Nov. 27, 1956 W. MÜNCH 2,771,635

APPARATUS FOR STRETCHING FILAMENTS

Filed Feb. 13, 1952

3 Sheets-Sheet 1

Fig.1

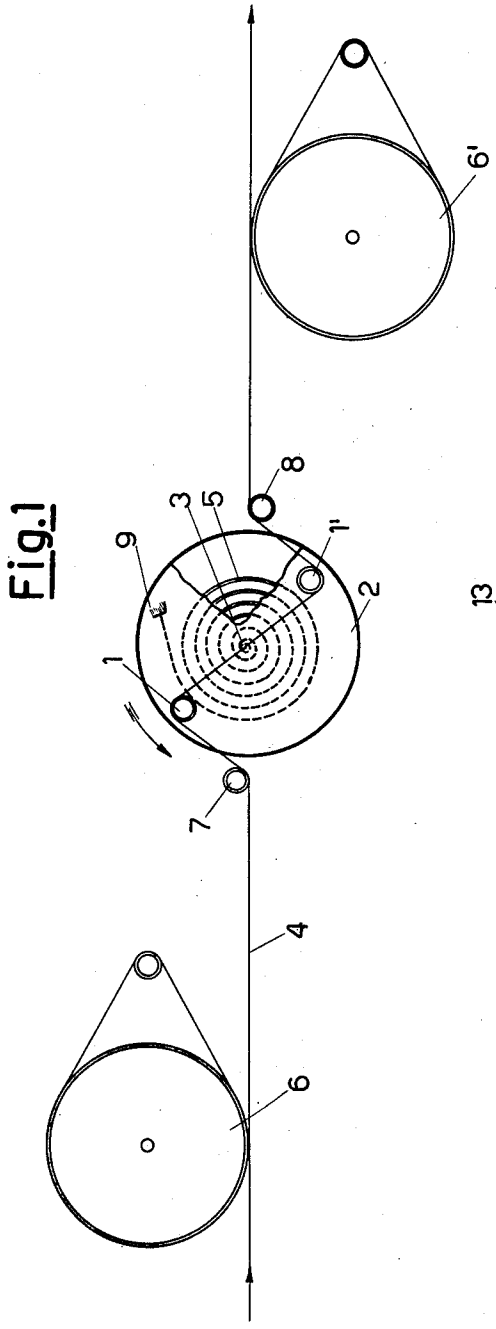
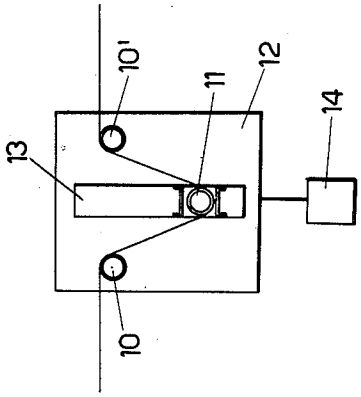


Fig.2



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3 Sheets-Sheet 2

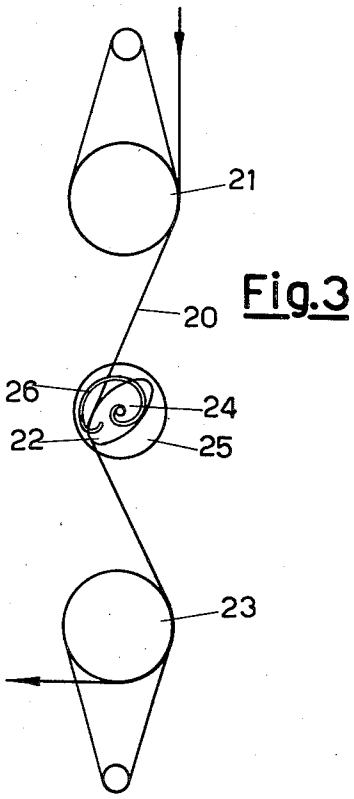
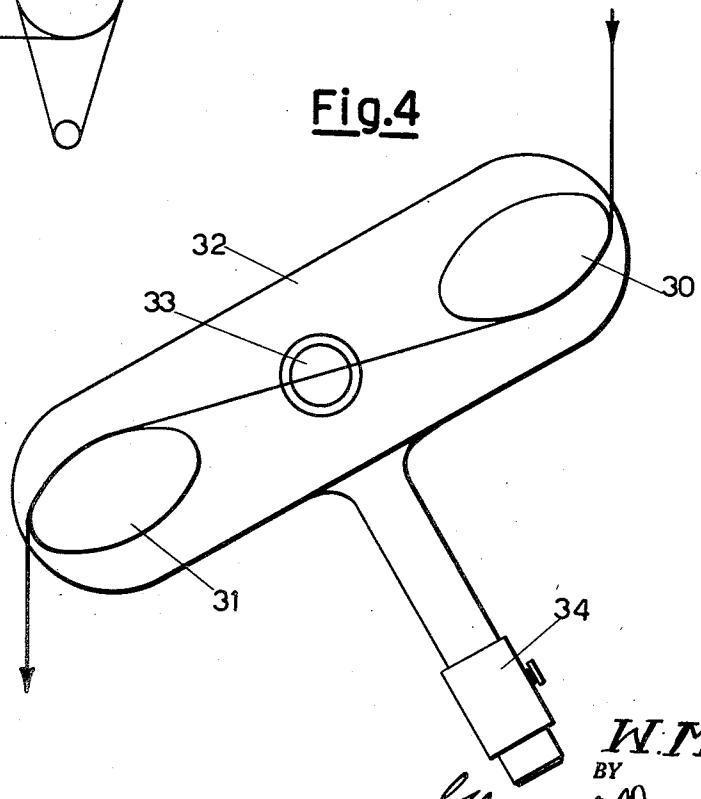


Fig.3

Fig.4



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APPARATUS FOR STRETCHING FILAMENTS

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3 Sheets-Sheet 3

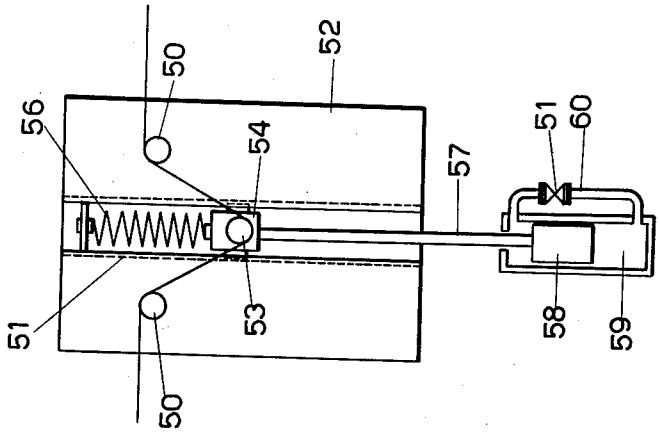

Fig. 7

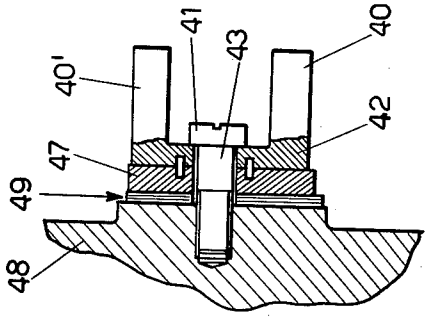

Fig. 6

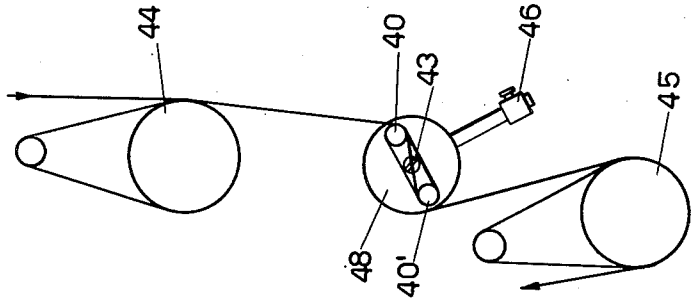

Fig. 5

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United States Patent Office 2,771,635 Patented Nov. 27, 1956

2,771,635

APPARATUS FOR STRETCHING FILAMENTS

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Application February 13, 1952, Serial No. 271,344

Claims priority, application Italy March 14, 1951

10 Claims. (Cl. 18—8)

The present invention relates to a method and an apparatus for the drawing or stretching of filaments and bundles of filaments of textile fibres, especially synthetic fibres, and particularly of those fibres which undergo a very considerable drawing or stretching, for instance to such a degree as to bring them to a length several times greater than the original length.

One example of such fibres are those made from polyamides: this invention, however, is not restricted in its application to said fibres although it has proved greatly advantageous in relation thereto.

It is known that the drawing of synthetic fibres serves to impart to them the desired mechanical properties, and particularly to increase their strength and their resistance to wear and in certain cases to decrease their elongation. The drawing operation in itself has been known for some time and can be effected in several manners. Thus, one can wrap a bundle of fibres that have just been spun about a roller or a plurality of rollers rotating with a certain peripheral speed, and subsequently wrap said bundle about a second roller or plurality of rollers rotating with a greater peripheral speed. The drawing is due to the resulting increase in the linear speed of the bundle of filaments—which is often simply called "yarn"—and the degree of stretch depends, as it is easily understood, on the ratio of the two speeds.

Experience has shown, however, that in this manner, it is not generally possible to obtain a drawn yarn with a uniformity of denier sufficient to assure the desired uniformity of characteristics of the yarn, such as for instance a uniform affinity for dyestuffs along all its length.

It is also known that in order to obtain a uniform stretching especially when the increase in length is very high, it is convenient to bring about the stretching as much as possible point by point, which can be obtained, as it is obtained for instance in certain wool spinning machines, by reducing to a minimum the free length of yarn wherein stretching occurs.

It has also been proposed, specifically with respect to the spinning of polyamides, to insert between the two systems of rollers a friction means or device to produce the desired stretch. In seeking the most suitable shape of such means it has been proposed to use a pin which does not rotate or which rotates in a direction opposite to the travel of the yarn, said yarn making one or more turns about said pin. Since the yarn is forced to slide over the periphery of the pin, it undergoes there an increase in tension due to friction which, some have stated, should have the effect of localizing the drawpoint thereby making it possible to obtain a yarn possessed of uniform characteristics.

Such a type of friction device, however, is not in fact completely satisfactory. It has been noticed that if a check is made during actual industrial operation the yarn tension in the vicinity of the drawing pin, before and after the same, it is found that such tension is not uniform even on a single machine inasmuch as some yarns

are under a stronger and others under a weaker tension; and furthermore even the tension of each individual yarn varies with time. The result of such tension variations is once again that the denier of the finished yarn is not uniform enough. It is believed that the cause of the different behaviors of the several yarns or of the several portions of a single yarn may be due to a different surface characteristic of the same, and therefore the possibility that slippages of a different amount may occur on the winding rollers or on the drawing pin itself. These difficulties cannot be eliminated by substituting for the drawing pin, equivalent friction surfaces. Therefore, the conclusion is reached that the insertion of a drawing pin or an equivalent means between two roller systems wherein the yarn has different linear speeds does not provide an entirely satisfactory drawing method. It is an object of the present invention to provide a new method for the drawing of yarns and a new apparatus for the same purpose which differ from those heretofore known in that they effect a truly uniform stretching.

In order that the essence of the invention be well understood, it is necessary to set forth certain preliminary considerations of a general nature.

When a filament or yarn slides over a friction generating surface, there arises along said filament or yarn a tension gradient. The amount of said gradient depends upon the tangential reaction of the surface on the yarn, and the amount of the total increase of the yarn tension depends upon the aforementioned gradient and upon the length of the portion of yarn which contacts the friction surface.

The tangential reaction itself depends upon the normal reaction and upon a friction coefficient which depends in turn upon several factors, and in a case like this—that is when the yarn slides along the friction surface with a speed that may be considered as substantially constant—depends mainly on the nature and structure of the contacting surfaces.

It follows that the increase in the yarn tension resulting from the sliding of the yarn over the friction surface, that is the snubbing action of the surface itself, depends essentially upon the structure of the contacting surfaces, the contact length, and the pressure exerted by the yarn on the surface. If all these factors were rigorously constant, a uniform drawing would result.

According to the present invention, there is obtained a uniform drawing by means of a device capable of exerting a certain snubbing action on the yarn and capable of reacting automatically to each variation of the tension of the same in the appropriate sense thereby to control the pressure of the yarn on the surfaces embodied in the stretching device or the length of contact between said surfaces and the yarn or the curvatures of such surfaces in the contact zones or two or more of such factors, in such a way as to maintain the snubbing action practically constant or at least to contain the variations thereof between predetermined limits. None of the existing stretching devices is capable of such an action which may be called a compensating action, inasmuch as in the known devices the length and curvature of the friction surfaces contacting the yarn are fixed and the pressure of the yarn upon the surfaces must necessarily vary in a sense opposite to the desired sense thereby increasing instead of damping the tension variations. This will be easily understood by considering that when the yarn slides over a drawing pin, if the yarn tension increases due for instance to an increase in the yarn-pin friction coefficient, the pressure of the yarn on the pin must increase as well; then the tangential reaction increases too, and in an even greater measure if the friction coefficient has increased, and therefore the increase of tension and snubbing action will be enhanced, where-

as when the same decreases all the phenomena described will be reversed and it will be the decrease that is enhanced. Variations of the yarn pin friction coefficient invariably occur in practice because the surfaces of the yarn and of the pin are not rigorously uniform, and especially because the yarn must be wetted with a lubricant, usually an emulsion of an oil and water, and it is practically impossible to apply said lubricant in an exactly uniform manner and in a constant amount to the entire length of the yarn.

It is therefore evident that the desired compensating action cannot be obtained with static rigid means generating a sliding friction, such as alone have been proposed and used heretofore.

I have therefore conceived a complex tensioning device, which may also be called snubbing or friction device, to be interposed between the two roller systems already described, said device being characterized by the fact that it or certain parts thereof are capable of becoming displaced with respect to a certain normal position when the yarn tension or the tension difference imparted to the yarn by the device itself, departs from its normal value, and that said displacements act in a compensating manner on the friction between the yarn and certain surfaces embodied in the device, that is act in a way to maintain the snubbing action close to its normal value. The device according to the invention embodies friction generating surfaces upon which the yarn slides exerting a certain pressure thereon; mounting means for said surfaces comprising parts which tend to move as a consequence of the pressure exerted by the yarn on the surfaces; and means for opposing such movement so as to maintain the device in its normal position when the yarn tension has its normal value and to allow limited or even considerable movements thereof when the tension departs from said value, said movements being such as to keep the pressure substantially to its normal value, or in the case that the contact length between yarn and friction surfaces or the curvatures of said surfaces should vary to a significant degree, to a value corresponding to substantially the same snubbing action. These last mentioned means, are termed call "loads," may belong to one or more of numerous classes; the simplest are resilient or gravity means but it is contemplated that different and even relatively complex devices may be used, such as electromagnetic devices, with which it may be possible to obtain a greater sensitivity and precision without substantial variations in the essential function of the device. In any case, the desired control will be obtained through a suitable graduation of the aforementioned means.

Some embodiments of the invention will be schematically described hereinafter merely by way of example: persons skilled in the art may effect therein any modification, variation and adaptation and may introduce therein any constructive devices that may appear suitable in each instance.

In the first embodiment schematically illustrated in Fig. 1, the friction surfaces consist of snubbing elements in the form of two rods or cylinders or equivalent bodies **1—1'** fixed on a mobile support consisting of a plate **2** pivoted at **3** onto a fixed support or frame which it has been thought unnecessary to illustrate. A spiral spring **5** located in the drawing below plate **2** (which has been shown as partly broken to uncover part of the spring) is connected at one end to plate **2** and at the other to a point **9** (schematically indicated in the drawing) of the fixed support or frame.

The invention will be better understood with reference to the appended drawings, wherein:

Fig. 1 schematically illustrates in elevational view one embodiment of the invention;

Fig. 2 illustrates schematically another embodiment of which only the friction device is shown, the thread feed and take-up cylinders being omitted;

Fig. 3 illustrates schematically a further embodiment;

Fig. 4 illustrates schematically a still further embodiment of which only the friction device is shown, the thread feed and take-up cylinders being omitted;

Fig. 5 illustrates schematically a still further embodiment;

Fig. 6 shows a sectional view of a detail of the friction device of Fig. 5; and

Fig. 7 illustrates a still further embodiment of which only the friction device is shown, the thread feed and take-up cylinders being omitted.

The yarn **4** moves from a low speed thread advancing device denoted generally **6** to a high thread advancing device **6'** and each of these devices consists of two rollers. The yarn follows a path defined by a straight line between such devices and the yarn is deflected from such path through an angle by passing under the guide or roller **7** on the path upwardly over snubbing element or rod **1**, then downwardly under snubbing element or rod **1'** and thence over roller **8** on the path. Thus, the yarn follows a substantially S-shaped path intermediate the advancing devices. Manifestly, the yarn **4** is ultimately wound about the high speed roller advancing device **6'**. Naturally, because of the greater speed of device **6'**, the yarn tends to adjust its S-shaped path and to come closer to the straight path which it may follow in one particular position of the support **2**. Thus the yarn causes a deformation of the spiral spring **5**; there is established a balance between the spring reaction and the couple due to the pressure of the yarn on the rods, which balance determines the normal position of the tensioning device. Consequently, if the yarn tension increases, its pressure on the rods will tend to increase and the spring will yield; if on the other hand the tension decreases the spring will become less deformed and will straighten out somewhat.

It can be seen that the displacements about the normal position allowed by the resiliency of the spring are such, as to correct the effects of the yarn tension variations. Actually, a yarn tension increase causes the plate **2** to rotate in the direction of the arrow and therefore renders the path of the yarn less tortuous, whereby the pressure on the rods tends to decrease and the length of contact of the yarn decreases and an excessive snubbing action is avoided, whereas a tension decrease allows the plate to rotate in the opposite direction and renders the path more tortuous, whereby the pressure on the rods tends to increase and the contact length increases and a falling of the snubbing action is prevented. If it is preferred, two or more separate springs may be used.

Many other modifications may be made in the above example. The shape and connection of the fixed and the mobile supports may be modified; weights or other mechanical or electromagnetic means may be substituted for the spring; the shape of the friction rods may be modified; briefly, any details of construction may be modified as long as the proper relationship between tension variations and yarn path variations are maintained.

Another embodiment is shown schematically in Fig. 2, where for the sake of simplicity only the tension device is illustrated. This latter comprises a support **12** rigidly connected to the frame of the machine, not shown, and having two rods **10—10'** fixed thereto.

A third rod **11** is placed between the two preceding ones, in such a position as to determine a tortuous path of the yarn to be stretched as indicated in the drawing. Rod **11** may slide with respect to support **12** in a direction which may be at a slant but is preferably perpendicular to the plane of the other two rods, as indicated in the drawing by the guide **13**. Rod **11** may differ in shape and/or material from the other two. Rod **11** is vertically loaded with a weight schematically indicated at **14** commensurate to the snubbing action desired. It is evident that even in this case to a yarn ten-

sion increase which would tend to increase the pressure on rod **11** there corresponds a less sinuous path of the yarn due to a rising of said rod, whereby an excessive snubbing action is avoided; whereas to a yarn tension decrease which would tend to decrease the pressure on rod **11** there corresponds a greater sinuosity of the path of the yarn due to a lowering of said rod, whereby an insufficient snubbing action is avoided.

An efficient regulation may also be obtained by means of snubbing surfaces having a radius of curvature that is variable from point to point. In this manner, to each displacement, whether it is rotary or more complex, of the snubbing surfaces, there corresponds a variation of the snubbing action due to the fact that points of the surfaces having different curvatures are more or less exposed to a frictional contact with different parts of the yarn. The tension of the yarn constantly tends to impart to the snubbing means, which in this case have surface curvatures which change from point to point, a position wherein their frictional resistance to the movement of the yarn is at a minimum; while suitable loads oppose to the desired degree each motion of the snubbing means in the direction above specified.

In the most frequent cases the curvature differences do not alone determine the regulation but contribute thereto. Figures 3 and 4 illustrate embodiments of the invention wherein curvature differences are exploited. In Fig. 3 the yarn **20** coming from a feed means, for instance the roller system **21**, is wound about a snubbing surface consisting of a surface of a body being preferably cylindric with a non-circular section, for example an elliptical section, as shown in **22**; the yarn makes one or more turns about said body and is then drawn away by a suitable means, for instance, a roller system **23**. The body **22**, made of any suitable substantially smooth material, is mounted in any convenient manner so that it may pivot about axis **24**, for instance, body **22** may be mounted on or be solid with a mobile support **25** of any suitable shape pivoted onto a fixed support not shown. At any rate there is a means which opposes the rotation of body **22** and of the mobile support in the sense which would be determined by the yarn tension, that is, in the drawing, counter-clockwise.

Such means may be a spiral spring **26** connected to the mobile and fixed supports, as indicated in the drawing, or other suitable means. In the position indicated in the drawing, if the yarn tension—or better the difference between the yarn tension after and before the device—decreases, the spring causes the clockwise rotation of body **22** whereby the same tends to oppose a greater resistance to the movement of the yarn and therefore to exert a stronger snubbing action, while if the tension difference increases, the spring yields a little more, body **22** rotates in a clockwise sense and the resistance which it opposes to the movement of the yarn tends to decrease.

Thus the tension and the snubbing action of the device are controlled due to the employment of a snubbing surface with a curvature variable from point to point. In the embodiment of Fig. 4, there are two rods **30—31** with a non-circular, for instance elliptical section mounted on an elongated mobile support **32** pivoted at **33** to a fixed support not shown. A counterweight **34** provides the desired load. Each variation of the yarn tension—or better of the difference between the yarn tension after and before the device—causes an angular displacement of mobile support **32**, to which there correspond rotary translational displacements of the rods **30—31** which displacements control the snubbing action of the device in the manner and according to the principles already set forth. In Fig. 4 the means for the feeding and the drawing away of the yarn, which may be of any known type, have been omitted.

It may be observed that the distance between the two rods of the device of Fig. 4 may be determined at will in the most suitable way in each case. The two rods may be so close as almost to touch each other, and then they may conveniently be formed in a single body having a central opening (hole or slit) for the passage of the yarn.

Fig. 4 illustrates a case in which the regulation is not dependent solely on the non-circular shape of bodies **30—31**, but such shape contributes thereto.

In order that the described system of regulation be effective and sensitive, the mobile means must respond to relatively small variations of the tension of the filaments or bundle of filaments and the loads must not be excessive. On the other hand it has been found that in these circumstances, when the tension changes the snubbing device does not generally pass in a gradual manner from one equilibrium position to another, but acquires an oscillatory motion each time its equilibrium is disturbed. The continuous oscillations of the snubbing device, or at least of its mobile parts, may be damped by creating resistances to the motion of the mobile parts. Such resistances, however created, are generally distinct from the loads inasmuch as these latter act even when the device is in equilibrium and in fact determine such equilibrium, while the damping resistances come into play essentially when the mobile part of the device begins to move, that is when the device passes from one to another equilibrium position. In other words, the loads exert their main influence on the equilibrium positions of the device, whereas the resistances exert their main influence on the manner in which the device changes over from one to another equilibrium position. This distinction does not imply any structural limitation, as it is possible according to the invention that a single means may furnish in part or entirely, concurrently or successively, both loads and resistances, and furthermore said distinction is not necessarily sharp as it is not ruled out that there may be an interaction between loads and resistances. The resistances may also oppose the beginning of any motion besides slowing down actual motions, as in the case of friction which, all loads being equal, decreases the sensitivity of the device, which may be harmful or advantageous depending on the circumstances.

The resistances used to oppose the motion of the mobile parts of the snubbing device, may be of any known type (sliding friction, rolling friction, hydrodynamic, electromagnetic, etc.) and operate according to different laws.

Fig. 5 shows a snubbing device substantially corresponding to that of Fig. 1 and illustrated in section on a larger scale in Fig. 6. As seen in this latter figure the two cylindrical rods **40—40′** are solid with the mobile support **42** which is reduced to a practically minimum size, so that the whole constitutes a single fork pivoted at **43**. The yarn is fed by roller system **44** and drawn away at a greater speed by roller system **45** after following a zig-zag path between rods **40—40′**; a counterweight **46** constitutes the load. A disc **47** is connected to fork **40—40′—42** and faces an element **48** which constitutes or is part of the fixed support on which the fork is pivoted. Between disc **47** and element **48** there is pressed a disc **49** made of hide or other suitable material, which rotates with disc **47** and creates the required friction when the mobile part of the device rotates about pivot **43**. To press the hide disc more or less according to the cases, any suitable mechanical means may be used. Thus, the whole mobile part of the device may be pressed more or less against the fixed support for instance by means of a screw or bolt **41** as indicated schematically in Fig. 6; or disc **47** may be axially slidable along pivot **43** and fixable at the desired distance from element **48**. The essential concept is to provide a frictional resistance between the mobile and fixed parts of the device.

The yarn passes between two fixed rods **50—50′** mounted on a fixed support **52** and a mobile rod **53** mounted on a mobile support or shoe **54** slidable in a groove **51** of the fixed support. A spring **56** opposes the motion of shoe **54** urging the same downwards. To shoe **54** there is connected through link **57** a piston **58**

reciprocable in a cylinder **59** which is closed and filled with a suitable liquid, for instance oil.

The piston could be provided with a port to allow the passage of the liquid when the piston moves and to create at the same time a hydrodynamic resistance to said passage. But it is more convenient to provide the piston with a pipe or by-pass **60** which allows of the passage of the liquid from one side to the other with respect to the piston, such by-pass being provided if desired with a valve **61** or other means for choking in a controllable manner the flow of the fluid so as to graduate the desired resistance.

Of course, the invention is not restricted to the embodiments described, as many others may be realized through the use of suitable constructional devices, without departing from the invention, or exceeding the scope of the patent.

What I claim is:

1. In an apparatus for the drawing of filaments and bundles of filaments, in combination with a low speed thread advancing device for feeding the filaments and a high speed thread advancing device for drawing the same away, the ratio of the high to the low speed being such as to cause the filaments to become stretched to several times their original length, a friction device interposed between said thread advancing devices and comprising a substantially elliptical snubbing element having a sliding frictional engagement with the filaments, said snubbing elements deflecting the filaments, at the point of engagement therewith, from a straight line between said low speed thread advancing device and said high speed thread advancing device and being displaceable to vary the degree of said deflection, the deflected filaments reacting on said displaceable snubbing element by a pressure, urging the element to become so displaced as to reduce said deflection to a minimum, and means for constantly urging said displaceable snubbing element to become so displaced as to increase said deflection against the increasing reaction pressure of the filaments until said pressure has reached a predetermined equilibrium intensity.

2. An apparatus as defined in claim 1 wherein the friction device is a pivoted support having a plurality of substantially elliptical rods fixed thereto.

3. An apparatus as defined in claim 1 wherein a spring constitutes said constantly urging means.

4. An apparatus as defined in claim 1 wherein a weight constitutes said constantly urging means.

5. In an apparatus for the drawing of filaments and bundles of filaments, in combination with a low speed thread advancing device for feeding the filaments and a high speed thread advancing device for drawing the same away, the ratio of the high to the low speed being such as to cause the filaments to become stretched to several times their original length, a friction device interposed between said thread advancing devices and comprising a mobile support and a snubbing element rigidly mounted on said support and having a sliding frictional engagement with the filaments, said snubbing element deflecting the filaments, at the point of engagement therewith, from a straight line between said low speed thread advancing device and said high speed thread advancing device and being displaceable with the support to vary the degree of said deflection, the deflected filaments reacting on said displaceable snubbing element by a pressure urging the same to become so displaced as to reduce said deflection to a minimum, actuating means operatively connected to said mobile support for urging the same to become so displaced together with said snubbing element mounted thereon as to increase said deflection against the increasing reaction pressure of the filaments, until said pressure has reached a predetermined equilibrium intensity, and means for creating a dynamic resistance to the displacements of said mobile support to prevent and dampen oscillations thereof caused by the contrasting action of said actuating means and of the reaction pressure of the filaments.

6. An apparatus as defined in claim 5 wherein a plurality of snubbing elements are rigidly mounted on said support.

7. An apparatus as defined in claim 5 wherein a friction disc operating on the mobile support constitutes said means for creating a dynamic resistance.

8. An apparatus as defined in claim 5 wherein hydraulic means operatively connected with the mobile support constitutes said means for creating a dynamic resistance.

9. An apparatus as defined in claim 5 including a fixed support to which the mobile support is pivoted, a plurality of cylindrical snubbing rods fixedly mounted on the mobile support and a fibrous disc disposed between the fixed and mobile supports constitutes the means for creating a dynamic resistance.

10. An apparatus as defined in claim 9 said actuating means comprises a counter-weight.

References Cited in the file of this patent

UNITED STATES PATENTS

1,014,980	Sykes	Jan. 16, 1912
1,981,351	Etzkorn	Nov. 20, 1934
2,289,232	Babcock	July 7, 1942
2,332,485	Hanson	Oct. 19, 1943
2,549,014	Romeyn	Apr. 17, 1951

FOREIGN PATENTS

59,397	Netherlands	May 16, 1947
371,910	Great Britain	May 2, 1932
671,781	Germany	Feb. 13, 1939