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MOISTURE REMOVING APPARATUS

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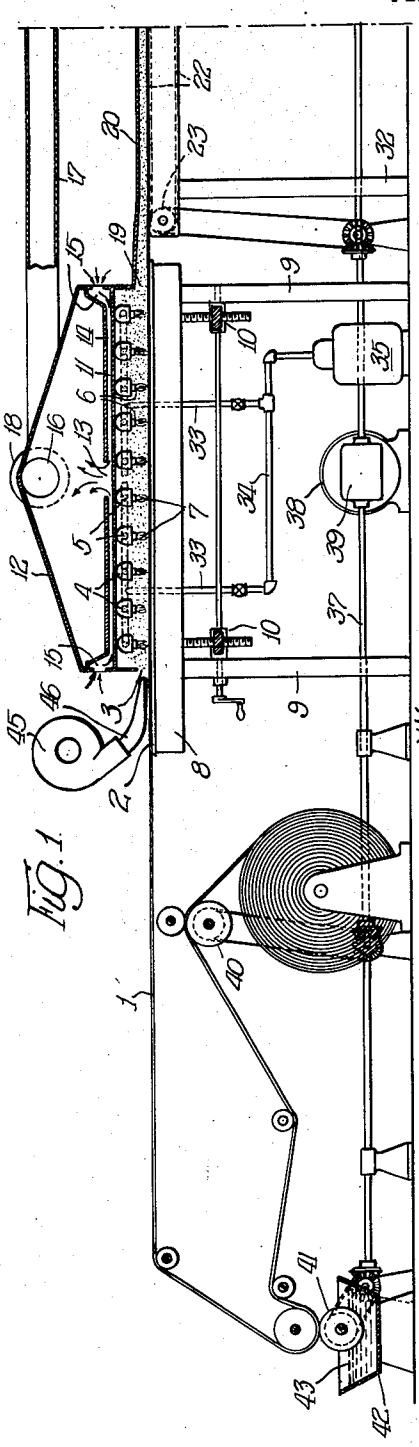


Fig. 1.

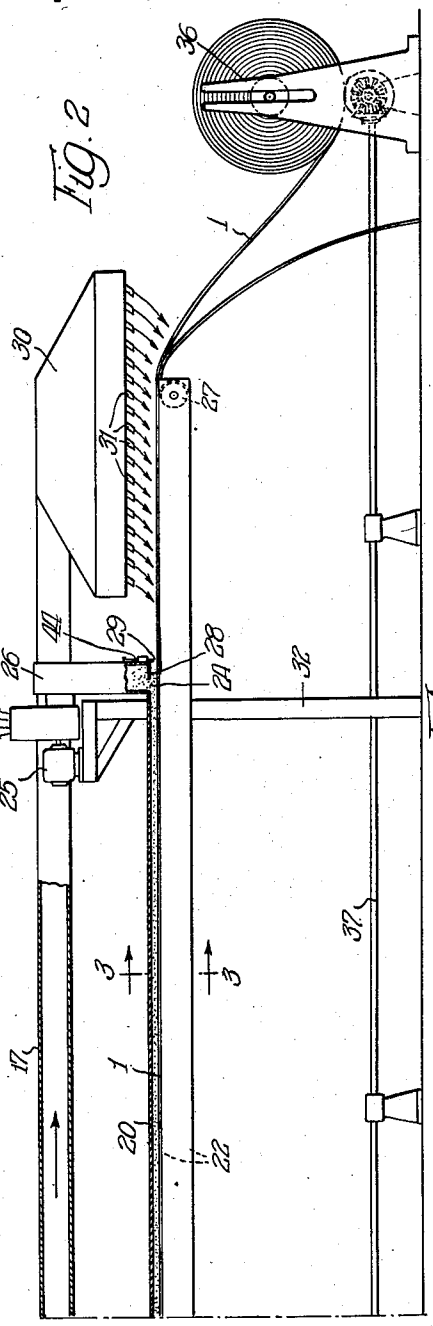


Fig. 2.

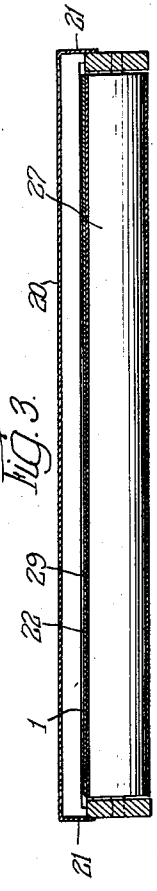


Fig. 3.

INVENTORS.
Ralph L. Atkinson,
BY Edward J. Hopkins,
Wilkinson, Huxley, Byron, & Knight
Attys

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MOISTURE REMOVING APPARATUS

Ralph L. Atkinson, Hinsdale, and Edward J. Hopkins, Chicago, Ill., assignors to United Wallpaper, Inc., Chicago, Ill., a corporation of Delaware

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This invention relates to a new and improved method of drying or removing moisture or other non-inflammable liquids from various materials, such as, for instance, paper webs or the like.

This invention is particularly applicable to manufacturing operations wherein benefits will flow from substantial reductions in the time or space, or both, required for drying or moisture-removing steps involved in the production processes. In the wallpaper industry, for instance, protracted and burdensome drying operations are employed to remove the moisture applied to the paper web as a part of the various surface coatings which constitute the wallpaper finish. Similar drying operations are required when and if wet adhesives are applied to one of the faces of wall or other paper. When more than one coating is applied, it is usual that each coating step requires a substantially dry web, wherefore it is necessary to subject the paper to a drying treatment after each coating operation, with the result that wallpaper having two or three applications of finishing coat material must be subjected to as many separate drying operations. If the paper is a prepasted product, an additional drying step is required.

At the present time, it is customary in the wallpaper industry to utilize drying operations employing long protracted periods of heating at relatively low temperatures. Temperatures have been employed far below a temperature at which any scorching or embrittlement of the paper would or could occur. In view of the use of relatively low temperatures and the fact that hot air is the customary drying medium, periods of long exposure have been required which necessitate extensive handling operations in order to accommodate the large volumes of moistened paper undergoing treatment during any particular drying operation.

Customary apparatus has consisted of extensive drying racks, called "festoon racks" which carry the wet paper through a predetermined path while it is arranged in closely looped festoons and while the same is exposed to drying air. Whereas these prior methods have been successfully utilized in the past to produce good wallpaper and similar products, they have been costly to operate and have consumed a tremendous amount of space which adds greatly to the difficulty and cost of manufacturing wallpaper. These drawbacks have been particularly burdensome in operations where a plurality of coating steps are utilized, as each surface coating treatment requires separate and additional drying treatments. In customary drying equipment a considerable portion of the time and space is consumed in bringing the water content to temperatures at which drying takes place rapidly. All other conditions being equal, the rate at which moisture leaves a material will increase as the temperature of the water approaches its boiling point. In drying parlance, this is frequently called the "conditioning" zone or period.

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In view of the foregoing, it is an object of the present invention to provide what may be regarded as a quick drying operation for materials such as paper webs of wallpaper and the like, whereby the same may be passed through the drying apparatus in the matter of seconds instead of minutes, with the result that the material is dried without delay and is promptly ready for the next step in the operation.

It is a further object to provide an apparatus by which the drying operation may be carried out and which consumes a minimum of space in the manufacturing plant.

It is a further object to provide a quick drying operation which utilizes high temperatures but which are so applied and adjusted to the drying operation that all likelihood of scorching or burning is avoided.

It is a further object to provide, as an initial step in such a quick drying operation, means of accomplishing the conditioning operation in a rapid and practical manner.

More specifically, this invention relates to a process which is carried out in three steps, the first of which involves the exposure of the material to be dried to the direct application of flames and to the burners supporting the flames whereby the material and the contained moisture are subjected to the heating action of the flame itself and the infrared rays emanating from the burners and the flames, and at the same time to the drying action produced by the heated air and hot products of combustion which are associated with the flames and which surround or are in contact with the web of the material. However, this first step is designed to act primarily as a preheating step rather than an initial drying step. Although some drying occurs, the important function of this original step is that of introducing energy as heat into the web and the moist coating to prepare the same for a quick drying action to be supplied by the subsequent treatment steps.

The process next involves a second drying step produced by the drying effect of the heated air and hot products of combustion originating in and flowing from the first zone or the zone of direct

flame treatment. This second step, however, is conducted in the absence of the flames or the direct effect thereof, but utilizes heat generated in the first zone. Generally speaking, it will not be necessary to supply further heat to the second zone other than that already possessed and held by the air and products of combustion taken from the first zone.

The third and final step involves another drying action which may be fairly independent of the first steps and serves as a supplemental and final step productive of the completed state of dryness or reduced moisture content, in the most efficient and quickest manner. This final step preferably utilizes new air, which in some instances may be heated. When heated air is used, the heat can be obtained from the burners used in the first zone, although other sources of heat may be employed if desired.

It is found that with gas burners of the type now available for use in practicing this invention, some excess of heat is generated by the burners themselves, whereby highest efficiency in the use of the heat generated dictates the desirability of heating the air for the third and final step from the burners of the first treating step or zone.

With the process thus outlined, reference will now be made to the accompanying drawing, which illustrates one specific embodiment of the invention and constitutes one application of the process by which the invention may be practiced.

In the drawing—

Figs. 1 and 2 are diagrammatic representations showing, in elevation and in part in cross section, a piece of equipment representing an embodiment of the present invention, as well as means for carrying out the process; and

Fig. 3 is a cross-sectional view taken on the line 3—3 of Fig. 1 looking in the direction of the arrows.

Referring to Figs. 1 and 2, which represent one embodiment of the invention, the material 1 to be dried is fed onto the horizontal flat surface 2, with the wet side of the material uppermost, and passed through the opening 3 into the first section of the drier, here designated as zone A. Zone A is the area bounded by the horizontal sheet partition 11, and the flat surface 2.

The flat surface 2 is the top of the table-like structure 8, having the supporting legs 9 and the gear and shaft arrangement 10 through which the vertical position of the flat surface 2 may be adjusted. The sheet partition 11 is the bottom of the air chamber 12, disposed above the flat surface 2.

Immediately below the horizontal sheet partition 11 is the horizontal row of burners 4, which are rotatably mounted and can be revolved about their axes 5 to a position substantially 90° from that shown in Fig. 1. These burners have the ceramic tips 6 which become incandescent during the operation of the burners. The burner fuel is supplied through the pipes 33, which in turn are supplied by the pipe 34 leading to a suitable carbureter 35.

The air chamber 12, referred to above, has in addition to the bottom partition 11 the central opening 13, the air passages 14, and the room air inlets 15, all disposed in close relation to the bottom 11. The additional opening 16 at the top of the chamber leads into the air conduit 17 containing the blower 18 which draws air from the chamber into the air conduit. As a consequence, air is also drawn into the air chamber 12 through

the inlets 15, into the air passages 14 and out the central opening 13 in which the passages 14 terminate. The heat from the burner flames 7 is transferred in part through the partition 11 and causes this air to become heated before entering the air conduit 17.

After entering zone A, the material to be dried is passed rapidly along the flat surface 2 below the burners 4. Because of the rotatable character of these burners, as explained above, they may be adjusted so that the flames are directed vertically downward toward the surface 2. They may also be rotated to any position of adjustment through 90° of rotation, the flames being projected in a direction substantially parallel to the surface 2 after 90° of rotation from the position shown in Fig. 1. Therefore, while on this flat surface 2, the material 1 can be subjected to varying degrees of association with the open flames 7 and the radiant heat from the burner tips 6. In addition, while in this zone A, the material is subjected to direct association with the hot gases that are products of the combustion of the burner fuel, and any air which has entered zone A and has not been utilized in the combustion of the fuel but which has become heated.

The material to be dried, after having been moved rapidly along the flat surface 2, passes through the opening 19 at the end of zone A, opposite to that through which the material originally entered, onto the continuous belt 22 supported by the horizontal rollers 23 and 27 and the vertical legs 32—32. This belt carries the material 1 into that section of the drier here designated as zone B. This section is the area bounded by the horizontal shroud 20 and the continuous belt 22 disposed immediately below the shroud. This shroud 20 is, in effect, an extension of the sheet partition 11 extending from that section and parallel to it, and having the narrow vertical sides 21 extending downwardly therefrom, in close relation with the continuous belt 22.

While in zone B, the material 1 is subjected to prolonged, direct association with the hot gases and air that have been drawn out of zone A into zone B. This gaseous material is drawn from zone A into zone B by the fan 25 which serves to expel any gaseous material contained in the conduit 26, which joins the shroud 20 at its termination 28.

The gaseous material in zone B is drawn into the conduit 26 through the opening 24 in the end 28 of the shroud 20, and is conducted away from the continuous belt 22. The continuous belt extends beyond the termination 28 of the shroud 20 through the opening 29 and into the section of the drier here designated as zone C. The height of the opening 29 may be regulated by adjusting the plate 44 mounted on the side of the conduit 26 above that opening. This height should be kept as small as possible to keep the amount of external air drawn into conduit 26 through the opening 29 at a minimum. This is desirable since an excessive amount of external air entering conduit 26 may produce condensation in that conduit.

Zone C is the area bounded by the enlarged termination 30 of the duct 17, which is disposed immediately above the extended portion of the continuous belt 22. This enlarged portion 30 has a plurality of angularly disposed vanes 31 which direct the heated air, forced through the duct 17 by the blower 18, toward the continuous belt 22

in a direction opposite to that in which the material 1 moves.

The reeling device 36 may be used to draw the material 1 through the drier as described, and to roll it into its final form. This device could, of course, be replaced with a different form of mechanism operating to draw the material through the drier without disposing it in rolled form, so that the material could be immediately passed on to a succeeding step in the manufacturing process.

The source of power for rotating the reeling device 36 is the power shaft 37 which extends the full length of the drier and associated components, as shown in Figs. 1 and 2. The shaft 37 is rotated by the electric motor 38 through the gear box 39, and has a number of power takeoff points in addition to that used for the reeling device 36.

As shown in Fig. 2, the reeling device 36 is driven by a conventional belt and pulley arrangement geared to the power shaft 37. As shown in Fig. 1, the continuous belt 22 is driven by the roller 23, which is in turn driven by another belt and pulley arrangement geared to the power shaft 37. The roller 40 is driven in a similar fashion, as is the applicator roller 41, here shown as a part of the applicator 42 which applies the liquid substance 43 to the material 1, which is subsequently dried.

This represents only one possible form of supplying power to the moving parts described above, of course, but it has been found desirable to use such a common source. To properly feed the material 1 through the drier, it is necessary to have such moving parts synchronized, so that the material will maintain the same rate of travel throughout all parts of the mechanism. The simplest method of synchronization is to have a common source of power such as shown here.

The blower 45 and the conduit 46 are disposed in relation to the opening 3 so that a blast of room air may be directed into that opening substantially parallel to the flat surface 2 when the blower is operated. An automatic arrangement may be used, if desired, so that the blower will operate when the passage of the material 1 through the drier is interrupted. When the blower is in operation ,a stream of relatively cool air flows between the burner flames 7 and the material 1 to be dried, which insulates the material from the heat produced by the burners, and reduces the temperatures of the material 1. This feature will prevent applying excessive heat to the material when it is not in motion, and will, therefore, prevent damage to it when the passage of the material through the drier is stopped and before the burners and the chamber have cooled off.

From the foregoing description it can be seen that the drying process is accomplished in three major steps. The primary function of zone A and its associated components is to raise the temperature of the material and of the liquid to be removed therefrom. In actual practice, the burners 4 in this section are properly regulated so that the temperature of the liquid and of the surface of the material 1 lying immediately below the liquid is kept slightly below the boiling point of the liquid. The length of this section is relatively short so that the amount of evaporation occurring while the material is within it is relatively small.

Rapid evaporation, however, occurs while the material is in Zone B, since the temperature of the liquid is still only slightly below the boiling point and the gases and air in contact with it still have a high temperature. The amount of evaporation taking place in zone B is determined largely by the following factors:

(a) The volume of gaseous material coming into contact with the liquid;

(b) The saturation point of those gaseous elements, which is a direct function of the temperature of those elements;

(c) The percentage of saturation of those elements with the liquid vapor which is dependent on the saturation point; and

(d) The temperature of the liquid itself.

The gaseous material in zone B is conducted out of association with the material 1 by the conduit 26 prior to the time that any of the above factors begin to materially reduce the rate of evaporation of the liquid. This removal of the gaseous material in zone B and the introduction of the new hot air in zone C is designed to prevent the halting of the evaporation process and the possible condensation of the liquid from the gaseous elements, after it has once left the material. The hot, dry air newly introduced in zone C is well below its saturation point in regard to the liquid vapor and, therefore, serves to remove any liquid remaining in the material after the evaporation period to which it has been subjected in zone B.

In the drawing and specification, there has been set forth a preferred embodiment of the invention, and although specific terms are employed, they are used in a generic and descriptive sense only and not for purposes of limitation, the scope of the invention being defined in the claims.

What is claimed is:

1. A device for removing non-inflammable liquid from normally inflammable materials, comprising, in combination, a plurality of rotatable open burners in spaced relation to a vertically adjustable surface, producing open flames capable of being directed toward or substantially away from said adjustable surface by a rotary movement of said burners, a duct adapted to direct a stream of air between said surface and said burners substantially parallel to said surface, a blower member operable at will associated with said duct, a shroud member associated with said open burners and said adjustable surface, a continuous belt disposed immediately below, and substantially parallel to, said shroud member, said shroud member terminating in a conduit, a second blower member associated with said conduit, said conduit extending away from said continuous belt, said continuous belt extending into association with the open end of a second duct having a third blower member associated therewith, said third blower member being adapted to force a stream of drying air through said second duct onto said continuous belt, and means for controlling the temperature of the air passing through said second duct.

2. A device for removing non-inflammable liquid from normally inflammable materials, comprising, in combination, a plurality of rotatable open burners in spaced relation to a vertically adjustable surface, producing open flames capable of being directed toward or substantially away from the said adjustable surface by a rotary movement of said burners, a duct adapted to direct a stream of air between said surface and said burners substantially parallel to said surface, a blower member operable at will associated with said duct, a shroud member associated with said open burners and said adjustable surface, a continuous belt disposed immediately below, and substantially parallel to, said shroud

member, said shroud member terminating in a conduit, a second blower member associated with said conduit, said conduit extending away from said continuous belt, said continuous belt extending into association with the open end of a second duct, said second duct extending from an air heating chamber associated with the aforementioned open burners, and a third blower member associated with said second duct adapted to force a stream of heated air through said second duct onto said continuous belt.

3. A device for removing non-inflammable liquid from a web of normally inflammable material, comprising, in combination, a plurality of rotatable open burners in spaced relation to a vertically adjustable surface, said burners producing open flames capable of being directed toward or substantially away from the said adjustable surface by a rotary movement of said burners, means operable at will for introducing a stream of air between said surface and said burners substantially parallel to said surface, a passageway associated at one end with said open burners and said surface, means for continuously moving said web of material through said passageway, means for continuously drawing the hot combustion-product gases from said burners through said passageway and subsequently out of association with said web of material, and means for directing a separate gaseous drying medium onto said web of material as it emerges from said passageway.

4. A device for removing non-inflammable liquid from a web of normally inflammable material, comprising, in combination, a plurality of rotatable open burners in spaced relation to a

vertically adjustable surface, said burners producing open flames capable of being directed toward or substantially away from the said adjustable surface by a rotary movement of said burners, a passageway associated at one end with said open burners and said surface, means for continuously moving said web of material through said passageway, means automatically operable when said last named means is inoperative for introducing a stream of air between said web of material and said burners, means for simultaneously rotating said burners substantially away from said web of material, means for continuously drawing the hot combustion-product gases from said burners through said passageway and subsequently out of association with said web of material, and means for directing a separate gaseous drying medium onto said web of material as it emerges from said passageway.

RALPH L. ATKINSON.
EDWARD J. HOPKINS.

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