FIG. II

Spool or Spools of Dry Yarn

Preshrinking

Tension Device

Spinning Tube

Positive Feed

Self Feed

Heating

Wetting

Air-Cooled

Rapid Drying

Rapid Refrigeration

Storage in Curled Form

Tension Device

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Rapid Refrigeration

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Refrigerated Storage

Sewing Machine

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This invention relates to a method for continuously curling plastic yarn to be employed as hair on a doll's head. An object of the present invention is the provision of a new and improved method for curling straight plastic yarn whereby to provide curled artificial hair for a doll's head. A further object of the present invention is to provide a new and improved method for curling plastic yarn wherein said curled yarn may be stored in uncurled form for substantial periods of time without causing the curl in the yarn to disappear. The above and other objects, features and advantages of the present invention will be more fully understood from the following description taken in connection with the accompanying illustrative drawings.

In the drawings:

FIG. 1 is a sectional view of apparatus for curling plastic yarn shown connected to one form of storage device embodying the present invention, said storage device being shown in elevation;

FIG. 2 is a sectional view taken along the line 2—2 of FIG. 1;

FIG. 3 is a perspective view illustrating the details of construction of a means for connecting the curling apparatus to a storage device;

FIG. 4 is a top plan view in reduced scale illustrating the curling and storage apparatus shown in FIG. 1;

FIG. 5 is a perspective view of a rod forming part of the mandrel included in the apparatus shown in FIG. 1;

FIG. 6 is an end view similar to FIG. 2 illustrating a modification of the present invention;

FIG. 7 is a side elevational view of a modified form of apparatus for continuously curling plastic yarn;

FIG. 8 is an enlarged side elevational view illustrating a further modification of the present invention;

FIG. 9 is a perspective view of a modified form of storage device embodying the present invention;

FIG. 10 is a perspective view of a modified form of mandrel which is adapted to be connected to the device for automatically curling yarn; and

FIG. 11 is a flow diagram illustrating various methods for continuously curling plastic yarn, each of said methods embodying the present invention.

Referring now to the drawings in detail and particularly to FIG. 1, a curling device 10 is shown therein connected to a storage device 12. The curling device 10 comprises a hollow horizontally disposed shaft 14 which is mounted for rotation on spaced ball bearings 16 and 18 which are supported by brackets 20 and 22, respectively, mounted on a horizontal surface 24. Fixedly mounted on shaft 14 as by a set screw 25 is a pulley 26 which is adapted to have thereon driven a belt 28 for rotating said pulley and said shaft. Disposed immediately to the left of bearing 16, as viewed in FIG. 1, is a collar 30 which is fixedly mounted on shaft 14 for rotation therewith. Collar 30 is provided with a passage 32 which is in registry with an aperture 34 in shaft 14 and extending through said passage and aperture is a tube 36 which extends outwardly from said collar 30 and is bent into a horizontal line therewithout. With further reference to FIG. 1, a pair of bearings 38 and 40 are mounted on shaft 14 to the left of collar 30 and are spaced from each other by means of a collar 42 which is fixedly mounted on shaft 14. Preferably, bearings 38 and 40 are of the ball bearing type whereby to substantially eliminate friction between the inner and outer races thereof. Fitted within member 46 is a collar 47 which slidably engages the side of the outer race of bearing 40. Member 46 is fixed to collar 47 as by set screw 44 to thereby prevent longitudinal movement of member 46. Member 46 being mounted on the outer races of bearings 38 and 40 normally remains stationary even while shaft 14 is rotating and, for reasons which shall become apparent hereinafter, when yarn is being curled upon said device the yarn further acts to prevent rotation of the member 46 with shaft 14.

Member 46 is provided with a plurality of cavities 50, here shown as two in number, which extend from a point within the member to the surface of the conical or tapered portion 48. The conical or tapered portion 48 is further provided with grooves 52 extending down opposed elements thereof from the points where the cavities 50 intersect the surface of tapered portion 48. Disposed within cavities 50 are a pair of rods 54 which have intermediate angular portions extending down said opposed elements of conical portion 48 within the grooves 52 therein. The free end portions 56 of rods 54 are preferably slightly convergent and may be tapered as shown in FIG. 1 and extend in substantially the same direction whereby to form a non-circular mandrel 58 for device 10. By disposing rods 54 within cavities 50, a convenient means is provided for connecting the mandrel to the member 46 in operative relation therewith. Furthermore, as may best be seen in FIG. 1, angular portions 56 of rods 54 extend above the surface of tapered portion 48 of member 46 whereby to render said tapered or conical portion non-circular. Accordingly, by the provision of rods 54, a non-circular tapered or conical member is provided, and a non-circular mandrel, here shown as substantially rectangular in cross section, is connected therewith in fixed relation thereto.

In operation, plastic yarn or thread 60, which is normally obtainable on relatively large spools, is drawn off the spool and led through the inside of hollow shaft 14 and to the outside of the shaft through tube 36. In this connection it is to be noted that the end 62 of tube 36 is disposed above the non-circular tapered portion 48. The thread 60 is wound around tapered portion 48 and thereafter shaft 14 is rotated by means of the pulley 26 and belt 28. Since tube 36 is rotatable with the shaft 14, the end 62 of the tube rotates around the tapered portion 48. It has been found that by making the mandrel non-circular, the turning of the curls relative to the mandrel is resisted. This resistance to the turning of the curls is further enhanced by rendering the tapered portion 48 non-circular although it has been found that forming the mandrel as a non-circular member is sufficient by itself to achieve this end. As the curls or turns of yarn are wound onto tapered portion 48, each curl tends to move downward toward the apex of the conical or tapered portion 48 thereby tending to push the adjacent curls downward toward said apex and hence toward the mandrel 58. Accordingly, the curls are self feeding in a direction longitudinally of mandrel 58 and no external feeding means is necessary. However, if desired, external feeding means such as opposed rollers 64 (FIG. 7) may be employed to positively feed the curled yarn along the mandrel in a direction longitudinally thereof. Although the rods 54 shown in FIG. 1 are relatively short, it is possible and sometimes highly desirable as will become apparent hereinafter to provide relatively long rods sometimes extending many feet from the tapered por-
tion 48. Furthermore, it is sometimes desirable to immerse the curled thread into a liquid for reasons which will become clear hereinafter. In order to accomplish this immersion automatically, rods 54 may be provided with dips or bows 66 which are adapted to lower the curls of yarn into a receptacle 68 (FIG. 8). Moreover, mandrel 58 may be formed of more than two rods 54 and may, in fact, be formed of four rods all of which may be embedded in member 46, as shown in FIG. 6.

Storage device 12 comprises a non-circular rod 70 of substantially smaller peripheral extent than that of the curls 72 formed on mandrel 58. One end 74 of the storage device 12 is adapted to be connected to mandrel 58 in a manner to be described hereinafter. The other end of the storage device is provided with a suitable fixed stop such as a ball 76 which is adapted to engage curls 72 as they move down the storage device in a manner to be described hereinafter for preventing said curls from unraveling off the storage device 12. As shown in FIG. 1, storage device 12 is formed into a helix and the rod 70 is square in cross-section. By forming the rod 70 into a helix, the device may be more conveniently handled. However, if desired, a storage device 12' made up of a straight rod 70' having a ball 76' at the free end thereof may be provided as is shown in FIG. 9. The end 74' adapted to be connected to the mandrel 58 preferably is bent at substantially a right angle to the main axis of the storage device 12', as at 78. In the helical form shown in FIG. 1, the curls 72 are moved along rod 70 by means of lateral pressure resulting from the self-feeding of the curls on the mandrel together with the force of gravity. When using a straight storage device such as shown in FIG. 9, it will be seen that portion 74' thereof is disposed in a substantially horizontal plane and the remainder of the storage device extends vertically whereby to permit the curls to move down said storage device towards the stop means or ball 76' under the influence of gravity.

With either construction, by forming the storage device of a rod of substantially smaller peripheral extent than the curls, it has been discovered that the curls tend to pile on top of one another and thereby permit the storage of, for example 20 curls in a space substantially equal to the width of the yarn forming the curls. Accordingly, for a given length of storage device, many times the amount of curled yarn can be stored thereon than could be stored on a storage device substantially equal to that of the curls 72. Moreover, with either storage device, the device is connected to the mandrel 58 and depends therefrom. It has been found that the weight of the storage device is sufficient to resist any turning moment applied to member 46 through bearings 39 and 40 whereby to prevent member 46 from turning.

Although mandrel 58 is preferably formed of rods 54 as hereinbefore described, it will be understood that other forms of mandrels may be employed without departing from the present invention. For instance, a peripherally continuous non-circular mandrel may be secured to the tapered portion 48 and may extend longitudinally therefrom and, in fact, member 48 may be initially formed as a non-circular member whereby to obviate the necessity for the portions of mandrel rod 54 extending above the surface thereof to render said tapered portion 48 non-circular. However, when employing the presently preferred form of the invention with mandrel 58 comprising the spaced rod 54, a suitable adaptor 80 is preferably fixedly connected to one of said rods 54 as by soldering to facilitate the connection of the mandrel with the storage device. Adaptor 80 is a U-shaped member of substantially the same longitudinal extent as the mandrel 58 and is provided with a tapered channel 82 having a bottom surface which diverges from the bottom of the adaptor whereby to render the bottom of the channel 82 horizontal when the adaptor is connected to the mandrel 58. Channel 82 defines a space of substantially the same peripheral extent and configuration as the end 74 of storage device 12 whereby to provide a simple and effective means for connecting the storage device to the mandrel by merely inserting the end 74 of the storage device into channel 82 of the adaptor. Of course, if the mandrel is a relatively long mandrel, as shown in FIG. 10, then adaptor 80 need not be used but need only extend inwardly from the free end of said mandrel for a few inches whereby to provide a suitable connection between the storage device 12 and the mandrel.

In accordance with the method for curling yarn embodied in the present invention, it is presently preferred that the yarn be thermoplastic or hygroscopic, or, of course, it may be both. The presently preferred yarns are cellulose acetate commonly known as acetate which is both thermoplastic and hygroscopic, and polyvinyliden chloride sold under the trade name "Saran" which is thermoplastic. Hygroscopic yarns may be plasticly deformed by wetting whereas non-hygroscopic yarns which are thermoplastic may be plasticly deformed by heating. Coming first to a method wherein heat is used as the plastic deforming agent, the plastic yarn, which may be constituted by a single thread or multiple strands of thread, is drawn off the spool and is passed through a suitable tension device. If the yarn displays a tendency to shrink excessively, it should preferably be preshrunk prior to treatment in accordance with the present invention. Thereafter, yarn passes through the spinning tube and is drawn over the mandrel as described and is wound around mandrel 58 which holds the yarn in its curled form as hereinbefore mentioned. The yarn is moved along the mandrel by self-feeding or by positive feeding such as by rollers 64 (FIG. 7). While still on the mandrel the thermoplastic yarn is subjected to heat as in a heating chamber whereby to cause plastic flow whereby to permanently deform the yarn into its curled state. Thereafter, the yarn may be cooled while in curled form and preferably while still on the mandrel to set the yarn in its curled state. When so cooling the yarn, the yarn is moving along the mandrel or it may be transferred to a storage device such as device 12 or 12' where cooling will take place with the yarn in curled form. Once the cooling has taken place, the storage device may be transferred to suitable storage rack until needed at the sewing machines which sew the yarn onto the heads of dolls to simulate a human being. However, if desired, the storage devices 12 and 12' may be used to effect a simultaneous transfer of the mandrel and directly to the sewing machine whereby the curled yarn is sewed onto the doll's head as artificial hair thereon.

If, however, the plastic deforming agent is to be moisture as would be the case with a hygroscopic yarn, then after the yarn has been curled onto mandrel 58, it is wetted as by immersing it in a container 68 (FIG. 8) and thereafter is subjected to heat for rapidly drying it, as by passing it through a heat chamber 75, or it may be exposed to the atmosphere as it is carried along a relatively long mandrel to air dry the material whereupon it is transferred to a storage device 12 or 12'. Of course, the curled hygroscopic yarn may be led directly off the mandrel to a sewing machine. In accordance with one highly desirable feature of the present invention, the yarn after having been plasticly deformed by either heating and setting or by cooling and drying may be stored on a spool or core, or a relatively long storage device is adapted to contain a much larger volume of curled yarn in a substantially smaller space than would be stored on a storage device 12 or 12'. Of course, when wound on a spool or core, the curled yarn is straightened out and accordingly, the present method is directed to means for preventing the curl from being permanently removed while storing curled yarn on a spool. The medium for accomplishing this highly desirable result is refrigeration. Particularly, after the
plastic yarn has been set by cooling or drying, it may be led off the mandrel 58 through a suitable tension device and rapidly refrigerated as by pouring thereon a rapidly evaporating liquid such as ethyl chloride or alcohol, or a cold liquid. After rapidly refrigerating the curled yarn, it may be led through a conventional cone winder and wound onto a cone or spool which is thereafter placed in refrigerated storage until needed. When needed the stored cone may be removed from refrigeration and the yarn fed to a sewing machine to be sewed onto the doll’s head. It has been found that after having been sewed onto the hair the curl in the yarn returns thereby providing the doll with curly hair. As a modification of the last step of the present method, it has been found that the yarn may be wound onto a cone prior to refrigeration and as it is wound onto the cone the yarn may be refrigerated by spraying thereon a volatile liquid and thereafter the wound cone may be stored as hereinbefore mentioned. In the case of yarn which has been plasticized by deforming, the step of cooling the yarn prior to rapidly refrigerating it may be dispensed with and the yarn may be rapidly refrigerated after it has been heated which refrigeration not only sets the curl but conditions it for storage in non-curl form on a cone of the type hereinbefore mentioned. We have found that the most expedient way of rapidly refrigerating the curled yarn is by means of spraying a cool volatile liquid onto the yarn which may be done by an operator or may be effected automatically.

When using Saran, it is preferred to heat the Saran yarn to temperatures between 170 and 240 degrees F. and preferably to heat Saran to a temperature of 200 degrees F. At these temperatures, it has been found that Saran rapidly takes on the curled form into which it has been placed on the mandrel. If the Saran is to be stored under refrigeration, it has been found that all that is necessary is for the Saran, after being removed from refrigerated storage, to be raised to at least 50 degrees F. in order to bring back the curl after storage in straight form under refrigeration. It has also been found that there is no minimum temperature to which the Saran may be subjected to when being stored under refrigeration. However, it is believed obvious that when reheating Saran after refrigeration in order to restore the curl thereto, it is undesirable that the temperature be raised to a temperature close to the temperature at which Saran effectively plastically deforms. Accordingly, it is advisable to store Saran yarn at temperatures under 120 degrees F. However, we have found that the most economical temperature for storing Saran yarn under refrigeration is approximately 40 degrees F. Since this temperature is approximately 30 degrees under room temperature whereby the heat of the room may be employed for raising the temperature of the yarn 30 degrees to restore the curl therein after refrigerated storage thereof.

With regard to acetic acid yarn, if it is desired to plastically deform the acetic acid yarn by heat, it is preferred that the acetic acid yarn be heated to a temperature between 260 degrees F. and 360 degrees F. and preferably to 300 degrees F. However, if it is desired to plastically deform acetic acid by wetting, it has been found that if 5% of water by weight of yarn is introduced onto the acetic acid yarn, the acetic acid yarn will deform and take on curl. Furthermore, there is no maximum amount of water or other liquid reagent above which the yarn will not take on curl, and as is shown in FIG. 8, it is possible to immerse the entire yarn in a liquid receptacle filled with water whereby to plastically deform said yarn. However, since the wetter the acetic acid yarn is made the more difficult it is to dry said yarn, it is preferred that the yarn be wetted by approximately 7% water by weight in order to achieve a plastic deformation of the yarn. When it is desired to store the acetic acid yarn in its uncurl form under refrigeration, it has been found that there is no minimum temperature below which the yarn cannot be stored, the storage being effective regardless of how low the temperature is. However, it has been found that in order to effectively preserve the curl in the yarn while disposed on cones or spools in a non-curl form, the storage temperature should not be above minus 10 degrees F. which latter value is the preferred value in order to obviate the necessity for expensive refrigerating equipment.

It has been discovered that it is more convenient when plastically deforming acetate to rely upon the hygroscopic properties of the yarn rather than on the thermoplastic properties thereof. Accordingly, in accordance with the presently preferred mode of carrying out this invention, after the yarn is wound on a mandrel 58, it has been found most desirable to pass it through a steam chest 84 which has a mixture of steam and water vapor at a temperature of approximately 200 degrees. Such a steam chest contains sufficient water vapor to plastically deform acetate by wetting and will be maintained at a 200 degree temperature which is the preferred temperature for plastically deforming Saran by heating. Accordingly, one simple apparatus may be employed to plastically deform either Saran or acetate by heating and wetting, respectively.

When rapidly cooling hygroscopic yarn such as acetate, caution should be exercised to use a cooling agent which contains substantially no water, since the water will act to plastically deform the yarn and thereby remove the curl therein.

While we have herein shown and described several forms of the present invention, it will be understood that various changes and modifications may be made therein within the scope of the appended claims without departing from the spirit and scope of this invention.

Having thus described our invention, what we claim and desire to secure by Letters Patent is:

1. A method of making curled yarn to simulate curly hair, comprising curling yarn made of plastic material and of hair thickness on a stationary tapering mandrel having a non-circular peripheral contour defined at least in part by flat planar surfaces with concomitant movement of the curls longitudinally of the mandrel, said curling operation being performed while said stationary mandrel is at rest with the successive curls disposed around the mandrel and progressively along the length thereof, softening the curled yarn on the mandrel, and setting said yarn after it has been softened in said curled condition.

2. A method of making curled yarn to simulate curly hair, comprising curling yarn made of plastic material and of hair thickness on a stationary mandrel which tapers longitudinally thereof and has a non-circular peripheral contour defined at least in part by flat planar surfaces, said curling operation being performed while said stationary mandrel is at rest with the successive curls disposed around the mandrel and progressively along the length thereof in the direction of the taper of the mandrel, softening the curled yarn on the mandrel, and setting said yarn after it has been softened in said curled condition.

3. The method according to claim 2, characterized in that the yarn is softened on the mandrel by steaming the yarn with moist steam.

4. A method of making curled yarn to simulate curly hair, comprising winding yarn made of plastic material and of hair thickness on a stationary tapering mandrel having a non-circular peripheral contour defined at least in part by flat planar surfaces and thereby forming successive curls disposed around the mandrel and progressively along the length thereof, said winding of the yarn being performed while said stationary mandrel is at rest, heating and moistening the curled yarn on the mandrel to soften the yarn in its curled condition on the mandrel, and setting said yarn after it has been softened in said curled condition.

5. A method of making curled yarn to simulate curly hair, comprising curling yarn made of plastic material and
of hair thickness and disposing the circled yarn on a stationary mandrel which tapers longitudinally thereof and has a non-circular cross section, with the successive curls disposed around the mandrel and progressively along the length thereof, said curling operation being performed while said stationary mandrel is at rest softening the curled yarn on the mandrel, setting said yarn after it has been softened in said curled condition, and progressively simultaneously moving the curled yarn along the mandrel from the point at which the yarn is curled to a point of discharge remote from said point of curling.

6. A method of making curled yarn to simulate curly hair, comprising winding finished yarn of hair thickness made of a plastic material of the group consisting of cellulose acetate and polyvinylidene chloride into curled form and disposing the curled yarn on a longitudinally tapering stationary mandrel which has a non-circular cross section, said winding of the yarn being performed while said stationary mandrel is at rest with the successive curls disposed around the mandrel and progressively along the length thereof, softening the curled yarn on the mandrel by the application of moist steam thereto and setting said yarn after it has been softened in said curled condition, and progressively simultaneously moving the curled yarn along the mandrel from the point at which the yarn is curled to a point of discharge remote from said point of curling.

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