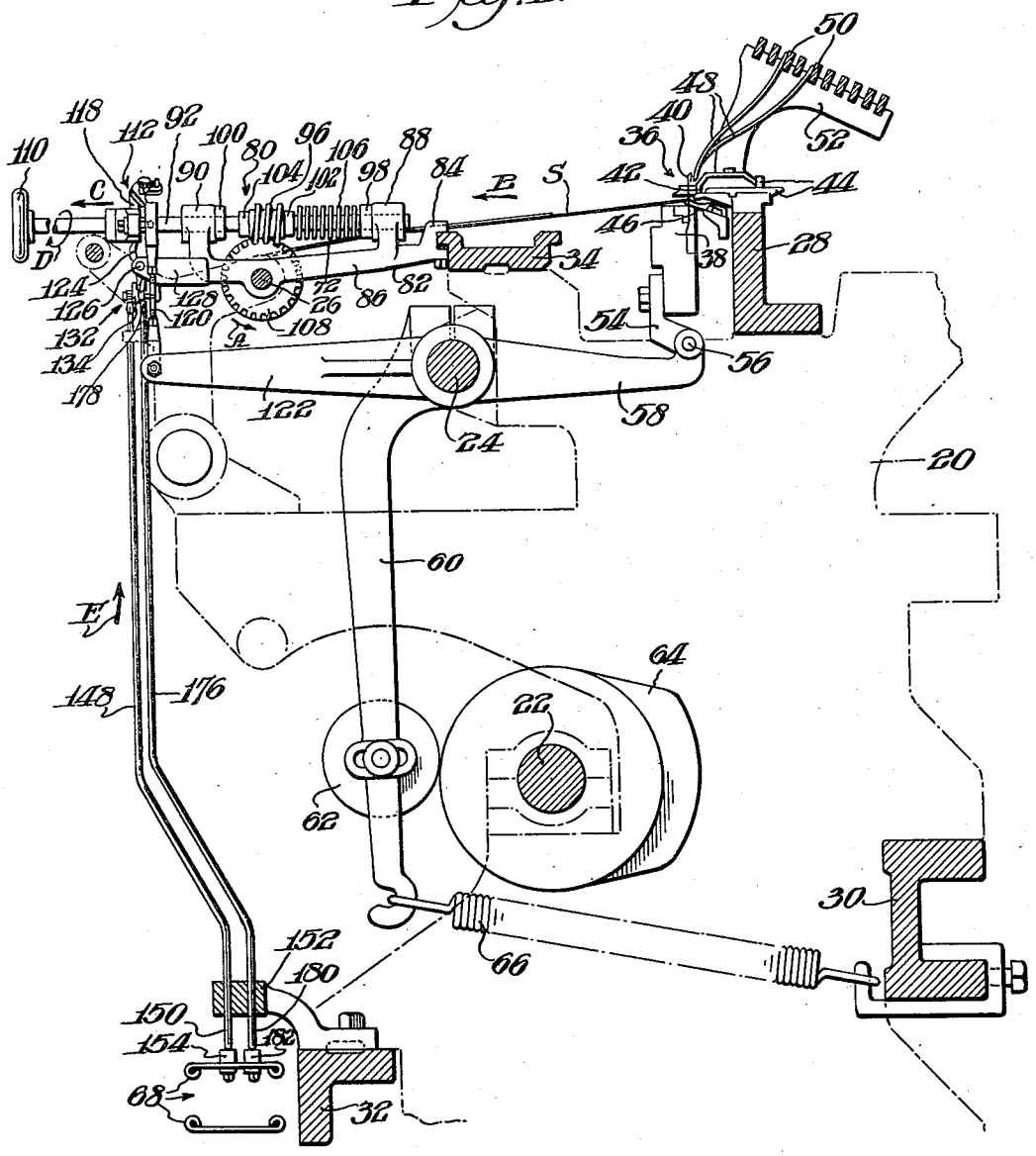
Nov. 3, 1942. A. HOFMANN ET AL 2,300,830

AUTOMATIC DRAW-OFF AND AUTOMATIC TENSIONING DEVICE FOR FULL-FASHIONED KNITTING MACHINES

Filed March 23, 1940 4 Sheets-Sheet 1

Fig. 1.



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Filed March 23, 1940 4 Sheets-Sheet 2

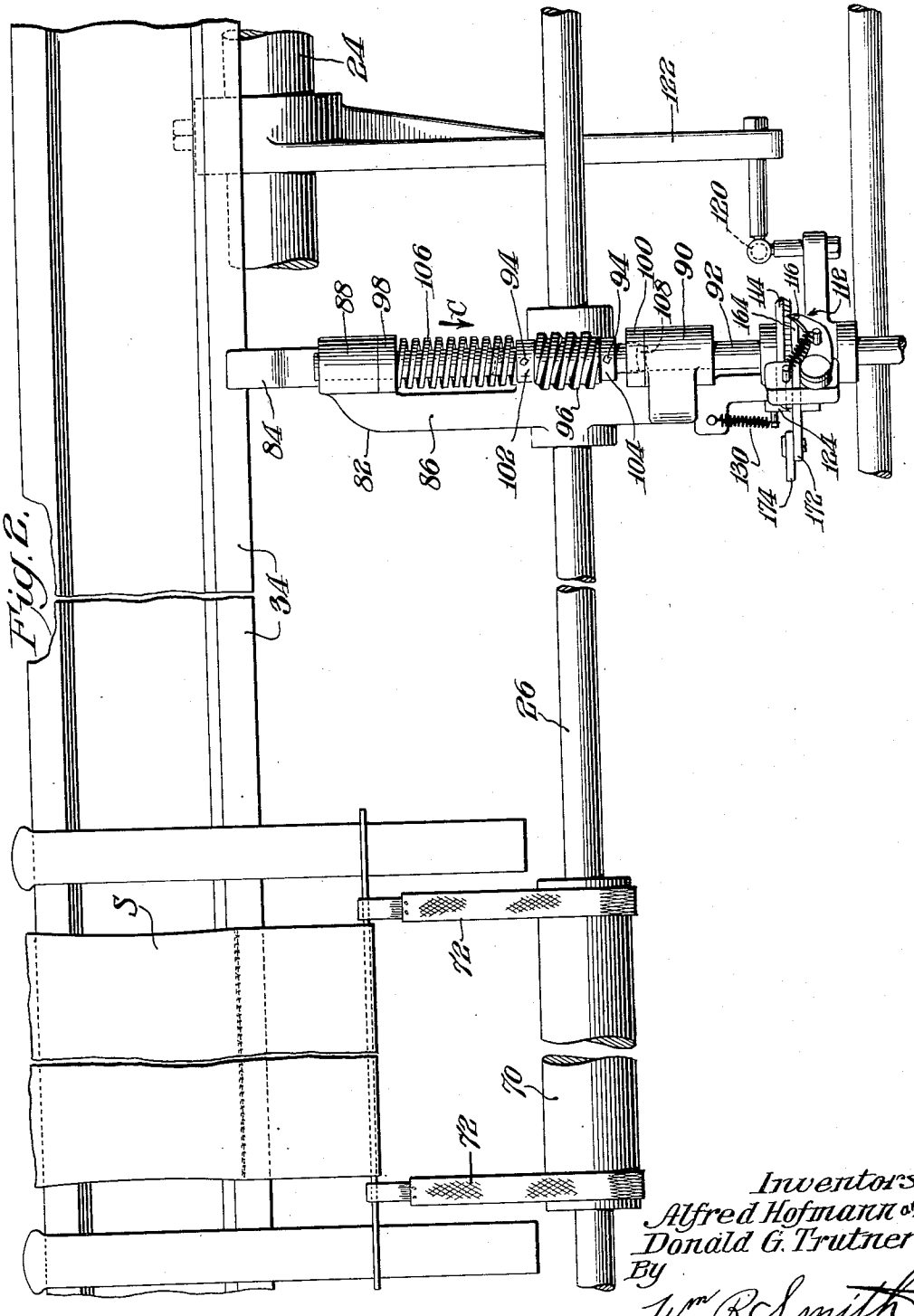


Fig. 2.

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AUTOMATIC DRAW-OFF AND AUTOMATIC TENSIONING DEVICE FOR FULL-FASHIONED KNITTING MACHINES

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Fig. 3.

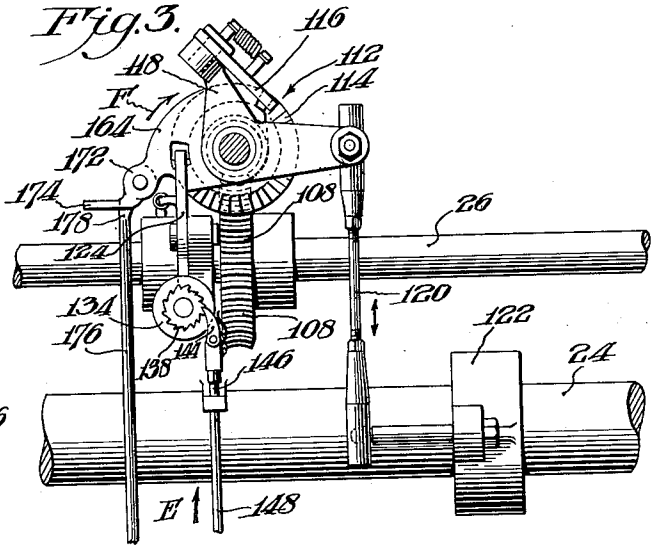


Fig. 4.

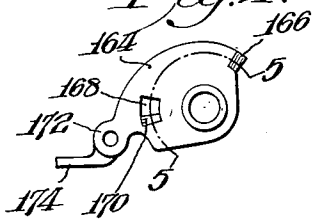


Fig. 5.



Fig. 14.

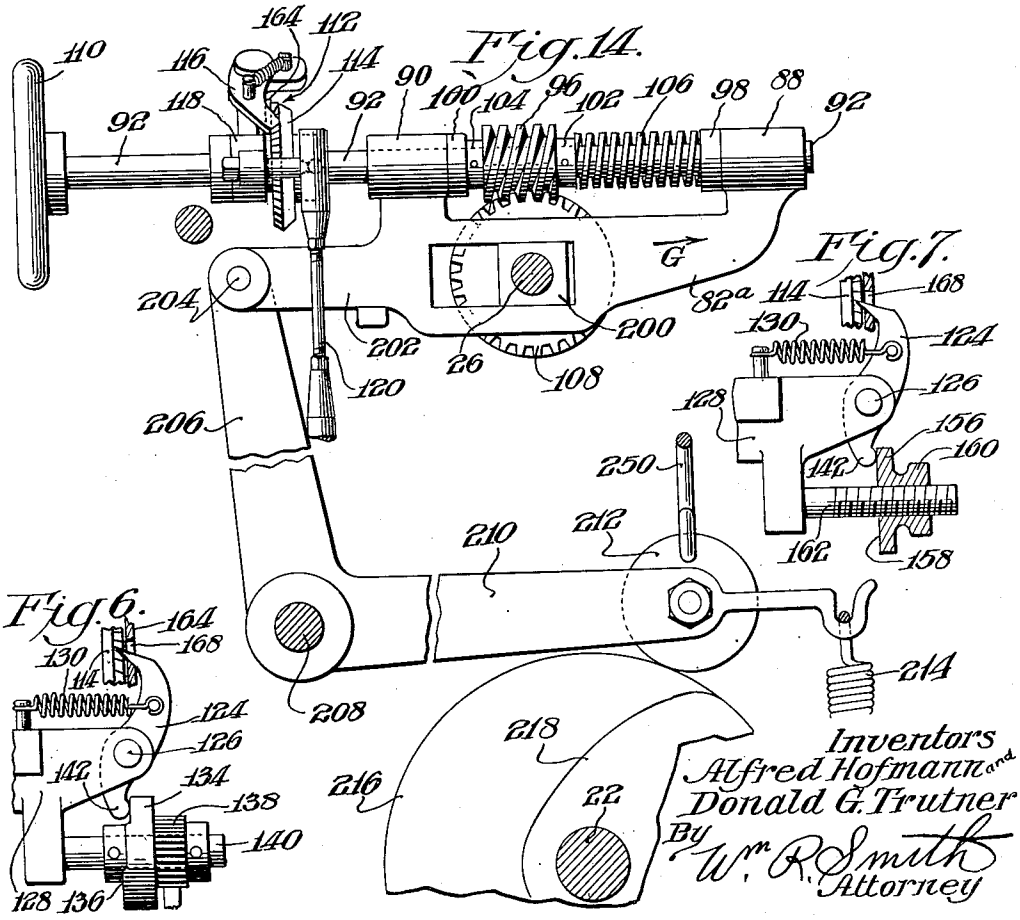


Fig. 7.

Fig. 6.

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Filed March 23, 1940 4 Sheets-Sheet 4

Fig. 8.

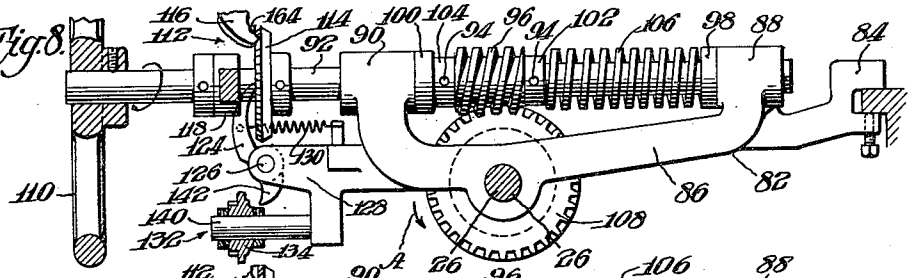


Fig. 9.

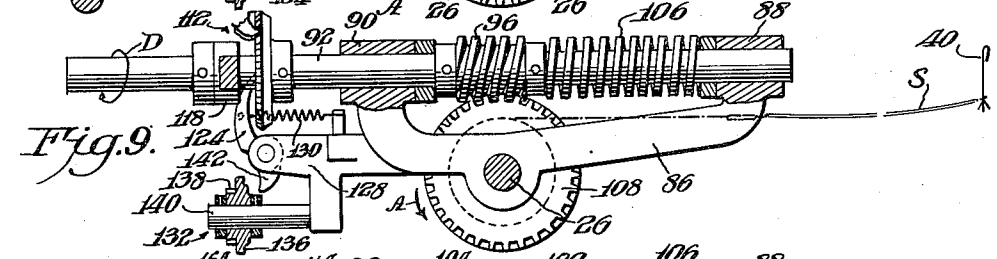


Fig. 10.

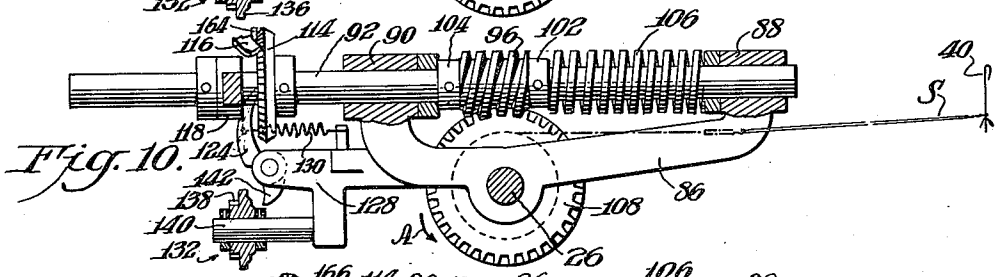


Fig. 11.

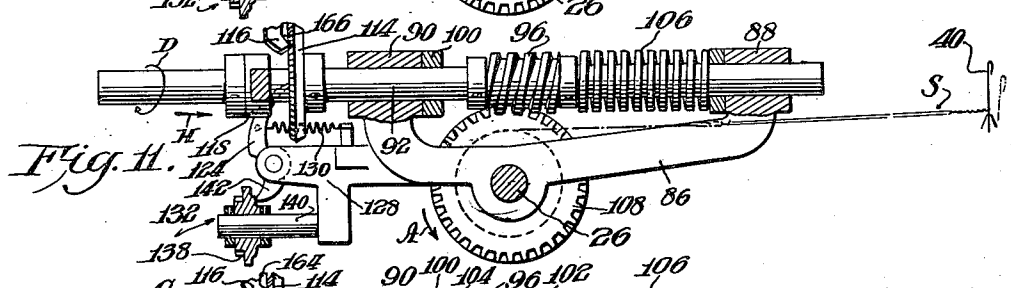


Fig. 12.

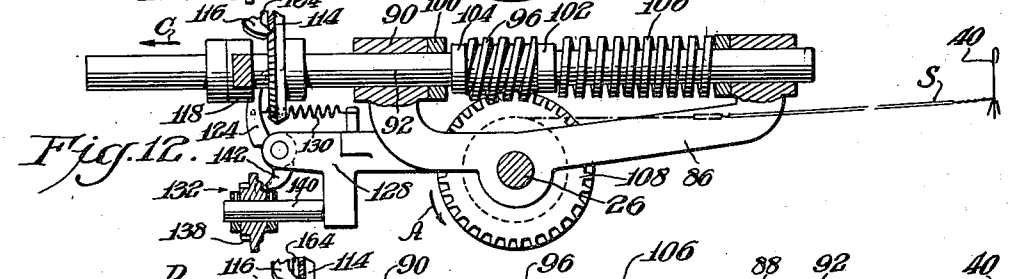
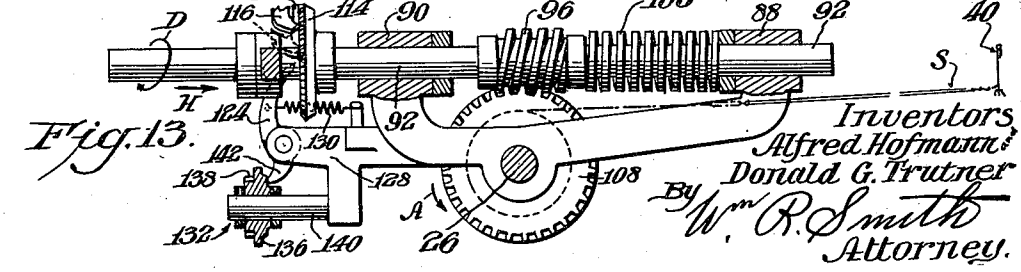


Fig. 13.



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UNITED STATES PATENT OFFICE

2,300,830

AUTOMATIC DRAWOFF AND AUTOMATIC TENSIONING DEVICE FOR FULL-FASHIONED KNITTING MACHINES

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Application March 23, 1940, Serial No. 325,562

23 Claims. (Cl. 66—149)

The present invention relates to flat knitting machines and, more particularly, to automatic draw-off and automatic tensioning of fabric being knitted on full-fashioned knitting machines.

It is a recognized fact in the art of knitting flat fabric, especially full-fashioned hosiery fabric, that such fabric and particularly the last knitted course of loops must be drawn away from the needles as soon as said loops are cast off the needles. For that purpose, commonly known knitting machines are equipped with a so-called draw-off or take-up motion, which maintains the fabric under tension and thus acts to clear the cast off knitted courses from the needles as they rise to the required position for the formation of the succeeding courses.

The construction generally used includes a rotary shaft carrying so-called ware rollers, which correspond in number to the number of knitting sections in the machine and to which the fabric blanks or webs are connected by suitable attaching means, said rotary shaft being operated by weights or expansion springs exerting a pull on the shaft in a predetermined direction to rotate said shaft for drawing the fabric blanks or webs away from the needles.

This drawing of the fabric away from the needles is of the greatest importance because the production of even, regular appearing courses is largely dependent upon it. Too much tension not only misaligns the needles laterally, particularly near the selvedges, and so causes broken needles and imperfect fabric, but also misaligns the needles in the direction of the tension, thereby varying the position of the hooks of the needles as they draw the kinked yarn off the sinker nibs so that loops of different sizes will be produced, whereas not enough tension will result in the failure of the fabric to be drawn with sufficient rapidity to clear the needles in their movement for the formation of the succeeding courses.

With the use of weights or springs exerting a pull on the ware roller shaft, to rotate the same for tensioning the fabric, it is impossible from a practical standpoint, to regulate the fabric tension with positive certainty to the required nicety because the tension imparted to the fabric depends directly upon the number and particular size of the weights, or the number and inherent strength of the springs used.

It is, therefore, the primary purpose of the invention to provide a fabric draw-off and take-up method and device conducted and constructed according to a principle basically different from that heretofore utilized in the art, whereby the tension no longer depends upon a force, the power of which in turn depends upon the inertia of weights or inherent strength of springs, and can be changed only to the extent that the addition or removal of weights or springs would provide, but upon a force, the power of which is created by controllable, adjustable, positively driven means, and can be varied by the controlled, adjusted action of such means whereby the tension imparted to the fabric may be regulated to the very degree necessary to produce the best results obtainable.

It is also well known in the art of knitting full-fashioned stocking fabrics that the fabric tension must be altered as knitting progresses, in order to knit loops of uniform size throughout the length of the stocking. Since full-fashioned stocking fabrics are narrowed during knitting, the fabric tension must be reduced as the length of the fabric increases. Otherwise, loops of various sizes would be produced.

Heretofore, the increasing or decreasing of tension to which the fabric is subjected has been obtained by the manual or mechanical addition or removal of weights or springs acting on the ware roller shaft. The manual addition or removal of weights or springs, of course, requires strict attention on the part of the operator, whereas the mechanical means so far devised for the addition or removal of weights or springs are too complicated and cumbersome to be of practical value.

Consequently, it is an important object of the invention to provide simple, yet effective, mechanism which may be readily associated with the knitting machine to function concurrently therewith at certain definite points in the course of its knitting operation for effecting automatically a controlled tension of the fabric during its production.

One of the most serious problems incidental to the proper tensioning of full-fashioned stocking fabrics arises from the necessity of narrowing the fabric. Since, during narrowing, only a relatively small number of edge loops of the fabric are lifted off the knitting needles by comparatively delicate transfer points, the remaining loops of the fabric being left on said needles, and since these points cannot, without detrimental springing, carry the weight of the normal knitting fabric take-up tension on said loops, it is necessary to provide a so-called fabric tension release motion.

The present invention, therefore, contemplates

the provision of improved means capable of effecting a release of the fabric tension during each narrowing operation by momentarily reducing the tensioning force from its adjusted full degree necessary for knitting only to that extent required for narrowing, thus preserving a predetermined degree of tensioning force on the fabric so that the loops remain in proper engagement with the needles and transfer points during narrowing, said improved means being further capable immediately upon termination of narrowing to reinstate automatically the full adjusted tensioning force existing before the release.

In certain existing machines of the type to which this invention pertains, there is provided specially devised mechanisms whereby the fabric may follow the horizontal movement of the needles during the loop forming operation for the purpose of preventing undue stretching of loops as the needles are moved against the presser edge and of eliminating other excess pull on the fabric when the loops are held by the knockover bits during knitting which results in even, uniform loops showing no sign of stretch and providing uniform fabric texture.

The present invention makes provision for obtaining such advantageous results, but this is without the necessity of additional specially devised mechanisms.

Moreover, the invention is particularly distinguished by the provision of an automatic tension and take-up mechanism incorporating a compound rotating and sliding tension applying and regulating device which is characterized by its inherent freedom from friction, thereby overcoming friction detrimental to accurate control and simplifying the construction and operation of said mechanism.

Other important objects and advantages of the invention will be in part obvious and in part pointed out hereinafter.

In order that the invention and its mode of operation may be readily understood by those skilled in the art, we have, in the accompanying drawings and in the detailed description based thereupon, set out a possible embodiment of the invention.

In these drawings:

Figure 1 is a sectional view through a flat knitting machine, illustrating in elevation the improved automatic take-up and tensioning device applied thereto;

Figure 2 is a top plan on an enlarged scale of a portion of the mechanism shown in Figure 1;

Figure 3 is an end view of the same;

Figure 4 is a detail in elevation of the releasing plate;

Figure 5 is a section taken on line 5—5 of Figure 4;

Figure 6 is a detail of a portion of the regulating mechanism;

Figure 7 is a detail illustrating a modification thereof;

Figure 8 is a side elevation, with parts in section, of the automatic take-up and tensioning mechanism;

Figures 9 to 13 inclusive are views similar to Figure 8, illustrating the various positions of the mechanism in the successive stages of its operation;

Figure 14 is a side elevation of a modification of the fabric take-up and tensioning mechanism.

Referring more particularly to the drawings, wherein like characters of reference will designate corresponding parts throughout, the machine frame is designated at 20, and carries the usual bearings for supporting the various shafts of the knitting machine including the rotatable longitudinally shiftable main cam shaft 22, the rockable needle bar shaft 24, and the rotatable ware roller shaft 26. The machine frame is also provided with the usual center bed 28, back beam 30, front beam 32, and front table 34.

Arranged about the center bed 28 in the customary manner are the multiple knitting sections, one of which is designated in its entirety for convenience herein by the reference character 36. The knitting section 36 comprises the straight needle bar 38 with its bank of needles 40 disposed to cooperate with the presser edge 42, sinkers and dividers 44, and knockover bits 46 for the formation of the courses of loops in the fabric being knitted on the machine.

Yarn is fed to the needles by means of the yarn carriers 48 connected to the carrier bars 50 supported in the brackets 52 on the machine frame 20.

As is customary in the straight needle bar type of knitting machine, the needle bar 38 is capable of both vertical and horizontal movements. For the purpose of imparting to the needle bar its vertical movement, said needle bar is provided with extension arms 54 pivoted, as at 56, to a link 58 in rigid engagement with the needle bar shaft 24. A lever 60, also rigid with the needle bar shaft 24, carries a roller 62 adapted for riding engagement with a cam 64. Constant contact of the roller 62 with the associated cam 64 is assured by means of a spring 66 having one of its ends attached to the lever 60, and the other of its ends suitably attached to the back beam 30 of the machine frame.

From the foregoing, it will be understood that whenever the roller 62 contacts the cam 64, the same will cause the needle bar shaft 24 to oscillate, thereby moving the needle bar 38 up and down for its knitting motion during a revolution of the main cam shaft 22 in the course of its knitting cycle. The needle bar 30 receives its horizontal movement through the well known mechanism not shown herein.

The control of the functions of the knitting machine incidental to its operation is governed, as usual, by the pattern chain mechanism 68, the construction and action of which are well known in the art and, therefore, require no elaborate detailed description herein.

In order to withdraw the fabric, under tension, away from the needles 40 as the fabric is knitted, there is suitably supported upon the machine frame the rotatable shaft 26 which may be the usual ware roller shaft extending through the length of the machine and carrying ware rollers 70 to which are attached by means of straps 72 (or like connecting means) the fabric blanks, such as the stocking blank represented at S. Rotation of the shaft 26 in the direction of arrow A, of course, will draw the fabric blank in the direction of arrow B and thus maintain said fabric blank under tension.

For that purpose, and in accordance with the present invention, the machine is provided with an improved automatic draw-off and automatic tensioning mechanism 80, several possible embodiments of which will now be described.

Disposed at a convenient point along the length of the ware roller shaft 26 to extend transversely thereof is a bracket frame 82 which, in the embodiment more clearly shown in Figures 1, 2, and 8, includes an end portion 86 adapted to receive

the rotatable ware roller shaft 26. The bracket frame 84 is moreover formed with a pair of aligned bearings 88 and 90 positioned to support a stub shaft 92 for free rotatable and longitudinally slidable movements. As shown in the drawings, one bearing 88 is located on one side of the ware roller shaft 26, whereas the remaining bearing 90 is located on the other side of said ware roller shaft so that the portion of the stub shaft 92 extending between said bearings becomes located in a position transverse to the ware roller shaft 26.

Fixed by means of lock screws 94 (or the like) to said portion of the stub shaft extending between the bearings 88 and 90 of the bracket 82 is a worm 96 of a length relatively shorter than the length of the stub shaft portion extending between said bearings. Suitable washers (or the like) such as represented at 98 and 100 may be placed on the stub shaft 92 so as to lay between the ends 102 and 104 of the worm and opposed bearings 88 and 90 respectively.

Preferably interposed between the washer 98 and end 102 of the worm 96 is a compression spring 106 normally acting to urge the stub shaft 92 and worm 96 connected thereto in an outward direction, that is, in the direction of the arrow C. Of course, it is to be understood the spring 106 may be placed at any point along the length of the stub shaft 92 where said spring will act normally to urge the shaft, together with the worm, in said direction C.

Enmeshed with the worm 96 is a worm wheel 108 affixed to the ware roller shaft 26 so that movement of the worm will actuate said shaft through the worm wheel in the manner hereinafter described in detail. It is to be noted that the threads of the worm and teeth of the worm wheel are so related that rotation of the stub shaft 92 in the direction of arrow D will rotate the ware roller in its take-up direction A. The stub shaft 92 may be rotated in the direction D by means of a hand wheel 110 secured to the end portion of the stub shaft 92. This shaft 92 is also adapted to be rotated in direction D automatically during the operation of the knitting machine. For that purpose, there is provided a ratchet device 112 which, in the embodiment shown, comprises a ratchet wheel 114 fixed onto the shaft 92 and a pawl 116 carried by a bracket 118 freely received on said shaft 92, but held thereon in spaced relation to the ratchet wheel 114.

The pawl carrying bracket 118 is connected by means of a link 120 to an arm 122 secured to the needle bar shaft 24 so that, upon oscillating movement of the latter in the manner hereinbefore stated, the arm 122 will be swung thus operating the ratchet actuating pawl 116.

It is to be noted that the worm 96 has a relatively small diameter, and that the helix angle of the worm thread is relatively steep (approximately 27°). It is also to be noted, particularly from Figure 3, that the worm wheel 108 is relatively wide and that the formation of the teeth is such as to conform to the steep helix angle of the worm thread. Because of this relationship of the worm 96 and worm wheel 108, there is produced a drive which is not self-locking, but one which is capable of rotation in either direction whether the turning force is applied to the worm 96 or to the worm wheel 108. Thus, referring for instance to Figure 1, when the spring 106 under compression tends to thrust the shaft 92 to the left, or when a turning force is applied to the worm wheel 108 to rotate the same in a direction opposite to that indicated by arrow A, such as is occasioned by a tension force created within the fabric S anchored on the needles 40, then said thrust or turning force tends to rotate the worm 96 and its shaft 92 in a direction reverse to that indicated by the arrow D and, therefore, the ratchet device 112 associated with the shaft 92 in the manner above stated will follow the reversed rotation of said shaft 92.

The ratchet wheel 114 and stub shaft 92 are normally prevented from back rotation by means of a dog 124 pivoted as at 126 to an extension 128 of the bracket frame 82 and disposed to engage said ratchet wheel. The dog 124 may be urged into its engagement with the ratchet wheel 114 by means of a spring 130 having one of its ends attached to said dog and the other of its ends suitably connected to the bracket frame 82.

Cooperatively associated with the dog 124 to control the function thereof is a regulating mechanism 132 which may be set and actuated automatically during the operation of the knitting machine, or may be set manually at the start of the knitting machine and then manually reset as the knitting progresses.

In Figures 1, 3, and 6, there is shown a possible construction for the automatically set and operated regulating mechanism. In this construction, there is provided a knob 134 having a stepped surface 136 and formed with a toothed portion 138. The knob 134 is mounted for rotation on a stud 140 on the extension 128 of the bracket frame 82 and is disposed to contact the free end 142 of the dog 124. Rotation is imparted to the knob 134 by means of a pawl 144 engaging the toothed portion 138 of said knob and carried by one end portion 146 of a rod 148, having its other end portion 150 extended through a guide 152 and projected in close proximity to the pattern chain 68 of the knitting machine. A set of buttons 154 is arranged on said pattern chain and is adapted, with actuation of the latter, to be brought in contact with the end portion 150 of the rod 148, thus moving said rod in the direction of arrow E, accordingly causing the pawl 144 to impart a partial rotation to the knob 134, thereby bringing the different steps on its stepped surface 136 in successive registration with the free end 142 of the dog 124 and therefore locating the ratchet engaging end of said dog in various positions as the operation of the knitting machine progresses.

In Figure 7, there is shown a possible construction of the manually set and reset regulating mechanism. In this construction, a knob 156 having a flat surface 158 and formed with a knurled portion 160 is mounted in screw-threaded engagement with a stud 162 carried by said extension 128 of the bracket frame 82, and is disposed to contact the free end 142 of the dog 124. Thus by screwing the knob 156 in and out, the flat surface 158 thereof is brought nearer to and further away from its support, and being in engagement with said free end 142 of the dog 124, locates the ratchet wheel engaging end of said dog in various positions.

Disposed concentrically with the ratchet wheel 114 and mounted for oscillation on the stub shaft 92 is a plate 164 preferably having the shape more clearly shown in Figure 4. This plate has a sector cut-away to constitute a forward edge 166 which is beveled for engagement with the ratchet wheel engaging end of the pawl 116. The plate also has an aperture 168 cut transversely thereof for the passage of the ratchet

wheel engaging end of the dog 124 therethrough, one side of the plate at said end of said aperture 168 having a beveled edge 170 adapted for engagement with said end of the dog 124. The plate may be moved to bring the beveled edges 166 and 170 thereof in engagement with the pawl 116 and dog 124 manually or automatically. For that purpose, the plate 164 may be formed with an extension 172 terminating onto a finger 174. Thus by manually raising the finger 174, the plate moves in the direction of arrow F. A rod 176 may also be provided with one end portion 178 suitably connected to the plate extension and its other end portion 180 passing through guide 152 and extending in close proximity to the pattern chain 68. A set of buttons 182 is arranged on said pattern chain to be brought, with actuation thereof, into contact with extended end portion 180 of said rod 176, which is thus raised to move the plate 164 automatically in the direction of arrow F.

In Figure 14, there is shown a modified construction of the automatic draw-off and tensioning mechanism which is particularly devised for use whenever it is desired to provide such a mechanism adapted to release the tension in an automatic fashion during the narrowing of the fabric being knitted on the knitting machine. This modified construction is basically similar to the preferred embodiment hereinbefore described, with the exception that there is provided a bracket frame 82*a* mounted for sliding movement to a bearing block 200 conveniently carried by the ware roller shaft 26. The bracket frame 82*a* is formed with an extension 202 connected, as at 204, to one arm 206 of a bell crank lever which is pivoted on a supporting shaft 208. The remaining arm 210 of the bell crank lever carries a roller 212 adapted to be urged into riding engagement by means of a spring 214 with either a neutral cam 216 or an active cam 218 on the main cam shaft 22, depending upon the position of the latter.

The cams 216 and 218 are so arranged on the main cam shaft 22 that when said shaft is in normal knitting position, the neutral cam 216 is in engagement with the roller 212, thus maintaining the bracket frame 82*a* rigid in relation to the tension spring 106 and associated elements, but when said shaft is shogged to its narrowing position, the active cam 218 is in engagement with said roller 212, accordingly causing the sliding movement of the bracket frame 82*a* in the direction of arrow G, thereby relieving the worm wheel 108 of the tension of the spring 106.

The tension and take-up operation of the device will be understood more clearly upon reference to Figures 9 to 13 inclusive. In the position illustrated in Figure 9, it is assumed that the welt of the stocking fabric has just been turned, which has necessitated the release of the tension so that the fabric S is slacked. At this point, it may be stated that while the slack in the fabric S may be taken up automatically, by setting the machine in operation, it is preferable to take up the slack initially by manual rotation of the shaft 92 by means of the hand wheel 110 before the machine is actually set in operation. In this manner, knitting of additional courses takes place only after the fabric S is under sufficient tension to assure the proper formation of loops in such additional courses.

The turning of the shaft 92, of course, rotates the worm gear 96 which drives the worm wheel 108 and ware roller shaft 26 connected thereto, thus taking up the fabric S, as represented in Figure 10, until the tension of the fabric reaches its maximum, when further rotation of the worm wheel in the direction of arrow A will be prevented because of the force opposed thereto by the fabric which is in engagement with the fixed needles 40. Under these conditions, it will be appreciated that any turning of the shaft 92 in the direction of arrow D will cause the worm gear 96 to travel in relation to the stationarily held worm wheel 108, thereby sliding the shaft 92 inwardly, that is, in the direction of arrow H and, accordingly, as indicated in Figure 11, compressing the spring 106, thus storing a force therein.

The amount of force stored in the spring is controlled by the regulating mechanism 132, which may have any one of the possible constructions hereinbefore described, and the operation of which will be fully explained hereinafter.

The spring 106, being compressed as above stated, it will be appreciated that upon the knitting of additional courses onto the fabric which thereby loses its original tension, said spring becomes free to expand and thus, as represented in Figure 12, its expansion causes the stub shaft 92, together with the worm gear 96, to slide outwardly, that is, in the direction of arrow C, since the shaft and worm gear, being locked by the cooperative function of the pawl 116 and dog 124, are prevented from rotation. The worm gear then acts as a rack and imparts a rotation to the worm wheel 108 and ware roller shaft 26 in the direction of arrow A, consequently taking up the added length of the fabric occasioned by the knitting of additional courses thereonto, and thus maintaining the fabric in its original tension.

With the operation of the knitting machine through its subsequent knitting cycle, the cam 64 and main cam shaft 22 (Figure 1) actuate the ratchet mechanism 112 so that, as represented in Figure 13, the pawl 116 rotates the stub shaft 92 and worm gear 96 in the direction of arrow D, again compressing the spring 106 by causing the shaft to move in the direction of arrow H due to the riding of said worm gear on the worm wheel which is prevented from rotation because of the force opposed to such rotation by the fabric under tension.

The operation of the device, as described, to automatically take up and tension the fabric as additional courses are knitted is repeated throughout the entire knitting of the stocking blank.

Attention is particularly called to the fact that, in the use of the device, the action of the predeterminable compression force of the spring 106 against the worm 96 rotatively transmitting this force to the take-up shaft 26 by means of the worm wheel 108, as well as the refeeding of the lost force to said spring, take place consecutively but in a manner that the active tensioning force of the spring remains in a predetermined (and, for all practical purposes, in a constant) relation to the combined tension exerted by the plurality of fabric blanks under tension. Furthermore, it is pointed out that the desired tension is obtained by compressing the spring until its reaction is equal to the tension desired, and that this tension is not exceeded because of the position of the dog 124.

As known in the art, it is desirable to reduce the tension as the stocking fabric reaches certain predetermined lengths and, in accordance

with the present invention, this may be accomplished automatically by actuation of the regulating mechanism 132 as shown, for instance, in Figure 1 of the drawings. The operation of this type of mechanism is as follows:

As the knitting machine functions, the pattern chain 68 is actuated as customary so that a button 154 eventually reaches a position to register with the end 150 of the rod 148 to raise the same in the direction of arrow E and, accordingly, rotate the knob 134 to vary the position of the dog 124 in relation to the ratchet wheel 114 and thus engage the latter at a time to control the amount of force to be stored in the spring 106. A set of buttons, such as that shown at 154, is arranged on the pattern chain 68 so as to correspond to the points in the lengths of the stocking fabric where the tension thereof is to be reduced.

With the use of the regulating mechanism shown in Figure 7, the tension may be varied whenever the operator finds it necessary. In other words, if the operator, by feeling the fabric being knitted, determines that the fabric is under improper tension, the proper tension may be restored to the fabric by manually screwing the knob 156 in or out, thereby adjusting the position of the dog 124.

By way of further explanation of the operation, function, and purpose of the dog 124 and its regulating mechanism 132, it is pointed out that in the operation of the present device, the worm 96 is initially confined axially by the initial pressure of the spring 106. As the worm 96 is rotated by the ratchet device 112, said worm turns the worm wheel 108 together with the wareroller shaft 26 until the total tension applied to all the pieces of fabric in the several sections of the knitting machine, reacting at the working radius of the worm wheel 108, becomes greater than the initial pressure of the spring 106. The instant this occurs, the worm wheel 108 and the wareroller shaft 26 stop turning. The worm 96, however, is still rotated intermittently by the ratchet device 112. As the worm wheel 108 cannot rotate, the worm 96 is transformed in character from a worm to a screw, with the now stationary worm wheel 108 functioning as a nut. This rotation of the worm 96 will cause its bodily advance in a direction which will cause the spring 106 to be compressed.

As hereinbefore mentioned, the worm 96 is rigidly fixed to its shaft 92, as is also the ratchet wheel 114. The working pawl 116 mounted on its carrying bracket 118, and the release plate 164, are confined axially on the shaft 92 and free to rotate thereon. With this construction, the working pawl 116 is always in the same position relative to the ratchet wheel 114, so that when the worm 96 advances rectilinearly in its screw-and-nut manner, the shaft 92, ratchet wheel 114, and pawl 116 move with said worm.

Assuming that sufficient tension has been built up in the fabric to arrest the rotation of the wareroller shaft 26 and worm wheel 108, as previously mentioned, and the worm 96 has moved forward against the pressure of the spring 106, these forces combine to rotate the worm 96 by reason of the steep helix angle in a direction counter to that caused by the working pawl 116. Thus when the pawl 116 on its carrying bracket 118 is rotated clockwise (Figure 3), it tends to screw the worm 96 forwardly. However, if there were nothing to prevent it, the ratchet wheel 114 would follow the pawl 116 back again on its return stroke.

To overcome the natural tendency of the ratchet wheel 114 to follow the pawl 116 during the back stroke, the second pawl 124 is provided. This pawl 124 having the fixed fulcrum 126 and the extended lower portion 142, bears against an adjustable stop surface 136 (Figure 6) or 158 (Figure 7) being urged thereto by the spring 130. The position of the stop surfaces 136 or 158 definitely controls the motion of the pawl 124 in a direction toward the ratchet wheel 114.

Assuming again that the tension of the fabric S has equalled the pressure of the spring 106 and the worm 96 started its movement against the pressure of the spring 106, for each stroke of the working pawl 116 the ratchet wheel 114 will rotate a definite number of teeth, and the backing pawl 124 will engage said ratchet wheel at the end of the stroke, effectively preventing reverse rotation of the rtachet wheel and associated parts. This cycle is repeated for each course laid by the knitting machine until the worm 96, functioning as a screw, has moved the shaft 92, ratchet wheel 114, and associated parts to the right, that is, in the direction indicated by the arrow H in Figure 13, until the backing pawl 124 is prevented by the stop surface of the regulating mechanism 132 from following the ratchet wheel 114 further. The working pawl 116 will continue to partially rotate the ratchet wheel 114 for each machine cycle, but the screw action of the worm 96 will carry said ratchet wheel beyond the range of the backing pawl 124 so that the ratchet wheel will follow the working pawl 116 on its return stroke. Thus there will be a constant but slight variation in tension when this balance is reached, but this is not sufficient to affect the process of knitting.

As additional courses are knitted, lengthening the pieces of fabric, the tension of the fabric will be reduced. The force exerted by the spring 106 will then be greater than the fabric tension, and the worm 96 and worm wheel 108 will again change character and function as a rack and pinion. The pressure of the spring 106 will cause the worm 96 and associated parts to move bodily to the left, that is, in the direction of arrow C in Figure 12, which will cause the worm wheel 108 to rotate counterclockwise, taking up the newly made fabric and restoring the tension therein. This leftward movement will again bring the ratchet weel 114 in register with the backing pawl 124 which, in its cooperation with the working pawl 116, will again screw the worm 96 against the spring 106, compressing the same to its former position.

The preceding explains how tension control is maintained. Tension variation may be had simply by changing the position of the stop surfaces of the regulating mechanism 132 which controls rightward position of the backing pawl 124. Obviously if the backing pawl 124 is permitted to travel more to the right, the worm 96 in its screw-and-nut character must also travel more to the right before the ratchet wheel 114 is out of the range of the pawl 124. This would mean compressing the spring 106 to a greater extent, which produces simultaneously a fabric tension increase to an equal value, because the force exerted by the spring 106 opposes the force exerted by the fabric tension. Therefore to increase the fabric tension, the opposing spring force is increased and the mechanism automati-

cally restores a balance between the fabric tension force and the spring compression force.

With that type of draw-off and tensioning device shown, for instance, in Figure 8, use may be made of the ordinary tension release mechanism found in present-day machines in order to temporarily release the fabric of a certain amount of its normal tension during the narrowing function of the knitting machine for the formation of narrowing courses, picot courses, or the like. However, as already described in connection with Figure 14, the draw-off and tensioning device may readily be modified to incorporate means for effecting such temporary release, as well as for equalizing the tension variances produced by the in and out motion of the needle bar. By using this modified type of automatic draw-off and tensioning device, any additional mechanism for releasing the tension whenever necessary or desired may be dispensed with.

According to the invention, this may be accomplished by mounting the device, as shown in said Figure 14. By so mounting the device, it will be understood that whenever the main cam shaft **22** is shogged to its narrowing position, the cam **218** engages the roller **212**, thus causing the bracket **82***a* to move in the direction of arrow G and, accordingly, temporarily destroy the action of the spring **106** to annihilate its tensioning force. Also, the embodiment shown in Figure **14** may be readily adapted to provide for the temporary release of the tension as the needles move to their in positions, for instance, by suitably shaping the cam **216** or by mounting the roller **212** to be shifted transversely of the arm **210** by means of a shifting fork **250** which may be controlled automatically by the pattern chain or other working part of the machine in any manner well known in the art. It is particularly to be noted in this respect that, upon return of the bracket **82***a* to its original position, the tension is automatically restored without requiring additional adjustments.

Whenever it is desired to completely destroy the tension, such for instance as to permit the turning of the welt, this may be accomplished by manually or automatically lifting the plate **164**, in the manner hereinbefore explained.

It is to be understood that the various embodiments of the invention as herein shown and described are capable of certain modifications and, therefore, any modifications coming within the scope of the subjoined claims are to be considered within the spirit of the invention.

What we claim is:

1. In a knitting machine having a rotatable draw-off ware roller shaft: a worm gearing consisting of a worm wheel fixed on said shaft and a worm enmeshed with said worm wheel; an element inherently capable of applying a directional force to said worm for imparting a rotating movement to the draw-off shaft through said worm wheel; and means for annihilating the directional force normally applied to the worm by said force supplying element.

2. In a knitting machine having a rotatable draw-off ware roller shaft: a worm gearing consisting of a worm wheel fixed on said shaft and a worm enmeshed with said worm wheel; an element inherently capable of applying a directional force to said worm for imparting a rotating movement to the draw-off shaft through said worm wheel; means for regulating the directional force to be applied to the worm by said force supplying element; and means for annihilating the directional force normally applied to the worm by said force supplying element.

3. In a knitting machine having a rotatable draw-off ware roller shaft: a worm gearing consisting of a worm wheel fixed on said shaft and a rotatable longitudinally movable worm enmeshed with said worm wheel; a compression spring operatively associated with the worm and disposed to normally act for moving the same in one rectilinear direction for imparting a rotating movement to the draw-off shaft through the worm wheel; means operable for rotating the worm for movement in the opposite rectilinear direction in relation to the worm wheel and against the action of said spring to compress the same for its action on said worm; and means relieving said worm from the action of said spring.

4. In a knitting machine having a rotatable draw-off ware roller shaft: a worm gearing consisting of a worm wheel fixed on said shaft and a rotatable longitudinally movable worm enmeshed with said worm wheel; a compression spring operatively associated with the worm and disposed to normally act for moving the same in one rectilinear direction for imparting a rotating movement to the draw-off shaft through the worm wheel; means operable for rotating the worm for movement in the opposite rectilinear direction in relation to the worm wheel and against the action of said spring to compress the same for its action on said worm; means for controlling the action of said spring on the worm; and means for relieving said worm from the action of said spring.

5. In a knitting machine having a rotatable draw-off ware roller shaft and a needle bar shaft: a worm gearing consisting of a worm wheel fixed on said shaft, and a rotatable longitudinally movable worm enmeshed with said worm wheel; a compression spring operatively associated with the worm and disposed to normally act for moving the same in one rectilinear direction for imparting a rotating movement to the draw-off shaft through the worm wheel; and means actuated by the needle bar shaft and operable for rotating the worm for movement in the opposite rectilinear direction in relation to the worm wheel and against the action of said spring to compress the same for its action on said worm.

6. In a knitting machine having a rotatable draw-off ware roller shaft, a needle bar shaft, and a pattern chain: a worm gearing consisting of a worm wheel fixed on said shaft, and a rotatable longitudinally movable worm enmeshed with said worm wheel; a compression spring operatively associated with the worm and disposed to normally act for moving the same in one rectilinear direction for imparting a rotating movement to the draw-off shaft through the worm wheel; means actuated by the needle bar shaft and operable for rotating the worm for movement in the opposite rectilinear direction in relation to the worm wheel and against the action of said spring to compress the same for its action on said worm; and means governed by the pattern chain for controlling the action of said spring on the worm.

7. In a knitting machine having a rotatable draw-off ware roller shaft, a needle bar shaft, a pattern chain, and a main cam shaft: a worm gearing consisting of a worm wheel fixed on said shaft, and a rotatable longitudinally movable worm enmeshed with said worm wheel; a compression spring operatively associated with the worm and disposed to normally act for moving the same in one rectilinear direction for impart-

ing a rotating movement to the draw-off shaft through the worm wheel; means actuated by the needle bar shaft and operable for rotating the worm for movement in the opposite rectilinear direction in relation to the worm wheel and against the action of said spring to compress the same for its action on said worm; means governed by the pattern chain for controlling the action of said spring on the worm; and means controlled by the main cam shaft for relieving said worm from the action of said spring.

8. In a knitting machine, a take-up element and a combined draw-off tensioning and releasing device for said element, said device including a spring compressible to various degrees to impart movement to said element under various degrees of tension.

9. In combination with the ware roller shaft and main cam shaft of a knitting machine, a combined draw-off tensioning and releasing device for said ware roller shaft controlled by said main cam shaft, said device including a spring compressible to various degrees to impart movement to said element under various degrees of tension.

10. In a flat knitting machine having a draw-off shaft: spring means associated with said shaft and deformable to apply tensioning driving force to the latter; and means operable to regulate the deformation of said spring means for varying the tensioning driving force applied thereby to said shaft.

11. In a flat knitting machine having a draw-off shaft: a yieldable element associated with said shaft and deformable to apply tensioning driving force to the latter; and means operable to regulate the deformation of said yieldable element for varying the tensioning driving force applied thereby to said shaft.

12. In a flat knitting machine having a draw-off shaft: a spring associated with said shaft and compressible for applying a tensioning force to the latter; and means operable to regulate the compression of said spring for varying the tensioning force applied thereby to said shaft.

13. In a flat knitting machine having a draw-off shaft: a spring associated with said shaft and compressible for applying a tensioning force to the latter; means operable to regulate the compression of said spring for varying the tensioning force applied thereby to said shaft; and means operable for automatically controlling said compression regulating means.

14. In a knitting machine, the combination with a fabric take-up element of: a spring compressible for applying a rotating tensioning force of predetermined degree to said element; and means operable to regulate the degree of compression in said spring for selectively increasing and decreasing the degree of tensioning force to be applied by said spring at various times during knitting.

15. In a knitting machine, the combination with a fabric take-up element of: a spring compressible for applying a rotating tensioning force of predetermined degree to said element; means operable to regulate the degree of compression in said spring for selectively increasing and decreasing the degree of tensioning force to be applied by said spring at various times during knitting; and means operable for automatically controlling said compression regulating means.

16. A fabric take-up device for knitting machines comprising: a fabric take-up shaft rotatably supported on said machine; a stub shaft; a bracket supporting the stub shaft for rotating motion longitudinally and sliding motion transversely of the fabric take-up shaft; a spring associated with said bracket and stub shaft disposed to be tensioned by rotation of said stub shaft and untensioned for sliding said stub shaft; and a gearing between said shafts operable to cause the tensioning of said spring by rotation of the stub shaft in relation to the fabric take-up shaft, and to cause the rotation of said take-up shaft through the sliding motion of the stub shaft by untensioning of the spring.

17. A fabric take-up device for knitting machines comprising: a fabric take-up shaft rotatably supported on said machine; a stub shaft; a slidable bracket supporting the stub shaft for rotating motion longitudinally and sliding motion transversely of the fabric take-up shaft; a spring associated with said bracket and stub shaft disposed to be tensioned by rotation of said stub shaft and untensioned for sliding said stub shaft; a gearing between said shafts operable to cause the tensioning of said spring by rotation of the stub shaft in relation to the fabric take-up shaft, and to cause the rotation of said take-up shaft through the sliding motion of the stub shaft by untensioning of the spring; and means for sliding said bracket in relation to said shafts to untension said spring without affecting said gearing.

18. In a flat knitting machine having a draw-off roller: a mechanism for applying a predetermined rotative tension force to the draw-off roller, said mechanism including a compression spring; and means automatically operable to regulate the degree of compression in said spring for automatically fractionally increasing and decreasing the tension force applied by said mechanism in timed relation to the knitting.

19. In a flat knitting machine having a draw-off roller: a mechanism for applying a predetermined rotative tension force to the draw-off roller, said mechanism including a compression spring; means automatically operable to regulate the degree of compression in said spring for automatically fractionally increasing and decreasing the tension force applied by said mechanism to a predetermined amount; and means for completely neutralizing the rotative effect of said rotative tension force on said roller, all of said alterations in tension forces being effected at predetermined times in relation to the knitting.

20. In a flat knitting machine having a draw-off roller: a mechanism for applying a predetermined rotative tension force to the draw-off roller, said mechanism including a compression spring; means automatically operable to regulate the degree of compression in said spring for automatically fractionally increasing and decreasing the tension force applied by said mechanism to a predetermined amount; and means for automatically controlling said compression regulating means in timed relation to the knitting.

21. In a flat knitting machine having a draw-off roller and pattern chain: a mechanism for applying a predetermined rotative tension force to the draw-off roller, said mechanism including a compression spring; means automatically operable to regulate the degree of compression in said spring for automatically increasing and decreasing the rotative tension force applied by said mechanism to a predetermined amount; and means operated by the pattern chain for

automatically controlling said compression regulating means in timed relation to the knitting.

22. In a flat knitting machine having a draw-off roller, a pattern chain, and a main cam shaft: a mechanism for applying a predetermined rotative tension force to the draw-off roller, said mechanism including a compression spring; means controlled by the pattern chain in timed relation to the knitting and operable to regulate the degree of compression in said spring for automatically increasing and decreasing the rotative force applied by said mechanism to a predetermined amount; and means governed by the main cam shaft for completely neutralizing the rotative effect of said rotative tension force on said roller.

23. In a full-fashioned stocking fabric knitting machine, a stocking fabric take-up device, a coil spring operatively associated with said device and compressible to apply a tensioning force to the latter, and means for automatically controlling the degree of compression of the spring for varying the tensioning force applied thereby to said device at predetermined points in the knitting of the stocking fabric.

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