Nov. 12, 1957 R. H. LAWSON ET AL 2,812,569

APPARATUS FOR CRINKLING YARN

Filed Oct. 8, 1954 3 Sheets-Sheet 1

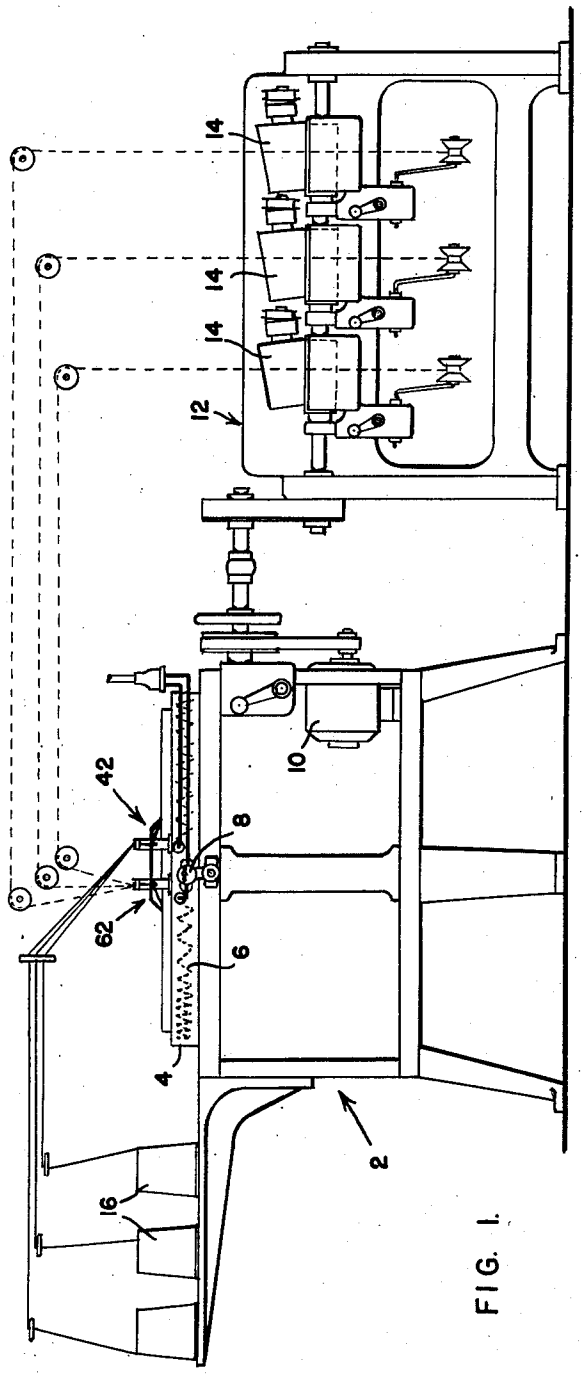


FIG. 1.

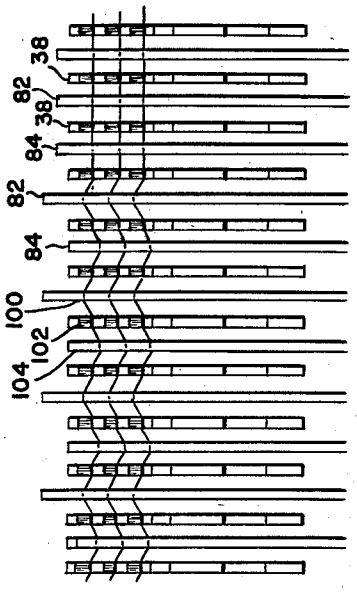


FIG. 9.

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APPARATUS FOR CRINKLING YARN

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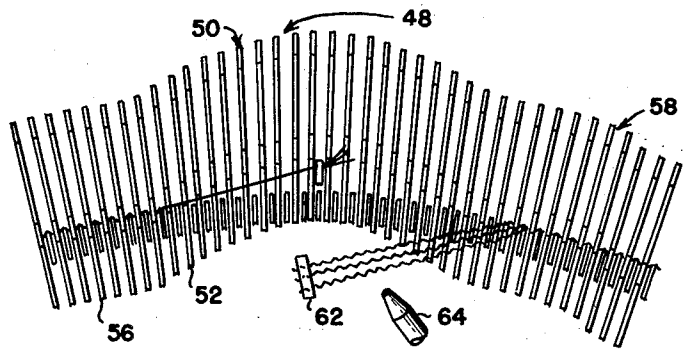


FIG. 2.

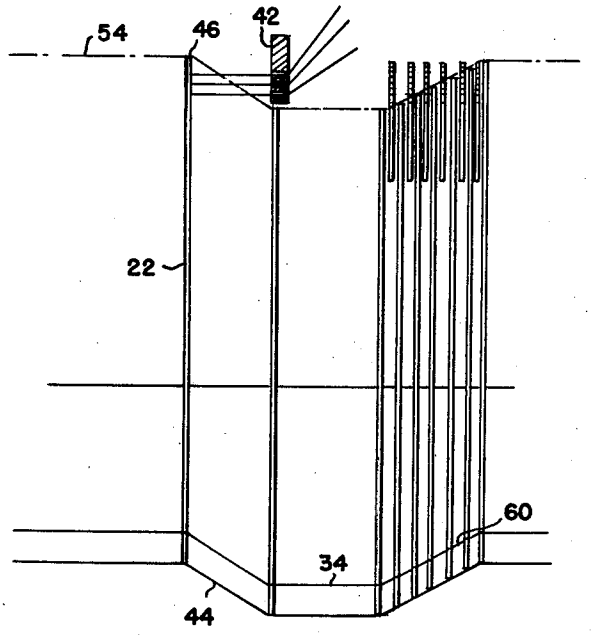


FIG. 3.

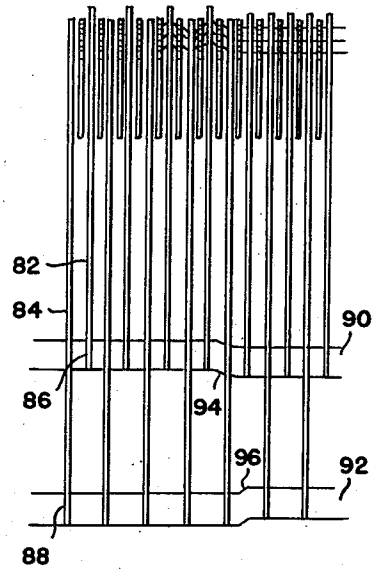


FIG. 11.

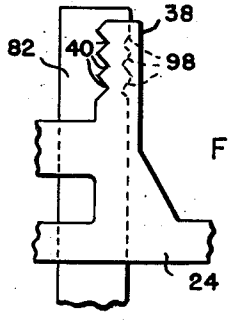


FIG. 10.

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APPARATUS FOR CRINKLING YARN

Filed Oct. 8, 1954 3 Sheets-Sheet 3

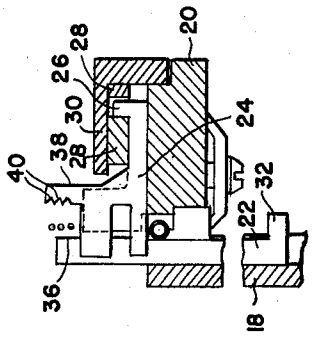


FIG. 4.

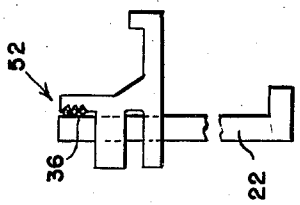


FIG. 5.

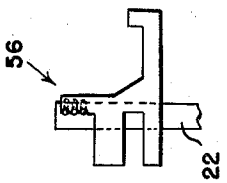


FIG. 6.

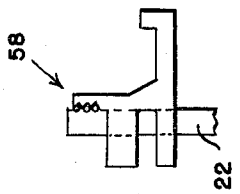


FIG. 7.

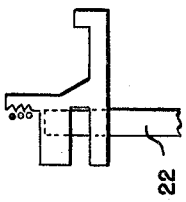


FIG. 8.

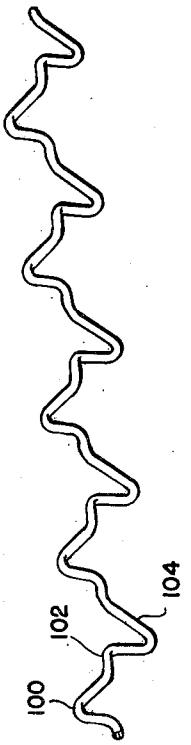


FIG. 12.

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APPARATUS FOR CRINKLING YARN

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Application October 8, 1954, Serial No. 461,232

12 Claims. (Cl. 28—1)

This invention relates to methods and apparatus for the crinkling of nylon or similar yarns particularly for the provision of hosiery in accordance with the disclosure of Frank R. Page Patent 2,601,451, dated June 24, 1952.

As disclosed in said Page patent, substantial advantages result from the utilization of crinkled nylon or similar yarn in the knitting of sheer ladies' hosiery. Various yarn crinkling procedures may be used in accordance with the disclosure of said patent, for example, the procedure of knitting the yarn into tubes followed by the setting of permanent crinkles in the yarn by the application of heat to the tubes, and then the subsequent ravelling of the yarn to produce a yarn supply suitable for knitting in accordance with the patent, or, alternatively, and as described in said patent (column 3, lines 41 to 60), by providing intermeshing heated elements in the form of pins and sinkers to impart zigzag configurations to yarns. It is the general object of the present invention to provide methods and apparatus to facilitate the crinkling of nylon or similar yarn in large quantities and at rapid rates. Briefly, in accordance with the present invention, the original straight nylon or similar yarn is fed, in the general fashion described in said patent, to a machine resembling a knitting machine and is crinkled therein without being knit while subject to a sufficient period of application of heat which will suffice to soften the yarn and provide therein, on cooling, permanent crinkles. The mechanism utilized for this purpose may, in fact, be reconstructed from a conventional knitting machine though it does not accomplish knitting. Rather, it embodies elements in the form of sliders replacing needles together with modified "sinkers" which cooperate therewtih to provide crinkling. Additionally, heating means is added, while many of the conventional parts of a knitting machine may be omitted. Cams of the types generally used for moving needles and sinkers are used in the machine for moving the sliders and the substitutes for the sinkers. Means improved over what is described in the patent is provided in accordance with the invention.

The machine in accordance with the invention may crinkle a plurality of yarns simultaneously while to each there is imparted the required heat to produce the ultimate setting of the crinkles. An efficient mechanism is thus provided.

The foregoing and other objects of the invention relating particularly to details of construction and operation will become apparent from the following description, read in conjunction with the accompanying drawings, in which:

Figure 1 is a diagrammatic elevation showing the general assembly of devices involved in carrying out a preferred embodiment of the invention;

Figure 2 is a diagrammatic plan view illustrating the cooperation of the various parts of the crinkling mechanism;

Figure 3 is a diagrammatic elevation illustrative of the same matter;

Figures 4 to 8, inclusive, are fragmentary elevations, partly in section, showing successive interrelated positions of the crinkling elements;

Figure 9 is a diagrammatic elevation showing the handling of yarns for the production of multiple crinkles therein arranged in three dimensions;

Figure 10 is a fragmentary elevation illustrative of the operations involved in Figure 9;

Figure 11 is a view on a smaller scale to show various cam actions involved in Figure 9; and

Figure 12 is a perspective view showing a fragment of a yarn crinkled in accordance with what is illustrated in Figures 9 to 11.

Referring first to Figure 1, there is indicated at **2** a preferred form of crinkling machine which is constituted essentially by a stripped down and modified conventional knitting machine. This machine is desirably of the type used for knitting large tubes such as used in the formation of underwear, or the like, such machine being used primarily because of its large circumference which in accordance with the present invention provides ample time of application of heat to the yarn being crinkled. For this application of heat, the cylinder of the machine is surrounded by a housing **4**, which may constitute in part the cam ring of the machine, in which there is located an electrical heating element **6** supplied with current controlled by a thermostat **8** to prevent overheating. Heat is thus applied to elements hereafter referred to as sliders and sinkers by conduction and through them, as well as by radiation, to yarns being crinkled. In the production of crinkles it is necessary to provide heating of the yarn to attain a temperature above its softening point so that the yarn on cooling will retain the crinkles imparted mechanically thereto. Nylon and similar yarns to which the invention is applicable are thermoplastic in nature and retain, on cooling, such shape as may be imparted thereto when their temperatures are above their respective softening points. This phenomenon of setting yarn into definite shapes is well known and is utilized in the common practice of preboarding applied to nylon knit articles to set the stitches therein.

The rotary cylinder of the machine **2** is driven by a motor **10** which also furnishes the drive for a winder **12** of conventional type wherein the crinkled yarn is wound upon cones **14**. The synchronization of the knitting machine and winder by the common drive makes possible the relative setting of speeds so that the crinkled yarn is not unduly stretched before it has been cooled to such temperature as will insure the maintenance of the crinkles imparted thereto. In other words, the crinkled yarn must not be stretched while still above its softening temperature; below that temperature, stretching will not remove the crinkles.

The straight nylon or similar yarn is fed to the machine from supply cones **16** mounted thereon.

Reference may now be made particularly to Figure 4 which shows the elements directly acting upon the yarn to impart crinkles thereto. Within the usual needle slots in the machine cylinder **18** there are slidably mounted the elements **22** which will be hereafter referred to as sliders. Within the conventional sinker ring **20** such as is used in a knitting machine there are mounted presser elements **24** in place of the conventional sinkers. For convenience, these elements **24** will be referred to as sinkers. The sinkers **24** are provided with butts **26** which are acted upon by cams **28** carried by the conventional sinker cap **30**. Radial movements are thereby imparted to the sinkers.

The sliders **22** are provided with butts **32** corresponding to conventional needle butts, and these operate within a cam race **34** (Figure 3) similar to, but less elaborate than, the cam race conventionally provided in a knitting machine. It may be remarked that a machine of the type indicated at **2** when used for knitting is generally provided

with a number of feeds of yarn. In the machine as modified for present purposes, feed occurs only at one point in the circumference.

In the first modification now being described, the sliders 22 are provided with straight edges 36 at their upper ends for cooperating with the yarns. Each of the sinkers 24 has an upper extension 38 provided with a number of notches 40 corresponding to the number of yarns being simultaneously crinkled. For simplicity of disclosure, it will be assumed that three yarns are being simultaneously crinkled, with the understanding, however, that a considerably larger number of yarns may be simultaneously crinkled.

The yarns to be crinkled are fed through a feed guide 42 which may be provided with a number of eyes corresponding to the yarns fed. The eyes are so positioned vertically as to feed the yarns at the individual levels of the sinker notches 40. At approximately the location where the feeder 42 is provided, a cam 44 causes the sliders 22 to rise by engagement of their butts 32 to cause them to rise successively to the location indicated at 46. Where the sinkers pass the feeder 42, they are retracted as indicated at 48 so that their extensions 38 pass radially outside the feeder 42. After passing the feeder, the cams 28 serve to move the sinkers inwardly until at about the position indicated at 50 in Figure 2 the sinkers occupy the radial position illustrated in Figure 4. At this phase of the operation, the sliders 22 are still being raised by cam 44, neither the sliders nor the sinkers at this point engaging the yarns.

The sliders 22 continue the rise and the sinkers 24 continue to move inwardly, reaching the relative positions illustrated in Figure 5 at the location indicated at 52 in Figure 2. The rise of the slider 22 to the position at 46 has now been completed and the yarns are substantially in contact, because of their tangential approach with the edge 36 of the slider in the position 52. The yarns are also about to be engaged by the sinker, being disposed in radial alignment with the notches 40 therein. The sliders retain the height, which is indicated at 54, throughout the major part of their revolution.

Beyond the position 52 the sinkers move further inwardly causing the troughs of the notches 40 to move substantially radially inwardly of the slider edges 36, the sinkers ultimately attaining innermost radial positions indicated at 56 and illustrated in Figure 6. In this position, the yarns have zig-zag configurations imparted thereto and these configurations are then maintained throughout the major portion of a revolution. The yarns in such condition are then heated by the application of heat from the heating element 6 and are raised to a temperature of softening of their material. The thermostat 8 may be set to control the current through the heating element to secure within narrow control limits the particular temperatures which may be required of the type of yarn which is being crinkled. By reason of the large circumference of the machine, the application of heat is maintained through a sufficient time period to insure the proper heating of the yarns despite a high rate of circumferential speed of the cylinder. The consequence is the throughput of a large quantity of yarn per unit time.

As the point of yarn removal is reached, which point is adjacent to that of feed, the sinkers 24 are partially withdrawn as indicated at 58 and as illustrated in Figure 7. This withdrawal is desirably such that the inner edge of the extension 38 of the sinker continues to overlap the edges 36 of the sliders so that the yarns are not free to move vertically. However, the tension on the yarns is substantially reduced with the result that the sliders may be freely drawn downwardly by cam 60 to clear the yarns, without pulling thereon, in the position illustrated in Figure 8.

As the sliders 22 move downwardly the yarns are successively released and pass through individual eyes in a

take-off guide 62, passing from this guide to the reeling mechanism 12. In the drawing off of the yarns little tension is imparted thereto, and despite the fact that at the instant of removal they may be at a temperature at which they are softened, there is not sufficient tension imparted to pull them to a straight condition and, thus, remove the crinkles. Desirably, however, they are rapidly cooled at the time of removal and for this purpose there is provided one or more nozzles 64 to direct a stream of cold air thereon to promote rapid cooling below the softening temperature. The procedure described imparts crinkles to the yarn and desirably these crinkles are so spaced along the yarn by choice of the indexing of the sliders and sinkers that there are avoided the conditions which might give rise to a synchronous repetition of crinkles and ultimate knitted loops as described as desirably avoided in said F. R. Page patent. The crinkles provided in accordance with the above are formed essentially in a single plane in each of the yarns, and have a more or less sinusoidal form. A greater irregularity of crinkling may be provided by causing the crinkles to be essentially three-dimensional, and this situation may be attained by the use of the apparatus and procedure which will now be described with reference to Figures 9 to 12, inclusive.

In accordance with this second procedure, there are used the same sinkers 24 as previously described and these and their structural parts are accordingly given the same reference numerals. The sliders, however, are somewhat different and are of two types indicated at 82 and 84, respectively. Both sets of these sliders are provided with the same upper edge constructions and, in accordance with this modification, the upper edges, instead of being straight as was indicated at 36, are provided with shallow notches indicated at 98 which are spaced the same as the notches 40 of the sinkers as indicated in Figure 10 and are in alignment therewith at the time the yarns are first received.

The sliders 82 are illustrated as relatively short in Figure 11 and are provided with butts 86 at an upper level arranged to travel in a cam race 90. The sliders 84, on the other hand, are longer and are provided with butts 88 arranged to operate in a cam race 92. For the major part, these cam races 90 and 92 are identical and have the same characteristic as the cam race 34 previously described, being provided at the region of feed and removal of the yarns with depressing and raising cam portions corresponding to 60 and 44. However, immediately following the position where the yarns are first engaged, the races 90 and 92 are provided with a rise 94 and a fall 96, respectively, so that by reason of the shallow notches 98 in cooperation with the sinker notches 40 the sliders 82 are displaced slightly upwardly and the sliders 86 are displaced slightly downwardly. These slight relative displacements produce a configuration of the yarn which is indicated generally in Figure 9 but is clearer from the fragmentary perspective view, Figure 12, which shows enlarged the multiple types of crinkles put into a yarn by this action. An upward crinkle 100 results from the rise of a slider 82, while a downward crinkle 104 results from the depression of a slider 84. An intermediate lateral crinkle 102 is produced by the movement of an interposed sinker 24. The crinkle configuration, therefore, as illustrated in Figure 12 is of a three-dimensional type which tends even further to prevent the appearance of any repetitive regions in a completed stocking. It will be evident that except for these additional movements of the sliders the steps involved in carrying out this modification are identical with those involved in the first modification described, and there need be, therefore, no special description of the operation except to state that the sliders are restored prior to reception of the yarn to a condition of alignment of all of their notches 98 with the corresponding sinker notches 40 as indicated in the right-hand portion of Figure 9.

It will be evident from the foregoing that methods and

apparatus are provided for the crinkling of yarn which are consistent with high rates of production and the formation of the permanent crinkles required for the carrying out of the knitting of stockings in accordance with said F. R. Page patent. It will be evident that various details of constructions and operations may be changed without departing from the invention as defined in the following claims.

What is claimed is:

1. Apparatus for crinkling nylon or similar yarn comprising a rotary cylinder, sliders mounted in said cylinder for axial movements relatively thereto, a carrier rotating with said cylinder, presser elements mounted in said carrier and radially movable relatively thereto, said sliders presenting outwardly facing surfaces and said presser elements presenting inwardly facing surfaces, means for feeding at least one yarn approximately tangentially between said surfaces of the sliders and presser elements, means for moving said presser elements radially inwardly to cause radial overlapping of said surfaces, thereby to impart zigzag configuration to said yarn, means for imparting softening heat to said yarn while it has said zigzag configuration, means for moving said presser elements radially outwardly to relieve pressure on said yarn, means for moving said sliders axially to clear said yarn, means guiding the cleared yarn inwardly towards the axis of rotation, and means for winding said yarn, the last mentioned means being synchronized with the rotation of said cylinder to prevent application of straightening tension to said yarn.

2. Apparatus for crinkling nylon or similar yarn comprising a rotary cylinder, sliders mounted in said cylinder for axial movements relatively thereto, a carrier rotating with said cylinder, presser elements mounted in said carrier and radially movable relatively thereto, said sliders presenting outwardly facing surfaces and said presser elements presenting inwardly facing surfaces, means for feeding at least one yarn approximately tangentially between said surfaces of the sliders and presser elements, means for moving said presser elements radially inwardly to cause radial overlapping of said surfaces, thereby to impart zigzag configuration to said yarn, means for imparting softening heat to said yarn while it has said zigzag configuration, means for moving said presser elements radially outwardly to relieve pressure on said yarn, means for moving said sliders axially to clear said yarn, and means guiding the cleared yarn inwardly towards the axis of rotation.

3. Apparatus for crinkling nylon or similar yarn comprising a rotary cylinder, sliders mounted in said cylinder for axial movements relatively thereto, a carrier rotating with said cylinder, presser elements mounted in said carrier and radially movable relatively thereto, said sliders presenting outwardly facing surfaces and said presser elements presenting inwardly facing surfaces, means for feeding a plurality of yarns approximately tangentially between said surfaces of the sliders and presser elements, means for moving said presser elements radially inwardly to cause radial overlapping of said surfaces, thereby to impart zigzag configurations to said yarns, means for imparting softening heat to said yarns while they have said zigzag configurations, means for moving said presser elements radially outwardly to relieve pressure on said yarns, means for moving said sliders axially to clear said yarns, means guiding the cleared yarns inwardly towards the axis of rotation, and means for winding said yarns, the last mentioned means being synchronized with the rotation of said cylinder to prevent application of straightening tension to said yarns.

4. Apparatus for crinkling nylon or similar yarn comprising a rotary cylinder, sliders mounted in said cylinder for axial movements relatively thereto, a carrier rotating with said cylinder, presser elements mounted in said carrier and radially movable relatively thereto, said sliders presenting outwardly facing surfaces and said presser elements presenting inwardly facing surfaces, means for feeding a plurality of yarns approximately tangentially between said surfaces of the sliders and presser elements, means for moving said presser elements radially inwardly to cause radial overlapping of said surfaces, thereby to impart zigzag configurations to said yarns, means for imparting softening heat to said yarns while they have said zigzag configurations, means for moving said presser elements radially outwardly to relieve pressure on said yarns, means for moving said sliders axially to clear said yarns, and means guiding the cleared yarns inwardly towards the axis of rotation.

5. Apparatus for crinkling nylon or similar yarn comprising means providing an inner circular array of spaced members presenting outwardly facing surfaces, means providing an outer circular array of spaced elements presenting inwardly facing surfaces, yarn feeding means, means providing relative rotation between said yarn feeding means and said arrays of members and elements, and yarn feeding means being arranged to feed at least one yarn between the surfaces of said members and elements, means for effecting relative radial movements and also relative axial movements between said members and elements to produce overlapping of their said surfaces to impart a zigzag configuration to said yarn, means for imparting softening heat to said yarn while it has said zigzag configuration, and means for removing the yarn from the region of said surfaces.

6. Apparatus for crinkling nylon or similar yarn comprising means providing an inner circular array of spaced members presenting outwardly facing surfaces, means providing an outer circular array of spaced elements presenting inwardly facing surfaces, said surfaces being notched, yarn feeding means, means providing relative rotation between said yarn feeding means and said arrays of members and elements, said yarn feeding means being arranged to feed at least one yarn between the surfaces of said members and elements, means for effecting relative radial movements and also relative axial movements between said members and elements to produce overlapping of their said surfaces to entrap said yarn in notches in said surfaces, and to impart a zigzag configuration to said yarn, means for imparting softening heat to said yarn while it has said zigzag configuration, and means for removing the yarn from the region of said surfaces.

7. Apparatus for crinkling nylon or similar yarn comprising means providing an inner circular array of spaced members presenting outwardly facing surfaces, means providing an outer circular array of spaced elements presenting inwardly facing surfaces, yarn feeding means, means providing relative rotation between said yarn feeding means and said arrays of members and elements, said yarn feeding means being arranged to feed a plurality of yarns between the surfaces of said members and elements, means for effecting relative radial movements and also relative axial movements between said members and elements to produce overlapping of their said surfaces to impart zigzag configurations to said yarns, means for imparting softening heat to said yarns while they have said zigzag configurations, and means for removing the yarns from the region of said surfaces.

8. Apparatus for crinkling nylon or similar yarn comprising means providing an inner circular array of spaced members presenting outwardly facing surfaces, means providing an outer circular array of spaced elements presenting inwardly facing surfaces, said surfaces being notched, yarn feeding means, means providing relative rotation between said yarn feeding means and said arrays of members and elements, said yarn feeding means being arranged to feed a plurality of yarns between the surfaces of said members and elements, means for effecting relative radial movements and also relative axial movements between said members and elements to produce overlapping of their said surfaces to entrap said yarns in notches in said surfaces, and to impart zigzag configurations to said yarns, means for imparting softening heat to said

yarns while they have said zigzag configurations, and means for removing the yarns from the region of said surfaces.

9. Apparatus for crinkling nylon or similar yarn comprising means providing an inner circular array of spaced members presenting outwardly facing surfaces, means providing an outer circular array of spaced elements presenting inwardly facing surfaces, yarn feeding means, means providing relative rotation between said yarn feeding means and said arrays of members and elements, said yarn feeding means being arranged to feed at least one yarn between the surfaces of said members and elements, means for effecting relative radial movements and also relative axial movements between said members and elements and relative axial movements between adjacent members to produce overlapping of their said surfaces to impart a zigzag three dimensional configuration to said yarn, means for imparting softening heat to said yarn while it has said zigzag configuration, and means for removing the yarn from the region of said surfaces.

10. Apparatus for crinkling nylon or similar yarn comprising means providing an inner circular array of spaced members presenting outwardly facing surfaces, means providing an outer circular array of spaced elements presenting inwardly facing surfaces, said surfaces being notched, yarn feeding means, means providing relative rotation between said yarn feeding means and said arrays of members and elements, said yarn feeding means being arranged to feed at least one yarn between the surfaces of said members and elements, means for effecting relative radial movements and also relative axial movements between said members and elements and relative axial movements between adjacent members to produce overlapping of their said surfaces to entrap said yarn in notches in said surfaces, and to impart a three dimensional zigzag configuration to said yarn, means for imparting softening heat to said yarn while it has said zigzag configuration, and means for removing the yarn from the region of said surfaces.

11. Apparatus for crinkling nylon and similar yarn comprising means providing an inner circular array of spaced members presenting outwardly facing surfaces, means providing an outer circular array of spaced elements presenting inwardly facing surfaces, yarn feeding means, means providing relative rotation between said yarn feeding means and said arrays of members and elements, said yarn feeding means being arranged to feed a plurality of yarns between the surfaces of said members and elements, means for effecting relative radial movements and also relative axial movements between said members and elements and relative axial movements between adjacent members to produce overlapping of their said surfaces to impart three dimensional zigzag configurations to said yarns, means for imparting softening heat to said yarns while they have said zigzag configurations, and means for removing the yarns from the region of said surfaces.

12. Apparatus for crinkling nylon or similar yarn comprising means providing an inner circular array of spaced members presenting outwardly facing surfaces, means providing an outer circular array of spaced elements presenting inwardly facing surfaces, said surfaces being notched, yarn feeding means, means providing relative rotation between said yarn feeding means and said arrays of members and elements, said yarn feeding means being arranged to feed a plurality of yarns between the surfaces of said members and elements, means for effecting relative radial movements and also relative axial movements between said members and elements and relative axial movements between adjacent members to produce overlapping of their said surfaces to entrap said yarns in notches in said surfaces, and to impart three dimensional zigzag configurations to said yarns, means for imparting softening heat to said yarns while they have said zigzag configurations, and means for removing the yarns from the region of said surfaces.

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