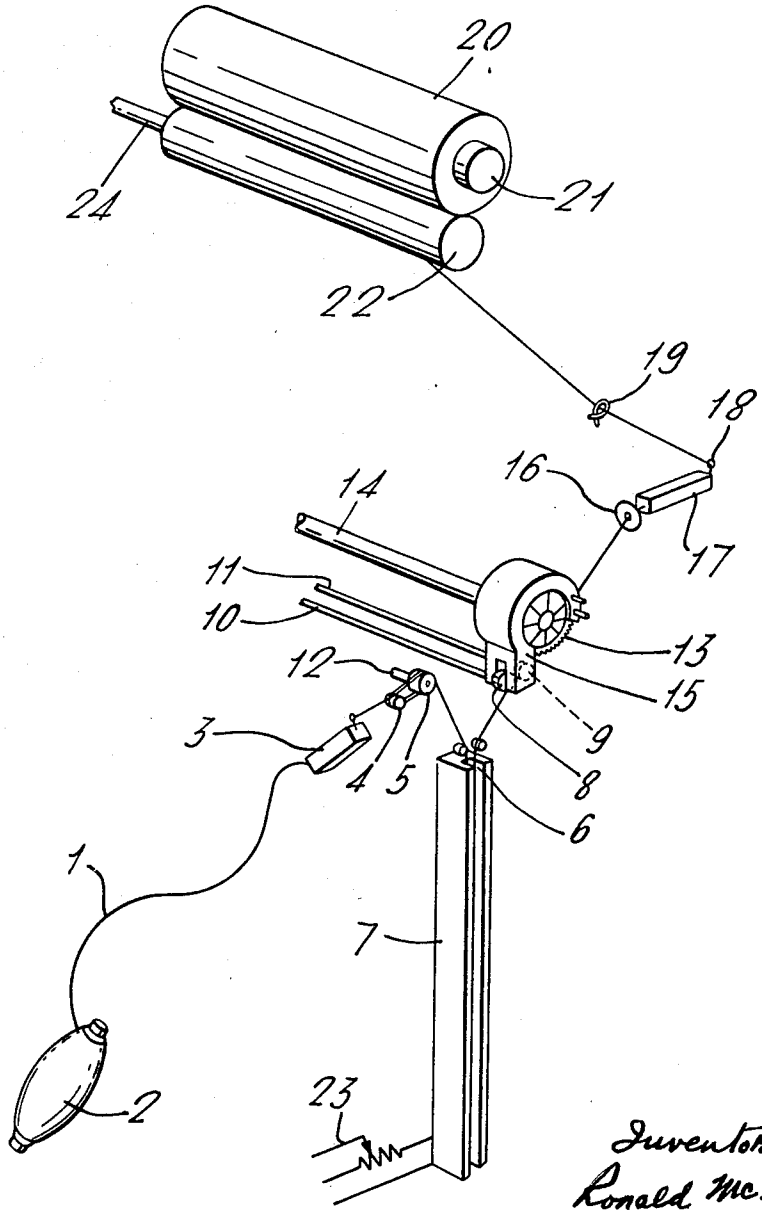
July 30, 1968 R. McINTYRE 3,394,439

METHOD AND APPARATUS FOR BUNCHING YARN

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Fig. 1.



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METHOD AND APPARATUS FOR BUNCHING YARN

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Fig. 2.

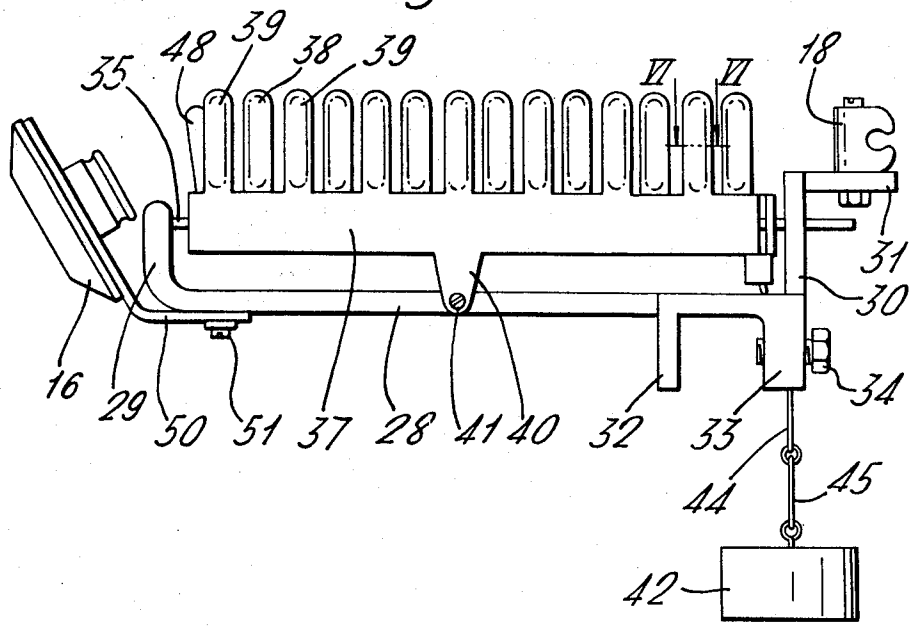
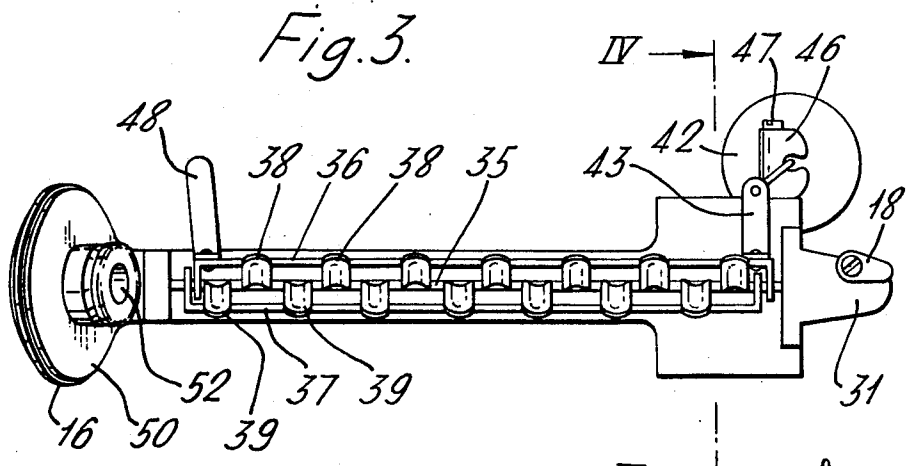


Fig. 3.



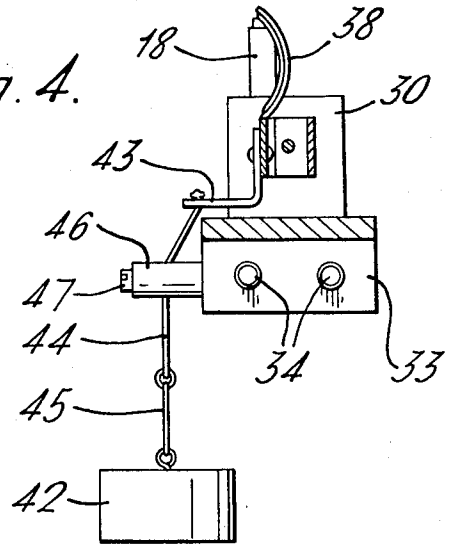
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METHOD AND APPARATUS FOR BUNCHING YARN

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Fig. 4.



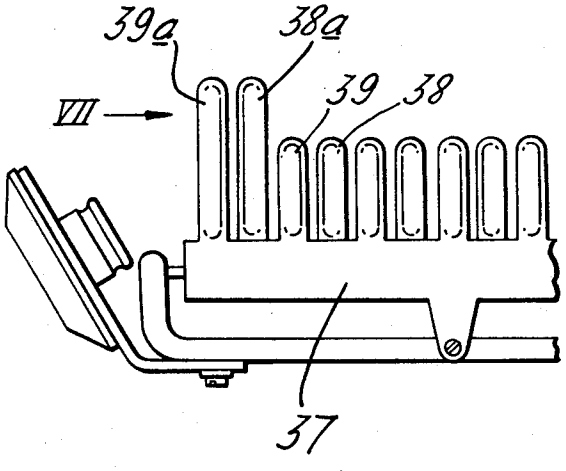
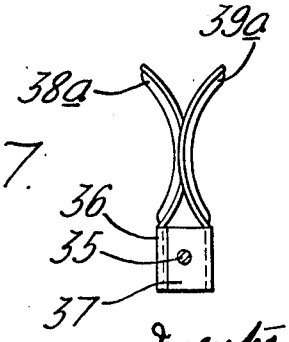


Fig. 5.

Fig. 6.



Fig. 7.



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3,394,439

METHOD AND APPARATUS FOR BUNCHING YARN

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13 Claims. (Cl. 28—1)

ABSTRACT OF THE DISCLOSURE

A stable package of yarn which has been crimped by longitudinal compression and which package is capable of being unwound at substantially constant tension is formed by passing the yarn from the crimping operation through an adjustable tensioning device to straighten the crimped yarn and winding the yarn in this straightened condition. The tensioning device is weight-loaded and the weight is damped by means of a resilient member.

This invention relates to a method and apparatus for bunching yarn by compressing the yarn along its longitudinal axis and also to forming packages of yarn crimped by longitudinal compression.

Packages of crimped yarn are formed on bobbins or the like without the use of flanges to support the yarn. A package wound under low tension will be unstable and likely to suffer damage during handling before being used, which damage affects the ability of the package to be unwound at a constant tension. A package wound under too high a tension will suffer deformation by creep, the ends of the package bulging outwardly. This form of deformation is also detrimental to the unwinding of the package, layers of yarn having moved relative to each other and snagging as they are unwound. Also, in packages wound under too high a tension successive courses of yarn can snag on each other due to the tightness of the package.

Depending on the nature of the immediately succeeding process to which the yarn is subjected the unwinding characteristics of a package assume a greater or lesser importance. When the next process is one of fabricating the yarn into an article, as for example by tufting into a carpet, it is important, for uniformity in the finished article, to be able accurately to control the feeder yarn to the fabricating apparatus or process to minimise or prevent snagging, loops being formed or filamentation of yarn and to maintain the yarn at a constant tension.

One factor contributing to snagging of yarn as it is unwound from a package, known as "webbing" or "stitch marks," is when yarn is misplaced at the ends of the package and extends in a straight line across the end face of the package instead of circumferentially around the package.

The yarn as it is removed from the setting chamber in the crimped condition is in a folded condition, that is to say the individual filaments follow a close and sharply defined zig-zag path. In order to form a package which will be self-supporting without the use of end flanges a certain tension must be imparted to the yarn as it is wound onto the take-up bobbin.

Tensioning the yarn in the folded condition straightens the yarn and, if the tension is large enough, stretches out the crimp formation imparted to the filaments of the yarn. On releasing the tension the yarn takes up a relaxed position in which the crimp in the filaments gives the yarn a bulked appearance, but the yarn does not return to the folded condition.

To form a stable package the yarn must be unfolded and conveniently the same tensioning which is required in order to form the package is employed to unfold the yarn.

As the method of crimping yarn by linear compression is developed and yarn throughput speeds increase the formation of good packages of yarn becomes more difficult.

According to one aspect of the present invention there is provided a method of crimping yarn which includes the step of introducing softened yarn into a stuffer box crimping chamber to form a plug of crimped yarn, passing the plug of crimped yarn through a setting chamber, withdrawing the yarn from the leading end of the plug through an adjustable tension device and forming the crimped yarn into a package, the tension device tensioning the yarn by an amount according to the denier of the yarn so as to straighten the crimped yarn and substantially remove the bulkiness imparted to the yarn by the crimp; the yarn being formed into a stable package capable of being unwound at substantially constant tension.

The rate of winding the crimped yarn into a package may be varied in response to movement of the leading end of the plug of crimped yarn so that the length of the plug is maintained within predetermined limits. The yarn can be formed into a package at speeds exceeding 1000 feet per minute.

According to another aspect of the present invention there is provided a method of crimping multi-filament thermoplastic yarn or yarn having a thermoplastic component at yarn throughput speeds greater than 1000 feet per minute comprising the steps of raising the temperature of the yarn to soften it, feeding the softened yarn into a crimping chamber where the yarn is crimped by longitudinal compression, removing the yarn from the crimping chamber in the form of a plug of crimped yarn through a setting zone, withdrawing the yarn from the setting zone and winding the crimped yarn into a package under a tension sufficient substantially to straighten the crimp imparted to the yarn and maintaining the tension constant within close limits whereby a stable package is formed having no crossed ends or loops and which package can be unwound at a constant tension without filamentation of the yarn occurring and without filamentary loops forming.

According to a further aspect of the present invention there is provided a method of forming a package of multi-filament crimped yarn wherein yarn passes onto a rotating bobbin to form a package of yarn at a speed of 1000 feet per minute or more, the tension in the yarn passing to the package being controlled to give a substantially constant relation between the tension and the denier size and tenacity of the yarn by passing the yarn through an adjustable tension device automatically controlled to maintain the tension in the yarn within limits so as to form a stable package substantially free from variations and imperfections which may have a deleterious effect on articles made from the package of yarn.

The tension in the yarn can be sufficient substantially to straighten the crimp imparted to each of the filaments of the yarn. When the physical properties of the yarn at the time of winding are affected, for example by heat, the tension applied to the yarn can be related to the tenacity of the yarn at the time of winding.

We have found that the yarn may not leave the setting zone at a constant rate and that irregularities may occur in the manner in which it is formed into the plug of yarn. For example the yarn may fold within the crimping chamber in such a manner that one fold may become entwined with an adjacent fold. Such irregularities in folding are pulled out when the tension is applied to the

yarn and whenever this occurs the length of the tensioned yarn is in effect increased and the tension decreases in proportion.

According to yet another aspect of the present invention there is provided a yarn tensioning device comprising a base member, a first comb-like member having finger projections spaced apart along one edge and secured to said base member, a second comb-like member having finger projections spaced apart along one edge and being pivotally mounted on said base member substantially parallel with said first base member and disposed so that the fingers of the first member alternate with the fingers of the second member, and a weight secured to said second member by attachment means at least a part of which means is resilient, said weight urging the second member to pivot in a direction tending to move its fingers away from the fingers of the first member.

In apparatus of this kind the yarn is tensioned by the snubbing action of the yarn on the fingers. In order to increase the tension the angle of deflection of the yarn at each finger is varied so as to increase the length of path of the yarn in contact with the fingers.

As the yarn passes through the apparatus the tension in the yarn is progressively increased, the folds in the yarn being pulled out by the increase in tension. When for any reason the length of yarn suddenly increases the weight serves to move the pivoted fingers and restore the tension in the yarn. Sudden movements of the weight in itself introduces a source of tension variation which source is substantially reduced or eliminated by attaching the weight to the pivoted fingers by resilient means which damps out the effect of the fluctuations of the fingers.

The resilient means can comprise a length of rubber or rubber-like synthetic material or spring means.

The finger projections of the comb-like members can be curved in opposite directions the convex surface of said fingers thus formed being adapted to contact yarn passing therethrough. Inlet and outlet yarn guides can be mounted on said base member to guide yarn passing through the device between the fingers. At least one finger projection on each of the comb-like members at one end of thereof can be of increased length, the yarn being arranged to pass into the device between said elongated fingers whereby fluctuations in yarn feed to the device are prevented from causing the yarn to deviate from its path between and in contact with the fingers of each of the comb-like members.

According to yet a further aspect of the present invention there is provided a yarn tensioning device for travelling yarn comprising a pair of parallel toothed comb-like members pivotally mounted with respect to each other, the teeth of each of the comb-like members being spaced apart so as to allow the teeth of the other comb-like member to pass therebetween, each of said teeth being curved to form a convex part, and the convex part of each of the teeth being adapted to contact yarn passing between and in contact therewith, a weight resiliently secured to one of said members urging the two members apart so as to impart drag to the yarn whereby variations in the rate of feed of yarn to the device allows the teeth of the pivoted member to move with respect to each other without substantially varying the drag imparted to the yarn.

The invention will now be more particularly described with reference to the accompanying diagrammatic drawings in which:

FIGURE 1 is a perspective view of the yarn path and the major components of an apparatus for crimping yarn;

FIGURE 2 is a side elevation drawn to an enlarged scale of one type of tensioning device by which yarn may be tensioned in the apparatus shown in FIGURE 1;

FIGURE 3 is a plan view of the device shown in FIGURE 2;

FIGURE 4 is a sectional elevation along the line IV—IV in FIGURE 3;

FIGURE 5 is a side elevation showing a modification of the tensioning device of FIGURES 2 to 4;

FIGURE 6 is a cross-section through one finger of the devices shown in FIGURES 2 to 5 along the line VI—VI in FIGURE 2 and drawn to an enlarged scale, and

FIGURE 7 is an end view of the fingers of the device shown in FIGURE 5 in the direction of arrow VII.

Referring to FIGURE 1 yarn **1** is drawn from a supply bobbin **2** through a tensioning device **3**. The yarn then passes around rollers **4** and **5** and once or more across a heated surface formed by the bottom of a groove **6** in a heater **7** before being gripped in the nip of a pair of rollers **8** and **9**.

Rollers **8** and **9** are driven by means of a suitable power source and transmission means (not shown) which drives shafts **10** and **11** on which the rollers **8** and **9** are secured. Roller **5** which is secured to shaft **12** is driven at a speed such that its peripheral speed is the same as or greater than the peripheral speed of the nip rollers **8** and **9**.

The yarn is fed by rollers **8** and **9** into a bunching zone within the member **15** from which it is removed transversely as a plug of crimped yarn by a toothed wheel **13** secured to and driven by shaft **14**, the yarn clinging to the periphery of the wheel **13** and passing through a setting chamber formed as an arcuate groove within member **15**.

Crimped and set yarn is withdrawn from the leading end of the plug, and passes through a guide **16**, tensioning device **17** and further guides **18** and **19** before being formed into a package **20** on bobbin **21**. The bobbin or package is rotated by a driven roller **22** contacting the periphery of the bobbin or package. Roller **22** is secured to shaft **24** which is driven through transmission means (not shown) by the same power source as arranged to drive shafts **10**, **11** and **14**. The yarn is laid on the package in well known manner by a reciprocating guide adjacent the nip of the package and the drive roller.

As described more fully in United States Patent No. 3,174,206, light sensitive means **25** and **26** co-operate with sources of light disposed so that yarn within the arcuate groove can cut off the light source from reaching the light sensitive means opposite it. The outputs from each of the light sensitive means are arranged to operate means causing the rate of rotation of the driven roller **22**, to vary so as to maintain the head of the plug of crimped yarn between the two light sensitive means.

In operation yarn is drawn from the supply bobbin **2** by the nip rollers **8** and **9**, the yarn passing several times around rollers **4** and **5**. As the yarn is tensioned between the nip rollers and the tensioning device **3** it is gripped by the driven roller **5** which then assists in feeding the yarn through the heater **7**. Heated and softened yarn passes between the nip rollers into the crimping zone where it is crimped by longitudinal compression along its length, the yarn being formed into a plug of crimped yarn. The plug is removed from the crimping chamber by the toothed wheel **13** at a rate substantially less than the rate at which yarn is fed into the crimping chamber. The wheel **13** positively engages the plug and conveys it through the setting zone formed by the arcuate groove in the member **15**. Depending upon the nature of the yarn the setting zone may be heated in order to set the crimp in the yarn.

Crimped and set yarn is withdrawn from the leading end of the plug by the rotating bobbin **21** or package **20** driven by roller **22**, the tension in the yarn being formed into the package being controlled by the tensioning device **17**.

As shown in FIGURES 2 to 4 the tensioning device comprises a base member **28** having two projecting lugs **29** and **30**. The lug **30** is provided with a further projection **31** extending generally parallel with the base mem-

ber. At one end of the base member are provided a pair of lugs **32** and **33** and set screws **34** threadably mounted in lug **33** by means of which the base member may be secured to a part of the machine frame.

A pin **35** passes through each of the lugs **29**, **30** and mounted on pin **35** are two comb-like members **36** and **37** having fingers **38** and **39**, respectively, extending therefrom, the fingers **38** of the member **36** alternating with the fingers **39** of member **37**. As shown in FIGURES 3 and 4 the fingers are curved so as to co-operate to define a path of travel for yarn passing through the device and, as shown in FIGURE 6, the fingers are rounded so as to provide a smooth surface over which yarn can run without snagging.

The comb-like member **37** is provided with an extension **40** having a hole through which screw **41** passes to secure the member **37** to the base and prevent it rotating upon pin **35** relative to the base member.

Comb-like member **36** is free to turn on pin **35** and is urged in the direction tending to separate the fingers by a weight **42** secured to a bracket **43** which is rivetted to member **36**. The weight **42** is attached to the bracket **43** by means of a length of cord or string **44** and a length of elastic rubber-like material **45**, the cord passing over a guide **46** secured to the base member **28** by screw **47**.

Extension piece **48**, rivetted to comb-like member **36** provides a convenient finger grip for manually moving the member **36** in the opposite direction to that in which it is urged by the weight to facilitate threading the device.

The inlet yarn guide **16** is secured by adhesive to a bracket **50** which is in turn secured to the base member **28** by screw **51**. The guide is shaped so as to present a large face to incoming yarn, the yarn passing through a hole **52**, the large face preventing ballooning of the yarn from causing the yarn to entangle itself around the fingers of the comb-like members before it has passed through the hole **52** in the guide.

The exit yarn guide **18** is secured to projection **31** of the base member by screw **53**.

Erratic feeding of the yarn to the device can be such as to cause the yarn to become misplaced from its tortuous path in contact with the convex faces of each of the fingers **38**, **39** particularly the first one or two fingers where the device has not attained full control over the yarn. In order to minimise this the first finger of each member **36**, **37** may be extended as shown at **38***a* and **39***a* in FIGURES 5 and 7 so that although the yarn path may be somewhat erratic the yarn does not deviate from the tortuous path between and in contact with alternate fingers.

In operation the yarn leaving the arcuate setting chamber is in a crimped configuration and as it passes through the tensioning device it is straightened out, the yarn leaving the tensioning device at a tension sufficient to straighten the yarn at the temperature of the yarn at that time. Although the yarn is still warm as it leaves the setting zone tensioning the yarn in this way does not substantially affect the crimp in the yarn, the crimp remaining latent in the yarn whilst it is in the form of the package.

As the crimp in the yarn is straightened, the length of yarn increases so that the yarn leaves the tensioning device at a faster rate than the rate at which the yarn in the crimped configuration is fed in.

This lengthening of the yarn may not occur steadily due to various factors, one of which is that yarn may have been compressed in the crimping chamber to overlap on itself. The result is that the movable member **36** of the tensioning device pivots to and fro on the pin **35** so that the weight **42** is always acting to tension the yarn. A rapid to and fro motion of the member **36** causes vertical motion of the weight **42** and in order that the weight be effective to tension the yarn at substantially all times it is necessary to damp the movement of the weight. For this purpose the attachment means by which the weight is secured to the movable member includes the resilient means **45** having a suitable frequency to prevent resonance and excessive movement of the weight in operation. The resilient means may for example, alternatively be spring means.

Another source of tension variation is when the rate of winding the yarn into the package varies, the tension tending to increase momentarily as the speed of winding increases and tending to decrease when the rate of winding decreases. This tendency is also damped by the resilient attachment means so as to maintain the tension in the yarn within the limits required for the formation of sound packages.

I claim:

1. A method of crimping yarn which includes the steps of introducing softened yarn into a stuffer box crimping chamber to form a plug of crimped yarn, passing the plug of crimped yarn through a setting chamber, withdrawing the yarn from the leading end of the plug through an adjustable tensioning device and forming the crimped yarn into a package, the tensioning device tensioning the yarn by an amount according to the denier of the yarn so as to straighten the crimped yarn and substantially remove the bulkiness imparted to the yarn by the crimped; the yarn being formed into a stable package capable of being unwound at substantially constant tension.

2. A method as claimed in claim **1** wherein the yarn is formed into a package at speeds exceeding 1000 feet per minute.

3. A method of crimping multi-filament thermoplastic yarn or yarn having a thermoplastic component at yarn throughput speeds greater than 1000 feet per minute comprising the steps of raising the temperature of the yarn to soften it, feeding the softened yarn into a crimping chamber where the yarn is crimped by longitudinal compression, removing the yarn from the crimping chamber in the form of a plug of crimped yarn through a setting zone, withdrawing the yarn from the setting zone and winding the crimped yarn into a package under a tension sufficient substantially to straighten the crimp imparted to the yarn and maintaining the tension constant within close limits whereby a stable package is formed having no crossed ends or loops and which package can be unwound at a constant tension without fllamentation of the yarn occurring and without filamentary loops forming.

4. A method of forming a package of multi-filament crimped yarn wherein the yarn passes on to a rotating bobbin to form a package of yarn at a speed of 1000 feet per minute or more, the tension in the yarn passing to the package being controlled to give a substantially constant relation between the tension and the denier size and tenacity of the yarn by passing the yarn through an adjustable tension device automatically adjustable to maintain the tension in the yarn within limits to form a stable package substantially free from variations and imperfections which may have a deleterious effect on articles made from the package of yarn.

5. A method as claimed in claim **4** in which the tension in the yarn is sufficient to straighten the crimp imparted to each of the filaments of the yarn.

6. A yarn tensioning device comprising a base member; a first comb-like member having finger projections spaced apart along one edge and secured to said base member; a second comb-like member having finger projections spaced apart along one edge and being pivotally mounted on said base member substantially parallel with said first base member and disposed so that the fingers of the first member alternate with the fingers of the second member; a weight; and attachment means at least part of which means is resilient, said weight being secured to said second member by said attachment means and said weight urging the second member to pivot in a direction tending to move its fingers away from the first member.

7. A yarn tensioning device as claimed in claim **6** wherein the resilient means comprises a length of rubber or rubber like synthetic material.

8. A yarn tensioning devices as claimed in claim 6 in which the resilient means comprises spring means.

9. A yarn tensioning device as claimed in claim 6 in which the finger projections of comb-like members are curved in opposite directions, the convex surface of said fingers thus formed being adapted to contact yarn passing therethrough.

10. A yarn tensioning device as claimed in claim 6 including inlet and outlet yarn guides mounted on said base member to guide yarn passing through the device between said fingers.

11. A yarn tensioning device as claimed in claim 6 in which at least one finger projection on each of the comb-like mmebers at one end thereof can be of increased length, the yarn being arranged to pass into the device between said elongated fingers whereby fluctuations in yarn feed to the device are prevented from causing the yarn to deviate from its path between and in contact with the finegrs of each of the comb-like members.

12. An apparatus for imparting tension to travelling yarn including a pair of parallel toothed comb-like members pivotally mounted with respect to each other, the teeth of each of the comb-like members being spaced apart so as to allow the teeth of the other comb-like member to pass therebetween, each of said teeth being curved to form a convex part, and the convex part of each of the teeth being adapted to contact yarn passing between and in contact therewith, a weight resiliently secured to one of said members urging the two members apart so as to impart drag to the yarn whereby variations in the rate of feed of yarn to the device allows the teeth of the members to move with respect to each other without substantially varying the drag imparted to the yarn.

13. Stuffer box crimping apparatus comprising a stuffer crimping chamber; means for feeding yarn into said chamber to crimp said yarn therein; means for removing crimped yarn from said chamber; winding means for winding crimped yarn into a package; and a yarn tensioning device disposed in the yarn path between said means for removing crimped yarn and said winding means, and including a pair of parallel toothed comb-like members pivotally mounted with respect to each other, the teeth of each of the comb-like members being spaced apart so as to allow the teeth of the other comb-like member to pass therebetween, each of said teeth being curved to form a convex part, and the convex part of each of the teeth being adapted to contact yarn passing between and in contact therewith, a weight resiliently secured to one of said members urging the two members apart so as to impart drag to the yarn whereby variations in the rate of feed of yarn to the device allows the teeth of the members to move with respect to each other without substantially varying the drag imparted to the yarn.

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