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R. D. McCROSKY

2,767,429

SNUBBING PIN FOR DRAWING YARN

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Fig. 1.

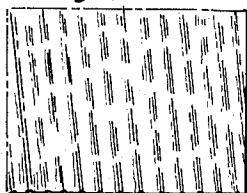


Fig. 2.

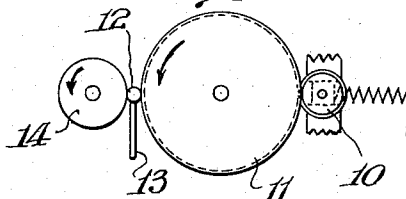


Fig. 3.

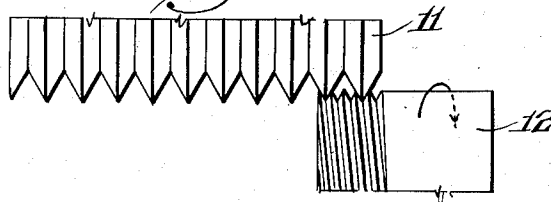


Fig. 1A

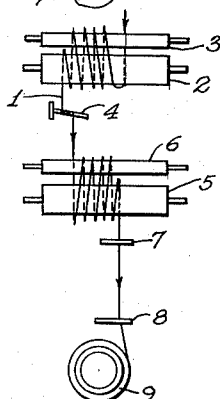


Fig. 4.

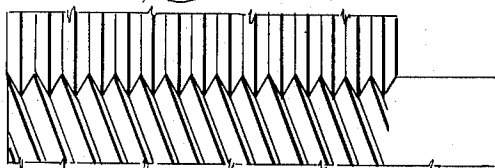


Fig. 5.

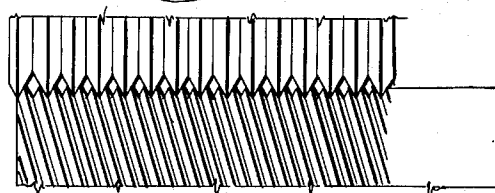
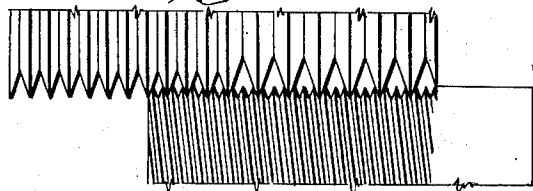


Fig. 6.



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SNUBBING PIN FOR DRAWING YARN

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6 Claims. (Cl. 18—8)

This invention relates to improved snubbing pins for use in drawing artificial filaments, and is more particularly concerned with snubbing pins having improved surface characteristics and methods for producing them.

Linear polymers can be formed directly into filaments from the molten state and the filaments so formed are capable of being drawn, i. e., permanently elongated, in the solid state by application of stress, into filaments exhibiting upon X-ray examination crystallite orientation along the fiber axis. These drawn and oriented filaments possess certain characteristics, not possessed by the filaments previous to drawing, which adapt them to a wide range of utility in the textile field.

In U. S. Patent No. 2,289,232, D. F. Babcock teaches how cold drawing of yarn may be conducted to obtain extremely uniform characteristics when using cold draw-able yarns which normally neck down at the draw point under sufficient tension. He obtains this end by interposing, between the feeding roll and the drawing roll in the drawing machine, a snubbing pin having a diameter up to one-half inch, and preferably a diameter one-eighth to one-fourth inch, to prevent wandering of the draw point. Suitable snubbing pins are disclosed as having a moderately smooth surface. A variety of materials are disclosed as satisfactory, agate being preferred because of its abrasion resistance, and because surfaces having the desired degree of smoothness can be obtained more readily and the yarn is not as likely to become damaged.

It has become desirable to process yarn at higher and higher speeds. Excessive breakage of filaments occurs when attempts are made to draw most artificial filaments at speeds above 500 yards per minute in accordance with the above disclosure. It might be expected, especially in view of this teaching of the patent, that breakage would be reduced by making the snubbing pins as smooth as possible. Surprisingly, it has now been found that greatly improved performance results from roughening the surface in a special and critical manner. It has also been found that a suitable rough surface makes possible much wider latitude in selection of pin diameters and choice of materials for optimum results. Rough surfaces in general do not achieve this result; only a particular rough surface produced in a particular way has been found to give the desirable results which will be discussed hereinafter. Roughened surfaces produced by a variety of lapping, tumbling, abrasive-blasting, and polishing methods have accomplished no improvement.

It is an object of this invention to provide a snubbing pin which will make possible the production of higher quality textile yarn in drawing operations. It is a further object of this invention to provide a surface on the snubbing pin which will not cause individual filaments to break out of a yarn bundle nor the whole yarn bundle to break during drawing of yarns. It is a still further object of this invention to provide a surface on a snubbing pin which will permit the drawing of yarns and bundles of filaments at markedly increased rates of speed

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without deterioration in either yarn quality or in the operating performance of the drawing operation. It is likewise an object of this invention to provide a means for producing such surfaces on snubbing pins time and time again within relatively narrow limits of variation. Other objects will appear hereinafter.

In accordance with this invention the above objectives are accomplished by grinding a thread-like pattern of fine ridges into the surface of the wear-resistant snubbing pins used for drawing artificial filaments. Since the useful range of thread-ground surface is a fineness of from 50 to 500 threads or ridges per inch, special grinding methods are provided by this invention to produce them rapidly and economically, and to reproduce the surface repeatedly with a high degree of uniformity. The process is most readily understood with reference to the drawings.

In the drawings, which illustrate preferred embodiments of the invention,

Figure 1 is a fragmentary and greatly enlarged view of the surface of a snubbing surface in accordance with one representation of this invention,

Figure 1A is a schematic representation of apparatus utilizing the snubbing surface of Figure 1 according to this invention in the form of a cylindrical pin,

Figure 2 is a diagrammatic side elevation of centerless grinder being used for applying a surface according to this invention to a snubbing pin,

Figure 3 is an enlarged plan view of part of the grinding operation of Figure 2, showing adjacent surfaces of the grinding wheel and snubbing pin,

Figure 4 is a plan view corresponding to Figure 3 showing a modification of the operation,

Figures 5 and 6 show still further modifications of the operation shown in Figure 3.

As stated above, a smooth surface for the snubbing pin is not effective for producing high quality yarns at high speeds with a minimum of operating difficulty. On the other hand, neither do any of the ordinary types of rough surfaces meet the needs of the industry. Only a particular type of snubbing pin surface produced in a particular way has been found to give highly desirable results. The optimum surface of the snubbing pin has been found to be ridges or threads of the general character of a rough thread-ground surface, as shown greatly enlarged in Figure 1.

Utilization of such a surface on a snubbing pin according to this invention is shown schematically in Figure 1A. Yarn 1 in drawable condition passes from a source of supply (not shown) helically about driven feed roll 2 and separating roll 3 and then onto and about snubbing pin 4. The yarn describes a helical path about the snubbing pin, being supported primarily on the surface ridges (not reproduced in this view). The yarn then passes on about driven draw roll 5 and accompanying separating roll 6 arranged similarly to the previous set of rolls but with the draw roll rotating at a greater peripheral speed than the feed roll, thus tensioning the yarn therebetween against the snubbing pin, whereupon the yarn is drawn to increased length. The drawn yarn passes from the second set of rolls through fixed guide 7 and is traversed by movable guide 8 back and forth along the surface of package 9 onto which the yarn winds.

The useful range of surface ridges for snubbing pins of this invention falls within the limits of 50 threads per inch to 500 threads per inch, and the preferred range is from 100 to 200 threads per inch. It is to be understood that these ridged surfaces of snubbing pins need not be well formed threads as commonly understood in the language of the machinist. Actually, it is preferable that the surface roughening be merely a plurality of fine ridges in a rudimentary thread form, such that

they resemble threads only when viewed under a low-power microscope.

Various methods will now be described for producing these surfaces on snubbing pins. Referring to Figure 2, the desired number of serrations per inch (i. e., threads with a zero lead) were ground on carbide wheel 10 and transferred by crush-dressing to a grinding wheel 11. The threads were put on snubbing pin 12, supported by work rest 13, by driving the pin in a screw-like motion across the face of this serrated grinding wheel with feed wheel 14. In this operation the pin can be either parallel to the axis of the grinding wheel or inclined at a slight angle thereto.

Prior to the production of these thread ground surfaces on snubbing pins, centerless thread grinding had not been applied to grinding fine threads, since it is not practical to form threads of sufficient fineness on the grinding wheel. This invention adapts centerless grinding to produce the required fine threads. Pitches finer than the pitch of serrations on the grinding wheel are ground by using a lead that is a fraction of the grinding wheel pitch. The lead is the axial distance a single thread advances in one complete turn. For single threads it is equal to the pitch and for multiple threads it is this multiple times the pitch. The pitch is the distance between adjacent threads or serrations. By this method threads have been ground as fine as 320 per inch and finer. Previously, in centerless thread grinding, the work was ground at the same pitch as the grinding wheel and the finest pitch produced was 32 threads per inch.

The method of grinding threads with pitches finer than the pitch of the grinding wheel is illustrated in Figure 3. The draw pin 12 is advanced across the grinding wheel at a lead which is a fraction of the pitch of the serrations on the grinding wheel 11. This grinds a single thread with the pitch of the thread on the draw pin equal to the lead of the draw pin. Hence, if the grinding wheel pitch is 0.300 inch and the lead of the draw pin is $\frac{1}{3}$ of this pitch, then the pitch of the single thread ground on the draw pin is 0.100 inch. It can be seen from Figure 3 that only the first serration on a freshly dressed grinding wheel grinds the thread into the draw pins. The subsequent serrations simply follow in the threads already ground until the first serration becomes somewhat worn, when the point of the second serration will begin to do part of the work.

To be effective for the purposes of this invention, the pin surface should be such that the yarn will principally run along the tops of ridges and not run in grooves. One factor in accomplishing this is making the ridge spacing or pitch sufficiently fine, for example, as described above. Another factor which will contribute to the desired result is making the yarn run at an oblique angle to the ridges by forming the ridges with a high helix angle. This is accomplished by using a lead which is greater than the pitch of the grinding wheel and results in multiple start threads. Such high helix angle multiple start threads are ground with the centerless grinder in the manner illustrated in Figures 4 and 5. Figure 4 shows the grinding of 32 start threads of the same pitch as the pitch of the grinding wheel serrations. The lead is determined by multiplying the pitch by the number of start threads desired; the greater the number of start threads, the greater the resulting helix angle. Figure 5 shows the grinding of 67 start threads of $\frac{1}{2}$ the pitch of the grinding wheel.

Combining the two procedures described above in the manner shown in Figure 5, by grinding threads finer than the pitch of the grinding wheel and simultaneously grinding multiple start threads, a draw pin surface is produced which is eminently suitable for the purpose. The lead of the draw pin is calculated after deciding on the desired fineness and helix angle of 0.012 inch and requiring 67 start threads at $\frac{1}{2}$ this pitch, the lead to produce this result would be $(\frac{1}{2})(67)(0.012)=0.402$

inch. This formula may be expressed in general terms as follows:

$$\text{lead}=(1/n)(S)(P)$$

Where n is an integer greater than one and $1/n$ is the fraction of the grinding wheel pitch desired, S is the number of start threads and is an integer not evenly divisible by n , and P is the pitch in inches of the serrations on the grinding wheel, where n/P falls in the range of 50 to 500 per inch.

The third technique which made this thread grinding process possible was the addition of lead directing lines at the feed end of the grinding wheel to prevent the work from slipping when grinding fine pitch threads. The innovation is illustrated in Figure 6. When it was attempted to grind threads on the draw pin with a pitch finer than the pitch of the grinding wheel, the work would often slip spasmodically, so that the final result was a thread pitch equal to the pitch on the grinding wheel. This can be prevented by cutting additional serrations in the grinding wheel at the entering end. These additional serrations are offset with respect to subsequent serrations so that they form the thread or threads which would otherwise lie intermediate between the grinding wheel serrations. With this arrangement some of the teeth of the grinding wheel ride in all of the fine pitch thread valleys, and it is impossible for the work to slip. For example, when it is desired to cut threads having a 0.006 inch pitch with a 0.012 inch pitch grinding wheel, then the wheel should have at its entering end some serrations with a pitch of 0.018 inch.

In the thread-grinding procedures described above, the grinding wheel has been dressed with a regular pattern and a fairly uniform thread pattern is transferred to the pin surface. As described, the pattern on the pin surface is in the form of practically continuous ridges and grooves. However, the ridges need not be continuous. By thread-grinding at two different helix angles in independent operations on the same pin, short length ridges of an elongated diamond shape are formed in a thread-like pattern. These discontinuous ridges accomplish the desired result if the ridge portions are of sufficient length to support the yarn.

The grooves on the pin surface likewise need not be continuous. By a procedure which will be called scratch-grinding, the surface can be ground or scratched into a satisfactory, although discontinuous series of closely spaced grooves. The pin is ground slightly oversize, preferably about 0.003 inch over the desired final diameter. The grinding wheel is dressed with a flat pointed diamond, taking about a 0.003 inch cut and passing the diamond across the face of the wheel at a uniform rate to provide closely spaced threadlike serrations. The pin is now ground to the desired final diameter by a single pass across the wheel at a uniform rate of feed determined by the general considerations discussed previously. In this way the pin is ground with closely-spaced discontinuous grooves or scratches arranged in an irregular thread-like pattern. The grinding wheel should be redressed frequently to maintain the required surface. Uniformity of snubbing pin surfaces is achieved by close control of (1) flatness of the grinding wheel dressing diamond (2) rate of dressing of the grinding wheel (3) axial feed and rotary feed of the work (4) depth of dressing cut and stock removal cut and (5) coarseness of the grinding wheel. The first two factors are of major importance in that they control the gross roughness or diamond lines on the grinding wheel which are in a large part responsible for grinding the grooves in the work. The other factors control the structure of the rudimentary thread-like ridges formed between the grooves or scratches.

In the surfaces formed by the grinding methods described above, the helix angle of the ridges or threads ground on the pin surface should differ from the helix angle of the yarn wrapped on the pin so that the yarn will

not run in grooves between ridges. In the case of thread-ground pins, the angle between the yarn and the ridges should be at least 7 degrees. In the case of scratch-ground pins, the grooves are sufficiently discontinuous to cause the yarn to run principally across the tops of ridges, and the angles between the yarn and the ridges may be as low as 2°. The required angle can be provided either by the helix angle of the ridges or the way in which the yarn is wrapped, i. e., the tilt of the pin may be adjusted in use, or both. The ridges may be of the order of a few thousandths of an inch high and need only be high enough to prevent the yarn from contacting or at least pressing against the bases of the grooves. It is preferred that the ridges be polished somewhat after they are ground, e. g., using rubber polishing wheels, although this is not essential to the improved performance.

The snubbing pin may be made out of a wide variety of wear resistant materials including stainless steel, chromium plated steel, Isolantite, illium, porcelain, phenolic resin compositions, agate, alumina, sapphire and Tantung G. Preferably, it is made of Alsimag, a bonded titanium dioxide ceramic which is extremely resistant to wear, but which is easily ground by the procedures described above into a surface of the desired characteristics. The pin may be hollow, as a tube is more easily heated when hot drawing is required.

Roughened pin surfaces prepared by a variety of lap-ping, tumbling, abrasive-blasting and polishing means have shown no improvement whatsoever over the pins of the prior art, even though the gross roughness is the same as for the rough thread-ground surfaces of this invention. Accordingly, it must be understood that a mere granular roughening of the surface of the snubbing pin does not give the surprisingly beneficial results which are achieved with the surface produced by the process of this invention. On the other hand, neither do all ridged pin surfaces give the improved performance obtained with the snubbing pin surfaces of this invention, e. g., longitudinal ridges on the snubbing pin gave no improvement. It is, therefore, seen that rather specific critical limits are prescribed for the surface of the snubbing pin in order to be able to produce high quality drawn yarns at high rates of speed.

Although there appears to be no theoretical limit for the diameter of the snubbing pin, there are practical limits outside the range of which for one reason or another it is not desirable to stray. Snubbing pins within the range of 1/8 to 2" diameter may be employed. With the smaller diameters, however, it is difficult to achieve the optimum anisotropic surface of this invention. With the larger diameters there are space limitations arising from practical design considerations which militate against their use. Accordingly, it is preferred to use a pin within the diameter limits of 3/8 to 1" diameter, since these pins may be readily, accurately and reproducibly given the surface of this invention, and since they readily meet the space requirements demanded by design considerations.

The marked improvement which the snubbing pins with the ridge-ground surface of this invention lends to the cold drawing operation for polyhexamethylene adipamide yarns is strikingly illustrated in the table below. Similar advantages are obtained when drawing yarns of other synthetic linear polymers.

It is to be noted in test A that, at the same drawing speed as that employed with the smooth pins of the prior art, the pin surface of this invention gives markedly fewer breaks in the drawing operation and markedly fewer broken filaments in the drawn yarn. This means that a much higher quality nylon can be produced with a marked improvement in the economy of the operation. It is to be further noted in test B that a doubling of the drawing speed, when using the pin surface of this invention, per-

mits the production of nylon yarns at a quality level and at an operating efficiency level the same as that experienced for the pins of the prior art at less than 1/2 this drawing speed. It is also to be noted that when the pins of the prior art are used at this increased drawing speed, yarns of definitely inferior quality are obtained. Furthermore, breaks occur so often in the drawing operation with the pin surfaces of the prior art at these high speeds that the operating efficiency under these conditions is below the economic level and in some instances under these conditions, nylon yarn simply cannot be drawn. Test C illustrates another important advantage of the pin surfaces of this invention. So-called off-standard yarn, which draws poorly on the pin surfaces of the prior art, gives an excellent quality product when drawn on the pin surfaces of this invention.

Table

Test	Snubbing Pin	Dwg. Speed, yds./min.	Bks./Lb.	Lbs. in Test	Broken Filaments/1,000 Yards	Yards In Test
A-----	0.8" dia. ridged....	516	0.07	1,748	0.04	360,000
	3/16" dia. smooth....	516	0.18	1,654	0.08	360,000
B-----	0.8" dia. ridged....	894	0.40	719	0.25	324,000
	3/16" dia. smooth....	894	0.97	128	0.52	38,000
C-----	0.8" dia. ridged....	423	0.19	642	0.17	331,000
	3/16" dia. smooth....	423	0.26	784	0.27	381,000
			0.91	712	0.81	361,000

¹ In two other tests at 894 Y. P. M., yarn which drew with 0.6 and 0.8 breaks per pound on 0.8-inch ridge-ground pins would not draw on smooth pins.

Since many different embodiments of the invention may be made without departing from the spirit and scope thereof, it is to be understood that the invention is not limited by the specific illustrations except to the extent defined in the following claims.

What is claimed is:

1. Yarn-drawing apparatus comprising, in combination, a pair of yarn-tensioning members and, located therebetween, a snubbing surface characterized by substantially parallel ridges so oriented as to intersect at an appreciable acute angle yarn tensioned against said snubbing surface by said members.
2. The apparatus of claim 1 in which the snubbing surface has cylindrical form with from about 50 to about 500 essentially circumferential ridges per inch.
3. The apparatus of claim 2 in which the ridges of the snubbing surface are continuous circumferentially.
4. The apparatus of claim 3 in which the ridges intersect the yarn tensioned against the snubbing surface at an angle of at least about 7 degrees.
5. The apparatus of claim 2 in which the ridges of the snubbing surface are discontinuous circumferentially.
6. The apparatus of claim 5 in which the ridges intersect the yarn tensioned against the snubbing surface at an angle of at least about 2 degrees.

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