Sept. 8, 1942. J. R. CALDWELL 2,294,957

METHOD OF CRIMPING TEXTILE FIBERS

Filed Nov. 23, 1940

FIG. 1.

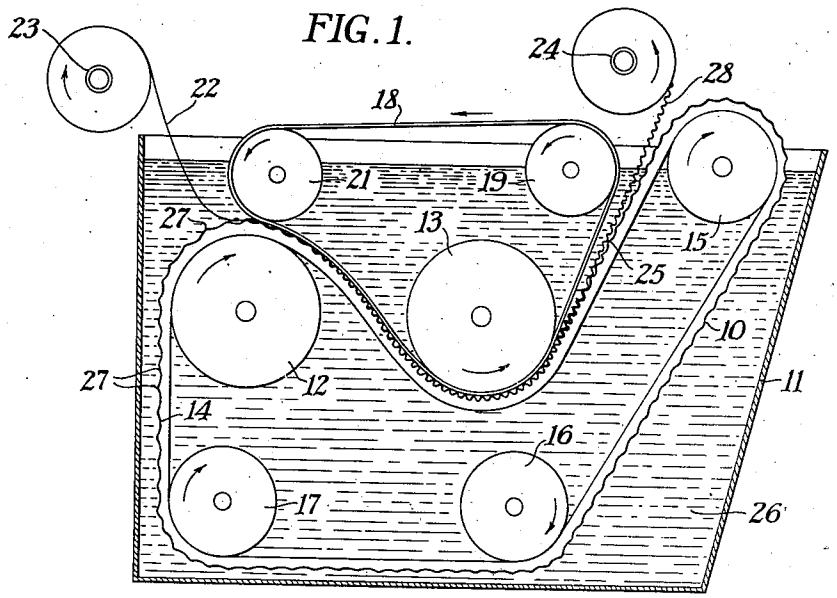


FIG. 2.

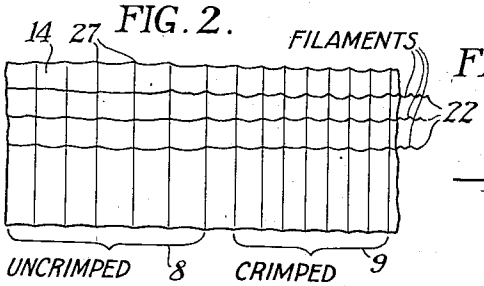


FIG. 3.

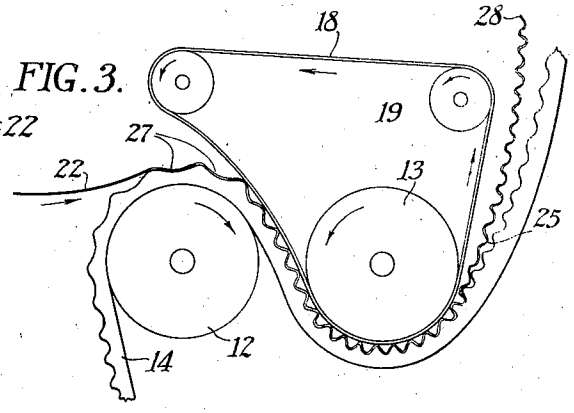
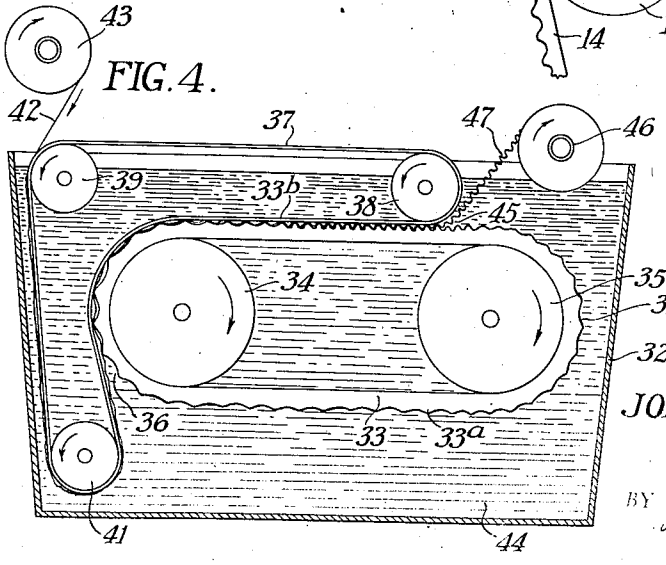


FIG. 4.



JOHN R. CALDWELL
INVENTOR

BY Daniel J. Mayne
ATTORNEYS

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METHOD OF CRIMPING TEXTILE FIBERS

John R. Caldwell, Kingsport, Tenn., assignor to Eastman Kodak Company, Rochester, N. Y., a corporation of New Jersey

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3 Claims. (Cl. 18—48)

This invention relates to crimping textile fibers and more particularly to crimping synthetic fibers, filaments, and threads to convert them into a crimped, wavy structure which closely resembles the structure of natural fibers.

Since the advent of artificial textile materials, effort has been continually directed toward the problem of duplicating certain desirable features found in natural fibers. As is well known, natural wool fibers are characterized by a crimped, kinky structure and rough scaly surface which permit the fibers to felt or cling together and thus form a strong elastic thread when spun. In addition, the waves and crimps in the filaments tend to fluff out the yarn and give it a springy, resilient feel. With the increased interest in substitutions of various synthetic staple fibers for wool, various methods have been proposed to impart the characteristic crimped and resilient structure of natural wool to the synthetic products.

An object of the present invention is to provide a method of imparting a substantially uniform crimp to synthetic textile fibers, filaments, and yarns. Another object of the invention is to provide a method for crimping synthetic textile fibers in the form of a roving composed of a plurality of continuous filaments maintained in substantially parallel strands. Still another object is to provide a method of crimping synthetic cut staple fibers oriented at random in the form of a coherent web or mat. A further object of the invention is to provide a method of impressing permanent crimps or waves upon filaments without deterioration in their physical properties. An additional object of the invention is to provide a method of crimping filaments, yarns, or rovings without substantial tension being exerted thereon. Other objects will appear hereinafter.

In accordance with the invention these and other objects are attained by passing the yarn, filament, fiber, or roving onto a moving endless conveyor belt made of an elastic material and having parallel flutes extending across its outer surface and supported or carried around a series of rolls. At the point the filaments to be crimped first contact the elastic belt, the belt is stretched, thereby causing the flutes to be of considerably greater width than depth. The filament will thus lie on the belt in lengths corresponding to the lengths of these extended flutes. An endless guiding belt cooperates with and contacts the surface of the fluted belt thus preventing the filaments from leaving the assumed position. The stretch in the fluted belt is then gradually relieved, causing a narrowing of the flutes and consequent deepening thereof. The filaments which originally lay in the extended or stretched flutes will then assume substantially the same contour as the now shortened and deepened flutes. This will, therefore, result in the filaments having a plurality of crimps along its unit length in relation to the number of flutes per unit length of the conveyor belt. The conveyor belt is then stretched to open the closed flutes somewhat and the filament having the desired crimps are at that point conducted from the apparatus. To facilitate crimp formation, the above described process may be carried out under the surface of a suitable liquid heated to a temperature sufficient to render the material thermoplastic and easily susceptible to the moulding or crimping action of the unstretched flutes.

In accordance with another feature of the invention I may employ a fluted belt having a rough or pebbled finish instead of one having only a fluted surface. By so doing it is possible to impress minute irregularities upon the surface of the filaments simultaneously with the crimping operation, thus producing filaments which closely resemble wool.

As contemplated in the invention, various methods may be employed to stretch and release the stretch of the fluted conveyor belt, as well as to conduct the filaments onto the conveyor and remove it therefrom. Two suitable methods are described herein.

The invention will be more clearly understood from the following detailed description and accompanying drawing in which:

Fig. 1 is a schematic view in elevation of one form of an apparatus suitable for use in crimping filaments, yarns, rovings and the like.

Fig. 2 is a magnified plan view of the fluted conveyor belt of Fig. 1 showing a stretched portion and an unstretched portion with parallel filaments uncrimped and crimped on the respective parts of the belt.

Fig. 3 is a magnified view in elevation of the two principal rolls and belts of Fig. 1 showing in more detail the stretch and contraction of the fluted belt as it passes from one roll to the other.

Fig. 4 is a schematic view in elevation of an alternative type of apparatus which may be employed in accordance with the invention for crimping filaments, yarns, rovings, and the like.

Referring to Fig. 1 there is shown a textile fiber crimping apparatus 10 mounted in a con-

tainer 11 and comprising stretching roll 12 and compressing roll 13 with an endless elastic fluted belt 14 associated therewith which also engages in its travel guide rolls 15, 16 and 17. A second endless belt 18 is mounted above rolls 12 and 13 and caused to contact the fluted belt 14 between roll 12 and 13 and passes between roll 13 and the fluted belt 14 on its travel. Guide rolls 19 and 21 serve to position the belt 18 as shown.

The filament or other material to be crimped is shown at 22 and is conducted through the apparatus from supply roll 23 to take up roll 24. In passing through the apparatus the filament 22 rests on fluted belt 14 from near the top of roll 12 to the removal point 25. It is held in contact with fluted belt 14 by belt 18 between roll 12 and 13. The container 11 is filled with water 26 maintained preferably at a temperature of about 75° C. by means not shown.

It will be understood that one or more of the rolls 12, 13, 15, 16 and 17 which engage fluted belt 14 may be driven by means, not shown, to cause the fluted belt 14 to travel in a clockwise direction; and similarly rolls 19 or 21 or both may be driven in a counterclockwise direction to cause belt 18 to move from the vicinity of roll 12 toward roll 13.

Assuming filament 22 has been passed through the apparatus from supply reel 23 to take up roll 24 and that the water in the apparatus is at the required temperature, the mechanics of the crimping operation will now be described. This operation will perhaps be more easily visualized if the magnified view shown in Fig. 3 is considered with the description of the apparatus more fully shown in Fig. 1.

As shown in Fig. 1, and more clearly in Fig. 3, the filament 22 first contacts the fluted belt as the belt passes over the top of roll 12. At this point the flutes 27 on the surface of the fluted belt 14 are stretched so that their width is greater than their depth. The position of the filament will be more clearly understood by reference to Fig. 2 in which a plurality of filaments 22 lie on fluted belt 14 which is stretched as shown in the bracketed portion 8 and contracted as shown in the bracketed portion 9. The filaments 22 will, therefore, lie on the belt 14 without any tension being exerted on it in substantially regular waves. As the fluted belt 14 progresses from roll 12 toward roll 13, the expanding effect produced by the passage of fluted belt 14 around roll 12 is gradually lessened and this results in a narrowing and deepening of the individual flutes 27.

The filaments 22 are prevented from sliding out of the flutes by endless belt 18 which is superimposed on fluted belt 14 shortly after filaments 22 are laid thereon. As flutes 27 gradually contract the filaments 22 assume a similar contour and in place of having the initial shallow U shape they gradually change to a deep narrow U as they approach roll 13.

The fluted belt 14 passes, it will be noted, under roll 13 with the fluted side against the surface of the roll. This produces an effect opposite to that of roll 12 and instead of expanding the flutes 27, roll 13 compresses or contracts them. The filaments 22 in these flutes are thus molded from a straight linear form to one comprising a plurality of uniform and evenly spaced crimps 28.

The fluted belt 14 after passing beneath and partly around roll 13 continues on to roll 15 which is mounted at an angle to roll 13. As belt 14 continues along this path, it again is gradually expanded until at a point 25 part way between rolls 13 and 15 the flutes 27 are opened sufficiently to permit the filaments 22 thus provided with crimps 28 to leave the belt 14 and proceed to windup roll 24, or to other apparatus, as may be desired.

An alternative type of apparatus for producing crimped filaments, yarns, and rovings is shown in Fig. 4 in which the crimping apparatus 31 is shown mounted in a container 32 containing a heated liquid 44. This liquid, for example, may be water maintained at a temperature of from 50–100° C. depending somewhat on the type of filament employed. The apparatus comprises an elastic fluted belt 33 which passes around two rolls 34 and 35. Roll 34 is driven by means, not shown, at a greater speed than roll 35. This results in placing an initial tension on the lower side of the belt 33*a* while the upper side 33*b* is relaxed. Therefore, the flutes 36 of belt 33 will be stretched to the maximum as the belt passes around roll 34. Associated with fluted belt 33 is guiding, endless belt 37 which passes around its system of pulleys or rolls 38, 39 and 41. This guiding belt 37 engages the surface of the stretched fluted belt as it passes around roll 34, as will be understood from the drawing.

As in the previously described apparatus and process, filaments 42 are brought from a supply spool 43 and conducted by endless guide belt 37 down through the heated fluid 44 and between guide belt 37 and fluted belt 33 at the point where the fluted belt is stretched over roll 34. The filament will lie in relaxed waves, the filament taking the contour of the expanded flutes. As the fluted belt 33 passes from roll 34 toward roll 35 the speed of travel of the belt is lessened and, therefore, the width of the flutes is contracted and the depth of the flutes increased. The filament will then assume the new shape of the flutes without substantial tension being exerted thereon.

Owing to the softening effect of the hot liquid bath, the filament is in a sufficiently plastic state to be easily moldable by the crimping action of the flutes. As the fluted belt 33*b* approaches roll 35 it will be gradually stretched, the flutes opened and the crimped filaments can be removed as at 45 and wound up on roll 46. The filaments are removed without tension and the crimps 47 will remain in the filament.

While I prefer to employ a belt made of an elastic material such as rubber, synthetic rubber, or rubber substitutes, it will be understood that any other suitable elastic material may be employed or that the belt may be made of a composite or laminated material. In some cases it may be advantageous to use a belt fabricated from a textile material such as felt or plys of canvas. I have found that a belt made from rubber vulcanized to a fabric backing is suitable.

Although I have also found that a parallel fluted surface is particularly suited for the crimping of filaments and the like, it is within the scope of my invention to employ an elastic surface which has parallel cuts or slits therein or any other such expedient which will expand and form opening and then crimp the filament upon closing of the openings as above described.

In the above description of the operation of my apparatus mention is made of employing heated water as the means of causing the filaments to be thermoplastic prior to the crimping step. In most cases, it is suitable to operate the

rolls and fluted belt partially or wholly immersed in a liquid bath, usually water maintained within a range of 50° C. to 100° C. Lubricants such as oils, waxes, soaps, and other such materials commonly employed to treat filaments and the like may be added to the bath in whatever amount that may be desirable. It is thus possible to crimp the filament and lubricate it at the same time. Alternatively, the bath may be a non-aqueous liquid such as toluene, or a petroleum fraction. When stretch-broken roving is crimped, it may be desirable to use a bath which has a softening action on the fiber, thus tending to restore some of the extensibility lost during the breaking operation.

Other modifications may be made in the apparatus in accordance with the invention. If desired, the rolls and belt may be heated and wet fibers supplied to the system effecting a simultaneous drying and crimping operation. Furthermore, jets of steam or hot air may be directed onto the rolls or belts at various points to soften the filaments and render them more amenable to crimping.

My invention is particularly suited for forming crimps in filaments, yarns, rovings, etc., composed of cellulose acetate, cellulose propionate, cellulose acetate butyrate, benzyl cellulose, ethyl and methyl cellulose and other synthetic filaments which are thermoplastic. Such materials when processed in accordance with my invention have a crimped and wavy structure which closely resembles natural wool.

While the invention is described in connection with a filament, as above suggested, it finds a most useful application in producing waves or crimps in continuous rovings composed of a plurality of short fibers maintained in essentially parallel alignment.

Rovings prepared by stretch-breaking a large-denier bundle of continuous filaments are especially suitable for treatment. In most cases it is desirable to subject the roving to carding or gilling operations for the purpose of orienting and distributing the staple fibers prior to the crimping treatment. My invention further affords a means for accurately controlling the frequency, amplitude and general contour of the deformations produced in the yarn structure. It results in impressing a permanent crimp or waves upon the filament without causing deterioration in physical properties.

When staple fibers in the form of a continuous roving are treated, the orientation and arrangement of filaments with respect to each other are not disturbed, and there is no tendency to break or tear the fibers. By employing suitable carding and gilling devices in conjunction with my invention, it is possible to convert a roving prepared by stretch breaking process into a product closely duplicating the essential properties of a wool "top" which may be processed satisfactorily on conventional wool machinery.

I claim:

1. A process for crimping moldable synthetic filaments which comprises laying the filament into surface contact with an elastic surface provided with a plurality of transverse flutes when the flutes are in a stretched position and crimping the filament by contracting the flutes upon the filament resting therein while the filament is in a moldable condition.

2. A process for crimping synthetic filaments made from thermoplastic materials which comprises laying the filament onto an elastic conveyor belt provided with transverse flutes when the flutes are in a stretched position, heating the filament to a thermoplastic condition, and crimping the filament by gradually contracting the flutes upon the filament resting therein while the filament is in a thermoplastic condition.

3. A process for crimping synthetic filaments made from thermoplastic materials which comprises laying the filament onto an elastic conveyor belt provided with transverse flutes when the flutes are in a stretched position, heating the filament to a thermoplastic condition, crimping the filament by gradually contracting the flutes upon the portions of the filament resting therein while the filament is in said thermoplastic condition and cooling the filament below the thermoplastic point before tension is exerted thereon.

JOHN R. CALDWELL.