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[54] METHOD OF AND APPARATUS FOR DRYING WET FILAMENT TOWS

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[51] **Int. Cl.**..**F26b 3/00**

[58] **Field of Search**.........................34/110, 114, 115, 122, 9

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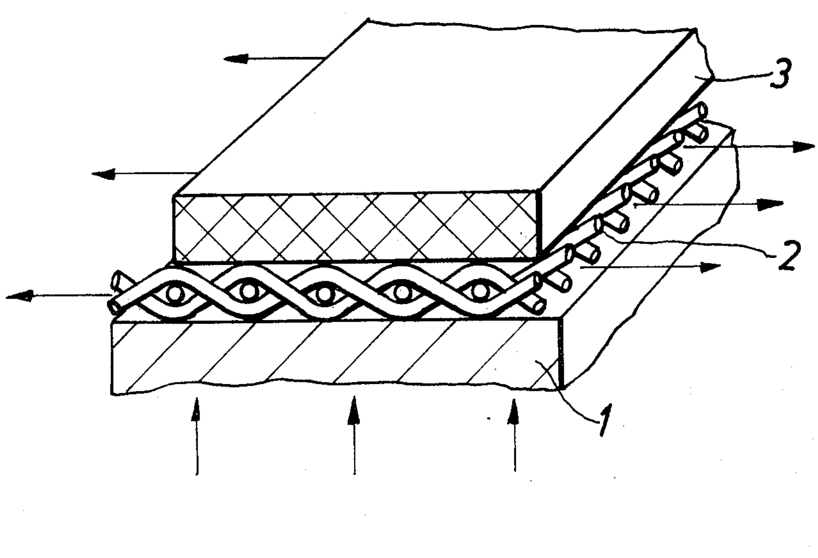
[57] **ABSTRACT**

Wet tows of filaments are dried on rotating drums at temperatures between 80° C. and 220° C. the surfaces of the drums having protuberances, for example in the form of wire fabric coverings, so that the vapors being formed between the two and the drum surface are able to escape through the interconnected cavities between the protuberances. Such drying of the tows imparts hardness to the handle of the fibers.

24 Claims, 3 Drawing Figures



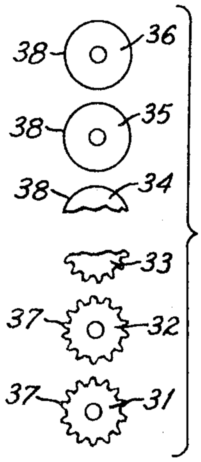


FIG. 3

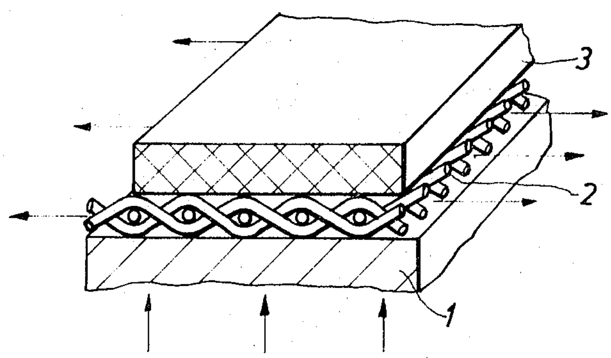


FIG. 1

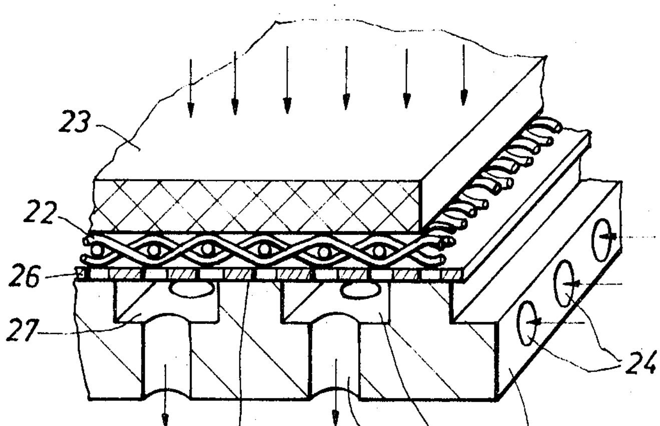


FIG. 2

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METHOD OF AND APPARATUS FOR DRYING WET FILAMENT TOWS

This invention relates to a method of and an apparatus for drying wet filament tows on rotating drums.

It is known that filament tows are conducted through driers of many different constructional forms for drying purposes. The most usual of these are: screening drum driers, screening band driers and calender driers. These driers produce their drying action by the transmission of the heat energy of a heat carrier to the material to be dried and the consequent evaporation therefrom of the adhering liquid. With the screening drum and screening band driers, the heat carrier is generally air, and with calender driers, the heat carrier is liquid or steam. Further transfer is effected either by blowing on to the tow or by direct heat conduction. Another possibility of transferring heat energy is the radiation of a suitable heat radiator.

It is known that the properties of textile fibers can be substantially influenced at the time of their production by thermal treatments, for example the capacity for shrinkage and elongation, the crimping, the degree of whiteness or the "handle" of the fibers.

The "handle" of a textile material is expressed by the sensorial perception on gripping the material in the hand. It depends in a complicated manner on the count, the bending modulus, the surface properties and the friction of the separate fibers one against the other, on the yarn construction and also on the weight or thickness of the material. The handle is extremely important for judging a material and for the feel thereof during wear. It is impossible to give a measuring factor for the handle, because of the complex nature of this property. It is graduated by the observer or by several observers according to terms such as soft, solid, hard, rough. A particularly soft handle is desirable for articles which are worn directly on the body, for example for under garments and socks. A full or solid handle is desirable, for example, for carpet fibers.

When a tow is dried on a smooth, heated surface, a fiber material with a soft handle is obtained. On drying a textile web or a tow in an air stream, a fiber material with a solid handle is obtained.

The invention has for an object to adjust as desired the handle of textile fibers and thus the handle of the yarns and manufactured articles produced therefrom by the drying method. At the same time, the occluded vapors forming during the drying between smooth, heated surfaces and the tow are to be carried away.

This object is achieved according to the invention by the drum surfaces being heated and being maintained at a temperature between 80° C. and 200° C., and by the heat transfer to the tow being effected by way of protuberances, so that the tow only comes into contact with the protuberances.

The result hereby obtained is that vapors which are formed and collect between the drum surface and the tow can escape between the protuberances. The drum surface is heated with steam, liquid or electrically, without the heat carrier coming into direct contact with the tow.

According to a further development of the method according to the invention, a gaseous heat carrier additionally flows in a manner known per se through the tow.

This combination of the method according to the invention with the method as known per se permits a particularly good adaptation of the drying procedure to different materials.

The tow is advantageously transported at a speed of from 30 to 100 m/min.

The method according to the invention has proved to be especially suitable when used for drying tows consisting of polyacrylonitrile polymers.

The apparatus of the invention for carrying the method into effect comprises a rotatable drum with a closed wall or surface, which is provided with a heating means. The feature according to the invention is that the wall is provided with protuberances, between which continuous gaps extend.

The protuberances can have many different forms. According to one embodiment of the invention, the protuberances consist of a fluting, produced, for example, by cutout grooves, which extend parallel to the drum axis or crosswise relatively to one another. A strong roughening of the drum wall is also suitable.

A surface layer which has proved to be particularly simple to manufacture and to be effective is one consisting of a wire fabric, wire gauze, a wire mesh or of a surface-structurized metal foil.

The required "handle" can be adjusted for each material which is to be dried, according to the choice of the nature and density of the protuberances. Thus, a punctiform or linear contact or even a small-area contact of the drum wall with the towcan be produced, so that the direct heat transfer is by way of the points of contact. With the interruptions or gaps, there is a smaller heat transfer by radiation. In addition, however, the tow can also be irradiated by electric heat radiators.

According to one particular development of the invention, spacer elements are arranged between the covering layer and the drum wall, and ducts or passages extend between these elements. The said ducts ensure a larger vapor space beneath the tow and thus a better extraction of the vapors which collect. The ducts are advantageously connected to a suction means. The use of a suction means has the advantage that the vapors removed by suction, and advantageously mixed with air, can be conveyed in a cycle, whereby special drying effects can be produced. However, in a manner known per se, it is only necessary for hot air or other treatment gases to be conveyed on to and drawn through the tow.

Connecting holes advantageously extend from the ducts through the drum wall into the interior of the latter, which is connected to a suction means.

According to one particularly advantageous and constructionally simple further development of the invention, the heating means consist of bores extending in axial parallel relationship through the drum wall and through which a heating medium can flow.

Conventional drying drums can also be converted in a simple manner into the apparatus according to the invention.

Three constructional examples of the apparatus according to the invention are partly shown in strictly diagrammatic form in a drawing, wherein:

FIG. 1 shows a surface of a drum with a wire fabric covering;

FIG. 2 shows a surface of a drum with a wire fabric covering and spacer elements; and

FIG. 3 is a showing of a calender dryer according to the invention.

In FIG. 1, a wall 1 of a steam-heated drum has a wire fabric covering 2 fixed to the smooth surface thereof. For drying purposes, a tow 3 of filaments rests on this wire fabric 2. In this case, heat conduction, heat transfer and radiation are used for drying the material. The steam condensed in the drum gives off its heat energy to the drum wall. This transmits the heat and transfers it to the wire fabric 2, which in its turn transmits the heat and transfers it to the filament tow 3. At the same time, the tow 3 receives the heat of radiation from the drum wall 1 and the wire fabric 2 bearing thereon. Consequently, with contact, the heat is only transmitted by way of continuously interrupted surfaces. The steam forming between the tow 3 and drum wall 1 can discharge freely into the cavities of the wire fabric 2.

By the combination of smooth, uncovered drying drums and drying drums covered with suitable wire fabrics 2, the required "handle" is adjustable.

According to FIG. 2, a drum wall 21 is heated through bores 24 with steam. The heat transfer is by way of a spacer element 25 to a slotted plate 26, on which is fixed a wire fabric 22. The filament tow 23 lies on the wire fabric 22. Passages 27, 28 extend between the spacer elements 25. The vapors and entrained air are discharged through bores 29 and blown cyclically from above on to the tow 23 again. Consequently, in this example, the following physical inter-relationships are used for the drying operation: transmission of the heat energy in gaseous form by hot gas being blown on to the tow, in liquid or vapor form by heat conduction and HEAT transfer, and also by radiation. The combination of these aforementioned types of heat transfer leads to the more intensive and more rapid drying.

A calender heater or dryer, as is used in Example **2**, for instance, is indicated in FIG. **3**. The heater is composed of cooperating heated, rotatably mounted drums, including first drum **31** for receiving an article to be heated, intermediate drums **32**, **33**, **34**, and **35**, and a last drum **36** for discharge of the heated article. At least some of the drums are of a construction as is shown in FIGS. **1** and **2**. The first drum **31** and the intermediate drums adjacent thereto, **32** and **33**, are of construction as is shown in FIGS. **1** and **2**, having protuberances **37** at their outer surfaces. The last drum and the intermediate drums adjacent thereto have smooth outer surfaces **38**.

EXAMPLE 1

A tow of polyacrylonitrile filaments is stretched by 260 percent in water at 98° C. After the stretching, the tow has a total count of 270,000 dtex. The count of the individual filament is 3.3 dtex. The tow is washed in water at 80° C. and provided with a finishing preparation. The tow is thereafter dried in conventional manner at a speed of 50 m/min. on a calender drier with **28** calender drums at a temperature of 130° C. The tow which is produced is crimped in the usual manner and cut into staple fibers. The fibers are processed into yarns and dyed. The dyed yarns are tested for their "handle". The material produced by the conventional drying method provides a yarn with a soft "handle".

EXAMPLE 2

A wet filaments tow pretreated in the same manner as in Example **1** is dried on a calender drier, the 28 drums of which are provided in accordance with the invention with a screening wire fabric. The wire fabric consists of a chrome-nickel steel. The thickness of the wire is 0.18 mm and the number of meshes is 450 meshes per square centimeter. After drying, further processing takes place as in Example 1. The material dried and produced in this way provides a yarn with a compact or solid "handle".

EXAMPLE 3

A tow of polyacrylonitrile filaments is stretched by 260 percent in water at 98° C. After the stretching, the tow has a total count of 270,000 dtex, the count of the individual filament being 3.3 dtex. The tow is washed in water at 80° C. and provided with a finishing preparation. The tow is thereafter dried at a speed of 50 m/min. on a calender drier having 28 calender drums. The first 12 drums are provided with a screening wire fabric, as in Example 1, and the last 16 drums are smooth. The first 12 drums are heated to 140° C. and the last 16 drums to 100° C. The tow is worked up in the usual manner into staple fibers. The yarn produced therefrom has a softer handle than the yarn prepared according to Example 2 and a fuller or more solid handle than the yarn produced according to Example 1.

EXAMPLE 4

A tow of polyacrylonitrile filaments is stretched by 360 percent in water at 98° C. After the stretching, the tow has a total count of 180,000 dtex, the count of the separate filament being 3.3 dtex. The tow is washed in water at 80° C. and provided with a finishing preparation. The tow is thereafter conveyed at a speed of 60 m/min. into a calender drier with 28 calender drums. The peripheral speed of the first 8 drums is 60 m/min., that of the 9th to 12th drums is 54 m/min. and that of the 13th to 28th drums is 51 m/min. The temperature of the drums 1 to 4 is 80° C., that of drums 5 to 8 is 140° C. and that of drums 9 to 28 is 130° C. The tow is thereafter crimped and laid as an endless band.

EXAMPLE 5

In another experiment, a tow is conveyed as in Example 4 into a calender drier, of which the smooth drums are provided with a screening wire fabric, as in Example 2. The speed setting of the calender drums is as Example 4, but the temperatures are in each case set 20° C. higher. The dried tow is crimped and laid as an endless band.

The endless bands produced according to Example 4 and **5** are processed on a turbo-stacker and processed in the usual way to form bulk yarns. The yarns are dyed and finished and tested for their handle. The yarn produced according to Example 4 has a soft handle, while the yarn produced according to Example 5 has a solid handle.

We claim:

1. Process for drying wet tows and controlling the handle of the fibers of the dry tow which comprises:

a. operating a conduction heater for supplying of heat thereby, said heater having a heat transferring surface defined by protuberances providing outwardly disposed areas for heat transfer by conduction from the heater, and cavities between the protuberances,

b. contacting a flat surface of the tow with said heat transferring surface for heating of the tow and at least partial drying thereof,

c. said operating of the conduction heater comprising the heating thereof for transfer of heat by conduction from the conduction heater heat transferring surface to the tow.

2. Process according to claim **1**, said heat transferring surface being porous for escape of vapors.

3. Process according to claim **2**, wherein a gas is passed through the tow to improve the drying.

4. Process according to claim **1**, said conduction heater being a drum dryer in which the outwardly disposed surface of the drum forms said heat transferring surface, and transporting the tow over the surface of the dryer during the drying.

5. Process according to claim **4**, the tow being transported at a speed of 30 to 100 m/min.

6. Process according to claim **1**, the temperature of said heat transferring surface being between 80° C. and 200° C.

7. Process according to claim **1**, the tow being composed of polyacrylonitrile fibers.

8. Process according to claim **1**, the tow being composed of polyacrylonitrile fibers, the temperature of said heat transferring surface being 80° C. to 200° C, said conduction heater being a drum dryer in which the outwardly disposed surface of the drum forms said heat transferring surface, and transporting the tow over the surface of the dryer during the drying, at a speed of 30 to 100 m/min.

9. Process of producing fibrous yarn of a desired handle from a wet tow of the fibers which comprises drying the tow by the process of claim **1**, and producing the yarn from the dried tow.

10. Process according to claim **12**, and utilizing a heat carrier for said heating the heat carrier supplying heat for the conduction heating without the heat carrier coming into direct contact with the tow.

11. A conduction heater suitable for drying wet lows comprising:

a. rotatable drum having a cylindrical outer wall,

b. protuberances disposed on the outer surface of said wall producing outwardly disposed areas for heat transfer by conduction from the heater, and cavities between the protruberances,

c. means for heating by a heat carrier means said wall for transfer of heat thereby to said protuberances for transfer of heat to the wall and directly from the wall to a tow placed in contact with the wall, without the heat carrier means coming into direct contact with the tow.

12. Heater according to claim 11, said cavities intercommunicating and defining continuous gaps.

13. Heater according to claim 12, said protuberances being defined by fluting.

14. Heater according to claim 12, said protuberances being formed by porous wire sheet.

15. Heater according to claim 12, said protuberances being formed by surface-structurized metal foil

16. Heater according to claim 11, and means defining passageways in said wall communicating with the cavities for removal of gas from the cavities during heating of an article by the heater.

17. Heater according to claim 16, and suction means for drawing gas from the cavities through said passageways during heating.

18. Heater according to claim 11, said protuberances being formed by a porous wire sheet overlying said wall, a porous spacer element interposed between said wire sheet and said wall supporting the wire sheet, and means defining ducts in said wall for passage of gas through the wire sheet spacer elements, and ducts.

19. Heater according to claim 18, and suction means for drawing gas through said ducts.

20. Heater according to claim 18, and passageways communicating said ducts with the interior of the drum, and suction means for withdrawing gas from the interior of the drum.

21. Calender heater composed of cooperating rotatable heated drums including a first drum for receiving an article to be heated and a last drum for discharge of the heated article, at least some of the drums are according to claim 11.

22. Calender heater composed of cooperating rotatable heated drums including a first drum for receiving an article to be heated and a last drum for discharge of the heated article, all of the drums being according to claim 11.

23. Calender heater composed of cooperating rotatable heated drums including a first drum for receiving an article to be heated and a last drum for discharge of the heated article, part of the drums being according to claim 11, and part of the drums having a smooth outer surface for transfer of heat from the drum to the article.

24. Calender heater composed of cooperating rotatable heated drums including a first drum for receiving an article to be heated and a last drum for discharge of the heated article, and several drums intermediate said first drum and said last drum, the first drum and intermediate drums adjacent thereto being according to claim 11, the last drum and intermediate drums adjacent thereto having a smooth outer surface for transfer of heat from the drum to the article.

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