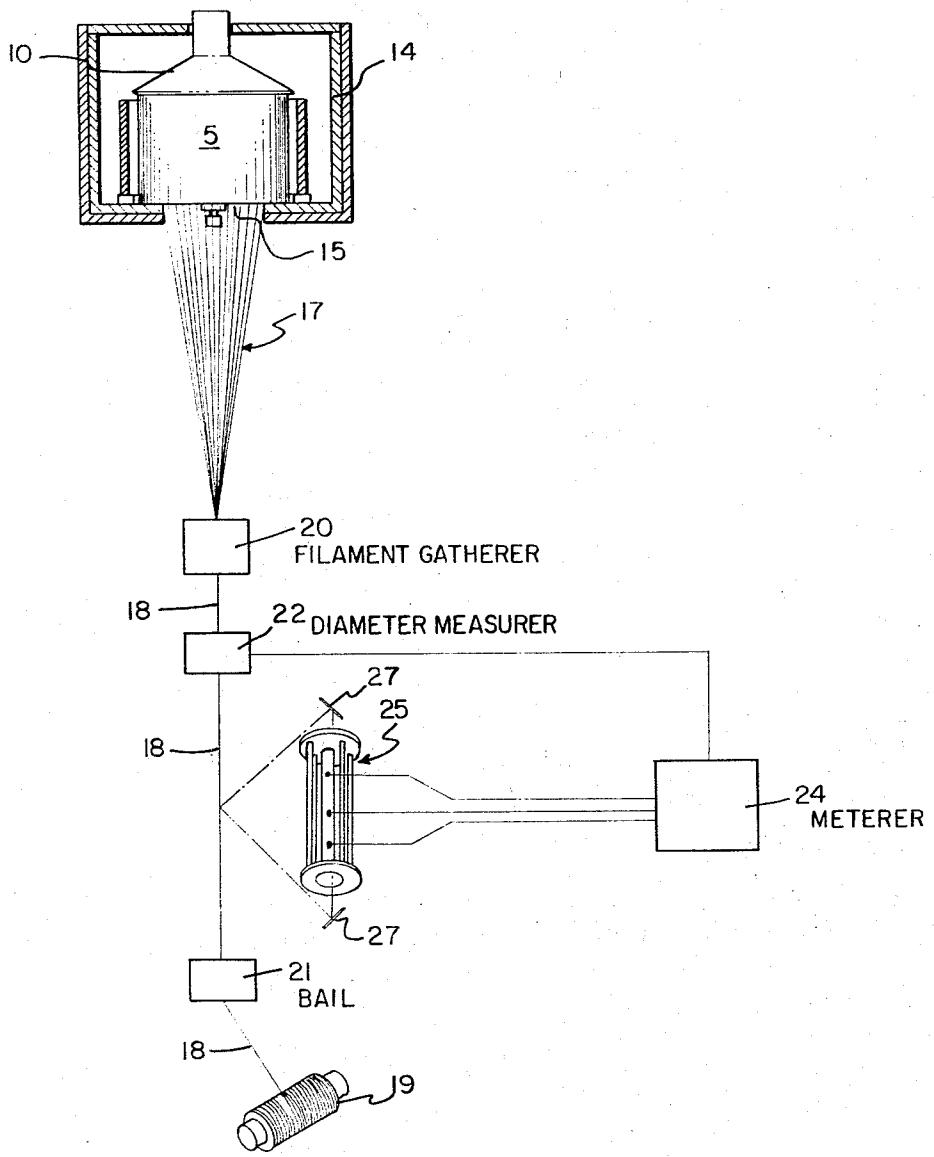
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DRYING PROCESS AND APPARATUS USING A COHERENT LIGHT SOURCE

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DRYING PROCESS AND APPARATUS USING A COHERENT LIGHT SOURCE

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This invention relates to the manufacture of textile fibers or yarns. More specifically, this invention concerns a method of drying these materials through the use of coherent light waves such as produced by a laser.

In the past, yarn or textile fibers, that is, the wide range of synthetic fibers such as rayon, dacron and orlon; and inorganics such as glass, have generally been prepared by heating the components until molten, and then forcing the molten mass through orifices to form filaments. Cotton and wool have been formed into threads by drawing them from a disordered mass. Nylon has been made from a cold forming process. Any of these yarns or fibers can then be bound, twisted, or plyed into strands if desired. From the forming stage, the material is sized, if necessary, and wound upon a winding spindle. The strands are often wet from the sizing operation and/or forming.

Now the art has generally desired to dry the strands completely or to a specific degree of moisture content before they are placed upon the spindle; however, such attainments have not been realized. Inherently, the filaments come from the orifices in varying diameters between about 0.0005 to 0.12 inch and at great velocities, frequently as high as about 5,000 to 15,000 feet per minute and sometimes higher. With conventional methods of drying using radiant heat, the temperature must be preset for the average diameter and velocity of the material passing through the drying stage. If the diameter decreases even for an instant, the material can be scorched, weakened and sometimes broken, while if the temperature is too low, the material is dried only partially. Since breakage is least desirable, the art has compromised upon partial drying before winding and then baking the entire package in an oven. It has been difficult to dry the filaments as they are formed because it has been impossible to change the temperature of the radiant heating device quickly in relationship to the diameter and mass of the strand passing through its waves because of the time lag in changing the temperature. The art then has compromised upon hollow, perforated winding spindle so that when placed in an oven, heat may pass into the winding in a fairly uniform manner. Even with such devices, however, the drying is only poor, at best, because the heat does not uniformly penetrate. Quite apparently, this solution to the problem is unsatisfactory because of the prolonged delay during baking and inadequate drying period, and costly material handling.

Furthermore, while the strand is being wound upon a winding spindle, the velocity gradually changes due to the gradually increasing diameter as the spindle fills. Hence the drying temperature must be modified to reflect the velocity of the strand passing therethrough. Ordinary radiant heat furnaces were incapable of modifying their temperatures in accordance with the changing velocities.

Quite unexpectedly, I have discovered that drying can be performed upon such materials even though the diameter and mass may vary and even though they pass through the drying stage with great velocities. I have discovered that a source of coherent light waves such as produced by devices commonly known as lasers or masers will perform such operations. Then coherent light sources can be instantaneously modified to change the heat produced by the light waves; and hence, drying of the strands of varying diameters and masses can be instantaneously regulated.

According to my invention, I monitor the diameter and if desired, the velocity, of the strands passing from the forming stage and relay this information to a source of coherent light which will be programmed to modify instantaneously the energy produced in response to the input. Generally, a so-called gas laser is preferred because of its flexibility and freedom from maintenance; however, the ruby type also has applicability.

Accordingly, the primary object of my invention is drying fibers or yarns as they pass from a forming stage and before they are wrapped upon a drying spindle.

Another object of my invention is the complete drying, when desired, of such materials, and thus the elimination of baking the wrapped strands in an oven as a separate process step.

A feature of my invention is using a source of coherent light to dry the yarns or fibers.

Another feature of my invention is monitoring the diameter of strands of material and relaying this information to a source of monochromatic light and thereby change its intensity.

And yet another feature of my invention is monitoring the velocity of the strand passing through the source of coherent light to dry it without scorching.

An advantage of my invention is that materials of varying diameters can be dried as formed at exceedingly throughput velocities without scorching or breaking them.

The many other objects, features and advantages of my invention will become manifest to those conversant with the art upon reading the following specification in which preferred embodiments of my invention of drying yarns and fibers are shown in the accompanying drawings and described herein by way of illustrative examples.

Of these drawings, the figure is a diagrammatic, schematic view of an apparatus which can be used with my process of forming, drying and wrapping yarns or fibers upon a spindle.

My invention will be particularly described with reference to the manufacture of glass fibers although as has been indicated, other materials such as rayon, dacron, and orlon which are made by a hot forming process can also be dried. Additionally, cold forming strand operations can utilize my invention along with natural fiber processes such as cotton and wool manufacture. With particular reference to the glass fiber, a diagrammatically illustrated apparatus for forming and winding the material upon a spindle is shown. The apparatus comprises a chamber **5** containing a number of glass marbles (not shown). From conduit **10**, the marbles are directed into a furnace **14** where they are heated to form a molten liquid. The liquid flows by gravity or is extruded and subsequently attenuated into fine glass filaments **17** through a bushing **15** having a plurality of orifices.

When forming continuous strands from finely drawn filaments by collecting the filaments at a guide, the common practice is to provide the guide with an applicator for evenly coating the surface of the filaments with material such as a lubricant, sizer or binder. The filaments are converged and grouped together to form a strand as they pass over the guide and usually are simultaneously coated with the liquid to prevent the filaments within the strand from abrading each other. Also, the liquid can give mass integrity to the group of stranded filaments thereby preventing loss from either fraying or breaking away.

Disposed beneath the gathering device **20** is a diameter indicating device **22** which measures the diameter (and the mass) of the strand **18** passing therethrough. When the diameter of the strand **18** is measured, the information which is relayed to a metering system **24** which in turn relays the information to the laser **25**, the source

of coherent light. Because of the instantaneous response to changes in diameter, and thus inherently mass, to which the source **25** responds, the strand **18** can be dried to the exact degree which is desired. The light from the laser **25** radiates from either end and is focused by mirrors **27** upon the strand **18**. Since the light emitted from the laser can be instantaneously regulated, the heat produced can be varied to compensate for even minute and rapidly changing variations in the diameter of the strand **18**.

If desired, the diameter indicating device **22** can be modified to measure the velocity of the strand **18** passing therethrough.

I prefer to use the well-known, helium-neon gas laser which provides continuous operation at several infrared wave lengths of 11, 180, 11,530, 11,600, and 12,070 A.; the strongest of these being the 11,530 A. radiation line. Alternatively, a system which utilizes a triggering method to increase the pulse rates of ruby lasers can be used. Instead of switching the laser pulse source fully on to make the ruby laser, which is the conventional method, just enough pulse excitation is applied to start the laser action. Immediately after the laser action begins, the excitation source goes off and the laser excitation stops. At this time, there are a large number of ions at a high energy state, since the relaxation time between the upper state (E level) and the ground state is in the order of several microseconds. A relatively weak excitation pulse can then restart the laser action. About 100 microseconds later, another excitation source supplies a short duration light pulse of low energy to the ruby causing it to lase light pulses that follow at 100 microsecond intervals provide 100,000 pulses per second. Generally, the structure utilized for such operation includes two spiral, coaxial flash tubes encircling the ruby. One of the flash tubes is smaller and is disposed nearer to the ruby and provides the trigger excitation pulses and the larger tube which surrounds the inner flash as well as the ruby provides the 200 microseconds preparation pulse.

It is apparent that changes and modifications may be made within the spirit and scope of the instant invention; however, it is my intention to be limited only by the appended claims.

As my invention I claim:

1. A process for drying strands, the steps which comprise: passing said strand through energy waves generated by a coherent light source; varying the intensity of said energy waves in response to the diameter of the passing strand, thereby drying it and then winding the dried strand upon a spindle.

2. The process according to claim **1** wherein the strand is a glass fiber.

3. The process according to claim **1**, wherein the strand is an organic fiber.

4. A process for drying strands, the steps which comprise: passing said strand through energy waves generated by a coherent light source; varying the intensity of said energy waves in response to the velocity of the passing strand, thereby drying it and then winding the dried strand upon a spindle.

5. The process according to claim **4** wherein the intensity of the coherent light source is also varied in response to the diameter of the passing strand.

6. A process for drying strands, the steps which comprise: measuring the diameter of said strand, passing said strand through energy waves generated by a coherent light means, changing the intensity of said light means in relation to the measured diameter of the strand passing therethrough, thereby drying it and then winding the dried strand upon a spindle.

7. The process according to claim **6** wherein the velocity of the strand is measured and the intensity of the energy waves is modified in relation thereto.

8. The process according to claim **6** wherein the strands pass through said energy waves at a velocity greater than about 5000 feet per minute.

9. A process for drying strands, the steps which comprise: generating energy waves from a coherent source of light; passing said strand through said energy waves thereby drying it and winding the dried strand upon a spindle.

10. A process for drying strands, the steps which comprise: generating energy waves from a coherent source of light; measuring the diameter of said strand; passing said strand through said energy waves and modifying the intensity of said light source in relation to the measured diameter of the strand passing therethrough.

11. The process according to claim **10** wherein the strand is glass fiber.

12. The process according to claim **10** wherein the strand is an organic fiber.

13. Apparatus comprising, means for forming a strand of fiber; means for measuring the diameter of said strand of fiber; coherent light source means disposed to focus its energy waves upon said strand; means for changing the intensity of the light radiated from said coherent light source means in relation to the measured diameter relayed from said diameter measuring means; means for winding said strand upon a spindle.

14. The apparatus according to claim **13** wherein the coherent light source means is a gas laser.

15. The apparatus according to claim **13** wherein the coherent light source means is a ruby laser.

16. The apparatus according to claim **13** including means for changing the intensity of the light radiated from said source in relation to the measured velocity.

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