June 18, 1935. A. W. FERRE 2,005,580

DRYING APPARATUS

Filed Sept. 7, 1934 2 Sheets-Sheet 1

Fig. 1.

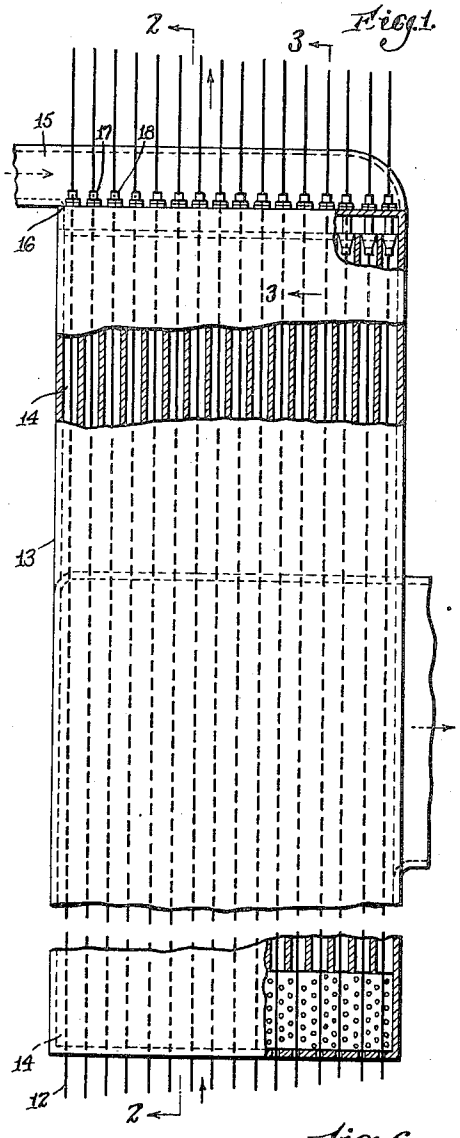


Fig. 2.

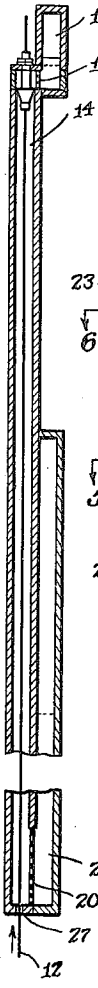


Fig. 3.

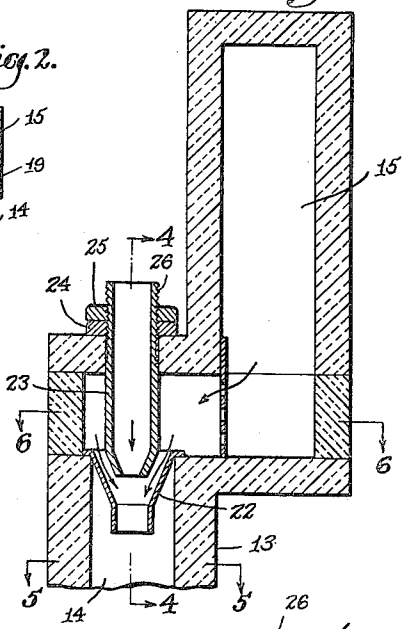


Fig. 4.

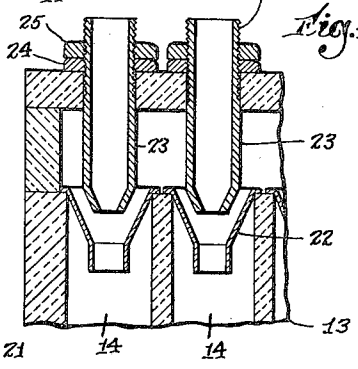


Fig. 5.

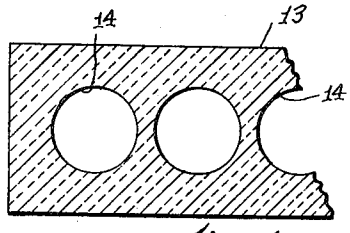
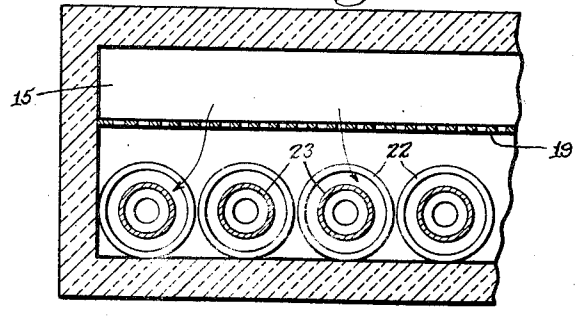


Fig. 6.



Inventor
ALBERT W. FERRE
by Robert J. Palmer
Attorney

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DRYING APPARATUS

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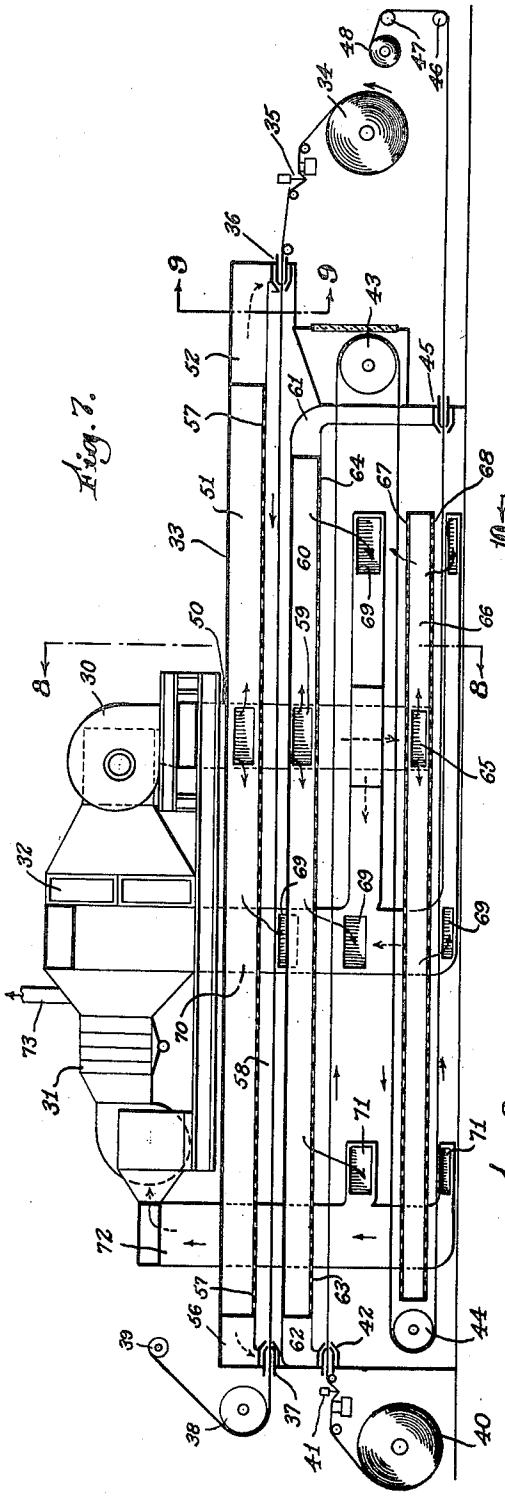


Fig. 7.

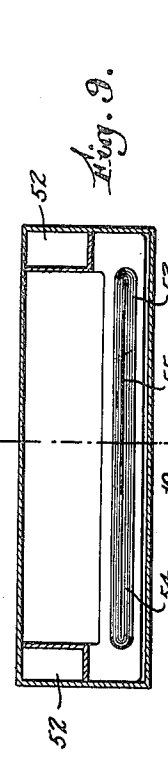


Fig. 9.

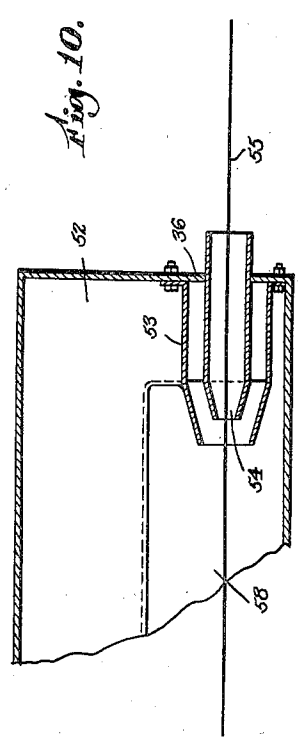


Fig. 10.

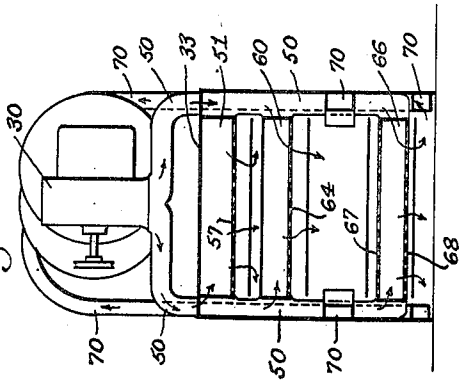


Fig. 8.

Inventor
ALBERT W. FERRE
by Robert J. Palmer
Attorney

Patented June 18, 1935 2,005,580

UNITED STATES PATENT OFFICE

2,005,580

DRYING APPARATUS

Albert W. Ferre, Wellesley, Mass., assignor to B. F. Sturtevant Company, Inc., Boston, Mass.

Application September 7, 1934, Serial No. 743,070

3 Claims. (Cl. 34—48)

This invention relates to drying apparatus, and relates more particularly to means for maintaining a desired air balance between drying air and air external a drier.

In drying systems of the type where it is customary to pass continuously, through drying air, sheet material or wires, for example, which have previously been coated with some form of coating material, the problem of preventing the escape of the drying air has been serious. In some cases, the vapor given off from the coated material in the drying operation is explosive, and, obviously, it is undesirable for such vapor to be vented to the atmosphere.

The difficulty of preventing the escape of the drying air and the vapor carried thereby in all drying systems, where the material is coated exterior of the drier and is passed into the drier, is that the drying air and the vapor carried thereby escape through the same openings through which the material to be dried enters and leaves the drying chamber. Since the static pressure exists within the drier, some of the air and vapor escapes regardless of how small the opening for the passage of the material is made.

According to a feature of this invention, the drying air under static pressure in the drying chamber passes through the outer nozzle of an injector type venturi, and the material to be dried is caused to pass through the inner or induced air flow nozzle of the same injector. The drying air under static pressure thus tends to induce air flow external the drying chamber into the chamber with the entering or leaving coated material to be dried, the inflow of external air forming an effective air seal for preventing the escape of the drying air and any vapor carried thereby.

According to another feature of this invention, the injector nozzles are made adjustable so that a perfect air balance will be maintained where desired. The injector action is regulated until no air flows in through the opening provided for the material, and no air or vapor flows out through this opening. This is desirable in certain instances where it is not desired to dilute the drying air with external air, or where it is desired to keep the drying and ventilating air systems separate.

The injector nozzles may, according to this invention, be adjusted to provide a positive inflow of external air through the opening provided for the passage of the coated material, the indrawn air providing make-up air, which may be equal to the amount of heated air which may be exhausted.

An object of the invention is to prevent the escape of drying air and vapors carried thereby from the drying chamber through the openings provided for the passage of material in or out of the chamber.

Another object of the invention is to provide a Venturi air seal for the passage of coated materials in or out of a drying chamber.

Another object of the invention is, where desirable, to maintain an air seal at the points of passage of coated material in or out of the drying chamber, which prevents the escape of drying air and vapor carried thereby, and the entrance of external air.

Other objects of the invention will be apparent from the following description, taken together with the drawings.

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

Fig. 1 is a view, partially in section, of a vertical tower drier provided with the Venturi air seals or locks, according to this invention;

Fig. 2 is a sectional view along the lines 2—2 of Fig. 1;

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

Fig. 4 is a sectional view along the lines 4—4 of Fig. 3;

Fig. 5 is a partial, sectional view along the lines 5—5 of Fig. 3;

Fig. 6 is a partial, sectional view along the lines 6—6 of Fig. 3;

Fig. 7 is a plan view, partially in section, of drying apparatus according to this invention, for the drying of sheet material, and is of the horizontal type;

Fig. 8 is a sectional view along the lines 8—8 of Fig. 7;

Fig. 9 is a sectional view along the lines 9—9 of Fig. 7, and

Fig. 10 is a sectional view along the lines 10—10 of Fig. 9.

The vertical tower drier of Figs. 1 to 6 inclusive is of the type in which a copper wire, for example, is first coated with an insulating material, then passed through the drier, is again coated, and again passed through the drier, this being repeated for a number of times. This form of tower drier is well known to those skilled in the art, and so only those elements necessary for an understanding of the present invention have been illustrated by the drawing. It is believed sufficient to say that the wire 12, which

enters and passes from the drying chamber 13, is a continuous wire which is coated and dried in a number of stages. The wire 12 is thus sprayed by apparatus (not shown) and enters the channel 14 at the lower left hand corner of Fig. 1, passes upwardly through the channel 14, and from the drying chamber through the venturi 16, which is shown at the upper left hand corner of Fig. 1. During passage through the channel 14, the wire is subjected to heated air, which enters from a source (not shown) through the air duct 15. The wire is then coated and has its direction reversed by apparatus (not shown), and it again enters the drying chamber 13 through the venturi 17, following which it passes through the drying chamber in the second channel 14, which is also supplied with heated air from duct 15, and then passes from the lower portion of the drying chamber 13, where it again has its direction reversed and is coated, and again enters another channel 14 of the drying chamber, and passes through a third venturi 18, and so on, there being, in the particular embodiment illustrated by the drawings, sixteen drying chambers 14 and sixteen Venturi nozzles at the upper portion of the drying chambers, similar to nozzles 16, 17 and 18. These nozzles will now be described with reference to Figs. 2 to 6 inclusive.

Referring now to Fig. 2, the air flow through th duct 15 enters the chamber 14 at the upper portion, through the grille 19, and passes therefrom at its lower portion through the grille 20, into a recirculated air passage 21.

Referring now to Fig. 3, it is seen that the air flow through the duct 15 passes through the outer injector nozzle 22 and induces air flow in the usual injector nozzle through the inner injector nozzle 23. The wire to be dried passes from the drying chamber 13 through the center of the inner nozzle 23. The drying air and any induced air from external the drying chamber then passes into the channel 14 in which the coated wire is subjected to the drying action of the air.

Figs. 4, 5 and 6 illustrate the parallel arrangement of the plurality of injector nozzles arranged at the upper portion of the vertical tower, drying chamber 13.

The injector nozzles are adjustable to enable external air to be indrawn or to enable a perfect balance between external and internal air to be maintained. This may be accomplished by moving the inner nozzle 23 up or down with respect to the outer nozzle 22, by manipulation of the nut 24 and lock nut 25 upon the threaded portion 26 of the inner nozzle 23. When the inner nozzle 23 is moved nearer the outer nozzle 22, the distance between the tip of the nozzle 23 and the converging walls of the nozzle 22 decreases. The drying air which produces the injector effect, passes through the space beween the tip of the nozzle 23 and the converging walls 22 and as this space decreases in area, the velocity of the drying air passing therethrough, consequently increases, thereby exerting a greater inducing effect upon the flow of external air through the nozzle 23.

Since the drying air is under static pressure, its tendency is to escape through nozzle 23, which it would do, were not the injector arrangement according to this invention, provided. Consider the nozzle 23 adjusted to its uppermost position. Then, the space between the tip of the nozzle 23 and the converging walls of its associated nozzle 22 is so great, the velocity of the drying air passing through this space so small and the injector force so weak that the drying air will ordinarily escape through the nozzle 23, thus preventing any entry of external air.

Now consider that the nozzle 23 is adjusted to its lowermost position. Then the space between the tip of the nozzle 23 is so small, the velocity of the drying air through this space so great and the injector effect so large that the flow of external air would be induced through the nozzle 23.

The upper and lower limits of the nozzle 23 are so chosen with respect to the pressure of the drying air and other factors to be considered, that at the lower limit of the nozzle movement, external air would be drawn into the system: at the upper limit of adjustment, the drying air would escape; and at some intermediate point, the location of which obviously depends upon the static pressure of the drying air and other physical factors involved, the inducing effect of the injector tending to draw in external air will balance the tendency of the drying air due to its being under pressure to escape through the nozzle 23. In the particular embodiment illustrated, it was perferred to maintain a heat balance to prevent heat losses. If external air was drawn into the drying chamber, it would dilute the heated air and, of course, being cooler than the heated air, would cause heat losses. In other drying systems, it may be perferred to draw in outside air for use as make-up air, or for other reasons, and so this may be accomplished by adjustment of the injector nozzle. If desired, this also may be accomplished by variation in the static pressure of the air supplied through the duct 15, but this is ordinarily not desirable.

The inflow of the external air into the lower portion of the drying chamber 13, through the small openings 27 through which the wire 12 passes into and out of the lower portion of the drying chamber, is prevented by the downward flow of the heated air in the direction opposing the entrance of outside air. The drying air is not under sufficient static pressure to cause it to pass through the small openings 27, especially in view of the fact that an easier path for it is provided through the grille 20 into the recirculated air passage 21. If desired, of course, the injector devices according to this invention could be used at the openings 27 in the lower portion of the chamber 13, and this may be desirable where conditions justify same.

Figs. 7 to 10 inclusive illustrate the application of the invention to a drying system of the horizontal type in which coated sheet material is dried. For example, fibrous sheet material may be coated with pyroxalin, and then dried. The upper portion of Fig. 7 comprises the usual blower 30 for forcing air through the system, the condenser 31 for enabling valuable material in the vapors from the coating material to be recovered, the heaters 32, etc.

The material to be dried enters the drying chamber 33 as follows: Cloth from the roll 34 passes through the sprayer 35 and thence into the drying chamber 33 through the venturi 36. It then passes through one section of the drying chamber and passes out through the venturi 37, and is passed over the roller 38, and is rewound on the roll 39. Cloth from the roll 40 is sprayed by the apparatus 41, and then passes through the venturi 42, and thence, once through the drying chamber and over the roller 43 in the drying chamber, then again through the drying chamber and over the roller 44, and then again through the drying chamber, then out through

the venturi 45, over the rollers 46 and 47, and then is rewound on the roll 48.

Heated air is forced by the fan 30 through the duct 50 and thence, first into the channel 51, from which a portion enters the channel 52, and then into the outer nozzle 53 of the venturi 36 to tend to induce air flow through the inner nozzle 54 of the venturi, through which the sheet material 55 to be dried passes.

Another portion of air from the channel 51 passes into a channel 56, which is similar to channel 52, but located at the other end of the drier, and which supplies air for injector purposes to the venturi 37.

Another portion of the air from the channel 51 passes through the openings 57, at each end of the drier, and then passes into the channel 58, through which the material 55 passes and serves to dry the coated material.

The duct 50, in like manner, supplies air through opening 59 into channel 60, and from which a portion passes into the channel 61 to operate the venturi 45, and into the channel 62 to operate the venturi 42, and another portion of which passes through the openings 63 and 64 to dry the coated material passing therebeneath.

Finally, the duct 50 supplies, through the opening 65 and into the channel 66, drying air, which passes from the opening 67 to dry the coated material passing thereabove, and through the opening 68 to dry the coated material passing therebelow. A portion of the drying air is drawn, by action of fan 30, into the recirculated air inlets 69, and thence into the recirculated air duct 70, and in contact again with the heaters 32. Another portion of the drying air is drawn in through the openings 71 into the duct 72 and thence through the condenser 31, where sufficient of the vapors collected by it may be condensed to enable the drying air, in its next circuit through the drying chamber, to dry the coated material.

The Venturi or injector nozzles shown by Figs. 7 to 10 inclusive are adjustable in the same way as those described in connection with Figs. 1 to 6 inclusive are, in order that they may be made to maintain a balance between the drying air and external air at the openings through which the coated material passes in and out of the drying chamber, or one or more of the venturis may be adjusted to draw external air into the drying chamber to provide make-up air. When external air is drawn into the drying chamber, a portion of the drying air may be exhausted to the atmosphere through the vent 73.

Whereas the invention has been described in connection with coated materials, it should be understood that it applies equally well to the drying of other materials. For example, the invention may be used in the drying of sheets formed from cellulose materials, such as paper, artificial cloth, or the like, and may also be used in textile mills, or in any other system where material previously treated is passed into or out of a drying chamber into which a conditioned vapor for drying purposes is supplied.

Whereas several embodiments of the invention have been described for the purpose of illustration, it should be understood that the invention is not limited to the details described, since many modifications may be made by those skilled in the art without departing from the spirit of the invention.

What is claimed is:

1. Drying apparatus comprising a drying chamber, means for providing drying air under static pressure within said chamber, an opening in said chamber through which material under treatment passes, means utilizing drying air for inducing the flow inwardly through said opening of atmospheric air, and means for adjusting the effect of said last mentioned means to induce the flow of external air into said chamber or to produce a balance between the drying air in said chamber and atmospheric air external said chamber to prevent the flow of drying air through said opening and the flow of atmospheric air through said opening.

2. Drying apparatus comprising a drying chamber, means for providing drying air under static pressure within said chamber, an opening in said chamber through which material under treatment passes, a venturi in said opening, means for conducting atmospheric air outside said chamber through said opening to said venturi, means for directing drying air through said venturi to induce the inward flow through said opening of atmospheric air, and means for adjusting the velocity of drying air flowing through said venturi to vary the volume of flow of external air through said opening into said chamber.

3. Drying apparatus comprising a drying chamber, means for providing drying air under static pressure within said chamber, an opening in said chamber through which material under treatment passes, a venturi within said opening, a nozzle within said opening for conducting atmospheric air outside said chamber to said venturi, means for directing drying air through said venturi to induce the inward flow through said nozzle of atmospheric air, and means for varying the distance between the tip of said nozzle and said venturi to vary the inducing effect of said drying air upon atmospheric air external said opening.

ALBERT W. FERRE.