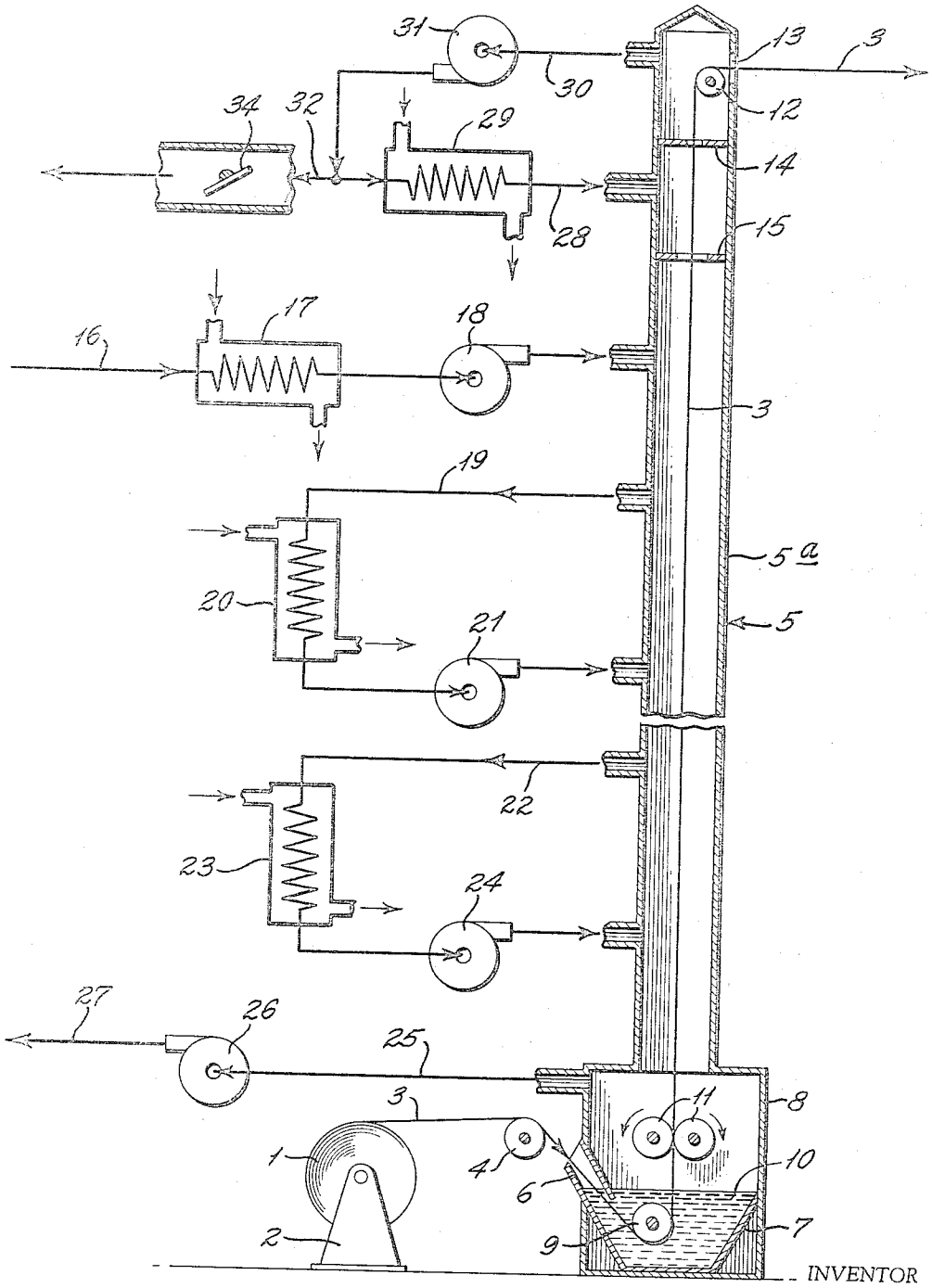
April 11, 1967 R. VAN ZALINGE 3,313,646

METHOD AND AN APPARATUS FOR SUBJECTING A FILM TO A HEAT TREATMENT, AND THE COATED FILM THUS TREATED

Filed May 16, 1963



INVENTOR

Roelof van Zalinge

BY Stevens, Davis, Miller & Mosher

ATTORNEYS

United States Patent Office 3,313,646 Patented Apr. 11, 1967

3,313,646

METHOD AND AN APPARATUS FOR SUBJECTING A FILM TO A HEAT TREATMENT, AND THE COATED FILM THUS TREATED

Roelof van Zalinge, Palestro, Pavia, Italy, assignor to Algemene Kunstzyde Unie, N.V., Arnhem, Netherlands, a corporation of the Netherlands

Filed May 16, 1963, Ser. No. 280,823
Claims priority, application Netherlands, May 18, 1962, 278,604
8 Claims. (Cl. 117—119.2)

The invention relates to a method and an apparatus for subjecting a film, in particular a film based on regenerated cellulose, to a heat treatment, in which the film is guided vertically upwards through a shaft, through which, moreover, a hot gas is circulated. In addition, the invention relates to the film thus treated. The heat treatment may consist in the drying of a coated film. However, it also may be carried out after, or form part of, a treatment for printing, dyeing or conditioning a film.

Methods of the above-mentioned type are known, in which the vertical shaft, both at its lower end and at its upper end, is in open communication with its surroundings. Such methods show various drawbacks. The elevated temperature of the air present in the drying shaft and possibly of solvents evaporated from the film causes a strong chimney effect in the shaft. As a result, large amounts of warm solvent air mixture escape from the top of the shaft, which means both loss of heat and, possibly loss of solvent.

Moreover, as a result of the vertical current of gas in the shaft cold air leaks into the shaft at its lower end and blows against the film in a non-uniform manner. As a result, in many applications the product obtained is of inferior quality. For instance, in the process of drying a coated film the cold leakage air will blow against the film coating, which is still warm and wet, in a non-uniform manner. As a result, the coating dries irregularly, thus showing wet and porous patches.

Another disadvantage to the known method is that, owing to the warm gases rising from the shaft, it is difficult for the warm coating to cool down and harden. In order that the film, after it has left the shaft, may be passed around guiding rollers for further transport without the coating being damaged, it is necessary for the coating first to be cooled down and hardened. By virtue of previous attempts to overcome the above problems, the extent of the above-mentioned drawbacks has been reduced somewhat, for instance by sucking in cold air near the discharge opening of the shaft, thus exerting a downward pressure on the warm gases in the upper half of the shaft.

However, as already mentioned, it is not possible in this way to prevent the occurrence of the chimney effect in the shaft entirely.

According to the present invention the above discussed disadvantages and drawbacks are avoided by providing an apparatus and method wherein the film, before it leaves the shaft, passes through at least one adjustable constriction and where below the last constriction an amount of cooling gas, under elevated pressure, is blown onto the film, which is sufficient to keep the entire shaft before this constriction under at least atmospheric pressure. This pressure in the shaft is due to the resistance the cooling air is subject to when passing through the constriction. The adjustability of this constriction makes it possible to choose any desired pressure in the drying shaft.

It is further to be preferred according to the invention, as far as circumstances permit, to feed the film to the shaft by way of a liquid seal. This simplifies the adjustment of an excess pressure in the shaft, without large amounts of warm gas escaping through the feed opening for the film.

Since an excess pressure prevails in the entire shaft, the leaking of air through various crevices or other openings invariably present in the shaft wall is avoided, as is the blowing of this leaking air against the film coating. Moreover, with the constriction suitably adjusted, it is now possible to open doors and sight glasses in the shaft during operation.

It should be added that feeding the film to the shaft by way of a liquid seal is known in itself. The gas pressure at the top of the open shaft is then equal to the atmospheric pressure. Although the use of a liquid seal alone prevents the occurrence of a current of gas resulting from chimney draught in the shaft, it has been found that there then prevails a negative pressure at the bottom of the shaft. As a result, cold air leaks through crevices or openings in the shaft wall, which cold air causes the aforementioned dull and porous patches on the coating. Moreover, when employing a liquid seal it is still impossible during operation to open doors or sight glasses in the shaft without cold air entering the shaft.

In actual practice it appears that crevices or other openings in the shaft wall cannot be avoided entirely. They are practically always found near doors and sight glasses in the shaft, and in places where roller shafts and lead-in chains are passed through the shaft wall.

It has been found that, when using the above-described method according to this invention, the constriction need not be adjusted to a very narrow width. The constriction does not therefore constitute an additional obstruction to guiding the film through the shaft. A slight excess pressure of the cooling air below the last constriction is sufficient to prevent warm air from escaping from the top of the shaft, so that it is not necessary to supply large amounts of cooling air for this purpose. According to the invention it is sufficient, and even to be preferred, to maintain the cooling air under an excess of atmospheric pressure of up to about 12 mm. water column.

In addition to its application to the above-described method, the invention relates to a generally known type of apparatus for coating a film by the method according to the invention, comprising a lacquer tank, a vertical drying shaft connected thereto, means for transporting the film through the lacquer tank and the drying shaft, means for collecting it and, provided in the drying shaft, a system for the circulation of warm air. The apparatus according to this invention is characterized in that, at the top of the drying shaft and before the first guiding roller over which the film is passed after it has left the lacquer tank, there is provided a blowing chamber which is separated from the surrounding air by a constriction, and which blowing chamber is connected to a circulating system for cooling air. According to the invention the lacquer tank is preferably so constructed that it also serves as a liquid seal at the lower end of the shaft.

Finally the invention also relates to coated film dried by the above-described method.

For the purpose of elucidating the invention there now follows a description, with reference to the accompanying drawing, which illustrates a preferred embodiment of the invention.

The single figure of the drawing shows a schematic partially sectional view of a coating and drying apparatus.

Referring now to the drawing, an uncoated cellophane film 3 is wound from a roller 1, which is rotatably

mounted on a support 2, and is guided into and through a coating and drying machine 5 by way of a guiding roller 4.

The film 3 enters the coating and drying machine 5 through a slit 6 which is formed by a section of the wall of a lacquer tank 7 and by a section of the wall of a widened part 8 of the machine 5.

A guiding roller 9 serves to guide the film 3 along the desired path through the slit 6 and, subsequently, through a lacquer bath 10 in the tank 7. The excess lacquer adhering to the film 3, which leaves the bath 10 in an upward direction, is scraped off by the doctor rollers 11.

The position of the doctor rollers 11 is one of the factors determining the thickness of the coating which will ultimately be present on the film.

The lacquer, the composition of which may vary very widely, is dissolved in a solvent which is evaporated at about 120° C. A frequently used solvent is, for instance, a mixture of toluene and ethyl acetate. The evaporation is effected in a tall drying shaft 5*a* through which hot air is circulated.

After the coated film has been dried and cooled, it is passed over a guiding roller 12 and carried off from the drying shaft in transverse direction through a wide opening 13.

After the film has left the drying shaft, it may be wound. In most cases, however, it will, prior to being wound, be subjected to a conditioning treatment in a conditioning tower.

At the lower end of the coating and drying machine the liquid lacquer in the slit 6 forms a liquid seal.

Provided at the upper end of the drying shaft 5*a*, one after the other and in the direction of travel of the film, there are two slits i.e. constrictions 15 and 14, the upper slit 14 having a width adjustable from 4 to 15 cm. and the lower slit 15 being considerably wider than the upper slit 14. Under operating conditions the slit 14 is generally adjusted to a width of 8 to 10 cm. Into the shaft, not far under the lower slit 15, there enters a line 16 through which there flows air which is heated to about 100° C. in a heat exchanger 17. This warm air is blown into the drying shaft by a fan 18.

At a still lower level two circuits 19, 20, 21 and 22, 23, 24 are connected to the drying shaft. The air is sucked from the shaft through the lines 19 and 22 by means of the fans 21 and 24, heated to about 120° C. in the heat exchangers 20 and 23, and subsequently pumped back into the shaft.

It is necessary to reheat the air, since evaporation of the solvent has abstracted heat from the air. Heating in the heat exchangers 17, 20 and 23 is carried out with the aid of superheated steam.

The lower the hot air gets down in the drying shaft, the more solvent it contains. In this way evaporation of the solvent takes place uniformly along the length of the shaft.

Although in the machine shown in the drawing only two reheating circuits are indicated, apparatus is naturally also conceivable, which is provided with more such circuits, or variants thereof in which the air is circulated partly countercurrent to and partly in the same direction as the direction of travel of the film.

The air, which is finally heavily laden with solvent, is discharged at the lower end of the drying shaft through a line 25 and is fed by a fan 26 and line 27 to a regeneration apparatus known per se (not shown). Here the solvent is separated from the air. The fan 26 displaces an amount by weight of gas which corresponds to the amount of air displaced by the fan 18, plus the amount of solvent given off by the film. Between the slits 14 and 15 cooling air is fed to the shaft through a line 28. This air is brought to a temperature of, for instance, about 50° C. in a heat exchanger 29.

From the space above the slit 14 air is sucked by a fan 31 through a line 30, and partially blown through line 28, and partially through a line 32.

Provided in the line 32 there is an escape valve 34. As a result of air leaking away by way of this valve, the amount of cooling air circulating in the space between the slits 14 and 15 is regularly refreshed. The pressure in this space is controlled by adjusting the slit 14. In this way it has been found possible to keep the entire drying shaft below the slit 15 under a slightly elevated pressure. As a result, it is impossible for cold air to leak into the lower portion of the shaft and blow against the wet film coating.

The cooling air further hardens the film coating sufficiently to prevent it from being damaged when the film is guided over the roller 12.

The above description has set forth a novel apparatus and method for the heat treatment of film, particularly for drying of coated film with heated gas. Obviously many variations of the method and apparatus are possible in the light of the above teachings. For instance, practically any type of film other than cellophane film also may be coated in the apparatus, and also use may be made of heat-carrying media other than air. It is therefore to be understood that within the scope of the appended claims, the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. In a method for subjecting a coated film bearing a solvent to a heat treatment in which the film is guided vertically upwards through an integral shaft sealed from the ambient at its lower end and through which a heated gas is circulated, the improvement comprising passing said film before it leaves the shaft through a first constriction and then through an adjustable constriction, and passing cooling gas under elevated pressure into said shaft in a zone between the first and adjustable constrictions and onto said film in an amount which is sufficient to pressurize the entire shaft below the first constriction to at least atmospheric pressure.

2. A method according to claim 1 wherein the film is based on regenerated cellulose.

3. A method according to claim 2 wherein the film is coated with a solvent containing lacquer before passage through said shaft.

4. A method according to claim 3 wherein the film is fed into the shaft by way of a liquid seal.

5. A method according to claim 1 characterized in that the cooling air is blown into the shaft under a pressure excess pressure of atmospheric pressure by not more than about 12 mm. water column.

6. An apparatus for the coating and drying of a film bearing a solvent comprising a lacquer tank, an integral vertical drying shaft in communication therewith and connected such that the contents of the lacquer tank can act as a liquid seal for the drying shaft and extending upwardly therefrom, means for transporting a film through the lacquer tank and the drying shaft, means for collecting the film as it leaves the drying shaft, means provided for circulating heated gas in the drying shaft, means provided at the upper end of the drying shaft to guide the film from said shaft, an area below said last mentioned means which is separated from the atmosphere in the remaining portion of the shaft by a first constriction and from the parts of the shaft therebelow through which the heated gas is circulated by a second constriction, and means to blow cooling gas into said area beneath said first constriction to pressurize the portion of the shaft below the constriction to at least atmospheric pressure.

7. An apparatus for the coating and drying of a film bearing a solvent comprising a lacquer tank, an integral vertical drying shaft connected to the lacquer tank such that the contents of the lacquer tank act as a liquid seal for the drying shaft, means for transporting the film through the lacquer tank and up through the drying

shaft, a system for circulating warm gas into and out of parts of the drying shaft, said drying shaft having an outlet near its upper end through which the film leaves the drying shaft, guide means mounted in said drying shaft near said outlet for guiding the film therethrough, means defining first and second spaced constrictions within said drying shaft below the outlet and above the zones of the drying shaft through which the warm gas is circulated, and a second system for circulating cool gas through a part of the drying shaft including the zone between the constrictions, and means for collecting the coated film after it leaves the drying shaft.

8. An apparatus as set forth in claim 7 wherein the upper of said first and second constrictions is adjustable.

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ALFRED L. LEAVITT, *Primary Examiner.*

A. H. ROSENSTEIN, *Assistant Examiner.*