June 11, 1963 R. SCHMIDT 3,093,330

FEEDING MECHANISM FOR YARN WINDING AND PROCESSING MACHINES

Filed April 11, 1960 5 Sheets-Sheet 1

Fig. 1.

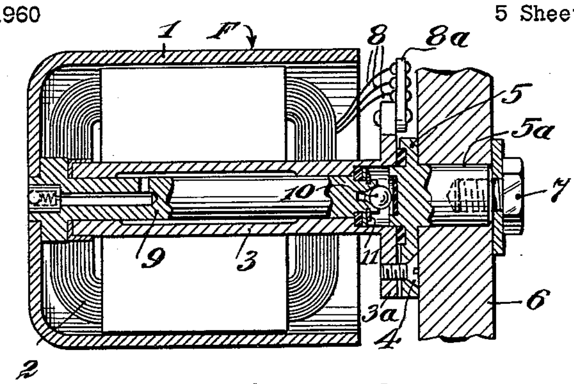
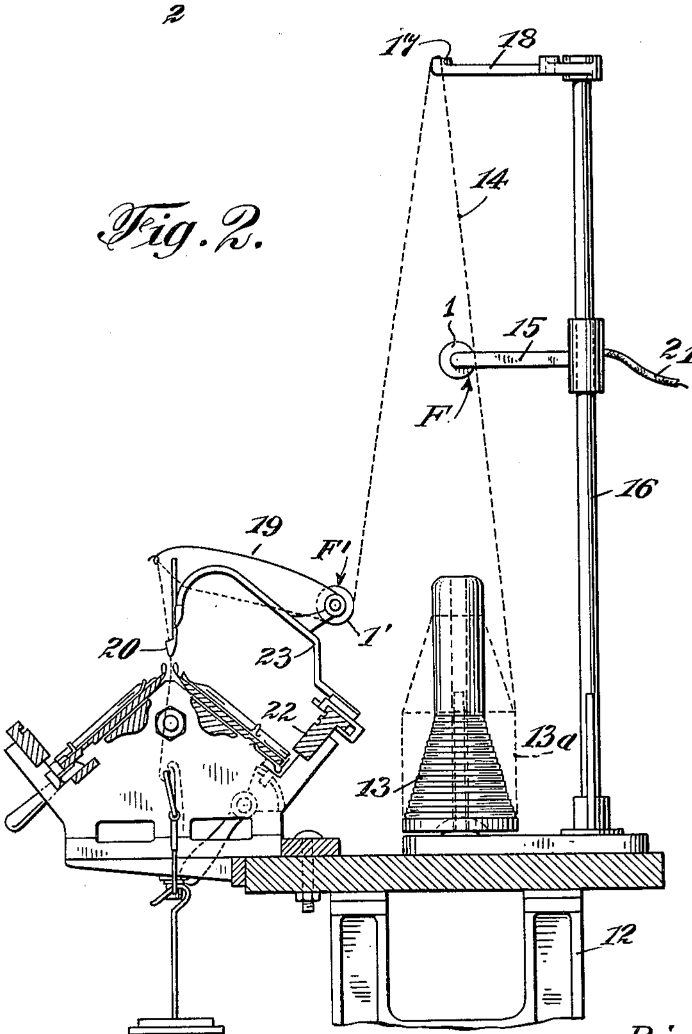


Fig. 2.



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FEEDING MECHANISM FOR YARN WINDING AND PROCESSING MACHINES

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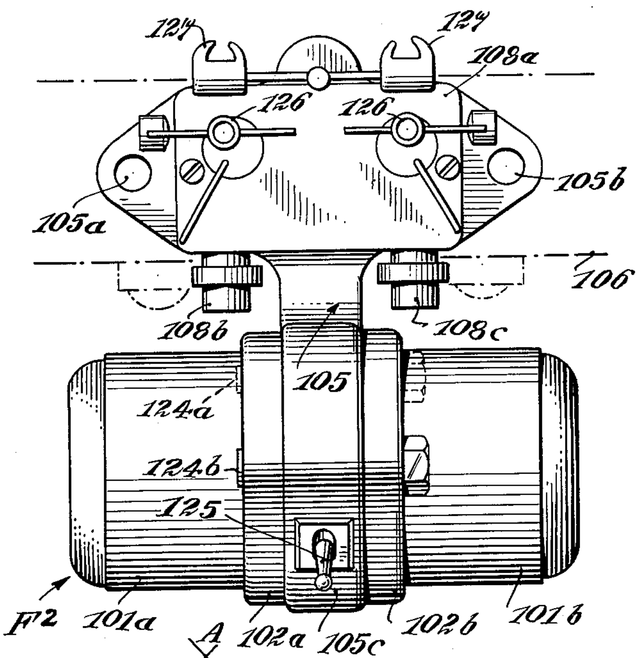

Fig. 3.

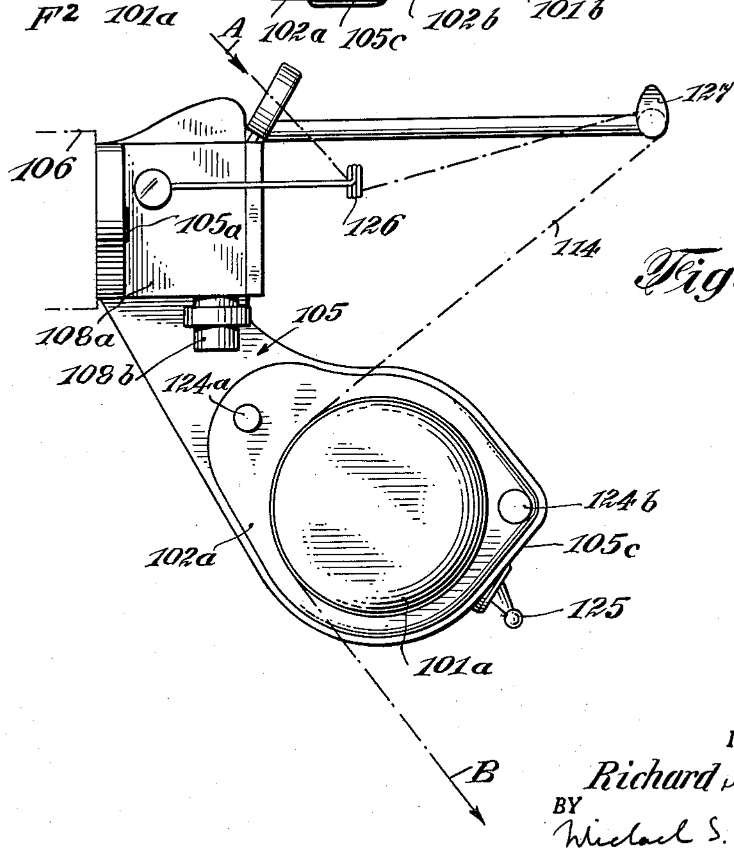

Fig. 4.

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FEEDING MECHANISM FOR YARN WINDING AND PROCESSING MACHINES

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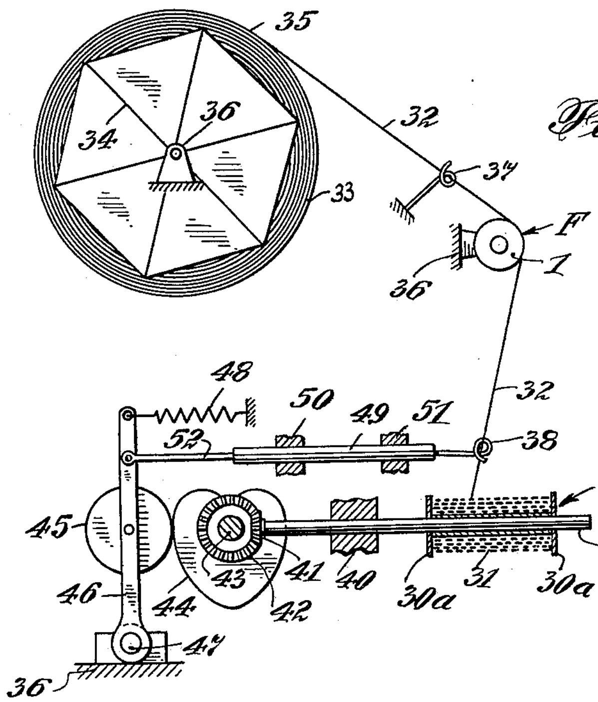

Fig. 5.

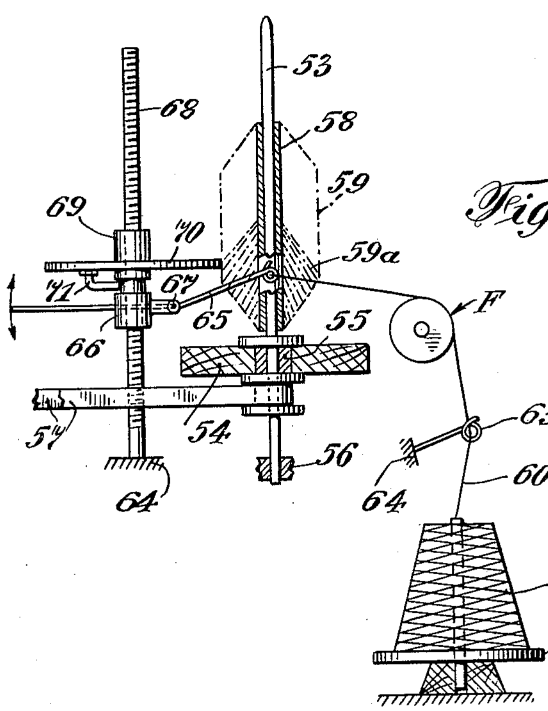

Fig. 6.

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FEEDING MECHANISM FOR YARN WINDING AND PROCESSING MACHINES

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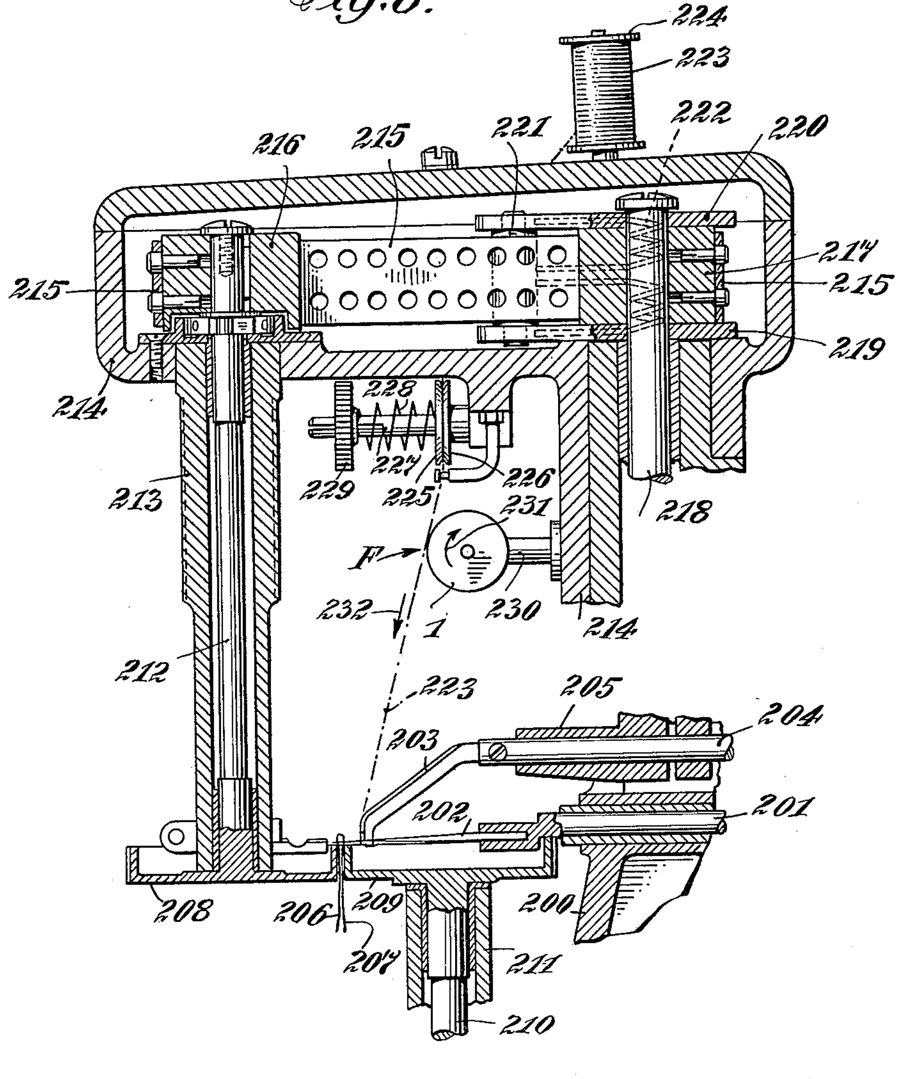
Fig. 8.



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FEEDING MECHANISM FOR YARN WINDING AND PROCESSING MACHINES

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Fig. 7.

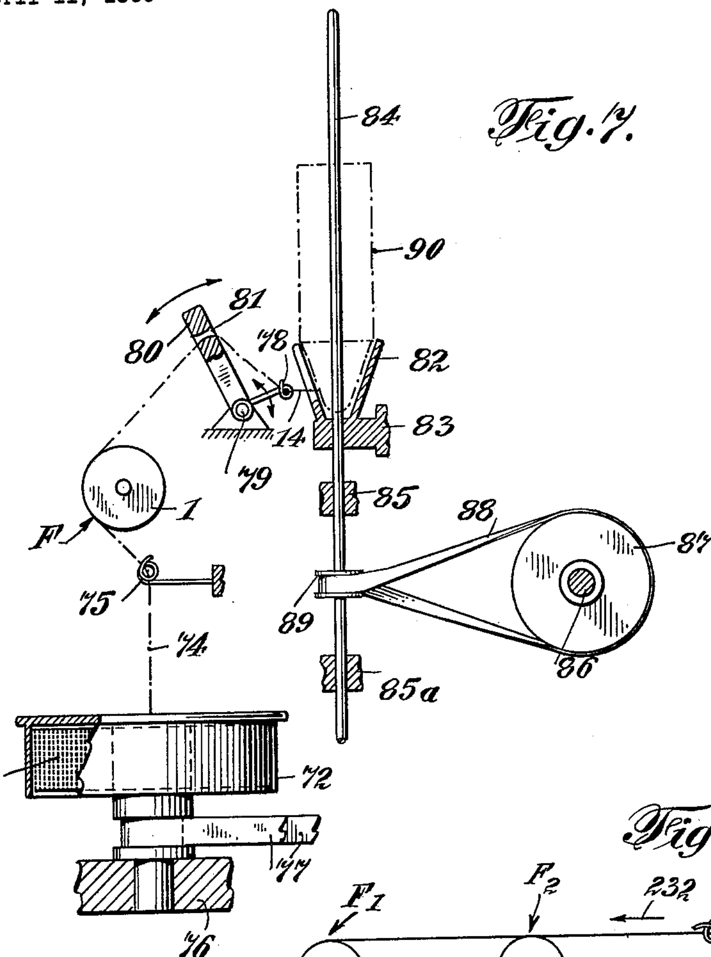
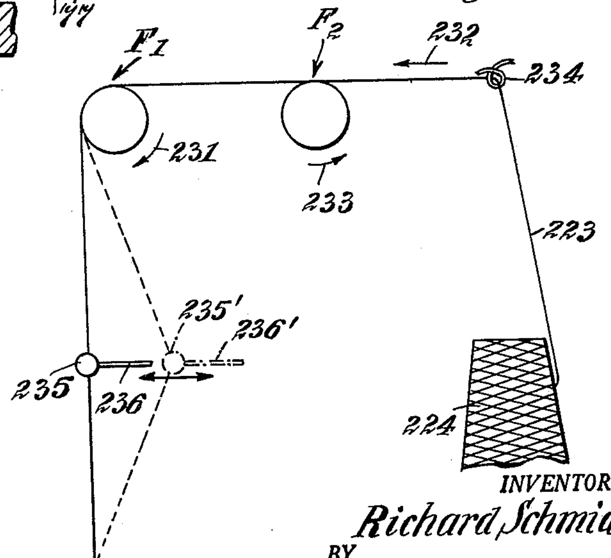


Fig. 9.



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United States Patent Office 3,093,330
Patented June 11, 1963

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3,093,330
FEEDING MECHANISM FOR YARN WINDING AND PROCESSING MACHINES

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Filed Apr. 11, 1960, Ser. No. 21,480
12 Claims. (Cl. 242—45)

The present invention relates to a yarn feeding mechanism, and more particularly to a universal yarn feeding mechanism which is equally useful in yarn winding machines as well as in yarn processing machines such as sewing, knitting and hosiery machines.

This application is a continuation-in-part of my application Serial No. 773,427, filed November 12, 1958, now abandoned.

An important object of the present invention is to provide a yarn feeding mechanism which may exert an accelerating or advancing action as well as a braking action upon the yarn to insure uniform movements of yarn to the needle means of a knitting or sewing machine or to the spindles of a winding machine under all kinds of working conditions.

Another object of the invention is to provide a yarn feeding mechanism of the above outlined characteristics which is of very simple construction and which may be readily incorporated in many types of known winding, sewing, knitting and hosiery machines without requiring substantial modifications in the construction and design of such machines.

A further object of the invention is to provide a yarn feeding mechanism which may operate with variable degrees of sensitivity and which may be readily adjusted to change its yarn advancing or braking action.

A concomitant object of the instant invention is to provide a yarn feeding mechanism which may be utilized for simultaneous control of two, three, or more yarns.

Still another object of the invention is to provide a yarn feeding mechanism which insures uniform advance of yarn to the yarn receiving or takeup element of a winding machine regardless of exact configuration of the takeup element and of the yarn package to be formed thereon.

An additional object of the invention is to provide a yarn feeding mechanism which occupies little space in a yarn winding or processing machine, which requires no attention once it is in operation, and which is capable of operating in a fully automatic way to adapt its yarn advancing or braking action to different operating conditions.

In circular knitting and hosiery machines of presently known design, the yarn feeding mechanism usually comprises two meshing gear wheels which are driven by the motor of the machine. The yarn passes between the teeth of the wheels whose axial distance is adjustable by hand or by a lever which is engaged by and is responsive to changes in tension of the processed yarn. A disadvantage of such construction is that the yarn is caused to buckle between the teeth and that, owing to inevitable slippage of yarn, an accurate regulation of the rate at which the yarn is fed is not possible. When the regulation of feed is automatic, the mechanism must comprise complicated transmissions mounted between the aforementioned lever and the wheels which adds to the initial cost and, moreover, cannot avoid at least some slippage so that the automatic regulation of yarn feed is not reliable under all operating conditions.

In so-called flat knitting machines, the yarn is payed out by spools in response to the pull of knitting needles during the formation of each successive loop. The required tension is generated by conventional yarn tensioning and braking devices. In order to insure uniform loop formation and to produce a knitted fabric of uniform elasticity and stretch, the spools must supply the yarn at a uniform rate. Despite careful winding of the yarn onto such spools, certain irregularities in the formation of convolutions on a spool and varying tensions in the yarn body on the spool cannot be avoided. During unwinding of differently tensioned or improperly convoluted yarn portions, the yarn must be drawn by knitting needles with an increased force which results in irregular loop formation or may break the yarn. In addition, since the needle carrier performs a continuous reciprocating movement with respect to the supply spool, the distance between the yarn guide and the supply spool is subject to continuous changes which also contributes to variations in the tension of the yarn.

The yarn feeding mechanisms presently utilized in circular knitting machines comprise pairs of rollers or meshing gear wheels which should advance the yarn at the exact speed at which the yarn must reach the needles. Such speed is comparatively low and, therefore, the feeding mechanisms must be equipped with costly step-down transmissions. To utilize such feeding mechanisms in flat knitting machines would result in greatly increased cost, particularly if the feeding mechanisms are to operate in a fully automatic way, i.e. if their rate of speed should be subject to automatic changes in response to varying degrees of yarn tension.

The situation is reversed in yarn winding machines, i.e. in such machines which wind a yarn package onto tubes, bobbins, spools, cones or other types of yarn receiving elements for storage or for use in knitting, hosiery and sewing machines. In all such winding machines, the yarn must be wound under constant and uniform tension since, and as explained hereinabove, any changes in such tension may cause irregularities in the characteristics of knitted or otherwise produced fabrics. In addition, any irregularities in the tension of yarn supplied to a spool or other yarn receiving element in a winding machine may cause irregularities in the formation of convolutions such as may again cause unsatisfactory advance of yarn from the yarn receiving element to the knitting needles, sewing needles or the like. Different tension in the yarn supplied to a yarn receiving element in a winding machine may develop as a result of irregular operation of the thread guides, as a result of a shift in the position of supporting means for the yarn receiving elements, as a result of changing resistance to withdrawal of yarn coming from the spinning room, or as a result of irregular operation of brakes.

In sewing machines, one or more yarns are engaged by the sewing needle and by one or more catchers or grippers. On their way to the needle and to the catchers, the yarns are subjected to a braking action and are subjected to different degrees of tension during the formation of consecutive stitches. The braking means usually comprises two spring-biased discs which receive the yarn therebetween. Different degrees of tension in the yarn are caused by changing the distance which the yarn must cover between the braking means and the needle. A disadvantage of such conventional discoid yarn brakes is that they fail to react to comparatively small fluctuations in tension and that they produce undesirable braking action if the yarn is of non-uniform thickness.

The improved yarn feeding mechanism overcomes the above outlined drawbacks of aforedescribed conventional feeding and braking mechanisms and consists essentially of a rapidly rotating preferably cylindrical roller whose peripheral surface is of mirror-like smoothness and tempered hardness. Depending on its rotational speed and on the direction of its rotation, the roller may be utilized as a yarn advancing or as a yarn braking means and, depending upon whether the yarn forms a fraction of a convolution, a full convolution, or more than one convolution about its peripheral surface, the roller may react to any changes in yarn tension with a higher or lower degree of sensitivity. If desired, the roller may be utilized for simultaneously controlling the advance of two or more yarns and, in its preferred form, constitutes the rotor of an electric motor. Such construction avoids undesirable vibrations and results in lower initial cost because the yarn feeding mechanism may operate without costly transmissions, externally mounted tension-responsive devices and the like.

The automatic adjusting action of the improved roller is due to the fact that any changes in the tension of oncoming or leaving yarn portion bring about changes in friction between the yarn and the peripheral surface of the roller so that the advancing or braking action of the roller becomes more positive in response to increasing yarn tension, and vice versa.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following detailed description of certain specific embodiments when read in connection with the accompanying drawings, in which:

FIG. 1 is an axial section through a yarn feeding mechanism embodying one form of my invention;

FIG. 2 is a transverse section through a flat knitting machine which comprises two yarn feeding mechanisms of the type shown in FIG. 1;

FIG. 3 is a front elevational view of a modified feeding mechanism which may be utilized with advantage in circular knitting and hosiery machines;

FIG. 4 is a side elevational view of the feeding mechanism shown in FIG. 3;

FIG. 5 is a schematic view of a spool winding machine which comprises a feeding mechanism of the type shown in FIG. 1;

FIG. 6 is a schematic view of a pirn winding machine which also utilizes a feeding mechanism of the type shown in FIG. 1;

FIG. 7 is a schematic view of a cop winding machine which utilizes a feeding mechanism of the type shown in FIG. 1;

FIG. 8 is a partly elevational and partly sectional view of a sewing machine which is combined with the feeding mechanism of FIG. 1 and in which the feeding mechanism acts as a braking device;

FIG. 9 is a schematic illustration of certain parts in a slightly modified sewing machine which utilizes two feeding mechanisms of the type shown in FIG. 1, one such feeding mechanism acting as a braking device and the other feeding mechanism being utilized to advance the yarn toward the braking device.

Referring now in greater detail to the illustrated embodiments, and first to FIG. 1, there is shown a yarn feeding mechanism F which comprises a cylindrical roller **1** whose peripheral surface is dead smooth or of mirror-like smoothness and tempered hardness and which is rotated at a peripheral speed of, say, between 600–1000 meters per minute. For example, if the diameter of the roller **1** is in the range of about 60 mm., the roller will rotate at 7500–15000 r.p.m. Since it is highly desirable that the roller rotate without any vibration, and since it is difficult to avoid vibration if a body revolving at such speeds is driven by a system of meshing gears or other types of indirect drive means which normally include a step-up or a step-down transmission, the roller is preferably directly coupled to the shaft of an electric motor. Accordingly to an important and preferred feature of my invention, the roller **1** constitutes the rotor of an electric motor whose stator is mounted in the roller as is shown in FIG. 1. The roller **1** is shown as a cupped hollow cylindrical body and consists of a current conducting

material, e.g. steel. The stator including the winding **2** is mounted on a tube **3** whose rear end is formed with a discoid flange **3*a***. This flange is fixed to a disc **5** by a plurality of screws **4**. The disc **5** is formed with a coaxial stud **5*a*** which is secured to a frame member **6** by means of a threaded coaxial bolt **7**. The flange **3*a*** carries a panel **8*a*** for the terminals of conductors **8** which are connected to the winding **2**.

The tube **3** rotatably receives a spindle **9** whose rear end defines a seat for a ball **10**, this ball constituting a thrust bearing for the roller **1**. The spindle **9** is held against axial displacements by a snap ring **11**. The forward end of the spindle is non-rotatably connected with the bottom of the roller **1**. Owing to the just described mounting of spindle **9**, the roller **1** rotates with little or no vibration. The frame member **6** may consitute a portion of the carriage or another component part of a two-bed flat knitting machine which is shown in FIG. 2. This machine comprises a frame **12** mounting a spool **13** with a yarn package **13*a*** thereon. The yarn **14** passes over a first feeding mechanism F which is mounted on a bracket **15** vertically adjustably carried by an upright member **16**. The yarn **14** may form a fraction of a single convolution, one full convolution, or more than one convolution about the peripheral surface of the roller **1**, and is thereupon led through a pot eye **17** mounted on a horizontal arm **18** at the upper end of the upright member **16**. The yarn **14** is then led about the peripheral surface of the roller **1'** forming part of a second yarn feeding mechanism F'. This mechanism supplies yarn to a tensioning and braking device **19** and thence to the needle **20**.

The mechanism F may be supplied with electric current through a loose cable **21** or through the upright **16**. The other mechanism F' receives current through a loose cable similar to the cable **21** or, preferably, through a rail **22** which slidably supports that portion **23** of the knitting machine which mounts the mechanism F', the needle or needles **20** and the tensioning means **19**, it being assumed that the mechanism F' travels along the frame **12**.

The arrangement shown in FIG. 2 is particularly suitable for use in connection with elastic yarns made of rubber or the like. Each yarn **14** requires a separate feeding mechanism F and a separate feeding mechanism F', or the length of rollers **1**, **1'** may be selected in such a way that they may accommodate two or more yarns **14**. The mechanism F may be omitted (therefore shown in broken lines in FIG. 2) and the knitting machine may operate only with the set of mechanisms F'.

It will be readily understood that the provision of a yarn feeding mechanism F' which may receive current through a loose cable or a rail **22** constitutes a considerable simplification if compared with a mechanism which must be driven by gears, transmissions or other indirect drives because the mounting of such indirect drives on a movable part of the machine is extremely complicated. In addition, the weight of one or more sets of such indirect drives on the reciprocable portion **23** of the knitting machine represents an additional load upon the frame **12**.

The sensitivity of the roller **1** or **1'** depends upon the extent to which a yarn is convoluted about its peripheral surface and also upon the rotational speed of the roller. The higher the rotational speed, the greater the sensitivity of the feeding mechanism, i.e. the roller will react more rapidly to varying tensions in the yarn if it rotates at a higher speed. The reaction of the roller to changing tension is such that, provided the tension arises in that portion of the yarn which has already passed beyond the roller, the convolution or convolutions on the peripheral surface of the roller engage the roller with increased frictional force and the roller therefore conveys the yarn with a more positive force until the tension drops to the desired level. On the other hand, if tension increases in that portion of the yarn which is about to contact the peripheral surface of the roller, the frictional force again increases causing the roller to exert a greater pulling force upon the oncoming yarn to thus compensate for increasing resistance of yarn to the advancing action of, say, a knitting needle **20** or a tensioning device **19**.

FIG. 3 illustrates a modified construction F^2 of a yarn feeding mechanism which may be utilized in many types of knitting and hosiery machines, preferably in circular knitting machines. The mechanism F^2 comprises two coaxial rollers **101***a*, **101***b* rotatably mounted on a supporting member **105** which is fixed to the frame member **106** of a knitting or hosiery machine by bolts insertable through cutouts **105***a*, **105***b*. The supporting member **105** mounts a casing **108***a* comprising terminals **108***b*, **108***c* for conductors (not shown) utilized to convey electric current to the motor means of which the roller **101***a* and/or the roller **101***b* forms a component part. The supporting member **105** further comprises an annular bracket **105***c* which supports the stators **102***a*, **102***b*. These stators are secured to the bracket **105***c* by bolts **124***a*, **124***b* (see FIG. 4). The switch means **125**, mounted on the bracket **105***c*, may be utilized for starting or arresting the roller-shaped rotor **101***a* and/or the rotor **101***b*.

The yarns **114** (only one shown) pass from the bobbins (arrow A) through the eyes **126**, **127**, and are wound once or more than once about the rollers **101***a*, **101***b* to be advanced toward the knitting machine (arrow B).

The control switch for the main motor of the knitting or hosiery machine is preferably connected with the switch means **125** in such a way that the motors **101***a*, **102***a* and **101***b*, **102***b* are started shortly before the knitting or hosiery machine is started and that the motors **101***a*, **102***a* and **101***b*, **102***b* are disconnected before the machine comes to a halt. Such arrangement eliminates idle running or piling up of yarns and requires less attention from an operator because the starting and arresting of the yarn feeding mechanism is fully automatic.

Alternately, the yarn feeding mechanism may comprise a single electric motor (say, the motor **101***a*, **102***a*) and a friction clutch or the like which latter couples the motor **101***a*, **102***a* with the roller **101***b*.

It is equally possible to utilize slightly conical rollers instead of fully cylindrical rollers **101***a*, **101***b*, and to place the conical rollers at an angle with respect to each other. Furthermore, each of rollers **101***a*, **101***b* may be of such length that it may simultaneously feed and control the tension of two or more yarns.

FIG. 5 illustrates one form of a yarn winding machine which utilizes a feeding mechanism of the type shown in FIG. 1. The feeding mechanism F insures that the yarn is convoluted onto a yarn receiving element **30** in such manner that the tension in each convolution of the yarn package **31** remains the same. The roller **1** of the mechanism F rotates at a peripheral speed of between 1500–3000 meters per minute which, at a diameter of 60 mm. or thereabouts, corresponds to about 7500–15,000 r.p.m. The roller **1** normally rotates at a peripheral speed higher than the speed at which the yarn **32** must be advanced to the element **30**, i.e. there normally exists a certain amount of slippage between the yarn **32** and the peripheral surface of the roller. However, if the tension in the yarn increases, the friction between the peripheral surface of the roller **1** and the yarn **32** also increases so that the roller exerts a more positive feeding action and compensates for the increasing resistance of the yarn to advance toward the yarn receiving element **30**. As stated before, the yarn may form less than one, one, or more convolutions about the peripheral surface of the roller **1** and the sensitivity of this roller increases proportionally with the length of yarn **32** in contact therewith as well as with the increasing rotational speed of the roller.

The reasons for variable tension in the yarn **32** are many. If the yarn is wound onto the element **30** under varying tension, the convolutions of the yarn package

31 are also under varying tension which results in nonhomogeneousness of the yarn package. Consequently, when the yarn is payed out by the element **30**, e.g. in a kntting or sewing machine, it must be drawn with variable force which is very undesirable for the reasons already explained hereinabove.

As is known, all types of winding machines comprise a series of horizontal or vertical spindles mounted for rotation on a supporting structure called a bed. The means for rotating the spindles may comprise a gear train, belts, rollers or the like which, in turn, are driven by the main drive shaft of the machine. Owing to such rotation of the spindles, the yarn is caused to be wound thereabout, either directly or onto suitable spools, bobbins or the like, and is automatically drawn from a payout or supply reel. In addition, since the yarn must be wound about the spindles in the form of a package whose layers must be arranged in a predetermined manner, each winding machine comprises suitable yarn guides which are reciprocated by suitable cam means so as to deposit the yarn in convolutions and layers of predetermined inclination with respect to the axes about which the spindles rotate. The various types of winding machines are distinguishable by specific yarn guiding assemblies which they utilize. The yarn receiving element may assume the form of a reel which is freely rotatable about a shaft or the convoluted yarn may simply consist of a skein which is formed on the spindle. Alternately, the yarn receiving element may assume the shape of a cupped member which is filled by convolutions of the yarn, or an immovable pin from which the yarn is withdrawn in a substantially radial direction. Still further, the yarn package may be a pirn from which the yarn is drawn in substantially axial direction. Such arrangement is also known as drawing the yarn over the head.

FIG. 5 shows an arrangement which winds the yarn **32** onto a receiving or takeup element in the form of a specific spool **30** whose discs or flanges **30***a* consist of wood, cardboard or paper and whose tubular central portion between the discs **30***a* receives the convolutions at a slight inclination with respect to the radial direction. The consecutively formed layers of convolutions **33** are slightly inclined with respect to each other, i.e. they are arranged substantially crosswise. Consequently, the convolutions at the respective longitudinal ends of the tubular central spool portion could not be properly supported were it not for the discs **30***a*.

The yarn **32** is dispersed by a payout reel **34**, known as a wift, which supports a source of yarn in the form of a package **35** and which is rotatably mounted in the frame **36** of the winding machine. The wift **34** is caused to rotate due to tension in the yarn **32** when the latter is wound onto the spool **30**. It will be readily understood that the wift **34** represents but one form of means for paying out or dispensoing the yarns in a winding machine and that it may be replaced by any other suitable yarn supporting device. The yarn **32** is led through an eye-shaped guide **37** which is fixed to the frame **36**, and thereupon about the peripheral surface of the roller **1** forming part of the feeding mechanism F which latter, too, is fixed to the frame **36**. The wift **34** and the eye **37** together constitute a retarding means for the yarn. The yarn **32** may form part of a single convolution, a full convolution, or more than one full convolution about the roller **1**, and then advances toward the reciprocable guide eye **38** and is finally wound onto the spool **30**. The spool is mounted on a horizontal takeup spindle **39** which is journaled in a stationary bearing **40**. The rear end of the spindle **39** carries a bevel gear **41** which meshes with a second bevel gear **42** mounted on the main drive shaft **43** of the winding machine. This shaft also carries a heart cam **44** whose periphery is scanned by a follower roller **45**. The follower roller is rotatably mounted in a lever **46** whose lower end is pivoted to the machine frame **36**, as at **47**, and whose upper end is biased by a spring

48 so that the follower roller 45 is permanently urged into contact with the cam 44.

The reciprocable guide eye 38 is connected to a shifting member 49 which is mounted in stationary bearings 50, 51 and which is reciprocable by a connecting rod 52 articulately connected to the lever 46. In this manner, the heart cam 44 causes the yarn 32 to be uniformly distributed over the tubular central portion of the yarn receiving spool 30. Of course, it will be readily understood that the wift 34 need not necessarily be mounted at a level above the spool 30, and also that the spindle 39 may be vertical, if desired. Moreover, the axial length of the roller 1 which is mounted between the yarn package supporting wift 34 and the guide eye 38 may be such that it may simultaneously feed two or more yarns 32.

FIG. 6 illustrates a pirn winding machine which comprises a series of vertical takeup spindles 53 (only one shown) mounted in the spindle bed 54 and rotatably received in bearings 55, 56. The spindle 53 is driven by the motor shaft (not shown) through an endless belt 57, and carries a yarn supporting or takeup element in the form of a tube 58 made of paper, cardboard or wood. The yarn package in the form of a pirn 59 has a cylindrical median portion and two conical end portions as is well known in the art. The broken lines 59*a* indicate the individual layers of the yarn body 59. The yarn 60 is delivered by a supply or payout reel 61 which supports a package 62. This reel 61 is mounted below the level of the bed 54. A stationary eye 63 guides the yarn 60 to the peripheral surface of the roller 1 which forms part of the above-described yarn feeding mechanism F and is fixed to the machine frame 64. The yarn thereupon passes through a rockable or oscillatable yarn guide 65 which controls the arrangement of layers 59*a* in the yarn package 59. The rockable guide 65 is pivoted to a sleeve 66, as at 67, the sleeve being mounted on a threaded spindle 68 which latter is secured to the frame 64. The spindle further carries a threaded nut 69 which is connected with a disc 70. The diameter of this disc is selected in such a way that its periphery contacts the cylindrical median portion of the pirn 59. The disc 70 is formed with a downwardly extending belt arm 71 whose free end projects into an annular groove in the periphery of the sleeve 66. If the disc 70 rotates, the nut 69 travels about the spindle 68 in upward direction and entrains the sleeve 66. Such rotary movements of the disc 70 are brought about whenever a yarn layer 59*a* reaches its maximum diameter so that the guide 65 is intermittently lifted by the sleeve 66 which causes the formation of pirn 59. The yarn feeding mechanism F compensates for any variations in the tension of yarn 60 between the reel 61 and the spindle 53.

FIG. 7 illustrates a cop winding machine. The yarn supplying or payout element assumes the form of an open cylinder 72 which contains a yarn package 73. The yarn 74 travels in upward direction through a stationary eye 75 and about the periphery of a roller 1 which forms part of the yarn feeding mechanism F. The cylinder 72 is mounted in a stationary bearing 76 carried by the machine frame and is driven by the machine shaft through an endless belt 77. Owing to rotation of the cylinder 72, the yarn 74 is twisted as it passes upwardly toward the feeding mechanism F.

The winding machine of FIG. 7 further comprises a swingable yarn guide 78 which is pivoted to the machine frame, as at 79, and is combined with a swingable lever 80 formed with a pot eye 81. The yarn 74 passes from the mechanism F, through the pot eye 81, and through the swingable guide 78 on its way into a slotted funnel-shaped container 82 which is rigidly fixed to the machine frame 83. This takeup spindle 84 extends coaxially through the container 82 and is journaled in bearings 85, 85*a*. The main drive shaft 86 of the winding machine which, as described hereinabove, drives the cylinder 72 through the belt 77, also rotates the spindle 84 through a driving pulley 87, an endless belt 88 and a driven pulley 89. The yarn package or cop 90 is wound directly onto the bare spindle 84 and forms a series of conical layers. Owing to the conicity of the funnel-shaped container 82, the cop 90 is automatically pushed upwardly and along the spindle 84 until it reaches a desired length.

It will be understood that the yarn feeding mechanism F is equally useful in yarn winding machines different from those shown in FIGS. 5 to 7. Also, and as explained hereinabove, each mechanism F may be formed with a roller of such length that the roller is capable of simultaneously feeding two or more yarns, or each feeding mechanism may comprise two rollers (FIGS. 3 and 4) at least one of which may be of slightly conical contour, if desired.

An important advantage of the improved feeding mechanism is that it is capable of immediately reacting to any changes in tension of the conveyed yarn in contrast to certain known yarn feeding mechanisms which were described hereinabove. The feeding mechanism of my invention may rotate within the range of, say, between 400–2000 meters per minute and, owing to such high speed, will react immediately and will instantaneously compensate for any changes in the yarn tension. In addition, the feeding mechanism is capable of reacting to very small changes in tension such as could not be detected at all by yarn feeding mechanisms of presently known design. As stated above, the sensitivity of the feeding mechanism is increased if the yarn forms one full convolution or more than one convolution about the roller 1, i.e. proportionally with the length of contact between the roller 1 and the yarn. It is further possible to drive the roller through suitable belting, cords or the like directly from the main drive shaft of a winding, hosiery, knitting or sewing machine, but the arrangement of FIGS. 1, 3 and 4 is preferred because it reduces vibration of the roller. Regardless of whether the roller 1 is driven by an electric motor, whether it forms part of an electric motor, or whether it is driven by belting, cords or in any other way, it may extend the full length of a yarn winding or processing machine so as to simultaneously feed yarns to all needles or to all spindles of the respective machine. Such comparatively long rollers are then preferably supported in suitably spaced bearings whose number and spacing depends upon the overall length of the rollers, i.e. upon the number of spindles in a winding machine, upon the number of needles in a flat knitting machine, and so forth. In a winding machine, the roller of the feeding mechanism is parallel with the spindle bed (i.e. with the part 54 shown in FIG. 6).

The feeding mechanism of my invention is utilized wherever it is likely that the yarn may be subjected to variable tension, i.e. the mechanism is preferably mounted in close proximity of that yarn guide which leads a yarn to the package formed on a spindle in a winding machine. The improved feeding mechanism may be used for winding of all types of yarns, e.g. those made of organic, fully synthetic or partially synthetic material, and even of rubber yarns and the like.

FIG. 8 illustrates a sewing machine in which the yarn feeding mechanism F is utilized in connection with a conventional braking arrangement which imparts to the yarn a predetermined tension on its way to the needle means.

Certain presently utilized yarn brakes comprise two spring-biased dish-shaped substantially discoid members which are mounted face-to-face and receive the yarn therebetween. Any variations in the braking or retarding action are brought about by changing the bias of spring means which acts upon the discoid members.

When the improved yarn feeding mechanism is utilized in connection with a braking arrangement or when the feeding mechanism by itself acts as a braking device, it is rotated in a direction counter to the direction in which the yarn advances toward the needle means. For example, the feeding mechanism may rotate at a peripheral speed of between 200–3000 meters per minute, and its braking action again depends upon the length of contact with the yarn. The tension in the yarn generates proportionally increasing frictional forces which cause the yarn to adhere to the peripheral surface of the roller forming part of the feeding mechanism so that the roller's braking action increases.

Referring now in greater detail to FIG. 8, there is shown a sewing machine in which the feeding mechanism F, acting as a braking device, is shown on a greatly enlarged scale when compared with other components of the sewing machine. The machine comprises a frame **200** which mounts a reciprocable needle bar **201**, the movements of this bar **201** being brought about by a system of eccentrics and/or cams mounted on the main drive shaft (not shown). The forward end of the needle bar **201** supports a sewing needle **202** which latter moves in rhythm with a catcher **203**. This catcher is mounted on a bar **204** which is axially shiftable in a bearing **205**. The bearing **205** receives a three-dimensional movement from a system of eccentrics (not shown) mounted on the main drive shaft of the sewing machine in a manner well known in the art.

It is assumed that the needle **202** must sew together two textile sheets **206**, **207** which are inserted between a pair of intermittently rotating drum-shaped transporting members **208**, **209**. The rear transporting member **209** comprises a downwardly extending driving shaft **210** which is rotatable in a bearing sleeve **211**. The bearing sleeve **211** is connected with the machine frame **200** in such a way that the rear transporting member **209** may be swung to a certain extent in a direction to the right, i.e. away from the front transporting member **208**. Such mounting of the member **209** is necessary because it facilitates the insertion of workpieces **206**, **207**. The front transporting member **208** has an upwardly extending shaft **212** which is rotatable in a bearing **213** but is held against axial movement in the bearing. The upper end of bearing **213** is rigidly connected to a frame member **214**. The shaft **212** is intermittently rotated by a perforated endless belt **215** which travels about a first wheel **216** on the shaft **212** and about a second wheel **217** on a shaft **218**. The shaft **218** carries two swingable arms **219**, **220** which receive the wheel **217** therebetween and whose free ends rotatably mount a belt tensioning roller **221**; the latter is biased by a helical spring **222** and bears against the belt **215** so that the belt is under constant and uniform tension.

The shaft **218** is operatively connected to and rotates with the shaft **210** of the rear transporting member **209** (the connection not shown) and is intermittently rotated with the shaft **210** by an eccentric mounted on the main drive shaft of the sewing machine through a suitable transmission of known design (not shown).

The sewing machine operates as follows:

When the transporting members **208**, **209** are at a standstill, the needle **202** is caused to perform a forward stroke and to penetrate the workpieces **206**, **207** which are held by the members **208**, **209**. When the needle performs its return stroke, the yarn forms a loop in front of the workpiece **207** and the loop is caught by the catcher **203** to be deflected over the edges of the workpieces to the exposed side of the workpiece **206** so that the needle **202** may pass through the loop when it performs the next working stroke and again penetrates the workpieces. While the needle passes above the peripheral zones of the transporting members **208**, **209** which engage and hold the workpieces **206**, **207**, the transporting members are caused to perform an angular movement so as to advance the workpieces, the extent of such angular movement corresponding to the desired length of stitches to be formed in the workpieces.

For the sake of simplicity, the FIG. 8 illustrates a sewing machine of the type which forms a single row of stitches. The yarn **223** is delivered by a supply spool **224** and passes between the adjacent end faces of two dish-shaped braking discs **225**, **226** which are mounted on a bolt **227** and are biased by a helical spring **228** so that they may exert a controllable braking force upon the yarn **223**. The tension of the spring is adjustable by a knurled knob **229** which is screwed onto the threaded end portion of the bolt **227**.

The tension produced by the braking discs **225**, **226** in the yarn **223** varies when the sewing machine is in operation. The exact control of such tension is particularly important when the needle **202** performs a return stroke to tighten the last stitch formed in the workpieces **206**, **207**. The more tight the stitches formed in the workpieces, the greater must be the tension produced in the yarn by the braking discs **225**, **226**. However, the discs **225**, **226** subject the yarn **223** to the same tension throughout the sewing operation, i.e. in all phases of stitch formation in the workpieces. The purpose of the additional braking device in the form of the aforedescribed yarn feeding mechanism F is to vary the tension in the yarn **223** in a fully automatic way so that the tension will reach a desired magnitude in each phase of stitch formation. The mechanism F is located between the discs **225**, **226** and the needle **202**, and is mounted on a bracket **230** which is carried by the frame member **214**. It is assumed that the yarn **223** forms a single convolution about the peripheral surface of the roller **1**. As is indicated by the arrow **231**, the roller **1** rotates in a direction counter to the direction of yarn advance, i.e. counter to the direction in which the yarn moves toward the needle **202** (arrow **232**). When the sewing machine utilizes such a mechanism F, the braking device **225**, **226** may be omitted altogether.

If the sewing machine is of the type which utilizes two or more yarns simultaneously, it must comprise two mechanisms F or the roller **1** must be of such length that it can simultaneously control the tension in two or more yarns. The improved feeding mechanism, here acting as a brake, is particularly useful in rapidly operating commercial sewing machines used in the garment industry. The roller **1** insures smooth transition from one yarn tension to a different yarn tension; its braking action depends on its diameter, on its rotational speed, and on the length of contact between its peripheral surface and the yarn **223**, and may be varied by changing any of these three factors.

FIG. 9 is a diagrammatic view of a modified sewing machine which utilizes two yarn feeding mechanisms F_1 and F_2, the first of which acts as a braking device in the manner as described in connection with FIG. 8 and the second of which acts as a yarn advancing device in the manner disclosed in connection with FIGS. 2–7. The mechanism F_2 is mounted between the braking device F_1 and a supply spool **224**; its purpose is to prevent any fluctuations in tension of the yarn **223** as the latter advances toward the braking device. Such fluctuations develop as a result of non-uniform winding onto the spool **224** or as a result of imperfections in the yarn. When the tension in the yarn payed out by the spool **224** (arrow **232**) increases, the feeding mechanism F_2 will produce a stronger feeding action because the friction between the peripheral surface of its roller **1** and the yarn **223** increases. Of course, it is possible to lead two or more yarns about the roller of the feeding mechanism F_2 and about the roller of the braking device F_1, i.e. to provide the sewing machine with two elongated parallel rollers **1**, one of which rotates in the direction of the arrow **231** (braking) and the other of which rotates in the direction indicated by the arrow **233** (feeding).

On its way to the sewing needle **202**, the yarn passes through an eye **234**, about the roller of the feeding mechanism F_2, about the roller of the braking device F_1 and through a second eye **235** which latter forms part of a deflecting system **236**. When the deflecting system moves into the position **236'**, it causes simultaneous shifting of the eye **235** into the phantom-line position **235'**, so that the yarn **223** is subjected to a greater tension which brings about a stronger braking action by the roller of the device F_1. This device then delivers yarn at a reduced speed or arrests the yarn at a selected stage of the sewing operation. When the yarn tension is normal, the feeding mechanism F_2 advances the yarn at a requisite rate to the needle **202**.

Depending upon whether the braking device F_1 permits the advance of yarn **223** at a faster or slower rate or arrests the yarn altogether, the feeding mechanism F_2 advances the yarn at the required speed, that is, its operation is synchronized with the operation of the braking device. Thus, the tension in the yarn portion extending between the roller of the braking device F_1 and the supply spool **224** is always the same. If the tension of yarn between the braking device and the spool would tend to increase, e.g. owing to improper formation of yarn convolutions on the spool, the feeding mechanism F_2 immediately eliminates undesirable tension in that portion of the yarn which travels toward the roller of the braking device F_1 because the yarn adheres to the roller **1** of the feeding mechanism with a greater force and the feeding mechanism produces a more positive advancing action in the direction of the arrow **232**. In other words, the feeding mechanism insures that the yarn **223** reaches the roller of the braking device at constant and uniform tension.

According to a slight modification of my invention, the eye **235** may remain stationary if the movements of the needle **202** can insure requisite tension in the yarn **223** at a point between the braking device and the needle. It is further possible to omit the braking device and to utilize a conventional braking assembly **225, 226** together with the feeding mechanism F_2.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can, by applying current knowledge, readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic and specific aspects of this invention and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the following claims.

What is claimed as new and desired to be secured by Letters Patent is:

1. In a textile machine, a feeding mechanism for moving a pair of yarns in predetermined directions and at predetermined constant speeds against variable resistance which the yarns offer to such movements, said mechanism comprising a rotary engine including a pair of coaxial electric motors each of which comprises a rotor, said rotors having smooth peripheral surfaces of tempered hardness, each of said surfaces engaging one of the yarns along at least a portion thereof, and said motors being adapted to drive the respective rotors at such peripheral speeds and in such directions that the peripheral speeds of the rotors exceed said predetermined speeds and that said rotors feed the respective yarns by friction in said predetermined directions whereby slippage occurs between the yarns and the respective surfaces, the peripheral speeds of said surfaces and the friction between said surfaces and the respective yarns being correlated with the resistance which the yarns offer in such a way that the yarns moving in said predetermined directions advance at said predetermined speeds.

2. In a textile machine, a yarn feeding mechanism for moving a yarn in a predetermined direction and at a predetermined constant speed against variable resistance which the yarn offers to such movement, said mechanism comprising a rotary element having a smooth peripheral surface of tempered hardness, said surface engaging the yarn along at least a portion thereof, and drive means for rotating said element at such peripheral speed and in such direction that the peripheral speed of said surface exceeds said predetermined speed and that the element feeds the yarn by friction in said predetermined direction whereby slippage occurs between the yarn and said surface, the peripheral speed of said surface and the friction between the yarn and said surface being correlated with the resistance which the yarn offers in such a way that the yarn moving in said predetermined direction advances at said predetermined speed, said drive means and said element together constituting an electric motor and said element constituting the rotor of said motor.

3. In a textile machine, in combination, yarn receiving means adapted to take up a yarn at a predetermined constant speed; a yarn dispensing arrangement comprising a source of yarn and retarding means adapted to resist withdrawal of yarn from said source with a predetermined force; and feeding means for withdrawing the yarn from said source and for advancing the yarn to said dispensing arrangement, said feeding means comprising an electric motor including a stator and a rotor, said rotor surrounding and being directly coupled with said stator and having a smooth peripheral surface engaging the yarn along at least a portion thereof so that, when the motor is started, the rotor withdraws yarn from said source and feeds it to said receiving means owing to friction which develops between the yarn and said surface, said motor being adapted to drive the rotor at a peripheral speed which is substantially higher than said predetermined speed and which is correlated to said predetermined force and to the friction between the yarn and said surface in such a manner that said rotor withdraws the yarn from said source at said predetermined speed.

4. In a textile machine, in combination, yarn receiving means adapted to take up a yarn at a predetermined constant speed; a source of yarn; retarding means adapted to resist withdrawal of yarn from said source with variable force; and feeding means for moving the yarn from said retarding means to said receiving means and comprising an electric motor having a rotor provided with a smooth peripheral surface of tempered hardness around which at least one convolution of the yarn withdrawn from said source is wound, and a stator directly coupled with and driving the rotor at a constant peripheral speed exceeding said predetermined speed and in such direction that the rotor advances the yarn toward said receiving means whereby said peripheral surface advances the yarn by friction but with substantial slippage, the peripheral speed and the smoothness of said surface being such that, in response to increasing or decreasing force of said retarding means; friction between the yarn and said surface respectively increases and decreases sufficiently to insure that the yarn advances toward said receiving means at said predetermined speed.

5. A combination as set forth in claim 4, wherein the peripheral speed of said rotor is a multiple of said predetermined speed.

6. A combination as set forth in claim 5, wherein said rotor is driven at a peripheral speed of 1500–3000 meters per minute.

7. In a sewing machine, in combination, means for advancing a yarn in a first direction; and a braking device for the yarn, said braking device comprising an electric motor including a rotor adapted to rotate at a high speed in a second direction counter to said first direction and having a dead-smooth peripheral surface of tempered hardness, the yarn being convoluted about and being in frictional engagement with said peripheral surface whereby said surface tends to oppose the advance of yarn in said first direction.

8. In a sewing machine, in combination, needle means; means for advancing a yarn toward said needle means, said advancing means comprising a feeding mechanism including a first electric motor comprising a rotor adapted to rotate at high speeds; and a braking device disposed between said needle means and said advancing means, said braking device comprising a second electric motor including a rotor adapted to rotate at high speeds in a direction counter to the direction of said first mentioned

rotor having a dead-smooth peripheral surface of tempered hardness, the yarn being convoluted about and being in frictional engagement with each of said surfaces whereby the rotor of said braking device tends to oppose the advance of the yarn toward said needle means.

9. In a sewing machine, in combination, needle means; means for advancing a yarn toward said needle means, said advancing means comprising a feeding mechanism including a first electric motor comprising a rotor adapted to rotate at high speeds; and a braking device disposed between said needle means and said advancing means, said braking device comprising a second electric motor including a rotor adapted to rotate at high speeds in a direction counter to the direction of said first mentioned rotor, each said rotor having a dead-smooth peripheral surface of tempered hardness and the yarn being convoluted about and being in frictional engagement with each of said surfaces whereby the rotor of said braking device tends to oppose the advance of yarn toward said needle means.

10. In a sewing machine, in combination, means for advancing a yarn in a first direction; and a braking device for the yarn, said braking device consisting of an electric motor having a roller-shaped rotor adapted to rotate at a high speed in a second direction counter to said first direction, said rotor having a dead-smooth peripheral surface of tempered hardness, the yarn being convoluted about and being in frictional engagement with said surface whereby the rotor tends to oppose the advance of yarn in said first direction.

11. In a sewing machine, in combination, needle means; means for advancing a yarn toward said needle means, said advancing means comprising a feeding mechanism consisting of an electric motor having a roller-shaped rotor formed with a dead-smooth peripheral surface of tempered hardness adapted to receive at least one convolution of the yarn, said rotor adapted to be rotated at high speeds in a direction to advance the yarn; and a braking device disposed rearwardly of said advancing means as seen in the direction in which the yarn advances, said braking device consisting of an electric motor having a roller-shaped rotor formed with a dead-smooth peripheral surface of tempered hardness, the yarn being convoluted about and being in frictional engagement with the surface of said last mentioned rotor whereby said last mentioned rotor tends to oppose the advance of the yarn toward said needle means.

12. In a sewing machine, in combination, means for advancing a plurality of yarns in a first direction; and a braking device for each yarn, each braking device comprising an electric motor including rotor means adapted to rotate at high speed in a second direction counter to said first direction and each of said rotor means having a dead-smooth peripheral surface of tempered hardness, each yarn being convoluted about and being in frictional engagement with the surface of the respective rotor means whereby said rotor means tend to oppose the advance of yarns in said first direction.

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