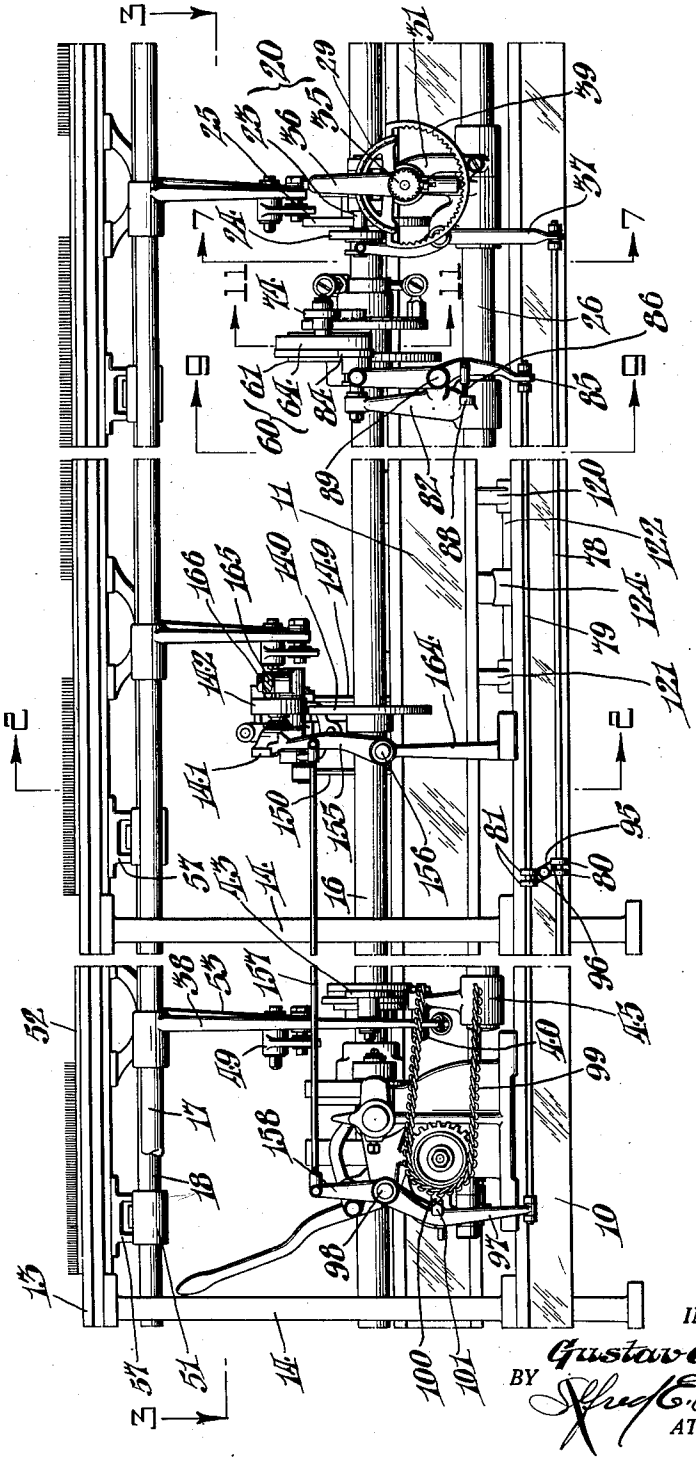
Oct. 10, 1939. G. GASTRICH 2,175,989

LOOP LENGTH REGULATING MECHANISM FOR STRAIGHT KNITTING MACHINES

Filed Aug. 12, 1937 7 Sheets-Sheet 1

Fig. 1.



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LOOP LENGTH REGULATING MECHANISM FOR STRAIGHT KNITTING MACHINES

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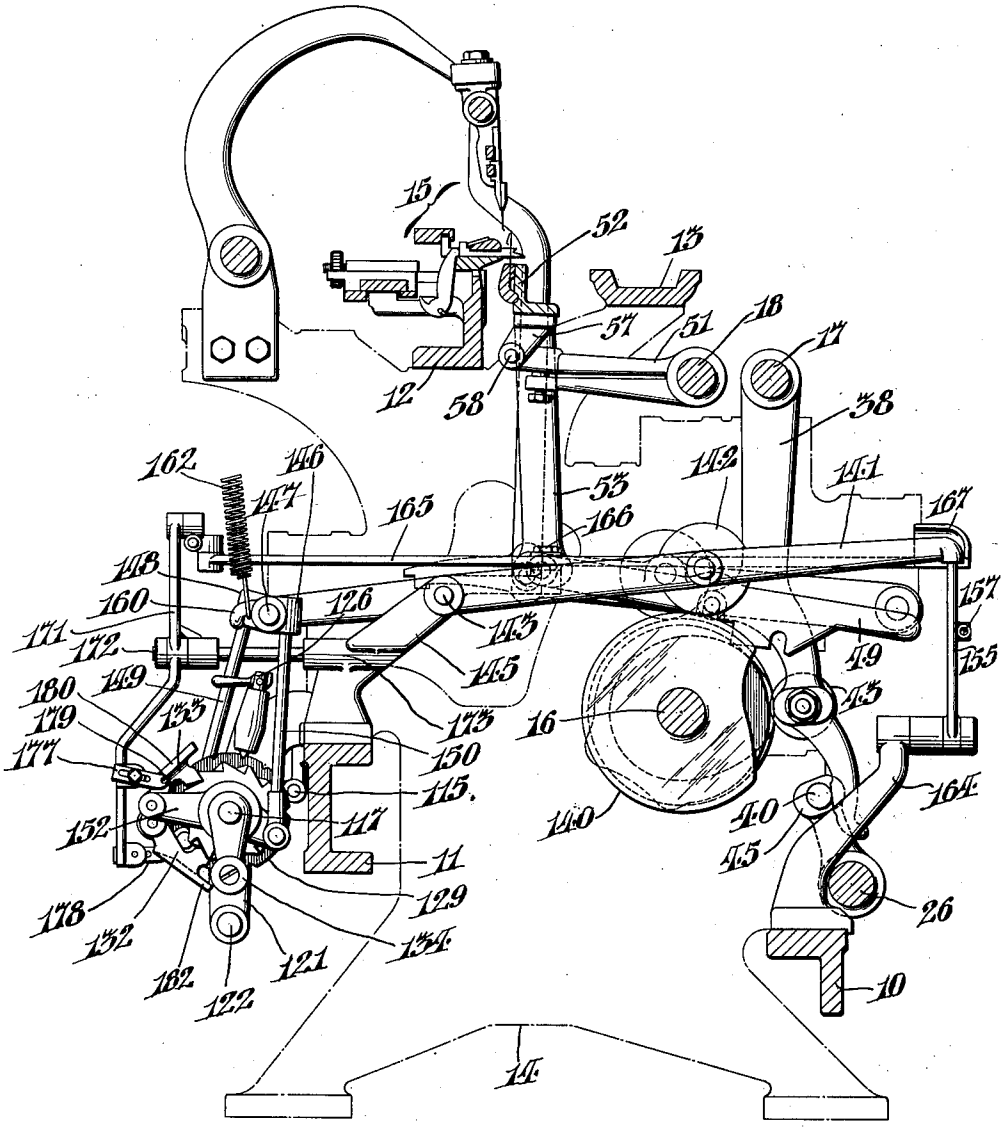
Fig. 2.



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LOOP LENGTH REGULATING MECHANISM FOR STRAIGHT KNITTING MACHINES

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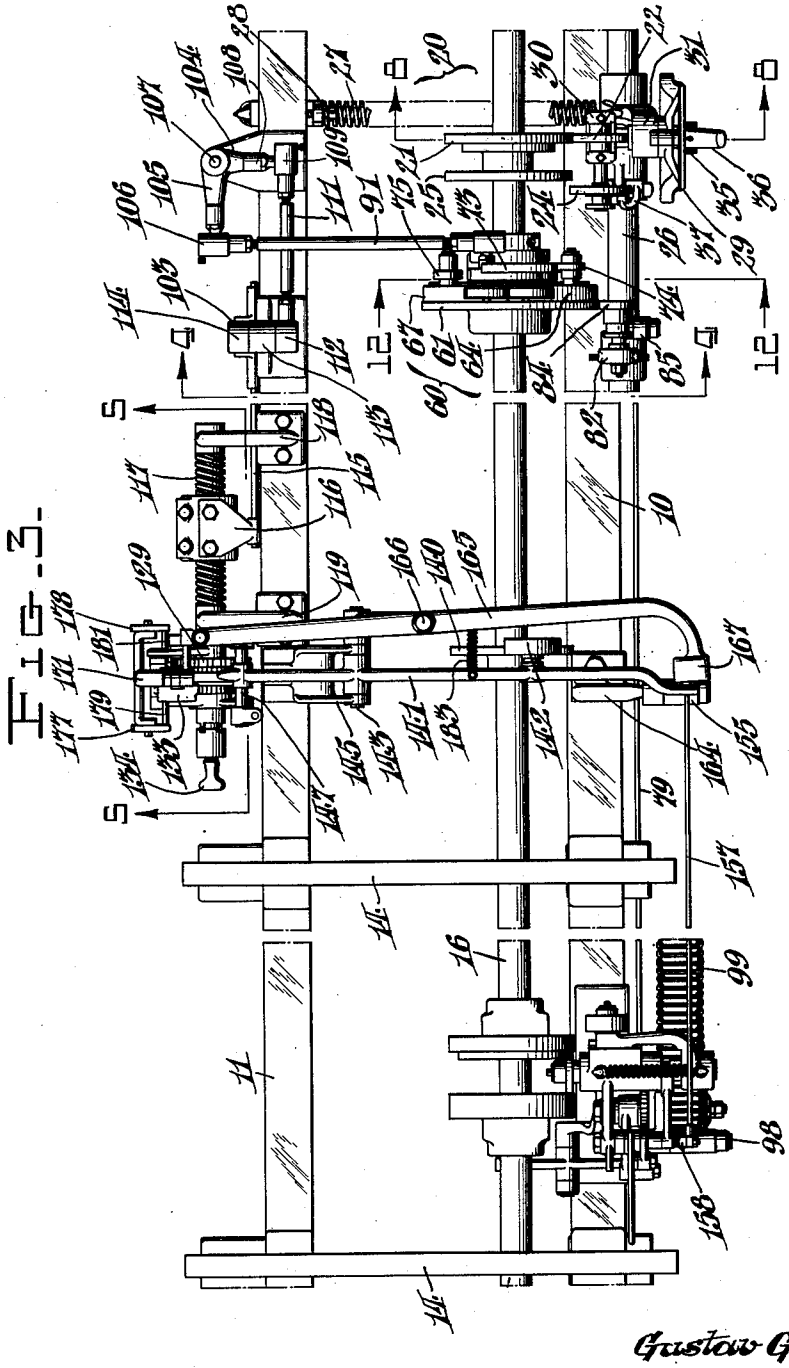
FIG. 3.



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LOOP LENGTH REGULATING MECHANISM FOR STRAIGHT KNITTING MACHINES

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FIG. 7.

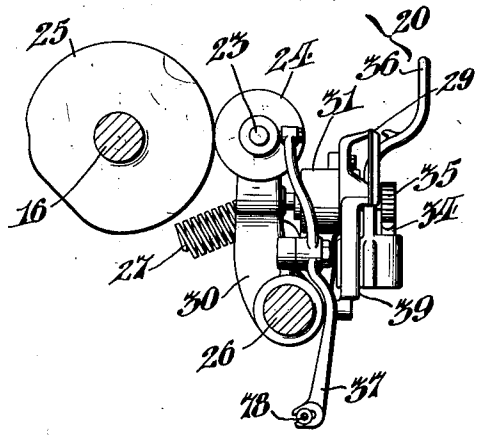


FIG. 8.

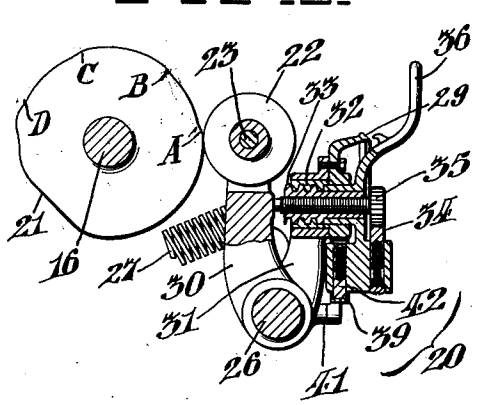


FIG. 4.

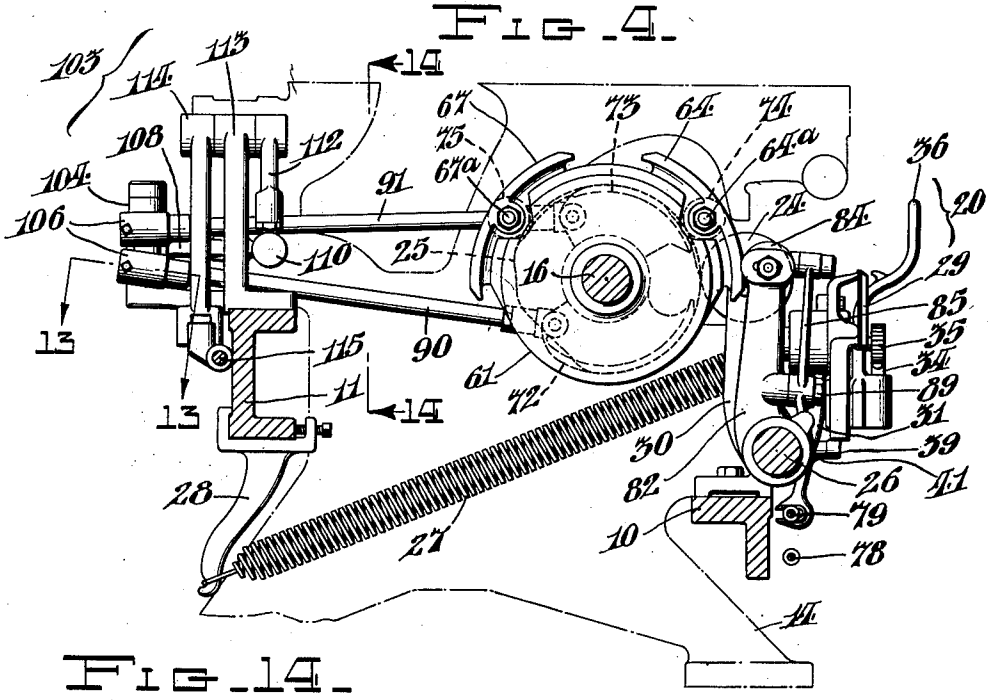
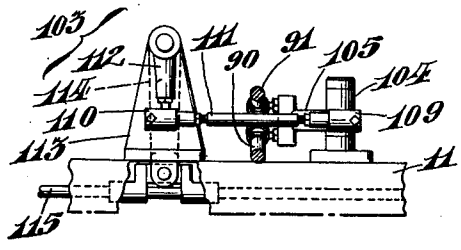


FIG. 14.



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LOOP LENGTH REGULATING MECHANISM FOR STRAIGHT KNITTING MACHINES

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FIG. 5.

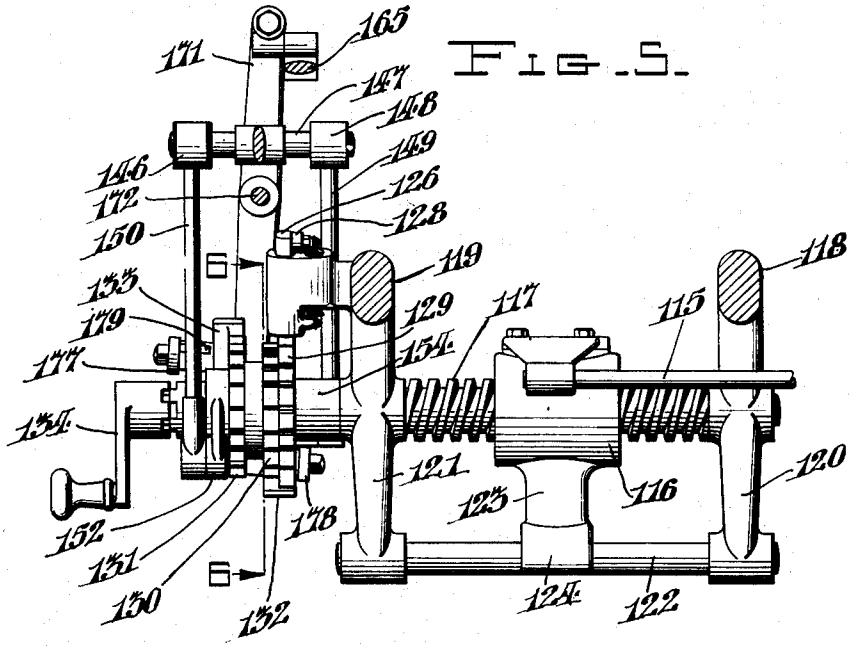
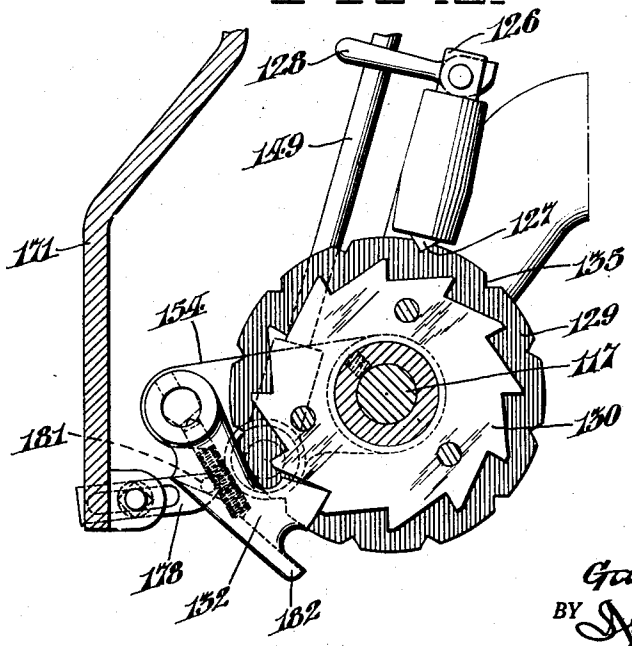


FIG. 6.



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Oct. 10, 1939. G. GASTRICH 2,175,989

LOOP LENGTH REGULATING MECHANISM FOR STRAIGHT KNITTING MACHINES

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Fig. 9.

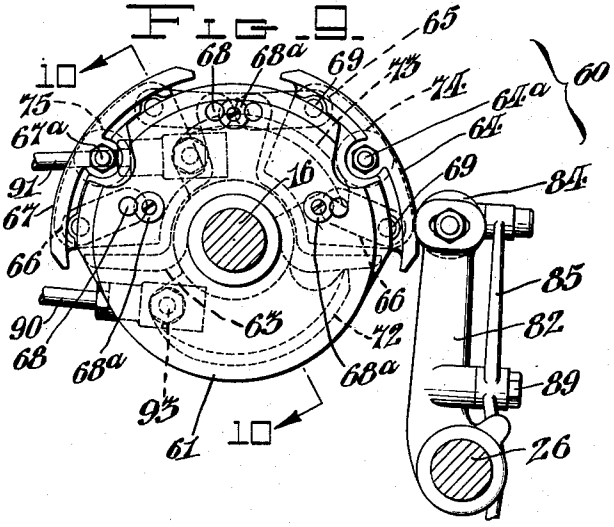


Fig. 10.

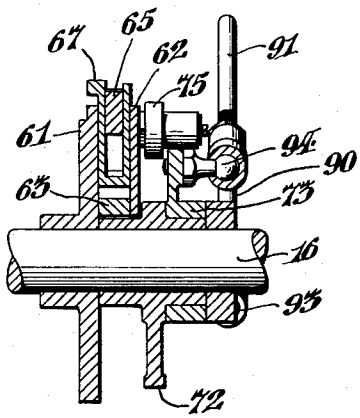


Fig. 11.

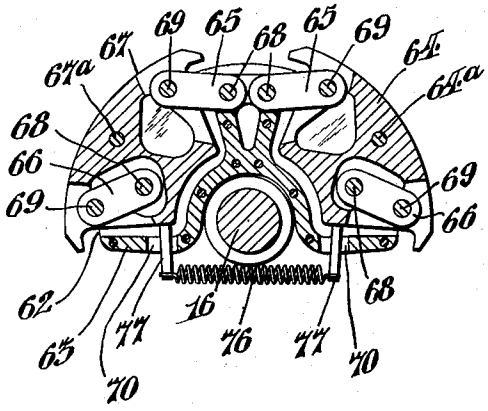


Fig. 12.

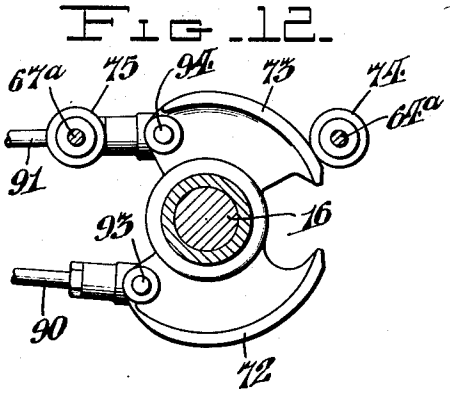
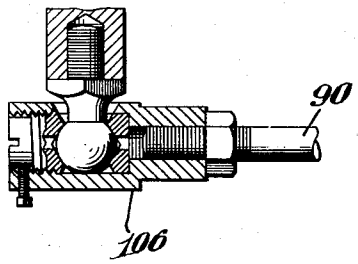


Fig. 13.



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Oct. 10, 1939. G. GASTRICH 2,175,989

LOOP LENGTH REGULATING MECHANISM FOR STRAIGHT KNITTING MACHINES

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Fig. 15.

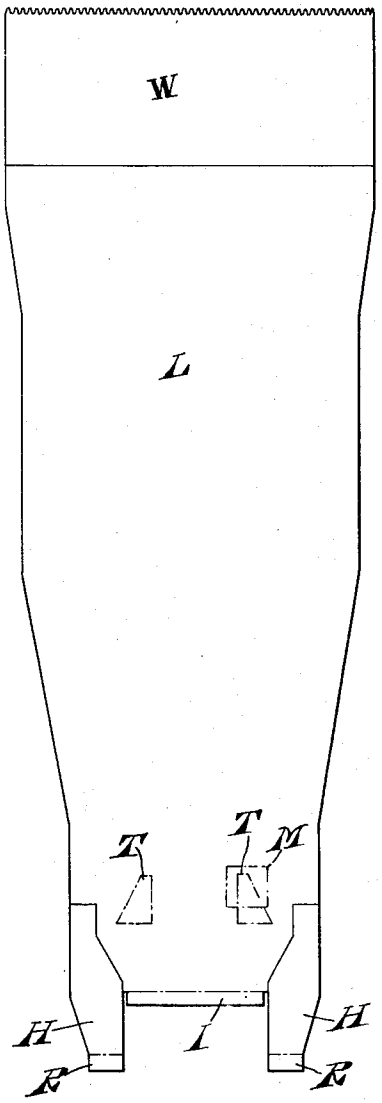
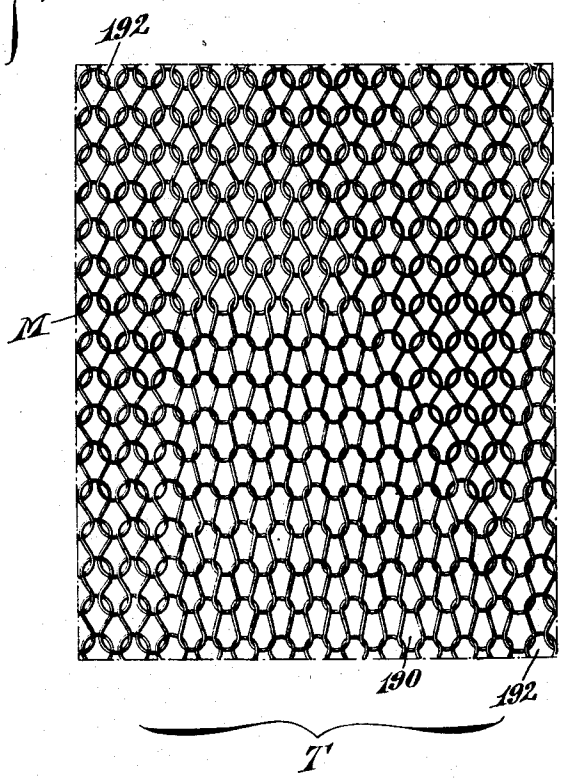


Fig. 16.



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Patented Oct. 10, 1939 2,175,989

UNITED STATES PATENT OFFICE

2,175,989

LOOP LENGTH REGULATING MECHANISM FOR STRAIGHT KNITTING MACHINES

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Application August 12, 1937, Serial No. 158,645

21 Claims. (Cl. 66—82)

This invention relates to knitting machines and particularly to the loop regulating mechanism of straight or full fashioned knitting machines.

Full fashioned stockings are generally shaped to conform to the contour of an average leg corresponding with a respective foot size. However, because of the variation in the size and contour of legs having the same foot size, it has been impossible to provide a perfect fit in every instance. For example, on an ankle of less than normal size, small pockets, due to slack in the fabric are apt to form.

One object of this invention is to provide means capable of overcoming this difficulty by producing slack take-up areas of short loops in areas of normal length loops.

Another object of this invention is to provide means including standard adjustable normal loop regulating mechanism, and pattern controlled auxiliary mechanism capable of effecting a change in the usual functioning of the standard loop regulating mechanism, so that it will perform the additional function of producing shorter than normal loops, without disturbing the adjustment of the standard loop regulating mechanism. One form of my invention embodies mechanism of such construction that it can be maintained at all times in fixed position, and rendered ineffective or effective by moving the normal loop regulating mechanism into and out of operating position.

Another object of this invention is to provide mechanism of the type referred to that will adjustably control the length of loops and maintain the same difference between the length of loops of certain length and loops of length shorter than said certain length loops regardless of adjustment.

Another purpose of this invention is to provide mechanism of the type referred to having means for governing the coursewise extent of the short loops in a knitted fabric, thereby governing the length of loops within a predetermined zone.

Another object of this invention is to provide means of the type referred to having independently operated pattern controlled mechanism for regulating the operation of the mechanism which governs the extent of the short loops.

With these and other objects in view, which will become apparent from the following detailed description of the illustrative embodiments of the invention shown in the accompanying drawings, my invention resides in the novel elements of construction, devices and combination of parts in cooperative relationship, as hereinafter more particularly set forth in the claims.

In the drawings:

Figure 1 is a front elevational view of a portion of a full fashioned knitting machine showing the relative position of various well known auxiliary units in relation to the new and improved structure embodying this invention;

Fig. 2 is a sectional view taken substantially along the line 2—2 of Fig. 1, showing an end elevation of some of the parts embodying the present invention;

Fig. 3 is a view taken substantially along line 3—3 of Fig. 1, showing a general plan view of the parts embodying the present invention;

Fig. 4 is a sectional view taken substantially along line 4—4 of Fig. 3, and showing some of the parts embodying the present invention;

Fig. 5 is a sectional view taken substantially along line 5—5 of Fig. 3, showing the adjusting unit;

Fig. 6 is a sectional view taken substantially along line 6—6 of Fig. 5, and showing a portion of the racking mechanism for actuating the adjusting unit shown in Fig. 5;

Fig. 7 is a sectional view taken substantially along line 7—7 of Fig. 1;

Fig. 8 is a sectional view taken substantially along line 8—8 of Fig. 3, showing a modified loop-regulating cam for effecting the production of shortened loops;

Fig. 9 is a sectional view taken substantially along line 9—9 of Fig. 1, illustrating the control rotor;

Fig. 10 is a sectional view taken substantially along line 10—10 of Fig. 9;

Fig. 11 is a sectional view taken substantially along line 11—11 of Fig. 1, showing the construction of the radially movable elements of Fig. 9;

Fig. 12 is a sectional view taken substantially along line 12—12 of Fig. 3, showing the circumferentially shiftable cam elements for controlling the radial movement of the segmental shoe elements shown in Fig. 9;

Fig. 13 is a sectional view taken substantially along line 13—13 of Fig. 4, showing the construction of the universal connection between various operating rods used in this invention;

Fig. 14 is a sectional view taken substantially along the line 14—14 of Fig. 4;

Fig. 15 is a view of a stocking leg blank, with certain areas produced by the mechanism of the invention being indicated by the triangles shown in dot-and-dash outline; and

Fig. 16 is an enlarged detail view of the loop formation included within the square M indicated in dot-and-dash outline in Fig. 15.

In the drawings and description, only those parts necessary to a complete understanding of the invention have been set forth; further information as to the construction and operation of other elements not herein specifically pointed out, but which are usual and well known, being available in the pamphlet entitled "Full Fashioned Knitting Machines", copyright 1920, and in the "Reading" Full Fashioned Knitting Machine Catalogues, copyright 1929 and 1935, published by the Textile Machine Works, Reading, Pennsylvania, and in a pamphlet entitled "Knitting Machine Lectures", published in 1935 by the Wyomissing Polytechnic Institute, Wyomissing, Pennsylvania.

A portion of a full fashioned knitting machine is disclosed in the drawings which includes front beam 10, back beam 11, center bed 12, and front bed 13, all of which are supported by frames 14 regularly spaced throughout the length of the knitting machine. The main cam shaft 16, presser shaft 17, the regulating shaft 26, and needle bar shaft 18, are all located in their conventional places in the machine frame. This frame work of the knitting machine supports the usual slur bar for actuating the jacks which in turn control part of the movement of the sinkers; the dividers, with their actuating mechanism; the needle bar, with its actuating mechanism; the usual narrowing mechanism, and all other conventional elements of a knitting machine. These elements form no part of the specific invention and are therefore merely referred to in a general manner.

This invention is applicable to existing knitting machines employing the usual normal loop regulating mechanism and usual needle bar actuating mechanism which normally include a regulating shaft, a presser lever and a needle bar fork, conventionally controlled by standard loop regulating mechanism, the usual function of which is to maintain the needle bar fork in a position to space the needles at a determined distance from the sinker head assembly during that portion of the cycle of operation of the knitting machine within which the yarn is fed to the knitting needles and the sinkers and dividers function to form the loops. This portion of the cycle of operation of the knitting machine will be hereinafter referred to as the loop-length-forming operation of the knitting machine.

Auxiliary mechanism is often utilized to variably position the knitting needles relative to the sinker head assembly while maintaining the usual loop regulating mechanism in adjusted position. These prior known auxiliary devices can only increase the size of the loops over and above the length produced by the usual loop regulating mechanism, and it is a purpose of this invention to construct apparatus that will automatically space the needles relative to the sinker head in a manner to effect the production of loops of length shorter than the loops produced by the usual loop regulating mechanism in accordance with a predetermined pattern.

Referring to Fig. 2 of the drawings, the knitting needles are supported in operable position adjacent the sinker head assembly 15 by the needle bar 52. This bar is supported by the needle bar hinge 57 pivoted by hinge pin 58 to the needle bar lifting arm 51 mounted on the needle bar shaft 18. Inasmuch as the present invention does not relate to the vertical movement of the knitting needles, the actuating mechanism for imparting this movement to the needles through the needle bar lifting arm 51 has not been shown. The horizontal motion during the interlooping operation of the knitting machine is imparted to the needles by mechanism actuated from the main cam shaft 16 through a cam follower 43 and a system of levers including a presser lever 38 secured to the presser shaft 17, a rocker arm 49 releasably connected to the presser lever 38, and a needle bar fork 53 pivoted to the rocker arm 49 at its one extremity and rigidly attached to the needle bar at its forked extremity. The horizontal adjustment of the needles relative to the sinker head assembly 15 during the loop-length-forming operation of the knitting machine is effected through the same system of levers, but in this case they are actuated by mechanism operating between the main cam shaft 16 and the regulating shaft 26. The effect of this mechanism is transmitted to the system of levers by a crank 45 which is rigidly mounted on the shaft 26 and which is provided with an abutting pin 49 in line and adapted to cooperate with the lower extremity of the presser lever 38.

Positioning of the needles relative to the sinker head assembly during the loop-length-forming operation of the knitting machine may be occasioned by the above recited mechanism under control of the regulating shaft 26 which causes the crank 45 to position the presser lever accordingly. One form of mechanism for effecting this positioning of the regulating shaft 26 is represented generally by the numeral 20. The preferred form of mechanism selected for carrying out this portion of the inventive thought embodies customary loop regulating mechanism and auxiliary loop regulating mechanism constructed and arranged in such manner that simultaneously with the former being shifted out of operating position, the latter automatically becomes effective. Referring to Figs. 7 and 8, a customary loop regulating cam 25 and an auxiliary loop regulating cam 21 are mounted for rotation with the main cam shaft 16; the contour of the former is of constant radius throughout the effective portion of its periphery, while the latter is provided with concentric surfaces of less radius than the surface of constant radius of the customary regulating cam which are distributed about the periphery of the latter for the purpose of producing shortened loops in a predetermined area or areas corresponding to the number and disposition of the surfaces of lesser radius.

The cams 25 and 21 function only during a portion of their rotative cycle to control the position of the presser levers 38 by means of the regulating shaft 26, other means such as the conventional presser cams control the position of these levers and consequently of the needles during the remainder of the knitting cycle. In the specific embodiment disclosed, loop length control surfaces are disposed over substantially the entire loop-length control portion of cam 21 and consist of zones A—B and C—D which will effect the positioning of regulating shaft 26 to produce shortened loops, and a zone B—C that will position the regulating shaft to effect the production of normal length loops.

A composite unitary structure is mounted on the regulating shaft 26 for supporting cam followers 24 and 22 in such manner that their co-

operation with the cams 25 and 21 is transmitted through the regulating shaft 26 to the crank 45 for positioning the presser lever 38 and hence positioning the knitting needles relative to the sinker head assembly 15. This unitary structure comprises a forked lever 30 oscillatably mounted on the regulating shaft 26 and supporting a shaft 23 upon which the cam follower 24 is mounted for rotation and axial shifting. The cam follower 22 is likewise mounted on shaft 23 for rotation but it is axially fixed in alignment with the auxiliary loop regulating cam 21. This construction is possible because the portion of the peripheral surface of cam 21 that effects the positioning of the needles for the production of shortened loops is of less radius than the portion of cam 25 which effects the positioning of the needles relative to the sinker head for the production of normal size loops. It becomes obvious therefore that the shifting of the cam follower 24 into alignment with its cam, renders the follower 22 ineffective but permits it to remain in operable position i. e. in alignment with its cam 21, and it is only necessary to shift cam follower 24 out of operating position, i. e. out of alignment with cam 25 to render the operation of cam 21 and follower 22 effective.

In the present embodiment of the invention the operation of either cam 25 or cam 21 with their corresponding followers is transmitted to the regulating shaft 26 through the medium of a lever 31 fixed to regulating shaft 26 and supporting an adjusting means for initially setting the regulating shaft for the production of loops of certain length. The end of lever 31 is displaced from the vertical into alignment with an abutting surface on the forked lever 30, and is in the form of a boss, bored to receive an internally threaded bushing 32 which is held therein by set screw means. An adjusting screw 33 provided with external threads mating with the internal threads of bushing 32 is threaded therein and is provided with internal threads of a much finer pitch than that of the external threads thereof. The screw 33 is provided with a relatively long plain cylindrical surface adapted to receive a combined adjusting handle and detent supporting element 36 which is fixed to the extended portion of screw 33. A knurled headed screw 35 provided with threads mating the fine pitched internal threads of screw 33 is threaded therethrough and the abutting end thereof coacts with the abutting surface of forked lever 30; said coaction being established by means of a spring member 27 having opposite ends thereof respectively secured to a hook portion of the lever 31 and to a bracket 28 which is fastened to the back beam 11, as better seen in Fig. 4. A spring pressed detent 34 is positioned in the handle 36, as shown in Fig. 8, in such manner that the detent cooperates with the knurled head of screw 35 for maintaining the same in adjusted position. The semi-circular internally toothed ring 39 is mounted in cooperative relation with the adjusting mechanism, and in this instance is fixed at its bottom portion to a boss 41 extending from lever 31. The extremities of the semi-circular ring are connected to a semi-circular dial element 29 of less radius than the ring, which in turn is screw fastened to the lever 31 as clearly shown in Fig. 8. Another spring pressed detent 42 which is carried by the handle 36 cooperates with the internal teeth of ring 39 for maintaining the handle 36 in adjusted position.

Provision is made for shifting the cam follower 24 out of, and into alignment with cam 25 in accordance with a predetermined pattern, and in the present instance illustrative mechanism is shown which includes the addition of a grooved connector to the follower 24 which cooperates with a pin at one end of a shift lever 37, pivotally mounted on the forked lever 30, see Figs. 1, 3 and 7. The end of lever 37 remote from follower 24 is connected to a rod 78 which is actuated from a main pattern chain 99 in a manner to be hereinafter more fully explained.

From the foregoing discussion it is apparent that normal loop length, for a given setting of the adjusting means cooperating with lever 30, can be effected while the cam follower 24 is in position to cooperate with cam 25. Upon the shifting of the follower 24 out of operating position it is apparent that cam 21 and its cooperating follower 22 will position the needles relative to the sinker head to produce loops the length of which will be governed throughout the effective portion of cam 21 in accordance with the contour of the peripheral portion A to D. The mechanism illustrated will effect the production of two spaced zones of constant width consisting of shortened loops equal in number to that which can be formed while the cam 21 is rotating with the portions A—B and C—D in engagement with follower 22. Intermediate these two zones, normal length loops will be produced while the portion B—C engages follower 22. This will occur in every course of loops knitted while the loop-length-forming mechanism is operating under the influence of cam 21 and follower 22, thus selectively producing constant width areas of any desired length throughout the knitting of the article. It is to be understood, however, that these surfaces which effect the production of shorter than normal loops may be distributed about the periphery of cam 21 in any manner, and this invention is not intended to be limited by the specific embodiment shown. Further, it becomes apparent that varied adjustments including micrometric positioning of the regulating shaft 26 can be effected for initially positioning the knitting needles relative to the sinker head assembly to govern the length of normal loops. It is also apparent that this form of adjusting means which cooperates with the forked lever 30 will maintain a constant relative loop length between the actuation of the normal loop cam 25 and its follower 24, and the actuation of the modified loop cam 21 and its follower 22, because any adjustment will equally affect each set of cams and followers, since both followers are supported by lever 30.

While constant width areas may be desirable in some instances, it is manifest that for practicability, the mechanism should be capable of producing various shaped areas of tight loops within areas of normal length loops in order to meet the requirements of the hosiery manufacturer. Thus in the case where pockets are formed in the ankle portions of stockings it may be desirable to form triangular areas of tight loops, as for instance are illustrated in Figs. 15 and 16.

For rendering the described mechanism versatile, pattern controlled mechanism, capable of influencing the operation of the auxiliary loop regulating mechanism is provided for varying the marginal border of the area or areas of tight or shortened loops. One form of apparatus that will conveniently permit pattern controlled variation of the marginal borders of the areas of short loops may operate in itself to govern the

length of loops over a predetermined area or zone, and also determine the area in which shortened or tight loops are formed. This may be accomplished by a mechanism 60, see Figs. 1 and 3, that will hold the regulating shaft 26 in position to produce predetermined length loops during a definite angle of rotation of cam shaft 16, and then permit the same to be influenced by the auxiliary loop regulating mechanism in accordance with a predetermined pattern.

Referring to Figs. 1, 3, 4, 14, and 9 to 12, inclusive, the mechanism 60 may conveniently take the form of a rotor fixed to the cam shaft 16 and capable of moving the regulating shaft, through the cooperation of an adjustable roller 84 mounted at the end of a lever 82 fixed to the regulating shaft 26, and a plurality of radially movable segmental shoe elements 64 and 67 mounted on the rotor device and cooperating with segmental cams 73 and 72.

The shoe elements 64 and 67 are mounted for radial movement on a supporting disc 61 fixed to shaft 16 and cooperating with a spaced disc 62 held in such relation by a spacing element 63, which provides with the two discs 61 and 62, pockets for the reception of the radially movable shoes 64 and 67. The two discs 61 and 62 and spacing element 63 are integrally united by screws passing through the three elements. The shoes are mounted within these pockets for limited radial movement by a series of links 65 and 66. Referring specifically to Fig. 11, wherein a manner of mounting shoes 64 and 67 is disclosed, the same are provided with transverse openings extending therethrough, and the ends of each are longitudinally slotted to receive the ends of links 65 and 66. The links 65 and 66 have their outer ends pivoted to the shoes 64 and 67 by the pins 69. The inner ends of links 66 are pivoted to the discs 61 and 62 by pins 68 passing through the transverse openings of the shoes and seating in the respective discs, while the inner ends of links 65 are fitted into a slotted portion of spacing element 63 and are pivoted to the same by pins 68. The pins 68 are maintained in position by washers 68*a*, secured by screws in the outer surface of disc 61, and having their peripheral edges engaging grooved ends of pins 68, see Fig. 9.

Provision is made to compensate for objectionable radial displacement of the shoes 64 and 67 by centrifugal force, and in this instance comprises studs 77 extending from each shoe, downwardly through slots 70 in spacing element 63 and joined together by extension spring 76. The shoe 64 is provided with a cam follower 74 mounted on pin 64*a*, and shoe element 67 is likewise provided with a similar cam follower 75 mounted on pin 67*a*.

Non-rotatable adjustable means is provided in the form of cams 72 and 73 arranged to cooperate with followers 75 and 74 respectively to position shoes 64 and 67 in such position that cooperation between these shoes and follower 84 of lever 82 positions the regulating shaft 26 for effecting the production of predetermined length loops depending upon the design of cams 72, 73 and the adjustment of roller 84. The regulating shaft 26 will be influenced by the cam 21 and follower 22 during the loop length forming portion of the operative cycle whenever the shoes 64 and 67 are not in operating position and when the follower 24 is out of alignment with its cam 25. One form of cam assembly capable of carrying out the desired function is specifically represented in Figs. 10 and 12, and includes the cam element 72 provided with hub portions which serve as a spacing element, a journal support for the cam 73, and also as an extended bearing. This cam element 72 is loosely journaled on the main cam shaft 16 and is collared in abutting relation with the disc 61. Inasmuch as it is desirable to have individual cams for each of the shoe elements 64 and 67, cams 72 and 73 are conveniently separated from each other so as to be operatively aligned with the rollers 75 and 74, respectively. In the present embodiment the cam 73 is journaled on the one hub portion of the cam element 72 and is maintained in axial position by the same collar that maintains cam 72 in abutting position relative to disc 61. The followers 75 and 74 are attached to the shoes 67 and 64 respectively by pins 67*a* and 64*a* which space them from the shoe elements to a point in alignment with their respective cams 72 and 73. A specific arrangement and proportioning of the cams 72, 73 and shoes 67, 64 have been disclosed in the drawings as illustrative of one embodiment of the invention. It is to be understood that the peripheral contours of cams 72, 73 may be varied in any desired manner for producing any desired loop length, or variation of loop length during their period of activity. Further, that the arcuate length of shoes 67, 64 are purposely disclosed as having a space between the trailing end to one and the leading end of the other. These shoes may be of such arcuate extent as to overlap when it is desired to render them effective over the entire portion of cam 21 that controls the length of loops.

Inasmuch as it is desirable that cam followers 84 and 24 be simultaneously shifted in opposite directions, an arrangement has been developed whereby this operation is controlled from the main pattern chain and requires but one button on the chain to simultaneously shift the one cam follower into operable position and the other cam follower out of operable position. A preferred form of mechanism provides a grooved connector on the shiftable follower 84 adapted to be engaged by a pin at one end of a shift lever 85 pivotally mounted on stud 89 extending from lever 82. Adjustable limiting means is provided in the form of a set screw 86 which is carried by the shift lever 85 in abuttable relation with element 88 on the lever 82. The lower end of shift lever 85 is connected to a connecting rod 79 paralleling connecting rod 78, but extending beyond the latter's terminus and engaging the lower end of a lever 97 pivotally mounted on a pin 98 in juxtaposed relation with the main pattern chain 99. Conventional abutting means 101 is mounted on lever 97 for cooperation with conventional pattern chain buttons 100 for displacing lever 97 in one direction while conventional spring means which is not shown returns lever 97 to its initial position after the pattern chain button 100 passes beyond the abutting means 101. The simultaneous shifting of the followers 84 and 24 in opposite directions coincident with the movement of lever 97 and rod 79 is effected by a lever 95, pivotally mounted on front beam 10, and provided with pins 96 engaging double collars 80 and 81 on rods 78 and 79 respectively. The pivot for lever 95 is located between the parallel rods 78 and 79, thus the shifting of rod 79 to the left causes a corresponding shift of rod 78 to the right.

It is thus seen that predetermined length loops will be produced when the follower 84 is in contact with either shoe 67 or 64 and the latter are operatively associated with their respective cams 72 and 73. It is further seen that by selectively

adjusting the cams 72, 73 circumferentially of the shaft 16, a selective control will be accomplished which can render the whole or any selected portion of the zones A—B, C—D effective to position the shaft 26 for the production of varying numbers of shortened or modified loops.

The determined adjusting of the cams 72 and 73 may be effected by an independently operable element the movement of which may be controlled from a pattern device. In the illustrated embodiment of the invention a traveling nut 116 is conveniently mounted outside of the machine frame at the rear thereof and on substantially the same horizontal plane as the main cam shaft 16. Referring to Fig. 5, the nut 116, in the present instance, is mounted for longitudinal movement on a screw 117 adapted to be rotated in a forward and reverse manner by mechanism to be hereinafter described. Two brackets are spacedly fixed to the back beam 11, and are provided with exteriorly extending arms 118 and 119 which support screw 117 outside of the machine frame. Two arms 120 and 121 extend downwardly from the ends of arms 118 and 119 for supporting a guide rod 122 in parallelism with screw 117. The nut 116 is provided with an extension 123 having a slide bearing 124 which cooperates with guide rod 122 which prevents rotation of the nut 116; thus translatory motion is imparted to nut 116 when screw 117 is rotated.

The changing of the longitudinal reciprocatory movement of nut 116 into transverse arcuate movement necessary to adjust the cams 72 and 73 may be effected in various ways, and in the present instance includes a system of levers and bell cranks. Cams 72 and 73 are pivotally attached by universal connectors 93 and 94, to connecting rods 90 and 91 which extend transversely of the machine frame to a convenient point above the back beam 11. A bell crank 104, Fig. 3, is pivotally attached to a bracket extending from back beam 11, by a pivot pin 107. The connecting rods 90 and 91 are joined to an arm 105 of bell crank 104 by universal ball and socket connectors 106, the details of which are illustrated in Fig. 13. An arm 108 of the bell crank 104 is attached by a universal connector 109 to a rod 111 which extends longitudinally of the machine frame and passes between the connecting rods 90 and 91, see Figs. 4 and 14.

For the purpose of decreasing the thrust necessary to operate the control mechanism 60, a device, see Figs. 3, 4 and 14, having a mechanical advantage is employed and illustratively embodies a rocker device 103 including a support 113 mounted on the beam 11 and supporting a transverse pin upon opposite ends of which are mounted levers 112 and 114 of different length. The shorter lever 112 is connected by a universal connector 110 to the rod 111, while the longer lever is connected to the reciprocable nut 116 by an intermediate rod 115.

It is thus seen that a rotative force applied to the screw 117 will effect the adjustment of cams 72 and 73 to thereby control the effectiveness of the loop-length shortening mechanism previously described.

Actuating mechanism for rotating the screw 117 in a forward and reverse direction is conveniently mounted beyond the rear of the machine, thus facilitating its mounting on the machine without interfering with other mechanism, and in the embodiment shown includes cam actuated pawl and ratchet mechanism the operation of which is controlled from the main pattern chain.

The screw 117 is provided with a plain extended portion for supporting the ratchets and auxiliary mechanism for effecting its rotation. Two reversely operated ratchet wheels 130 and 131 are fixed to the extended shaft portion of screw 117. A crank 152 is journaled on the shaft portion of screw 117 and located adjacent the ratchet wheel 131. The crank 152 is provided with rearward and forward arms extending on either side of screw 117. The rearward arm supports a pawl 133 in alignment with ratchet wheel 131, while the forward arm is attached to a connecting rod 150 the other end of which is connected to one end of a shaft 147 by a coupling 146. A crank 154 is likewise journaled on the extended shaft portion of screw 117 and separated from the ratchet wheel 130 by a detent disc 129 to be hereinafter described. The crank 154 has but one arm at the end of which a pawl 132 is mounted in alignment with ratchet wheel 130. The two pawls 132 and 133 are resiliently urged into active engagement with their respective ratchet wheels by conventional spring pressed detent means of the type clearly shown in dotted lines in Fig. 6. A connecting rod 149 is connected to the arm of the crank 154 between the pawl support and the journal portion, for imparting oscillatory motion thereto. The other end of connecting rod 149 is attached to the shaft 147 by a coupling 148, and at the end of said shaft remote from rod 150.

It is thus seen that if a vertical reciprocating motion is imparted to the shaft 147, a forward or reverse rotation can be imparted to the screw 117 and hence translate the nut 116 in a determined direction depending upon whether pawl 132 or pawl 133 is in active engagement with its respective ratchet wheel. A vertical reciprocatory motion may be imparted to the shaft 147 by any pattern controlled mechanism, and in the particular embodiment shown in Figs. 1, 2 and 3, a cam on the main cam shaft has been selected for this function, the effectiveness of which is controlled from the main pattern chain of the knitting machine. The motion of the cam is transmitted through a lever 141 pivoted on an axle 143 in a bracket 145 rigidly attached to back beam 11. The lever 141 supports a cam follower 142 in alignment with a cam 140 on the main cam shaft 16. Cam follower 142 is normally prevented from following the contour of cam 140 by a pattern chain actuated lever 155 pivoted on pin 156 which is supported in a bracket 164 rigidly attached to the front beam 10. The rearward extension of lever 141 is connected to the shaft 147, and is provided with a hook 160 for receiving one end of a tension spring 162 arranged to maintain the follower 142 in engagement with its cam 140 when the pattern chain actuated lever 155 is not in position to prevent the follower from following the contour of the same. The pattern chain actuated lever 155 is attached to one end of a connecting rod 157 the other end of which is connected to a lever 158 pivotally mounted on stub shaft 98, which lever has an extension aligned with the pattern chain 99. This lever 158 is urged in a counterclockwise direction about the shaft 98 by conventional spring means that has not been disclosed. Buttons placed on the pattern chain in alignment with an abutment on the extension of lever 158 cause the lever to pivot about shaft 98 against the action of the spring means, hence providing a selective release for the lever 141 to enable the follower 142 to

cooperate with cam 140 and consequently operate the spindle 117 and the nut 116.

It is recognized that any pattern controlled actuation of the reciprocating nut 116 must include means, also controlled by a pattern mechanism, for selectively throwing the pawls 132 and 133 into and out of engagement with their respective ratchet wheels. One type of suitable mechanism for performing this function is disclosed in Figs. 2, 3, 5 and 6, and utilizes an additional movement of lever 155 for actuating mechanism for throwing the selected pawls into and out of operating position. The addtional movement of lever 155 can be effected by employing an extra high button on the main pattern chain for cooperation with pivotal lever 158. The mechanism for lifting the pawls out of driving engagement with their respective ratchet wheel comprises, in the embodiment disclosed, pins 179 and 181 mounted on adjustable plates 177 and 178, and arranged to engage cam lips 180 and 182 on the respective pawls 132 and 133. These cam lips are so designed that their cooperation with their respective pins 179 and 181, lifts the pawls to such a point that they miss the succeeding tooth of the ratchet wheel and perform an idle operation when the cranks 152 and 154 are oscillated by the action of the cam 140 and its follower 142. The movement of the pawls, however, remains within the operative effect of the resilient means urging the same into operative engagement with the ratchet wheels, so that upon the withdrawal of either of pin 179 or pin 181, the respective pawl will be urged into active cooperation with its associated ratchet.

In order to always insure the simultaneous engagement of one pin and cam, and the disengagement of the other, a common support is provided in the form of a lever 171 which is pivoted to a rod 172 mounted in a boss 173 of the fixed bracket 145. The adjustable plates 177 and 178 supporting pins 179 and 181, are secured to this pivotal lever 171 in position such that the pins cooperate with the cam lips 180 and 182 of the pawls 133 and 132 respectively. A lever 165 extending transversely of the machine frame is connected to the upper end of common support lever 171, and is horizontally oscillated about a pivot 166 by the combined action of the additional movement of pattern chain actuated lever 155 cooperating with abutment 167, and spring 183 extending from horizontally fixed lever 141 to horizontally oscillatable lever 165.

Means in the form of the notched disc 129 is fixed to the shaft extension of screw 117 for preventing the overrun of either of the ratchet wheels 130 and 131 during their operation. This disc 129 is located between ratchet wheel 130 and the hub for crank 154, and cooperates with a spring pressed plunger 126 provided with a pointed end 127 for engaging the notches 135 spaced about disc 129 a distance corresponding to the spacing of the ratchet teeth about the periphery of ratchets 130 and 131. A handle 128 provided with a cam end is connected to the plunger 126 for rendering the plunger effective during operation of the racking mechanism, and ineffective at times when it is desired to manually rotate screw 117. This last function is conveniently accomplished by providing a common declutchable crank 134 at the end of the shaft extension of screw 117.

Operation

The proper manipulation of the adjusting device associated with arms 30 and 31 governs the normal loop length. The width or coursewise extent of the zone of shortened loops is initially determined by locating nut 116 along screw 117 by operating the declutchable crank 134. Pattern chain buttons are mounted, in alignment with lever 97, on those links of the chain 99 that correspond to the courses in which shortened loops are to be produced. The same links may or may not include buttons of single or double height in alignment with lever 158, depending upon whether the contour of the zone of shortened loops is to remain constant or vary in accordance with a predetermined pattern.

During the normal operation of the knitting machine, or when it is functioning to produce loops of normal length, the follower 84 is held out of alignment with segmental shoe elements 64 and 67, while the follower 24 is aligned with and in active engagement with its cam 25 thereby rendering follower 22 inoperative relative to its cam 21 even though the latter follower is always aligned with its cam. This normal operation continues until a button on pattern chain 99 moves lever 97 about its pivot thus actuating the two connecting rods 78 and 79 in opposite directions. This action shifts follower 24 out of alignment with its cam 25, thereby permitting follower 22 to follow the contour of its associated cam 21, and also simultaneously shifts follower 84 into alignment with shoes 64 and 67 for controlling the coursewise width of the shortened loop zones.

The operation of the knitting machine will now be influenced during the loop-length-forming phase of its operation by the cooperation of the control unit 60, the cam 21 and follower 22. As the shoe 64 rotates about shaft 16 with its roller 74 in engagement with cam 73, and its arcuate surface in contact with roller 84, regulating shaft 26 is positioned to effect the production of loops the length of which will be determined by the design of cam 73, and the adjustment of roller 84. Immediately after roller 74 passes beyond the forward end of cam 73, lever 82 with follower 84 forces shoe 64 inwardly under the action of spring urged lever 31, whereupon the follower 22 is permitted to follow the relieved surface A—B for a period depending upon the circumferential position of cam 73.

The cam 21 in the present instance is provided with a surface B—C of such radius that the regulating shaft 26 will be positioned for effecting the production of normal length loops, and as the point B arrives at the follower 22, the latter is forced outwardly to follow the contour B—C. Continued rotation of the parts brings point C into engagement with follower 22 when the follower is again moved inwardly to follow the contour between C and D. Somewhere between the points C and D, depending upon the circumferential location of cam 72, roller 75 on shoe 67 will engage cam 72 at its forward portion whereupon the shoe 67 actuates the follower 84 thus moving lever 82 and shaft 26 to a position effecting the production of loops whose length is dependent upon the design of cam 72 and the adjustment of follower 84.

The cycle above outlined may be represented in a coursewise diagram consisting from left to right of loops governed by cam 73 and the adjustment of follower 84; loops governed by the contour of cam 21 between points A and D; another set of loops whose length is determined

by the design of cam 72, and the adjustment of follower 84.

During each successive loop-length-forming operation of the knitting machine, the above cycle will be repeated as long as successive links of the pattern chain include buttons in alignment with lever 97, thus producing areas of shortened loops within areas containing loops of normal length. These zones will be of regular contour unless a link of the chain includes beside the button in alignment with lever 97, another button in alignment with lever 158, in which event, depending upon the height of the last mentioned button, the racking mechanism will effect the rotation of screw 117 to move nut 116 a definite increment either to the right or left from its initial setting, affecting correspondingly the position of cams 72 and 73. In the present embodiment, the adjustment of cams 72 and 73 varies the extent of the distance between points A and B, and the distance between points C and D of cam 21 that will be effective for the production of shortened loops, and this action of nut 116, therefore, varies the contour of the shortened loop zones. The variation in contour of the shortened loop zones in the present instance will only be present in the outer margins. The mechanism disclosed in the drawings is such as to always effect the outward displacement of follower 22 at point B of cam 21, and inward displacement at point C, thus producing regular marginal inner edges in the areas of shortened loops.

The specific arrangement and design of parts shown which illustrate an application of this invention, are particularly adapted for the production of areas T, T of shortened loops 190 at the lower portion of the stocking blanks adjacent the heel tabs H, H, symmetrically located on each side of the longitudinal center line of the blank, and of substantially right triangular form, see Fig. 15. The stocking leg blank generally indicated at S, Fig. 15, in addition to the reinforced heel portions H, H, comprises a welt W, a main leg portion L, heel ravel areas R, R, and an instep ravel area I. The structure of the loops included within the area indicated by the dot-and-dash outline M of Fig. 15, is illustrated on an enlarged scale in Fig. 16. It will be observed that the loops 190 of the area T, see Fig. 16, are of an appreciably tighter construction than the normal length loops 192 which form the remainder of the portion M, this difference in the length of the loops is effected by the mechanism and in the manner previously set forth. As illustrated the number of short loops 190 in the different horizontal courses, see Fig. 16, of the areas T, T, varies in accordance with the pattern followed during the operation of the aforesaid mechanism. Obviously the inclusion of an area of tight loops within a section composed of looser normal length loops, will have a fashioning effect on the associated fabric and consequently provide a stocking which will fit snugly about the ankle of the wearer without, however, detracting from the appearance of the stocking.

Of course, the improvements specifically shown and described, by which I obtain the above results, can be changed and modified in various ways without departing from the scope of the invention herein disclosed and hereinafter claimed.

I claim:

1. A knitting machine including means for effecting the production of loops of certain length entirely across desired courses comprising means movable into and out of operating position, and auxiliary mechanism for effecting the production of loops of length shorter than said first mentioned loops operating for portions only of selected courses comprising rotatable means fixed with respect to its axis of rotation and rendered active with the movement of said movable means out of operating position, and rendered inactive with the movement of said movable means into operating position.

2. A knitting machine including a cam shaft and a regulating shaft, means on said regulating shaft movable into and out of position to cooperate with means on said cam shaft for effecting the production of loops of certain length entirely across desired courses, and auxiliary mechanism for effecting the production of loops of length shorter than said first mentioned loops operating for portions only of selected courses comprising rotatable means fixed with respect to its axis of rotation and rendered active with the movement of said movable means out of operating position, and rendered inactive with the movement of said movable means into operating position.

3. A knitting machine including a cam shaft and regulating shaft, means on said regulating shaft movable into and out of operating position with means on said cam shaft for effecting the production of loops of certain length entirely across desired courses, and auxiliary mechanism including means on said regulating shaft for effecting the production of loops of length shorter than said first mentioned loops operating for portions only of selected courses comprising rotatable means fixed with respect to its axis of rotation and rendered active with the movement of said movable means out of operating position, and rendered inactive with the movement of said movable means into operating position.

4. A knitting machine including cam means provided with a peripheral portion of constant radius cooperating with a shiftable follower for effecting the production of loops of certain length entirely across desired courses, and auxiliary mechanism including cam means provided with peripheral portions concentric to but of less radius than the peripheral portion of said first mentioned cam adapted to cooperate with a cam follower constantly maintained in alignment therewith and effective for a portion of a course only when the first cam follower is shifted out of alignment with its cam element, for effecting the production of loops of length shorter than said first mentioned loops.

5. A knitting machine including a sinker head assembly and a needle bar supporting a plurality of knitting needles, adjustable means including an element movable into and out of operating position for spacing said needles relative to said sinker head to produce loops of certain length entirely across desired courses during the loop-length-forming operation of the knitting machine, and auxiliary means comprising a rotary cam flower fixed with respect to its axis of rotation for producing for a portion of a course only loops of length shorter than said first mentioned loops cooperating with said first mentioned means and rendered effective when the movable element is moved out of operating position for positioning the needles relative to the sinker head while maintaining the adjustment of the adjustable means.

6. A straight knitting machine including means movable into and out of operating position for producing loops of certain length entirely across

desired courses, and auxiliary means for producing loops of length shorter than said first mentioned loops operating for a portion of a course only when the first named means is out of operating position, and adjustable means for varying the length of the first mentioned loops and cooperating with the auxiliary means for maintaining a constant loop difference between said first and second means.

7. A straight knitting machine including unitary means for producing loops of certain length entirely across desired courses and loops of length shorter than said first mentioned loops for a portion only of a course comprising variable positioning means, common supporting means for a fixed and a movable element each arranged to cooperate with the variable positioning means, and adjusting means cooperating with said common support so constructed and arranged to maintain a constant loop difference between said first mentioned loops and said loops of shorter length.

8. A straight knitting machine comprising a needle bar supporting a plurality of knitting needles, mechanism for positioning said needles for the production of loops of certain length including a rotatable element shiftable parallel to its axis of rotation into and out of operating position, and a rotatable element fixed relatively to its axis of rotation effective when said shiftable element is moved out of operating position for varying the position of the needles by a fixed increment for effecting the production of loops of length shorter than said first mentioned loops operating for portions only of selected courses.

9. A straight knitting machine including loop-length regulating means, auxiliary regulating mechanism for producing loops of length shorter than those produced by said loop-length regulating means effective upon the first mentioned regulating means being rendered ineffective, and means cooperating with the auxiliary regulating mechanism and arranged to regulate the length of loops during part of its operative cycle and render said auxiliary regulating mechanism effective during another part of its operative cycle.

10. A straight knitting machine including loop-length regulating means, auxiliary regulating mechanism for producing loops of length shorter than the loops produced by said loop-length regulating means effective upon the loop-length regulating means being rendered ineffective, and means cooperating with the auxiliary loop regulating mechanism comprising rotatable elements cooperating with non-rotatable positioning elements for regulating the length of loops during part of its operating cycle and rendering said auxiliary loop-length mechanism effective during another part of its operating cycle.

11. A knitting machine including means for producing loops of certain length comprising means movable into and out of operating position, and auxiliary means for producing loops of length shorter than said first mentioned loops when the first mentioned means is out of operating position, and control mechanism for said auxiliary means movable into and out of operating position respectively with the moving of said first mentioned means out of and into operating position.

12. A straight knitting machine including composite means for effecting the production of loops of certain length and loops of length shorter than said first mentioned loops including rotatable means shiftable axially with respect to its axis of rotation and rotatable means fixed with respect to its axis of rotation, control mechanism for said composite means including rotatable means shiftable along its axis of rotation, and common means for simultaneously shifting both said shiftable means along said axes to place one in operative position at the same time the other is displaced from operative position.

13. A knitting machine including means for producing loops of certain length comprising means movable into and out of operating position, auxiliary means for producing loops of length shorter than said first mentioned loops when the first mentioned means is out of operating position, and control mechanism arranged to operate on said auxiliary means during a limited part of its operating cycle when said movable means is out of operating position.

14. A knittin machine including means for producing loops of certain length comprising means movable into and out of operating position, auxiliary means cooperating with said first mentioned means for producing loops of length shorter than said first mentioned loops and rendered effective upon the moving of the first mentioned means out of operating position, and control mechanism including rotatable elements radially movable with respect to their axis of rotation cooperating with said auxiliary means when said first mentioned means is out of operating position.

15. A knitting machine including means for producing loops of certain length comprising means movable into and out of operating position, auxiliary means for producing loops of length shorter than said first mentioned loops when the first mentioned means is out of operating position, and control mechanism arranged to effect the production of loops corresponding to the setting of said first mentioned means during part of its operating cycle, and render said auxiliary means effective during another part of its operating cycle.

16. A knitting machine including means for producing loops of certain length comprising means movable into and out of operating position, auxiliary means for producing loops of length shorter than said first mentioned loops when the first mentioned means is out of operating position, and control mechanism for said auxiliary means including rotatable elements radially movable with respect to their axis of rotation cooperating with adjustable means for producing loops corresponding to the setting of said first mentioned means during part of its operating cycle and rendering said auxiliary means effective during another part of its operating cycle.

17. A knitting machine including a cam shaft, and a regulating shaft, means mounted on said regulating shaft and cooperating with means mounted on said cam shaft for producing loops of certain length and loops of length shorter than said first mentioned loops, control mechanism mounted on said cam shaft including radially movable means rotating with said cam shaft and cooperating with non-rotatable adjustable means and means on said regulating shaft, said control mechanism being constructed and arranged to produce said certain length loops during a part of its operating cycle, and be ineffective during another part of its operating cycle.

18. A knitting machine including means for

producing loops of certain length comprising means movable into and out of operating position, auxiliary means for producing loops of length shorter than said first mentioned loops when the first mentioned means is out of operating position, control mechanism arranged to affect the operation of the auxiliary means when the first mentioned means is out of operating position, and independently operable mechanism for governing the control mechanism in accordance with a predetermined pattern.

19. A knitting machine including means for producing loops of certain length comprising means movable into and out of operating position, auxiliary means for producing loops of length shorter than said first mentioned loops when the first mentioned means is out of operating position, control mechanism arranged to effect the production of loops corresponding to the setting of said first mentioned means during part of its operating cycle, and render said auxiliary means effective during another part of its operating cycle, and independently operable mechanism for governing the extent of the operating cycle of said control mechanism within which said auxiliary means is rendered effective.

20. A straight knitting machine including loop regulating mechanism operating between a cam shaft and a regulating shaft of the knitting machine for producing loops of certain length, auxiliary loop regulating mechanism cooperating with said first mentioned loop regulating mechanism and adapted to effect the production of loops shorter than said first mentioned loops when said first mentioned loop regulating mechanism is rendered ineffective, control mechanism for said auxiliary loop regulating mechanism, and an independently adjustable element connected to said control mechanism and movable in accordance with a predetermined pattern for determinedly producing shortened loops in accordance with said predetermined pattern.

21. In a knitting machine the combination comprising, a regulating shaft, cam means associated with said regulating shaft for automatically effecting the production of loops of certain length entirely across desired courses, and auxiliary means having a cam separate from said first means associated with said regulating shaft for effecting the production of a group of loops of length shorter than said loops of certain length in a portion only of a desired course.

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