

March 6, 1962

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3,023,481

YARN CRIMPING APPARATUS

Filed Nov. 24, 1959

2 Sheets-Sheet 1

FIG. 1

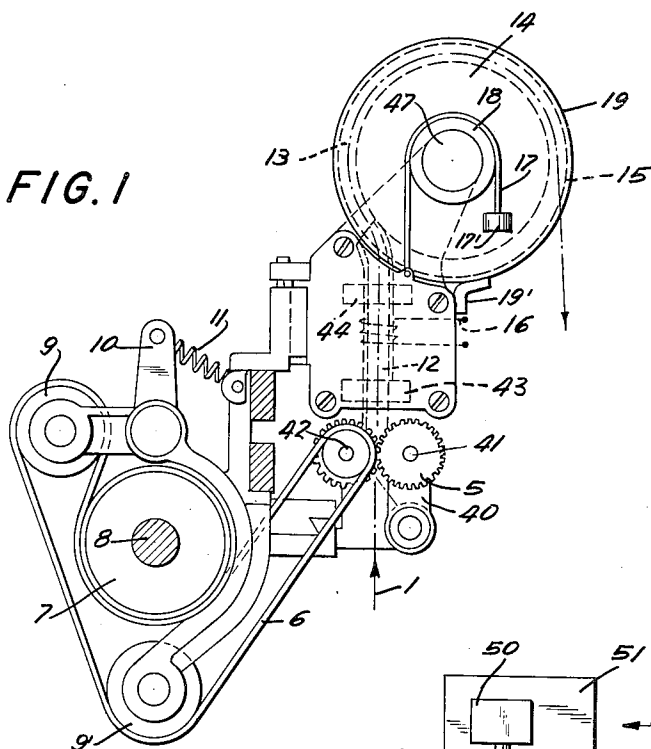
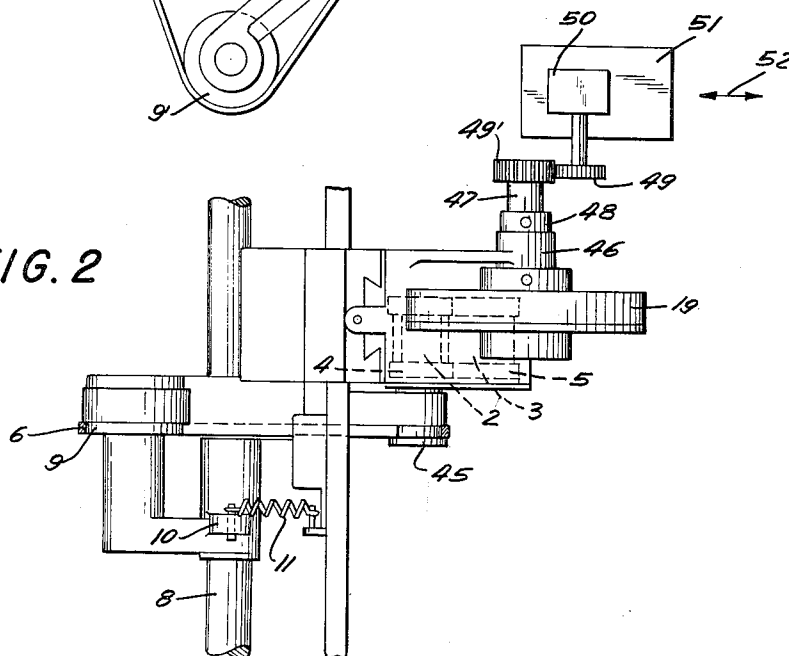


FIG. 2



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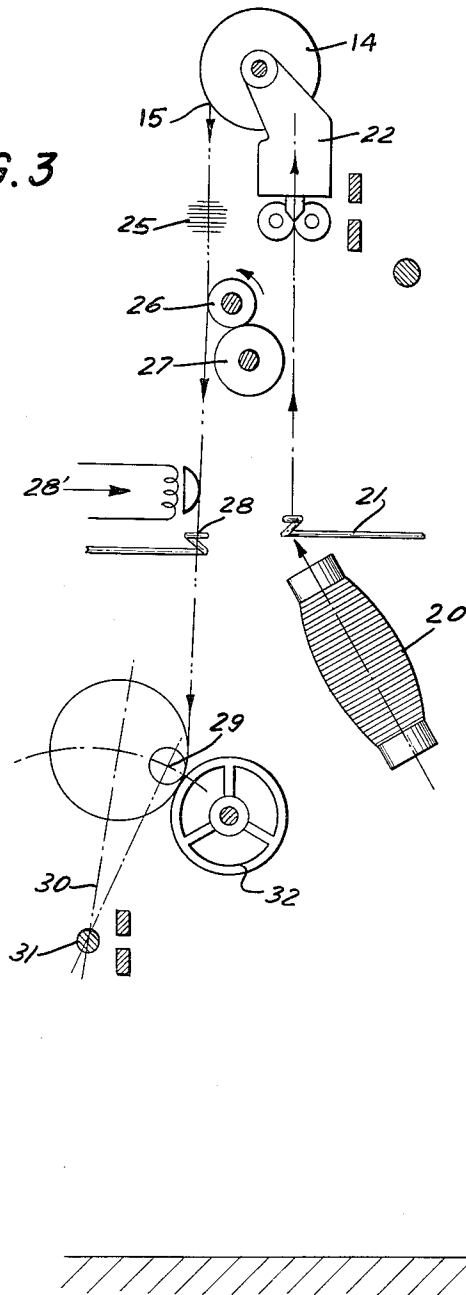
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YARN CRIMPING APPARATUS

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2 Sheets-Sheet 2

FIG. 3



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YARN CRIMPING APPARATUS

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10 Claims. (Cl. 28—1)

The present invention relates to apparatus for crimping thermoplastic yarn.

More particularly, the present invention relates to that type of yarn crimping apparatus which uses the stuffer box technique.

In this latter type of yarn crimping apparatus the yarn is stuffed into a stuffer box and is heated and then withdrawn. For example, the stuffer box may have a hinged weighted lid and the yarn is injected into the box by input rollers, the box filling up with the crimped sliver until the lid opens under pressure from the sliver and discharges substantially the entire box of yarn. Inasmuch as this process is necessarily discontinuous, it is impossible to treat all of the yarn uniformly and the result is an uneven crimp and irregular dyeing.

One of the objects of the present invention is to provide a yarn crimping apparatus which will enable not only the degree of crimp imparted to the yarn to be controlled but which will also provide for exceedingly uniform heating and cooling of the crimped yarn so that the product obtained can, for example, be knitted, woven or dyed without the production of stress marks or dye patterns.

Another object of the present invention is to provide a yarn crimping apparatus which is exceedingly simple and rugged so that it will have a long life and which also is very reliable in operation.

It is also an object of the present invention to provide a structure which will produce a highly contractile crimped yarn or which with a simple modification can be used for producing a crimped yarn which is only slightly contractile and thus is soft and moderately bulky without being excessively contractile.

With the above objects in view the invention includes in a yarn crimping apparatus an elongated stuffer tube member having opposite open ends and forming a crimping chamber, one of the open ends of the stuffer tube member being an entrance end into the crimping chamber and the other of the open ends being a discharge end out of the crimping chamber. An annular drum is formed with an annular channel extending around a given axis, and this channel forms a receiving chamber for receiving the yarn from the crimping chamber, the discharge end of the stuffer tube member communicating with the annular channel so that the yarn can move directly from the stuffer tube member into the annular drum member. A means is provided for supporting one of these members for rotary movement, at a relatively low speed, around the axis of the drum member, and a heating means is provided for heating the yarn at a part of the path through which it moves in the apparatus. Finally, a suitable means is provided for withdrawing the crimped yarn from the annular channel.

The novel features which are considered as characteristic of the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawings, in which:

FIG. 1 is a partly schematic side elevation of one embodiment of a structure according to the invention;

FIG. 2 is a top plan view of the structure of FIG. 1; and

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FIG. 3 is a diagrammatic side elevation of the manner in which the structure is incorporated into a machine which includes a series of units according to the invention arranged side by side and also, if desired, back to back.

Referring now to FIGS. 1 and 2, the yarn which is to be crimped with the apparatus of the invention is fed upwards, as viewed in FIG. 1, along the path 1 into an elongated tubular member 12 which has opposite open ends and which forms a stuffer tube the interior of which constitutes a crimping chamber. Brackets 43 and 44 fixedly mount the stuffer tube 12 on the framework of the machine, and the yarn is fed into the lower open end of the tube 12, as viewed in FIG. 1, this end being the entrance end of the stuffer tube, by a means which in the illustrated example takes the form of a pair of input rollers 2 and 3, the yarn 1 being nipped between the input rollers 2 and 3 and fed therefrom directly into the stuffer tube 12.

The lower end of the stuffer tube 12, as viewed in FIG. 1, is of the configuration of a V having concavely curved sides and this lower end of the stuffer tube directly engages the surfaces of the input rolls 2 and 3 which thus directly feed the yarn into the interior of the stuffer tube 12. Because of the direct engagement between the entrance end of the stuffer tube 12 and the exterior surfaces of the input rolls 2 and 3 the compressed yarn in the stuffer tube cannot escape to the exterior between the entrance end of the tube 12 and the input rollers 2 and 3. The stuffer tube 12 is made of any suitable metal and has an interior smooth surface. The input rollers 2 and 3 are fixedly carried by a pair of shafts 42 and 41 which are supported by the wall 40 as well as by another wall located to the rear of the wall 40 of FIG. 1 for rotation about their axes in any suitable bearings, and these shafts in addition to fixedly carrying the input rollers 2 and 3 also fixedly carry gears 4 and 5 which mesh with each other, the shaft 42 additionally carrying a driving pulley 45 which is fixed to the shaft 42 through any suitable set screw or the like to rotate with the latter.

The upper end of the stuffer tube 12, as viewed in FIG. 1, forms the discharge end of the crimping chamber, and this discharge end of the stuffer tube 12 communicates with an annular channel 13 which forms a receiving chamber for the yarn moving out of the stuffer tube 12 through the discharge end thereof. The annular channel 13 is formed in the exterior periphery of a drum member 14 which is supported for rotation about its axis in any suitable way such as by the bearing 46 carried by the framework of the machine (FIG. 2). Actually the drum member 14 is fixedly connected with a shaft 47 which turns in the bearing 46 and which carries collars 48 or the like so as to be restrained against axial movement. A gear train 49, 49' driven at any desired speed from a suitable drive 50 such as a motor and gear box is connected with the shaft 47 so as to rotate the latter together with the drum member 14. As is diagrammatically indicated in FIG. 2, variable speed drive 50 together with the gear 49 is carried by a support 51 which can be moved on suitable unillustrated guides back and forth in the direction of the arrows 52 so that in this way the gear 49 can be placed into or out of mesh with the gear 49' and thus it is possible for the operator to drive the drum 14 or to allow the drum 14 to be turned without being driven, as will be apparent from the description which follows. The drum means includes in addition to the annular drum member 14 an annular stationary cover 19 form of a ring fixedly carried by the supporting framework, as by a bracket 19' (FIG. 1), and the stationary cover 19 cooperates with the channel 13 to form a substantially closed annular passage. The ring or cover 19 is formed with a cutout through which the upper dis-

charge end of the stuffer tube 12, as viewed in FIG. 1, extends directly into the channel 13. Also, at a point spaced somewhat more than 180° in a clockwise direction from the discharge end of the stuffer tube 12, as viewed in FIG. 1, the covering ring 19 is formed with a relatively small cutout 15 through which the crimped yarn may be withdrawn, as indicated diagrammatically in FIG. 1.

Heat for setting crimp in the yarn is applied, as illustrated diagrammatically in the example of FIG. 1, through a heater coiled around an intermediate portion of the stuffer tube 12, this heater 16 being electrically energized, but, if desired, the heat may be applied to that part of the rotary drum 14 which receives the yarn from the tube 12. In this latter event heat is directed by radiation, for example, to the region of the drum 14 adjacent to the discharge end of the tube 12. In either event, the yarn cools as it moves beyond the region where the heating is applied, and the yarn has cooled sufficiently before it is withdrawn through the outlet 15 from the receiving chamber 13. The degree of heat is adjusted through any suitable controls such as variable resistors, or the like, and if desired, the temperature may be automatically stabilized.

A belt 6, which is endless, passes around and in engagement with the pulley 45 so as to turn the latter and thus turn the gear 4 from which the drive is transmitted to the gear 5 and to the input rollers 2 and 3. The belt 6 passes around a driving pulley 7 fixed to a drive shaft 8 which is supported for rotation by suitable bearing which extends through the driving pulleys 7 of a series of units of the invention arranged side by side. An idler pulley 9 is turnably carried by one arm of a bell crank 10 supported on the framework for free turning movement about an axis parallel to that of the shaft 8, and a spring 11 is fixed at one end to a stationary part of the frame and at its other end to the bell crank 10 to urge the latter in a clockwise direction, as viewed in FIG. 1, so that in this way the belt 6 is maintained under tension, the framework in addition supporting a second idler pulley 9' for rotation about a stationary axis parallel to the axis of the shaft 8, and in this way the belt 6 is driven and transmits its drive to the input rollers 2 and 3 which form a means for feeding the yarn into the stuffer tube 12.

During operation, the yarn is injected into the crimping chamber by the input rollers 2 and 3 and within the crimping chamber the yarn is crimped by the back pressure of crimped yarn already in the interior of the stuffer tube 12, or when the operation is started a starting plug of a suitable material such as cotton wool may be placed in the chamber if the latter is empty. The yarn accumulates in this way within the stuffer tube 12, and the pressure of the yarn within the crimping chamber formed by the interior of the stuffer tube 12 against the incoming yarn is determined by the coefficient of friction of the yarn against the side of the crimping chamber, the length of this chamber, and the pressure exerted against the yarn as it enters the rotating drum 14 after leaving the tube 12.

Where the coefficient of friction of the surface of the crimping chamber is μ , the length of the crimping chamber is L , and the pressure exerted against the yarn as it enters the rotating drum 14 is P_2 , the pressure P_1 against the incoming yarn can be determined according to the formula

$$\frac{P_1}{P_2} = ke^{\mu L}$$

where k is an arbitrary constant.

The pressure P_2 is exerted by the crimped yarn already in the circular channel 13 against the yarn in the crimping chamber by virtue of a reverse pressure produced by already crimped yarn which is assumed to be immovable with respect to the drum. It must be remembered that the yarn upon entering the annular channel 13 is in the

form of a body which has a considerable inherent resiliency thus tends to expand resiliently with the result that it pushes against and presses against the surface of the channel 13 and is actually immovable with respect to the channel 13, and, if desired, the surface of the channel 13 may be roughened slightly. The yarn within the channel 13 simply slides along the inner surface of the closure ring 19. This reverse pressure P_2 can be regulated according to the force required to turn the drum 14 and the shaft 47 therewith. Assuming that the gear 49 is out of mesh with the gear 49' so that the drum 14 is not driven by an outside force, the yarn itself which moves into the channel 13 pressing against the side thereof and immovable with respect to the surface of the channel 13 will slowly turn the drum 14 around its axis, and a band 17 of leather or the like is connected at one end to the framework and extends around a pulley 18 fixedly carried by the shaft 47, the brake band 17 carrying a weight 17' at its free end, so that in this way the brake band 17 by frictional contact with the pulley 18 which is fixed to the shaft 47 provides a predetermined resistance to the turning of the drum 14. The weight 17' is shown diagrammatically in FIG. 1 and any desired combination of interchangeable weights may be applied to the end of the band 17 so as to adjust the braking force and thus control the pressure exerted by the crimped yarn in the channel 13 on the yarn being pushed out of the crimping chamber formed by the interior of the stuffer tube 12. The back pressure of the yarn in the channel 13 on the yarn leaving the tube 12 may also be controlled, alternatively, by connecting the drive 49, 50 to the gear 49' so as to rotate the shaft 47 and the drum 14 therewith, this drive being adjustable so as to turn the drum 14 at a slow rate slower than the rate at which the drum would turn if there were no drive or braking means applied thereto, and thus by constraining the drum to turn through the variable speed drive at a speed slower than that at which it would ordinarily turn as the result of the crimped yarn moving into the channel 13, a controlled back pressure is provided which may be regulated according to the speed of turning of the drum 14. Thus, either the brake means 17 or the drive 49, 50 may be used to regulate the back pressure. The amount of load required is determined by experimenting in connection with each yarn which is crimped, and the loading is a function of the temperature employed for crimping and the nature of the yarn being crimped.

The drum 14 turns in a clockwise direction, as viewed in FIG. 1, and thus the yarn travels through a substantial distance, somewhat more than 180° around the axis of the drum, before it is withdrawn through the cutout 15 of the cover 19. Suitable nip rollers are provided for moving the yarn from the cover 19 through a tensioning device in the form of a comb or disc brake 25 indicated diagrammatically in FIG. 3, and the structure shown in FIG. 3 and described below makes the extraction of the yarn at a predetermined rate and the yarn is then wound up onto a package.

Inasmuch as the speed of rotation of the drum 14 is quite low, a complete revolution occupying, for example, several minutes, particularly if fine yarn is being crimped, there is plenty of time available for the application of heat to the crimped yarn and for cooling thereof, so that the yarn becomes equally heat-set from the outside of the compressed yarn up to the middle of the yarn, and thus the heat is uniformly applied throughout the yarn. It is important, subsequent to heating, that the yarn be cooled while the yarn is still under some pressure, so that in this way the crimp is not extracted by the subsequent winding operation. Although structure is shown in FIG. 1 and described above for heating the yarn within the crimping chamber formed by the interior of the stuffer tube 12, it is also possible, as pointed out above, and in fact it may be more convenient, to heat the yarn in that part

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of the drum 14 into which the yarn enters upon leaving the discharge end of the stuffer tube 12, this latter type of heating at the portion of the drum 14 in the region of the discharge end of the stuffer tube 12 may be effected by heating a portion of the drum 14 by electrical induction or by concentrating heat on the required portion of the drum by radiation from a heat source.

Although in the description above the structure referred to discharges the yarn from the crimping chamber into the receiving channel 13 of the rotating drum 14, it is of course possible to provide a structure where the relative movement of the parts is reversed for attaining the same ends. Thus, if the drum itself must be made of particularly large dimensions, for example in the case of crimping yarns of high denier, then the drum can be made stationary and the stuffer tube 12 together with the associated feed rollers could be supported for turning movement about the axis of the drum, and the same results would be produced. In a construction of this latter type the crimped yarn is preferably fed along the axis of the drum from one side, and the crimped yarn is removed from the apparatus along the same axis from the other side of the drum.

Referring now to FIG. 3, there is schematically illustrated therein an assembly of parts suitable for incorporation into a machine as illustrated. Although FIG. 3 shows only one assembly as seen from the side, the machine actually consists of a series of such assemblies arranged in side by side relation, and if desired the machine may include two series of assemblies respectively located on opposite sides of the center line of the machine with the assemblies of one series back to back with the assemblies of the other series.

Each of these assemblies includes the bobbin 20 from which the yarn is continuously drawn. The yarn passes upwardly through a guide eye 21, which may be a pig-tail guide, and from the guide 21 the yarn moves upwardly to feed rollers, such as the rollers 2 and 3 described above, which pull the yarn from the supply bobbin 20. From the feed rollers the yarn enters the stuffer tube of a crimping assembly 22 which may have the same construction as the above-described assembly which includes the tube 12, and from the stuffer tube into the drum 14. The yarn is extracted from the drum 14 at the discharge opening 15 formed in the cover ring 19, and the yarn then passes through a comb-like member 25 which guarantees that the yarn is linearized before it is wound. The rate at which the yarn is extracted from the receiving channel of the drum is controlled by passing the yarn around a pair of nip rollers 26 and 27, these rollers being spring loaded toward each other while one of them, the roller 27, for example, is driven in a known way. The yarn upon leaving the nip rollers 26, 27 passes downwardly through another guide eye 28, and beyond the guide eye 28 the yarn is wound onto a support 29 carried by an arm 30 which is pivotally supported at 31. The yarn package which is formed with this package forming means shown at the lower portion of FIG. 3 rests against a driven roller 32 driven in any known way and the driven roller 32 is driven with a peripheral speed which is somewhat less than the linear speed imparted to the yarn by the nip rollers 26, 27.

The yarn which is produced on such machine in the above-described manner is contractile, which is to say, if a length of it is drawn from the package 29 and allowed to contract, its final length is approximately one half of that of the equivalent length of the yarn in its uncrimped condition. Yarn of this type has certain uses, but an alternative form of yarn is one which is bulked or fluffed, but does not possess excessive contractile characteristics. Yarn of this latter character can be produced on the machine illustrated in FIG. 3 simply by energizing a second heater located in the region of the guide eye 28, this second heater being illustrated dia-

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grammatically at 28' in FIG. 3. The heater may be electrical and all that is required is to close a switch in order to energize the heater, and it may include a coil which heats the curved plate along which the yarn slides, as indicated diagrammatically in FIG. 3. If desired, a heater tube may be provided in the region of the guide eye 28 through which the yarn moves so as to be heated a second time, but a curved plate is preferred. The temperature provided by the second heating means 28' is slightly in excess of that used for crimping and derived from the heating means 16 shown diagrammatically in FIG. 1. The speed of the driven roller 32 is such that the yarn is drawn over the heated surface of the second heater 28' while the yarn is subjected to a small degree of contraction of its uncrimped length on the order of 10%, for example, and this will reduce the tendency of the yarn to high contraction while allowing a sufficient degree of crimp to be retained so as to ensure that the resulting yarn is still soft and moderately bulky without being excessively contractile. The yarn is collected in the package forming means 30-32 in the same way as described above. Where the second heater 28' is energized so as to produce a yarn which is bulked or fluffed, the take-up speed of the yarn on the package 29 may be slightly less than the speed of the yarn at the nip rollers 26, 27, the yarn speed on the package 29 being, for example, 30% less than the speed at the nip rollers 26, 27. The yarn which is produced in this way, with the second heater 28', is set to a degree of contraction which is not excessive as compared to its original length, but owing to the configuration of the distortions imparted to each filament of the yarn, considerable bulk is produced in the yarn, and such a yarn has a greater more extended range of use than yarn produced in a fully contractile condition.

The above-described apparatus can operate over a wide range of temperatures. For example, in the case of nylon, the temperature may be approximately 150° C.-180° C. in the yarn in the stuffer tube 12, while the temperature at the second heater 28' may be on the order of 200° C. Inasmuch as these temperatures are not high, the materials of the drum and tube are not critical. For example, the stuffer tube may be made of mild steel which is chrome-plated at its interior surface, and the drum may be made of ordinary mild steel.

It will be understood that each of the elements described above, or two or more together, may also find a useful application in other types of yarn crimping apparatus differing from the types described above.

While the invention has been illustrated and described as embodied in yarn crimping apparatus using the stuffer box technique, it is not intended to be limited to the details shown, since various modifications and structural changes may be made without departing in any way from the spirit of the present invention.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can by applying current knowledge readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the following claims.

What is claimed as new and desired to be secured by Letters Patent is:

1. In an apparatus for crimping thermoplastic yarn, in combination, an elongated tubular member having opposite open ends one of which is an entrance end and the other of which is a discharge end, said tubular member forming a crimping chamber; an annular member formed with an annular passage extending around a predetermined axis and communicating with said discharge end of said tubular member, said annular passage forming a receiving chamber which receives yarn from said

crimping chamber; means supporting said members for turning movement one with respect to the other around said axis; heating means cooperating with one of said members for heating the yarn at a portion of said one member; means for feeding yarn to be crimped to said entrance end of said tubular member; and means cooperating with said annular member for removing yarn from said annular passage, said annular passage being closed except for the place where the yarn is removed therefrom.

2. Apparatus for crimping thermoplastic yarns, comprising, in combination, an elongated tubular member having opposite open ends one of which is an entrance end and the other of which is a discharge end, said tubular member forming a crimping chamber; a pair of input rollers cooperating with said entrance end of said tubular member for feeding yarn into said crimping chamber formed thereby; an annular member formed with an annular passage extending around a predetermined axis and communicating with said discharge end of said tubular member, said annular passage forming a receiving chamber which receives yarn from said crimping chamber; support means supporting one of said members for turning movement around said axis with respect to the other of said members; heating means cooperating with one of said members for heating the yarn in the chamber of said one member; and means cooperating with said annular member for removing yarn from said annular passage, said annular passage being closed except for the place where the yarn is removed therefrom.

3. In an apparatus for crimping thermoplastic yarn, in combination, an elongated stuffer tube having opposite open ends one of which is an entrance end and the other of which is a discharge end, said stuffer tube forming a crimping chamber; a rotary drum member formed with an annular channel communicating with said discharge end of said stuffer tube to receive yarn from the latter, said discharge end of said stuffer tube communicating with said annular channel at a predetermined angular position with respect to the axis around which said channel extends; means supporting said rotary member for turning movement around said axis; heating means cooperating with the yarn for heating the same while it is in the apparatus; and means at a part of said annular channel angularly displaced from the portion thereof communicating with said discharge end of said stuffer tube for removing yarn from said annular channel, said annular channel being closed except at said part thereof from which the yarn is removed.

4. Apparatus for crimping thermoplastic yarn comprising, in combination, an elongated stuffer tube having an entrance end and a discharge end; means cooperating with said entrance end of said tube for supplying yarn into the latter; heating means cooperating with said tube for heating yarn moving therethrough; an annular receiver drum turnable about its axis and formed with an annular channel communicating with said discharge end of said tube to receive yarn therefrom; and means cooperating with said drum to remove the yarn therefrom, said channel being closed except for the place where the yarn is removed therefrom.

5. In an apparatus for crimping thermoplastic yarn, in combination, rotary drum means having a periphery formed with an annular receiver channel; brake means cooperating with said rotary drum means for braking the rotation thereof; an elongated stuffer tube having a discharge end communicating with said channel to deliver yarn thereto, the yarn moving along a predetermined path formed in part by said stuffer tube and in part by said channel; and heating means located at a portion of said path for heating the yarn at said portion of said path.

6. In an apparatus for crimping thermoplastic yarn,

in combination, rotary drum means formed at its periphery with an annular channel adapted to receive yarn, said channel being entirely closed except at one part where yarn is removed from said channel; drive means cooperating with said drum means for rotating the latter; and a stuffer tube communicating with said channel for delivering yarn thereto.

7. In an apparatus for crimping thermoplastic yarn, in combination, a rotary drum having a periphery formed with an annular channel; a stationary annular cover surrounding said drum and covering said channel, said cover being formed with a pair of angularly spaced cutouts; a stuffer tube having a discharge end extending through one of said cutouts into said channel to deliver yarn to the latter; and means cooperating with the other of said cutouts for removing yarn from said channel.

8. In an apparatus for crimping thermoplastic yarn, in combination, a rotary drum having a periphery formed with an annular channel; a stationary annular cover surrounding said drum and covering said channel, said cover being formed with a pair of angularly spaced cutouts; a stuffer tube having a discharge end extending through one of said cutouts into said channel to deliver yarn to the latter; means cooperating with the other of said cutouts for removing yarn from said channel; and tensioning means located between said other cutout and said means for removing yarn from said channel through said other cutout for tensioning the yarn as it moves from said other cutout so as to prevent uneven yarn from being produced.

9. In an apparatus for crimping thermoplastic yarn; a stuffer tube member and a drum member, the latter being formed with an annular receiving channel which communicates with said stuffer tube member to receive yarn therefrom and one of said members being supported for turning movement with respect to the other of said members about the axis of said annular channel; nip roller means cooperating with said channel for removing yarn therefrom at a given speed; tensioning means cooperating with the yarn before it reaches said nip roller means for preventing uneven yarn from passing to said nip roller means; and package forming means cooperating with said nip roller means to collect the yarn therefrom and form a package therefrom, said package forming means forming a package while the yarn is under a relatively small tension.

10. In an apparatus for crimping thermoplastic yarn; a stuffer tube member and a drum member, the latter being formed with an annular receiving channel which communicates with said stuffer tube member to receive yarn therefrom and one of said members being supported for turning movement with respect to the other of said members about the axis of said annular channel; nip roller means cooperating with said channel for removing yarn therefrom at a given speed; tensioning means cooperating with the yarn before it reaches said nip roller means for preventing uneven yarn from passing to said nip roller means; package forming means cooperating with said nip roller means to receive the yarn therefrom and to form a package from the yarn; and heating means located along the path of movement of the yarn from said nip roller means to said package forming means for heating the yarn, the latter cooling on its way from said heating means to said package forming means and the yarn being in partially contracted condition before being collected by said package forming means.

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