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G. M. KARNS

2,223,914

THREAD PRODUCTION

Filed May 24, 1938

FIG. 1.

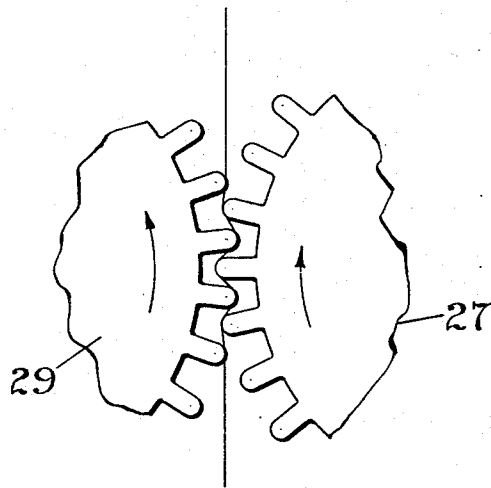
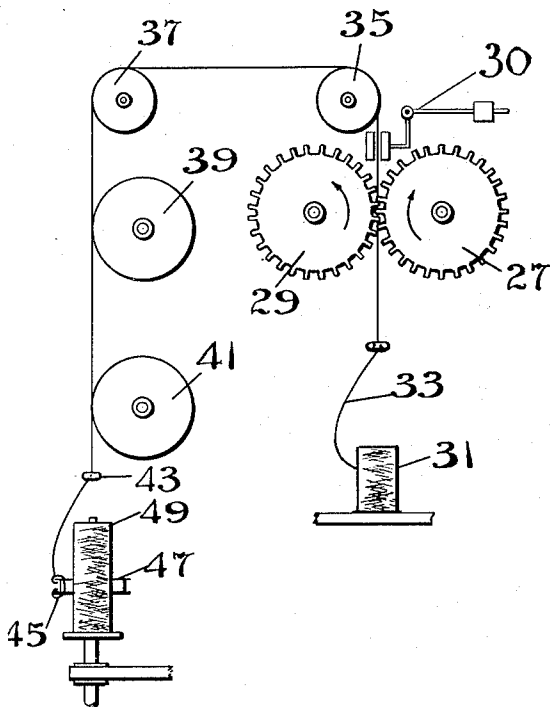


FIG. 3.

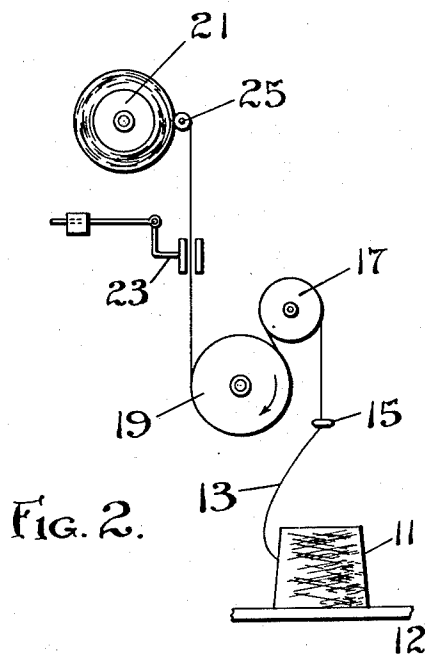


FIG. 2.

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2,223,914

THREAD PRODUCTION

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Application May 24, 1938, Serial No. 209,699

4 Claims. (Cl. 242-147)

The present invention relates to thread production and more particularly it relates to a thread tensioning device which will greatly diminish the intensity of tension fluctuations in a thread during a winding operation.

In winding thread it is desirable to maintain the tension at a reasonably uniform and low level because excessive tension for even a very short time will stretch a thread beyond its elastic limit over a short length to produce a "shiner." A shiner in a thread is evidenced by a higher luster than is present in the adjacent sections of the thread, and threads containing shiners are unsatisfactory for use as the weft or filler thread in certain types of fabrics, since they will be clearly visible in the finished product. It has also been observed that large fluctuations in tension are very undesirable in the cold drawing of superpolymer threads of the type described in patents to W. H. Carothers, Nos. 2,071,250 and 2,071,251.

Unless the tension on the thread is quite uniform up to the time it is cold drawn, the thread will be found to be of quite non-uniform denier after the drawing operation.

Under certain conditions, for instance in the winding of thread from processed bucket cakes of rayon and similar packages, it has been found that there is a very considerable fluctuation in tension imparted to the thread, by what are variously known as plucks, tugs or jerks, as it is being drawn from the processed package. Even though the actual magnitude of the tensions necessary to draw the thread from the cakes may be small, these wide fluctuations in tension on the thread are very undesirable because the fluctuations may be increased proportionally later in the winding operation. This proportionate increase in tension takes place on cone winding devices now on the open market which are provided with either a conventional washboard type or finger type tensioning device. The tension imparted to the thread by such tensioning devices is due to angular snubbing; that is, the tension is developed by causing the thread to deviate from a straight line by interposing surfaces over which it must slide.

When a processed package of thread is unwound on such a machine, the tension required to remove the thread from the package is multiplied by a factor which varies exponentially with the angularity of the snubbing in accordance with the following formula:

$$T_1 = T_2 (e^{Kr})$$

In the equation, T_1 is the tension on the thread

after it leaves the last element of the tensioning or guiding devices; T_2 is the tension on the thread after it is drawn from the cake and as it approaches the first element of the tensioning or guiding devices; e is the base of the natural logarithms; the constant K is the coefficient of kinetic friction of the thread on the surfaces over which the thread is being drawn, as determined by the method described by Sellars, "Textile World," December 1934, page 78 (approximately 0.35 for viscose rayon on porcelain or steel for the range of speeds generally used); and r is the total snubbing angularity of the thread in radians, as determined by adding together all the arcs of contact of the thread with the snubbing surfaces.

It is evident therefore that, even though the largest tension required to draw thread from the cake may be small in actual magnitude, and even though the difference in magnitude between the highest and lowest tension during winding may likewise be small, when these tensions are multiplied by the use of an angular tensioning device, as described, they become great in magnitude, because the percentage variations (amounting to 1000% or even more) are not changed when the tensions are multiplied.

Since the tension necessary to draw the thread from bucket cakes of rayon, or the like, varies from about 1 or 2 grams to 10 or 15 grams or more, it will be readily apparent that the use of a washboard tensioning device which, in combination with the necessary directional guides, offers a total snubbing angularity in the neighborhood of 500°, will at times produce an extremely high tension on the thread at the point where it is being wound. For example, applying these data in the formula given above, we find that a change in tension from 2 grams to 10 grams at the cake will cause a change in tension at the point where the thread is being wound from 42 grams to about 210 grams. Since the application of this high tension is of extremely short duration (about 0.02 of a second), the thread is not broken, but is stretched beyond its elastic limit over a short length and a shiner is produced in the thread. Obviously, if the pull were still greater, or were of a longer duration, the thread would be broken.

It is evident, therefore, that if a satisfactory yarn product is to be obtained, the windup tension must be of the proper magnitude and must not be subjected to large percentage variations. In certain cases where the average tension and the percentage variation in tension are not too

great, the percentage variation in tension may be brought within a reasonable figure by the use of an additive tensioning device. However, in many cases the average tension is so great and the percentage variation is so high that the use of additive tension alone is insufficient.

It is, therefore, an object of the present invention to provide a thread tensioning device which will impart a more uniform tension to the thread.

It is a further object of this invention to provide a thread tensioning device which will greatly diminish the tension fluctuations necessarily occurring when the thread is withdrawn from the package being unwound.

It is a still further object of this invention to provide a thread tensioning device for imparting a uniform tension to the thread, even though the thread has varying tensions imparted to it from the package being unwound.

Other objects of the invention will appear hereinafter.

The objects of the invention may be accomplished, in general, by passing the thread about an element rotating somewhat faster than the linear speed of the thread and then passing the same through an additive tensioning device.

The details of the invention will be more readily understood by reference to the following detailed description taken in connection with the accompanying illustration in which:

Figure 1 is a side elevational view of portions of two cooperating, synchronized, rotating elements between which the thread passes.

Figure 2 is a diagrammatic, side elevational view showing a thread tensioning device according to the present invention applied to a thread passing from a bucket cake to a spindle.

Figure 3 is a diagrammatic, side elevational view showing a thread tensioning device of the present invention applied to a superpolymer thread passing from a package to a bobbin and being cold drawn therebetween.

Referring to the drawing, reference numeral 11 designates a processed and dried bucket cake of rayon thread supported on a base member 12 of a coning machine. The thread 13 is drawn from the bucket cake 11 and passed upwardly through a guide 15, then over a freely rotatable roller 17, and from there around a positively driven roller 19. The positively driven roller 19 is rotated in the direction of the passage of the thread, but has a peripheral speed in excess of the linear speed of the thread, the latter being determined by the rotational speed of cone 21.

Inasmuch as any tension on the thread after it reaches roller 19 is reduced, as hereinafter described, to a definite fraction of that tension as it passes around the roller, the magnitude of the fluctuating tensions and the difference between the extremes of tension due to fluctuation are correspondingly reduced. When an additive tension is now applied to the thread by means of a pinching tensioning device or the like, 23, the fluctuations become a small percentage of the total tension on the thread and large percentage variations in tension on the thread from thereon are avoided. The pinching tensioning device may be of the type described and claimed in the copending application of Guenther Serial No. 209,653, filed May 24, 1938, or it may be of the well known spring pressed double disc type, or, as illustrated, it may consist of two cooperating elements pressed together by means of a weight.

By the term "additive tensioning device" as used throughout the specification and claims is

meant a device which will impart to a thread leaving the device a tension which will be substantially independent of the tension on the thread as it approaches the device. "Additive tension" is the tension imparted to the thread by such a device.

The reduction in the magnitude of the fluctuating tensions upon passing about the rotating roller is accomplished in the following manner. Due to the fact that the positively driven roller 19 operates at a peripheral speed in excess of the linear speed of the thread, a frictional drag is imparted to the thread and the final tension on the thread after it passes from the rotating roller 19 will be greatly reduced in accordance with the physical laws governing the frictional resistance of a thread against a cylinder about which it passes, as shown in the formula:

$$T_2 = \frac{T_1}{e^{Kr}}$$

in which T_2 is equal to the tension on the thread after it has passed from the roller 19, T_1 is the tension on the thread between the cake and the roller 19, e is the base of the natural logarithms, K is the kinetic frictional coefficient between the thread and the roller (0.35 for viscose rayon on porcelain or steel), and r is equal to the angular contact of the thread with the roller 19 expressed in radians. The angular contact of the thread with the roller 19 as illustrated in Figure 2 is approximately 210° , or about 3.66 radians. Assuming that tension irregularities are such that T_1 varies from 2 to 20 grams, a variation of 900%, the tension on the thread as it passes from the roller 19 will vary from 0.55 gram to 5.55 grams. Now adding thereto an additive tension of say 15 grams which will be imparted by the pinching tensioning device 23, the tension on the thread immediately above the tensioning device 23 will be 15.55, with a 2 gram tension at the cake, and a tension of 20.55 grams with a 20 gram tension at the cake, or a variation of 32%. The tension on the thread will be subsequently multiplied in accordance with the above-mentioned formula $T_1 = T_2 (e^{Kr})$ by the snubbing angularity as the thread passes over the button guide 25, thus imparting a tension at the cone (assuming the snubbing angularity of the button guide 25 to be approximately 180°) of 46.6 grams with a 2 gram tension at the cake and 61.6 grams with a 20 gram tension at the cake. It will thus be seen that the tension fluctuation at the cone is still only 32%.

If desired, a still greater diminishing of the tension can be accomplished by employing a plurality of positively rotating wheels 19, each of which rotates at a peripheral speed greater than the linear speed of the thread, due to the fact that the angular drag on the thread by the rotation of the rollers will be much larger.

In place of one or more rollers or wheels, the same results can be accomplished by means of a pair of tooth wheels as illustrated in Figure 1 of the drawing.

In this case, the two rotating tooth wheels 27 and 29, are driven synchronously. The teeth are preferably provided with rounded edges so as to prevent any degradation of the thread and the teeth are maintained spaced from each other such a distance that they will not clamp the threads therebetween. In this modification, as in the case of the modification shown in Figure 2, the two tooth wheels 27 and 29 are driven at a speed in excess of the linear speed of the thread so as

to impart a positive pulling drag on the thread. It will be readily apparent that the two tooth wheels 27 and 29 may be made of any size so as to produce substantially any degree of angular contact of the thread desired. By making relatively large diameter wheels with a large number of teeth, an angular contact of the threads with the teeth of as much as 1000°, or more, may be obtained. In the specific arrangement as shown in Figure 1, angular contact of the threads with the teeth of about 500° will be obtained. Therefore, if the arrangement of Figure 1 were substituted for the roller 19 in Figure 2, and the tensioning member 23 were adjusted to impose a constant tension of 20 grams in addition to the tension on the thread at that point, there will be a tension relationship between T₁, the tension at the cake; T₂, the tension on the thread after it has been passed between the teeth of the two tooth wheels; T₃, the tension on the thread after it has passed the pinching tensioning device 23; and T₄, the tension on the thread after it leaves the last element of the tensioning and guiding devices, as follows:

T ₁	T ₂	T ₃	T ₄
Grams	Grams	Grams	Grams
2	0.07	20.07	60.21
10	0.35	20.35	61.05
20	0.70	20.70	62.10

Thus it will be seen that, although the tension at the cake varies to a very large extent, the tension at the windup package will remain substantially constant and uniform.

Referring to Figure 3 of the drawing, reference numeral 31 designates a package of a superpolymer thread of the type described in U. S. Patent No. 2,071,250 to W. H. Carothers. The thread 33 is drawn from the package 31 at an uneven tension which is caused by uneven wind, tucks, etc. The thread is passed upwardly between the teeth of synchronized rollers 27 and 29 of the type illustrated in Figure 1. After passing between the rollers 27 and 29, the thread is passed through a pinching tension device 30, over guide rollers 35 and 37, and thence around roller 39 about which it passes a plurality of times to prevent any slip taking place during the drawing operation between rollers 39 and 41. From the roller 39, the thread passes a plurality of turns about roller 41, thence downwardly through guide 43, and through a traveler 45, which is mounted on ring 47 of a ring twisting machine. The thread is finally wound on the bobbin 49 after being drawn and twisted. It is usually desirable in the cold drawing of superpolymer yarn to draw the thread out to approximately four times its original length and, therefore, since the thread is drawn down to one-fourth of its original denier, any considerable variation in tension between the unwinding package and the first drawing roller will produce uneven drawing and decidedly uneven denier in the thread. It is, therefore, desirable that the unevenness in tension necessary to withdraw the thread from the processed package 31 be first reduced in magnitude by means of rotating tooth wheels 27 and 29, and then uniformly tensioned by means of an additive tensioning device in the manner above described.

To produce a useful and desirable result, it is necessary that the total snubbing angularity about the rotating elements be sufficient to decrease the tension at that point by a substan-

tial amount. Also, the tension to be added by the tensioning device above the rotating cylinder or the like should be sufficiently large to overshadow the tension variation of the yarn leaving the rotating cylinder. In winding from bucket cakes of rayon, 95% of the plucks are 15 grams or less, and a few may go as high as 20 grams, which represents a variation of 1400 to 1900% from the low tension level of 1 gram at which a portion of the yarn is wound. In order to obtain the best results, the rotating element should lower these tensions at least to one-half, and a constant tension should be added which amounts to at least as large a fraction of the maximum pluck as that to which the maximum pluck is reduced, namely one-half of 20, or 10 grams. Thus, we see that the percentage fluctuation between top and bottom tensions is reduced 14 to 19 fold. In order to obtain suitably uniform results, it is desirable that the percentage variation in tension of the thread at the point where it is wound on the core be reduced to at least $\frac{1}{10}$ of the percentage variation in tension at the cake.

It should be noted that in its preferred form this invention comprises the mounting of the positively driven roller or rollers so that should the thread break, and the tension drop to zero, the thread will not be wound around one or more of the positively driven wheels or rollers and thereby necessitate the subsequent cutting off or otherwise removing the thread as waste.

The positively driven rollers such as 19 in Figure 2, or 27 and 29 in Figures 1 and 3, may be driven in any suitable manner, such as, for instance, by an independent electrical motor or by pulleys and belts, by chains and sprockets, gears or the like connected to a suitable constant or variable speed shaft. When using tooth wheels such as 27 and 29, it is necessary to synchronize the same so that the teeth from one of the wheels will make no contact with the teeth of the other. It is necessary only that the peripheral speed of these wheels be somewhat higher than the linear speed of the thread.

It is obvious that many changes and modifications may be made in the above details of the invention without departing from the nature and spirit thereof. It is, therefore, to be understood that the invention is not to be limited except as set forth in the appended claims.

I claim:

1. In a thread tensioning mechanism, two synchronously rotated toothed members adapted to engage a thread passing between said members, the teeth of said members intermeshing without contact in spaced relationship from each other and having an angular frictional contact with said thread permitting sliding engagement therewith, said toothed members having a peripheral speed in the direction of movement of said thread at the line of contact therewith exceeding the linear speed of said thread.

2. In a thread tensioning mechanism, two synchronously rotated toothed members adapted to engage a thread passing between said members, the teeth of said members having rounded edges, said teeth intermeshing without contact in spaced relationship from each other and having an angular frictional contact with said thread permitting sliding engagement therewith, said toothed members having a peripheral speed in the direction of movement of said thread at the line of contact therewith exceeding the linear speed of said thread.

3. In a thread tensioning mechanism, two syn-
chronously rotated toothed members adapted to
engage a thread passing between said members,
the teeth of said members intermeshing with-
out contact in spaced relationship from each
other and having an angular frictional contact
with said thread permitting sliding engagement
therewith, said toothed members having a pe-
ripheral speed in the direction of movement of
said thread at the line of contact therewith
exceeding the linear speed of said thread, and
an additive tensioning device positioned adjacent
said toothed members in such a manner that
the thread will pass from the toothed members
through said additive tensioning device.

4. In a thread tensioning mechanism, two syn-
chronously rotated toothed members adapted to
engage a thread passing between said members,
the teeth of said members intermeshing with-

out contact in spaced relationship from each
other and having an angular frictional contact
with said thread permitting sliding engagement
therewith, said toothed members having a pe-
ripheral speed in the direction of movement of
said thread at the line of contact therewith
exceeding the linear speed of said thread, the
teeth of said intermeshing members having suf-
ficient angular contact with the thread to lower
the tension thereon at least to one-half the ten-
sion on the thread immediately before contact
with said intermeshing members, and means to
supply an additive tension which amounts to at
least as large a fraction of the maximum ten-
sion on the thread prior to its engagement with
said intermeshing members as that to which this
maximum tension is reduced.

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