May 31, 1960 D. STARKIE 2,938,258

METHOD AND MEANS FOR PROCESSING THERMOPLASTIC YARN

Filed April 18, 1958 5 Sheets-Sheet 1

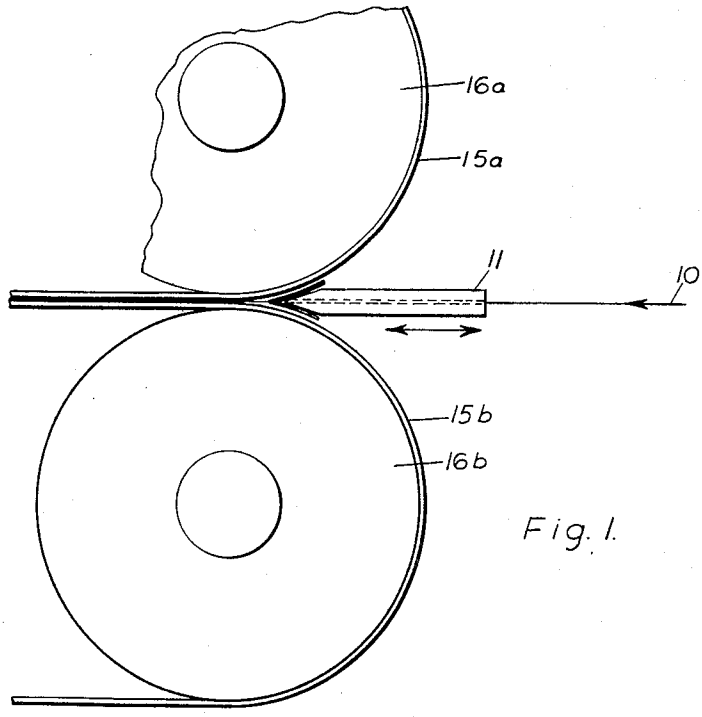


Fig. 1.

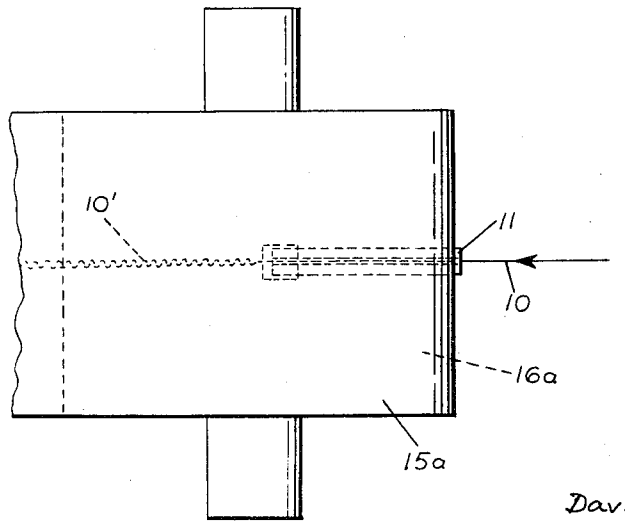


Fig 2.

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May 31, 1960 D. STARKIE 2,938,258

METHOD AND MEANS FOR PROCESSING THERMOPLASTIC YARN

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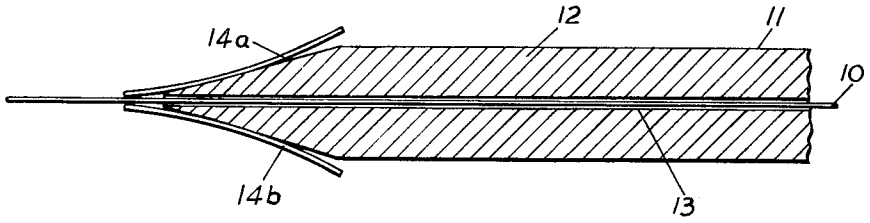


Fig. 3.

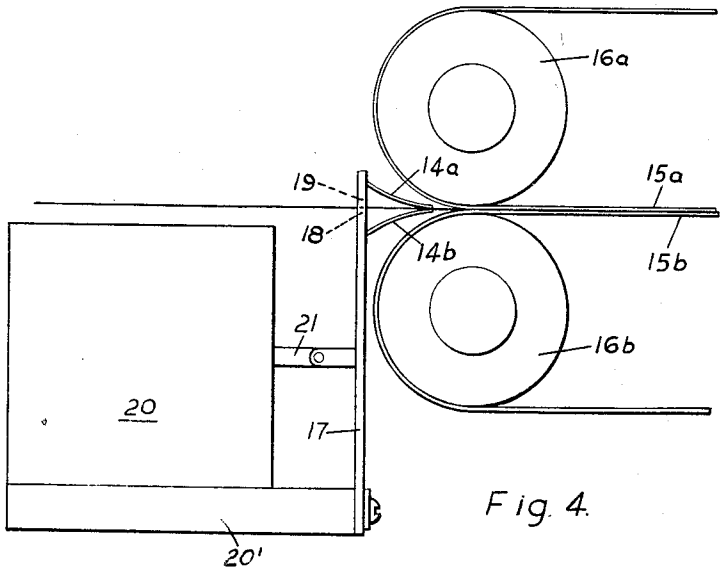


Fig. 4.

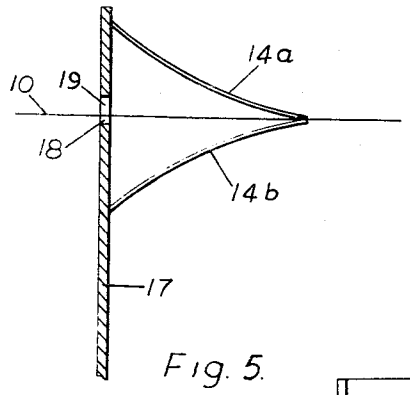


Fig. 5.

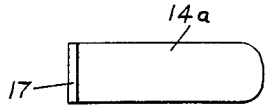


Fig. 7.

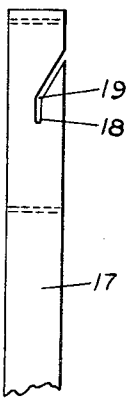


Fig. 6

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METHOD AND MEANS FOR PROCESSING THERMOPLASTIC YARN

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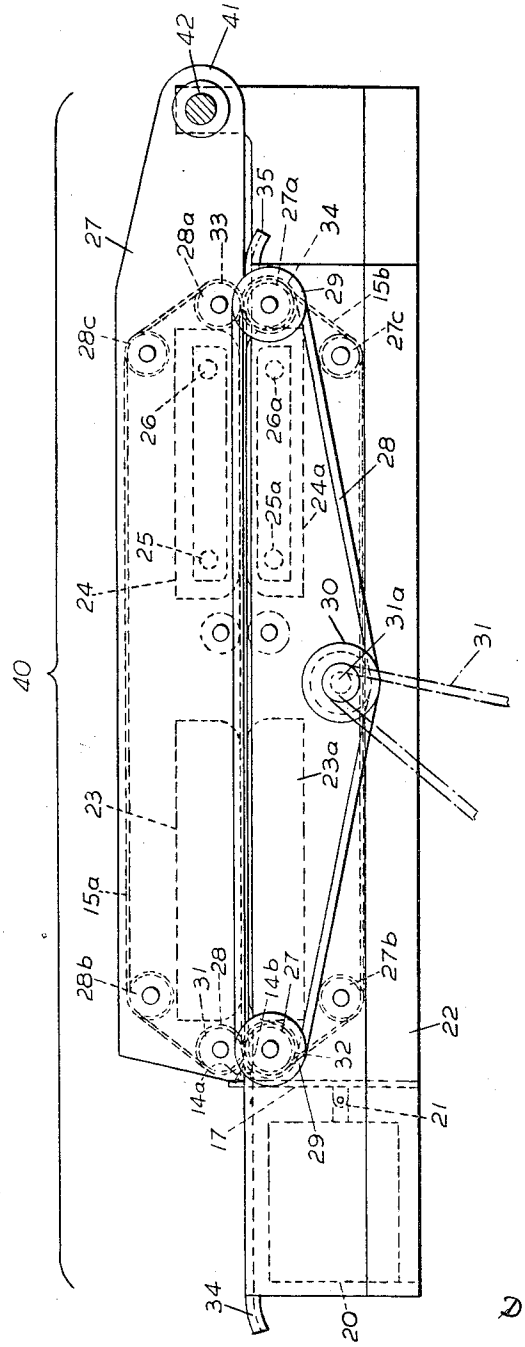


Fig. 8.

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METHOD AND MEANS FOR PROCESSING THERMOPLASTIC YARN

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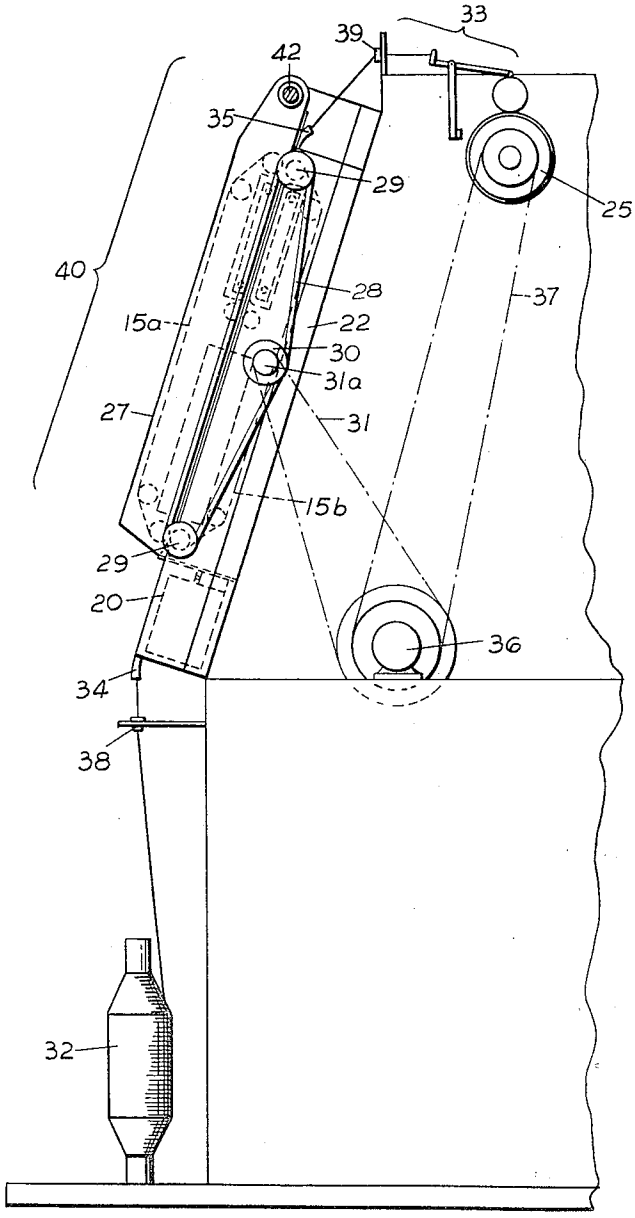


Fig. 9.

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METHOD AND MEANS FOR PROCESSING THERMOPLASTIC YARN

Filed April 18, 1958 5 Sheets-Sheet 5

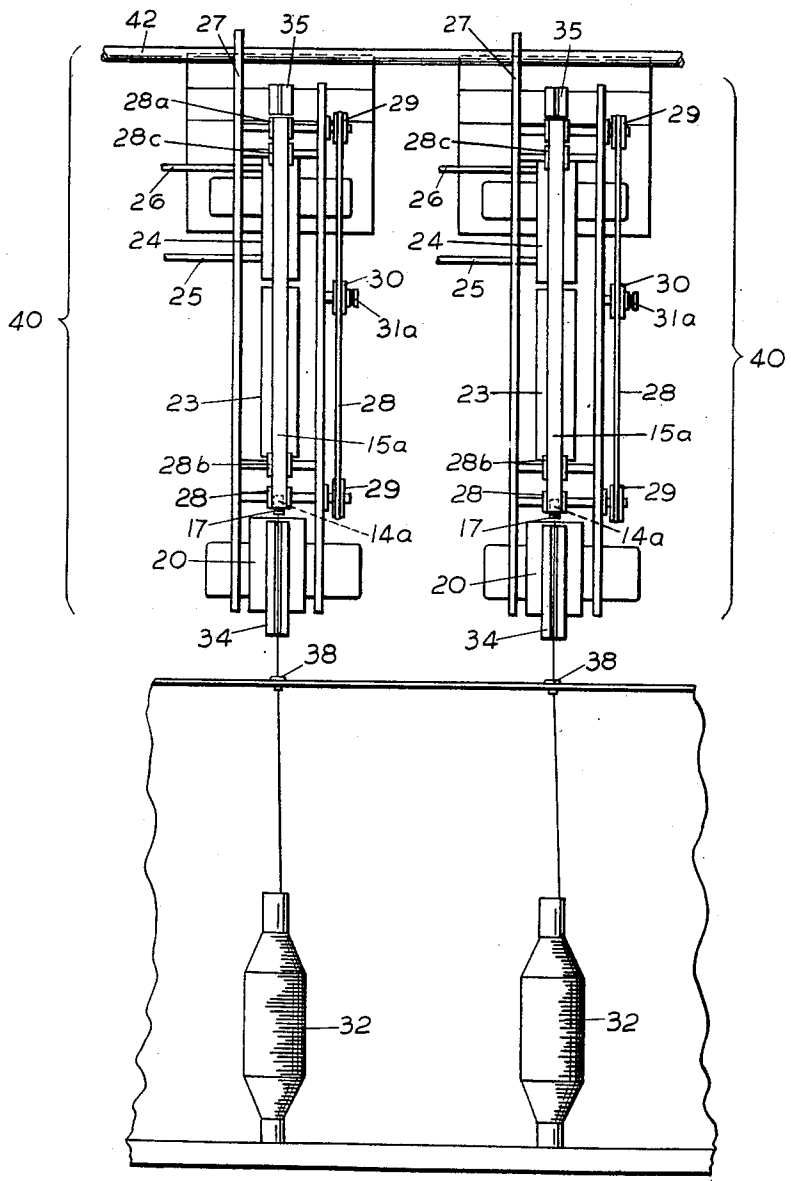


Fig. 10.

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2,938,258

METHOD AND MEANS FOR PROCESSING THERMOPLASTIC YARN

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Filed Apr. 18, 1958, Ser. No. 729,455

Claims priority, application Great Britain Apr. 27, 1957

14 Claims. (Cl. 28—1)

This invention refers to the manufacture of synthetic fiber yarn of the "stretch" type. Such yarns are finding increasing application in textiles and particularly in hosiery by reason of the additional elasticity, close fit, and warmth which they impart to a knitted garment, and the fact that they enable one garment to fit a range of sizes.

A number of synthetic fiber stretch yarns are already available to textile manufacturers. All are of the continuous filament type, containing either a single or a number of filaments, and all are able to be provided with stretch properties by reason of the thermoplastic nature of the materials from which they are made. Well-known examples of thermoplastic materials which are in common use as textile fibers are nylon and "Terylene." By thermoplastic nature is meant the ability of the material to retain the shape or form in which it has been held while at an elevated temperature.

The basis of manufacture of all stretch yarns is that the synthetic yarn is held in a crimped or folded condition by some means or other while at an elevated temperature and, on cooling, it remains crimped. If a crimped yarn is pulled, the crimps straighten out and the yarn extends in length; when the extending force is removed, the crimps reform and the yarn contracts in length. It is obvious that the type, shape, and size of the crimps will have a pronounced effect on the degree of extensibility and recovery, and the thermal insulating properties of the garment made from a stretch yarn.

The present invention as viewed from one aspect provides a method of manufacturing a synthetic fiber yarn of the "stretch" type which comprises feeding a thermoplastic yarn to a crimping station at a repetitiously-fluctuating linear speed, receiving the yarn and continuing its travel beyond the station at a speed less than the mean linear speed so that the yarn adopts a crimped form at the crimping station and its continuing travel is in crimped form, and setting the yarn in that form.

As viewed from another aspect the invention also provides a method of manufacturing a synthetic fiber yarn of the "stretch" type which comprises crimping a thermoplastic yarn by feeding it to a crimping station through a vibrating device, receiving the crimped yarn at the crimping station and continuing its travel in crimped form, and setting it in that form.

The invention also provides a method of manufacturing synthetic fiber yarn of the "stretch" type, which comprises crimping a thermoplastic yarn by feeding it, at a repetitiously-fluctuating speed by means of a vibrating feeding device, between a pair of co-operating travelling surfaces which receive the crimped yarn from said device and hold it in its crimped form, and setting the yarn in that form by heat treatment.

The invention further provides apparatus for producing a crimped thermoplastic yarn, comprising yarn feed means for feeding the thermoplastic yarn to a crimping station at a repetitiously-fluctuating linear speed, yarn conveying means for receiving the yarn and continuing its travel beyond the station at a speed less than the mean linear speed of the yarn, so that the yarn adopts a crimped form at the crimping station and its continued travel is in crimped form, and heating means for heat treating the travelling crimped yarn to set it in that form.

The invention still further provides apparatus for producing a crimped thermoplastic yarn comprising means for crimping the thermoplastic yarn which includes a vibrating device for feeding the yarn to a crimping station, conveying means for receiving the crimped yarn at the crimping station and continuing its travel in crimped form, and heating means for heat treating the travelling crimped yarn to set it in that form.

Conveniently the vibrating device is of reciprocating resilient form to grip the yarn in a feed stroke and slip on the yarn in a return stroke.

The above and other features of the invention set out in the appended claims are incorporated, by way of exemplification, in the constructions which will now be described, as specified embodiments with reference to the accompanying drawings in which:

Figure 1 is a diagrammatic view, in side elevation, of the main components of yarn crimping apparatus according to the invention,

Figure 2 is a plan view thereof;

Figure 3 is an enlarged view, in longitudinal section, of the crimping device,

Figure 4 is a diagram in side elevation of the main components of modified yarn crimping apparatus,

Figure 5 is an enlarged detail of a yarn feeding device of the modified apparatus,

Figure 6 is an end view of the yarn feeding device,

Figure 7 is a plan view of the yarn feeding device,

Figure 8 is a side view of a crimping unit of the modified apparatus,

Figure 9 is a side view of the modified apparatus,

Figure 10 is a front view of the modified apparatus.

The thermoplastic yarn **10** (for example nylon or Terylene) may be a monofilament or a plural filament yarn. It is drawn from a continuous source of supply and is advanced to a crimping station by a vibrating feeding device indicated generally by the reference **11**. This feeding device **11** is vibrated longitudinally of the yarn and it operates to grip the yarn and to feed it during advance towards that station. Thus the yarn is fed to the station at a repetitiously-fluctuating linear speed. At the crimping station the yarn is received by means (bands **15***a*, **15***b*) which continues the travel of the yarn at a speed less than the mean linear speed at which the yarn is drawn off its supply and advanced to the crimping station. It therefore results that the yarn is caused to pile itself up into crimps at the crimping station. It is received and its travel is continued in this crimped form (as illustrated at **10'** in Fig. 2) and during this continued travel it is set in crimped form.

The vibrating device **11** consists in this example (but not in another example hereinafter described) of a tube **12** having a smooth bore **13** of a diameter sufficiently small to guide the yarn to be processed but sufficiently large to offer little or no resistance to the passage of the yarn. At its delivery end the tube is tapered as shown and is provided with two leaf springs **14***a*, **15***b* between the tips of which the yarn **10** emerges. These springs tend to grip the yarn. Thus as the device **11** is moved towards the crimping station i.e. to the left in the drawings, the yarn is gripped by the springs **14***a*, **14***b* and is advanced towards the crimping station at a speed greater than that at which the means **15***a*, **15***b* can receive it, but when the device **11** moves in the opposite direction the springs slip over the yarn.

At the crimping station the yarn is received and gripped between the surface of two endless bands **15***a*, **15***b* travelling over rollers of which only one pair **16***a*, **16***b* is

shown. The linear rate of travel of the bands is less than the speed at which the device **11** advances towards the crimping station, and indeed is less than the mean speed at which the yarn is drawn off its supply. As a result, on the advance of the device **11** (until the springs **14***a*, **14***b* nearly touch the bands) the yarn is folded at the crimping station into a sinuous form and in this form it is gripped between and held by the bands **15***a*, **15***b*. As the device **11** returns, the yarn is held by the bands and the device slips back over the yarn to an extent providing, beyond the delivery end of the device, adequate yarn to form the next fold upon the next advance of the device.

While it is thus held in its crimped or sinuous form the yarn is set; that is to say it is heated (preferably to a temperature above the boiling point of water) and is permitted to cool. For this purpose the bands **15***a*, **15***b* may be made of metal and may themselves be heated, for example electrically, by steam, hot air, infra-red radiation, or dielectric heating means. The yarn may be cooled following the heating.

It will be appreciated that the amplitude of the crimps or folds formed in the yarn **10** will be related to the length of stroke of the device **11**; the pitch of the crimps will depend on the relation between the speed of vibration of the device **11** and the speed of the bands **15***a*, **15***b*. By varying these factors, changes in the crimped form and hence in the characteristics of the resultant stretch yarn can be made.

It will be appreciated that the end of the tube **12** is tapered and the springs **14***a*, **14***b* given the shape shown in Figure 3 in order that the delivery end of the device **11** may fit closely into the nip between the bands. The device **11** may be vibrated by any suitable means, for example electromagntically or mechanically. An economic rate of production may call for supersonic vibration frequencies which can be provided by electromagnetic or magnetostrictive or any other means of generating supersonic frequencies. The axis of the bore **13** and the line along which the device is vibrated may be inclined at a slight angle to the nip of the bands **15***a*, **15***b* but disposed in the same plane as the nip to ensure correct folding of the yarn. It may be advisable to reduce the rigidity of the yarn to enable it to take up the folded form more easily, for example by heating it as it is fed to or through the device **11**.

It is not necessary to provide a separate pair of take-off bands such as **15***a*, **15***b* for each vibrating device **11** and for each yarn being processed. A number of vibrating devices may be operated side by side or constructed as a single unit each feeding its yarn to a common pair of take-off bands. This enables a plurality of crimped yarns each drawn from its own supply package to be processed side by side.

In the modified apparatus shown in Figures 4 to 10 the aforesaid tube **12** is dispensed with and is substituted by an upright **17** (see particularly Figures 4, 5 and 6) made of stout spring material and having a guide hole **18** for the yarn. As shown in Figure 6 the hole **18** is conveniently provided at the root end of a slot **19** which opens into a side of the upright **17** to facilitate threading up, the yarn being first passed laterally along the slot **19** into the hole **18** and then passed laterally between the leaf springs **14***a*, **14***b*. The ends of these leaf springs are rounded as shown in Figure 7 to facilitate threading up. The leaf springs **14***a*, **14***b* (see particularly Figures 5 and 7) are attached to the upright **17** above and below the hole **18**, and the upright **17** (Figure 4) is supported by the attachment of its lower end to the base **20'** of a vibrator **20** which is of electromagnetic, magnetostrictive or any other known type. The operating arm **21** of the vibrator **20** is connected to an intermediate part of the upright **17** so as to effect reciprocatory flexings of it about its attachment to the vibrator base **20'** and thereby

imparting the required yarn feeding vibrations to the leaf springs **14***a*, **14***b*.

Figure 8 shows how the vibrator feed means can form part of a crimping unit **40**. In this unit **40**, a lower support structure **22** for the lower endless band **15***b* also supports lower heating means **23***a* (adjacent the crimping station to set the yarn) and lower cooling means **24***a* with inlet and outlet **25***a*, **26***a* for cold water (remote from the crimping station to cool the set yarn). The upper endless band **15***a*, upper heating means **23** (adjacent the crimping station to set the yarn), and upper cooling means **24** with inlet and outlet **25**, **26** for cold water (remote from the crimping station to cool the set yarn) are supported by an upper support structure **27** of said unit **40**. This upper support structure **27** is hinged to the lower support structure **22** at a location **41** remote from the crimping station and consequently it can be swung upwardly with its supported parts to allow for threading up.

The lower endless band **15***b* travels over pairs of rollers **27**, **27***a* and **27***b*, **27***c* which are spaced to accommodate the lower heating and cooling means **23***a*, **24***a*. Similarly the upper endless band **15***a* travels over pairs of rollers **28**, **28***a*, and **28***b*, **28***c* which are spaced to accommodate the upper heating and cooling means **23**, **24**. The lower endless band **15***b* is driven through the intermediary of a sprocket chain **28**, end sprocket wheels **29**, and an intermediate sprocket wheel **30**, and the upper endless band **15***a* is driven through the intermediary of these means and end inter-meshing pinions **31**, **32**, **33**, **34** which engage and disengage upon displacement of the upper support structure **27** for threading up. The intermediate sprocket wheel **30** is driven by belt **31** and small pulley **31***a* from a suitable source of power such that the linear speed of the endless bands and consequently of the crimped yarn is less than the rate at which the yarn is fed to them. There may be entry and exit guide plates **34**, **35** in the unit **40** leading to and from the endless bands and each having a groove for the yarn.

Conveniently the apparatus is disposed in substantially upright manner as shown in Figures 9 and 10 from which it will be seen that the yarn passes upwardly from a supply **32**, through a guide **38** and the crimping unit **40** and then through a guide **39** up to take off means **33**. An electric motor **36** is provided to drive the belt **31** and there is a belt and pulley transmission **37** from this motor to the take up means.

In this example a number of the crimping units **40** are disposed in side by side spaced positions and sharing a common hinge pin **42** and take off means.

I claim:

1. A method of manufacturing synthetic fiber yarn of the "stretch" type which comprises feeding a thermoplastic yarn to a crimping station at a repetitiously-fluctuating linear speed, receiving the yarn and continuing its travel beyond the station at a speed less than the mean linear speed so that the yarn adopts a crimped form at the crimping station and its continuing travel is in crimped form, and setting the yarn in that form.

2. A method of manufacturing a synthetic fiber yarn of the "stretch" type which comprises crimping a thermoplastic yarn by feeding it to a crimping station through a vibrating device, receiving the crimped yarn at the crimping station and continuing the travel of the yarn in crimped form, and setting the yarn in that form.

3. A method according to claim 1 wherein the setting is effected by heat treatment applied to the yarn as it leaves the crimping station.

4. A method according to claim 2 wherein the yarn, as it leaves the crimping station, is gripped between travelling surfaces and heated while so gripped.

5. A method according to claim 4 wherein the yarn is cooled following the heating while still gripped by the travelling surfaces.

6. A method of manufacturing synthetic fiber yarn of the "stretch" type, which comprises crimping a thermo-

plastic yarn by feeding it, at a repetitiously-fluctuating speed by means of a vibrating feeding device, between a pair of co-operating travelling surfaces which receive the crimped yarn from said device and hold it in its crimped form, and setting the yarn in that form by heat treatment.

7. Apparatus for producing a crimped thermoplastic yarn, comprising yarn feed means for feeding the thermoplastic yarn to a crimping station at a repetitiously-fluctuating linear speed, yarn conveying means for receiving the yarn and continuing its travel beyond the station at a speed less than the mean linear speed of the yarn so that the yarn adopts a crimped form at the crimping station and its continued travel is in crimped form, and heating means for heat treating the travelling crimped yarn to set it in that form.

8. Apparatus for producing a crimped thermoplastic yarn comprising means for crimping the thermoplastic yarn which includes a vibrating device for feeding the yarn to a crimping station, conveying means for receiving the crimped yarn at the crimping station and continuing its travel in crimped form, and heating means for heat treating the travelling crimped yarn to set it in that form.

9. Apparatus according to claim 7 wherein the conveying means are endless travelling bands.

10. Apparatus according to claim 9, having the heating means and cooling means associated with said endless travelling bands.

11. Apparatus according to claim 8, wherein the vibrating device is of reciprocating resilient form to grip the yarn in a feed stroke and slip on the yarn in a return stroke.

12. Apparatus according to claim 11, wherein the vibrating device comprises a pair of leaf springs disposed substantially in V-formation, with the apex directed towards the conveying means, and a vibratory member carrying the springs.

13. Apparatus for producing a crimped thermoplastic yarn comprising means for crimping the thermoplastic yarn which means includes a vibrating device for feeding the yarn at a repetitiously-fluctuating linear speed to a crimping station, co-operating endless travelling bands for receiving the crimped yarn between them at the crimping station and for holding it in crimped form while continuing its travel, and means for heat setting the yarn in crimped form.

14. Apparatus for producing a crimped thermoplastic yarn comprising means for crimping the thermoplastic yarn which means includes a vibrating device, having means for gripping the yarn on a feed stroke and for slipping on the yarn in a return stroke, for feeding the yarn at a repetitiously-fluctuating speed to a crimping station, means for vibrating said device to make feed strokes towards and return strokes away from the crimping station, yarn conveying and gripping means for receiving and gripping the crimped yarn at the crimping station and for holding it in crimped form while carrying it beyond the crimping station, and means for heat setting the yarn in crimped form.

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