 threaded thereon. A parti-cylindrical plate 34 has a pair of slots 36 therein around the pair of bolts 32 adjacent one end of the pipe 12, and another parti-cylindrical plate 35 has a pair of slots 37 therein around the pair of bolts 32 adjacent the other end of the distributing pipe.

The plates 34 and 35 are curved to fit against the exterior surface of the distributing pipe, and are movable up and down by positioning the slots therein relative the bolts 32 when the wingnuts 33 are loosened and serve to block off sufficient of the superheating steam discharge nozzles 15 to suit the width of the surface to be heated.

When the surface to be heated has maximum width requiring all of the nozzles of the distributor pipes to be in operation, the plates 34 and 35 will be raised to their uppermost positions so that no nozzles are blocked. When a surface to be heated is narrower than maximum, the plates 34 and 35 are lowered to block off sufficient of the nozzles to suit the width of the surface. This is accomplished through the stepped construction of the lower edges of the plates. As illustrated by Fig. 7, the plate 34 has stepped horizontal, lower edges 40, 41 and 42, the outer edge 40 being lowermost, the intermediate edge 41 being higher than the edge 40, and the inner edge 42 being higher than the edge 41.

Likewise, the plate 35 has the stepped, horizontal lower edges 43, 44 and 45, the outer edge 43 being lowermost, the intermediate edge 44 being higher than the outer edge 43, and the inner edge 45 being higher than the edge 44.

For a maximum width surface to be heated, the plates 34 and 35 are raised to their uppermost positions and the wing-nuts 33 are tightened to hold them in that position. At such time, none of the nozzles 15 are blocked, and superheated steam is applied from all the nozzles.

When a surface having a width less than the said maximum width by a dimension equal to the added lengths of the plate edges 40 and 43 is encountered, the plates 34 and 35 are lowered so that the outer nozzles 15 are blocked by the outer plate edges 40 and 43.

When a surface having a width less than the maximum by a dimension equal to the added lengths of the plate edges 40, 41, 43 and 44 is encountered, the plates are lowered further until their edges 41 and 44 block off more of the nozzles.

When a surface having a minimum width is encountered, the plates are lowered still further until the plate edges 42 and 45 block off still more of the nozzles.

In the operation of the heat exchanger illus-

trated by Figs. 1, 2 and 3, electric heat is applied to the heating elements 25, and steam is supplied through the piping 23 into the interior of the tube 20. The steam is caused by the spirally wound tube 27 to spin around the inside of the tube whereby its interior and the exterior of the element 25 are effectively scoured for preventing the formation of insulating steam layers. The tube 27 also provides extended heat transfer surface for facilitating the superheating of the steam. On reaching its right hand end of the tube 20, the steam passes through the cross-connecting tube 22 into the interior of the right hand end of the tube 21, and passes along the length of the tube 21 around a heating element 25 therein, and is caused to spin around that element by a tube 17 wound spirally around same. The superheated steam is then discharged through the slot 24 into the interior of the pipe 12, and is projected from same through the nozzles 15 onto the surface of the material being heated.

In the embodiment of the invention illustrated by Figs. 1-3, the steam for each exchanger is superheated first in a tube 20 and then in a tube 21 before being discharged into the distributing pipe 12.

For some duties where such a high degree of superheat is not required, the embodiment of the invention illustrated by Fig. 6 may be used. In this embodiment, a single, exterior tube 20 is used, it being connected adjacent its right-hand end through a connecting tube 45 with a distributing tube 46 within the pipe 12, and having its right hand end welded to the right hand end of the pipe 12. The tube 46 has a slot 47 at its left hand end through which steam is discharged within the pipe 12. As in the case of Figs. 1-3, the tube 20 of Fig. 6 contains an electric heating element 25 and a tube 27 wound spirally therearound.

In the operation of the heat exchanger illustrated by Fig. 6, the steam is superheated in the tube 20 directly by the electric heating element, and is superheated in the tube 46 through the contact of its walls with the wall of the pipe 12, and is discharged through the slot 47 into the interior of the pipe 12, and from the pipe 12 through the nozzles 15 into the surface being heated.

As disclosed by my patent, several heat exchangers of the type illustrated by Figs. 1-3 or by Fig. 6 are used within one hood. One or more of such heat exchangers preferably each includes a thermostatic control as illustrated by Figs. 4 and 5 of the drawing. A tube 50 extends through the left hand end of the pipe 12 and a small distance into the exterior thereof, and has the spaced, small inlet openings 51 therein inside the pipe 12. The thermostat bulb 52 is within the tube 50 alongside the openings 51 and exposed to superheated steam entering there-through. The bulb 52 has a capillary tube 53 leading through the left hand end of the tube 50, to a bellows which is not illustrated, for actuating an electric switch in the electric supply leads to the connection 26 for the electric heating elements in the tubes 20 and 21. The wall tube 50 also contacts the wall of the pipe 12.

In operation, the bulb 52 responds to the temperature of the steam entering the openings 51, and to the temperature of the wall of the tube 50, and acts to disconnect the electric current supplied to the heating elements when the operating temperature has been reached.

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Where a higher degree of superheat than can easily be provided by the two tubes 20 and 21 with a distributing pipe 12 is desired, another or other similar tubes may be used.

While embodiments of the invention have been described for the purpose of illustration, it should be understood that the invention is not limited to the exact apparatus and arrangement of apparatus illustrated, since modifications thereof may be suggested by those skilled in the art without departure from the essence of the invention.

What I claim as my invention, is:

1. A heat exchanger for heating and distributing a gas, comprising a distributing pipe, means for discharging heated gas longitudinally of the pipe against a surface to be heated, a gas heating tube in contact along its length with the exterior of said pipe, an elongated electric heating element supported within said tube, means for supplying gas to be heated into one end of said tube, and means for supplying heated gas from the other end of said tube into said pipe.

2. A heat exchanger as claimed in claim 1 in which the electric element is in the form of a cylindrical rod, and a relatively small tube is wound spirally around the rod in contact therewith and with the inner surface of the gas heating tube.

3. A heat exchanger as claimed in claim 2 in which the gas heating tube is flattened where it contacts the small tube.

4. A heat exchanger for heating and distributing a gas comprising a distributing pipe, means for discharging gas longitudinally of said pipe against a surface to be heated, a pair of gas heating tubes in contact along their lengths with the exterior of said pipe, an elongated electric heating element supported within each of said tubes, means for supplying gas to be heated into one end of one of said tubes, means for supplying gas from the other end of said one of said tubes into the adjacent end of the other of said tubes, and means for supplying gas from the other end of said other of said tubes into said pipe.

5. A heat exchanger as claimed in claim 4 in which the electric elements are in the form of cylindrical rods and relatively small tubes are wound spirally around the rods in contact therewith and with the inner surfaces of the gas heating tubes.

6. A heat exchanger as claimed in claim 5 in which the gas heating tubes are flattened where they contact the relatively small tubes.

7. A heat exchanger as claimed in claim 1 in which means is provided for adjusting the first

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mentioned means for varying the length along the pipe from which gas is discharged therefrom.

8. A heat exchanger as claimed in claim 7 in which the adjusting means comprises a curved plate attached to the pipe and slidable therearound to partially block the discharge means.

9. A heat exchanger as claimed in claim 1 in which the pipe contains a relatively small tube having a thermostat therein, and having an opening therein for admitting gas from the pipe into the interior thereof in contact with the thermostat.

10. A heat exchanger as claimed in claim 1 in which adjusting means is provided for adjusting the first mentioned means for varying the length along the pipe from which gas is discharged therefrom, said adjusting means comprising a pair of curved plates adjacent each end of the pipe, and slidable therearound to partially block the discharge means.

11. A heat exchanger for heating and distributing a gas comprising a distributing pipe, means for discharging heated gas longitudinally of the pipe against a surface to be heated, a gas heating tube in contact along its length with the exterior of said pipe, an elongated electric heating element supported within said tube, means for supplying gas to be heated into one end of said tube, a second tube within said pipe and having one end adjacent the other end of said first mentioned tube and connected thereto for receiving gas therefrom, and means for supplying heated gas from the other end of said second tube into said pipe.

12. A heat exchanger as claimed in claim 11 in which the electric heating element is in the form of a cylindrical rod, and a relatively small tube is wound spirally around the rod in contact therewith and with the inner surface of the gas heating tube.

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