

Aug. 2, 1938.

G. BITZER

2,125,831

MULTIPLE LOOP REGULATING MECHANISM

Filed Dec. 29, 1937

8 Sheets-Sheet 1

FIG. 1.

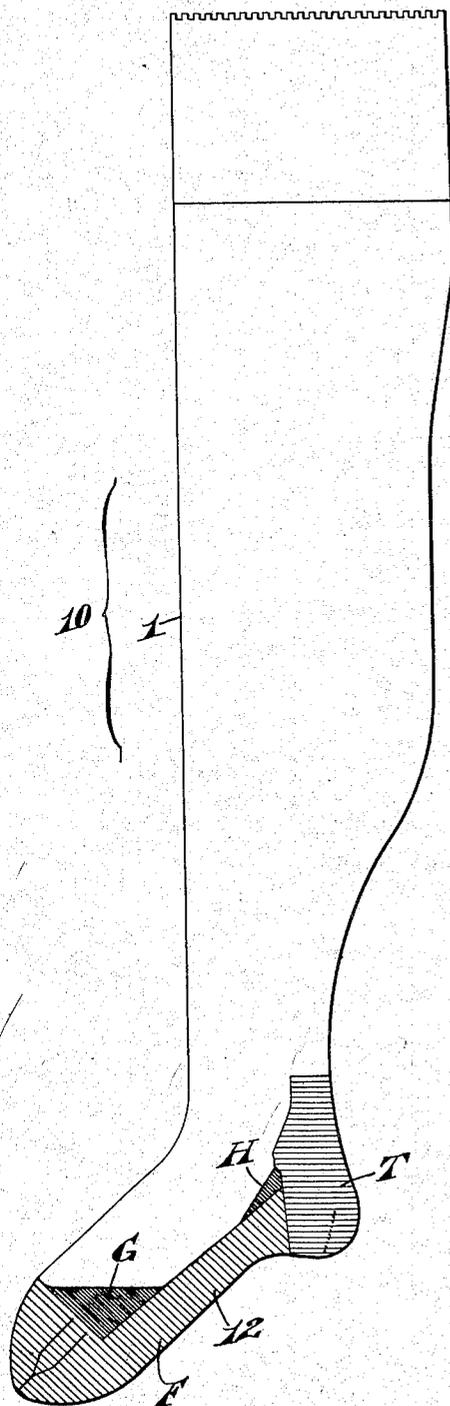
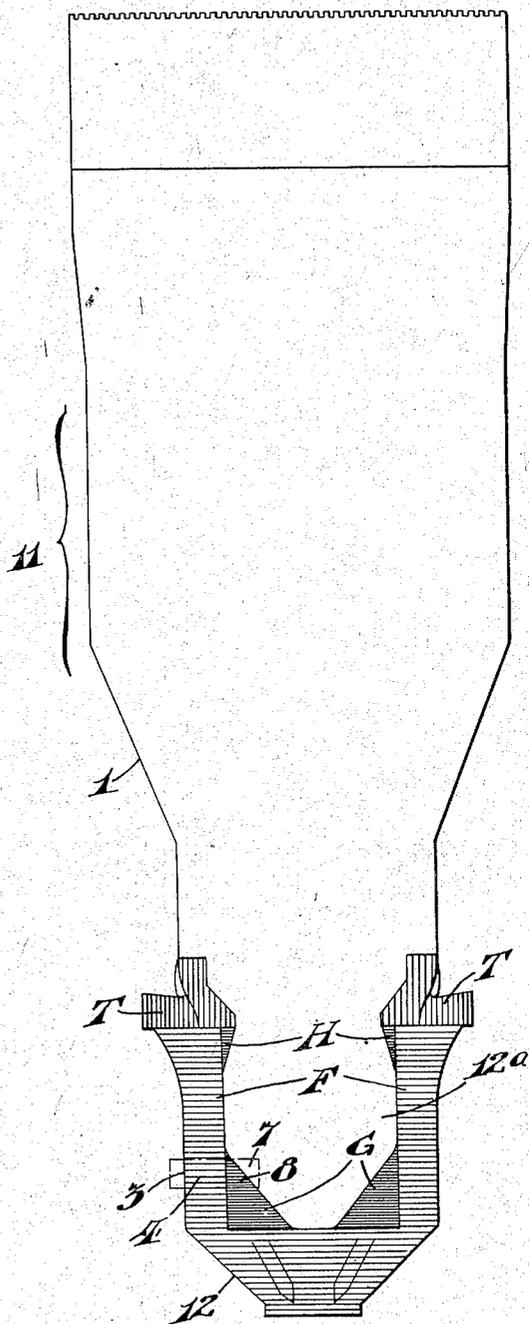


FIG. 2.



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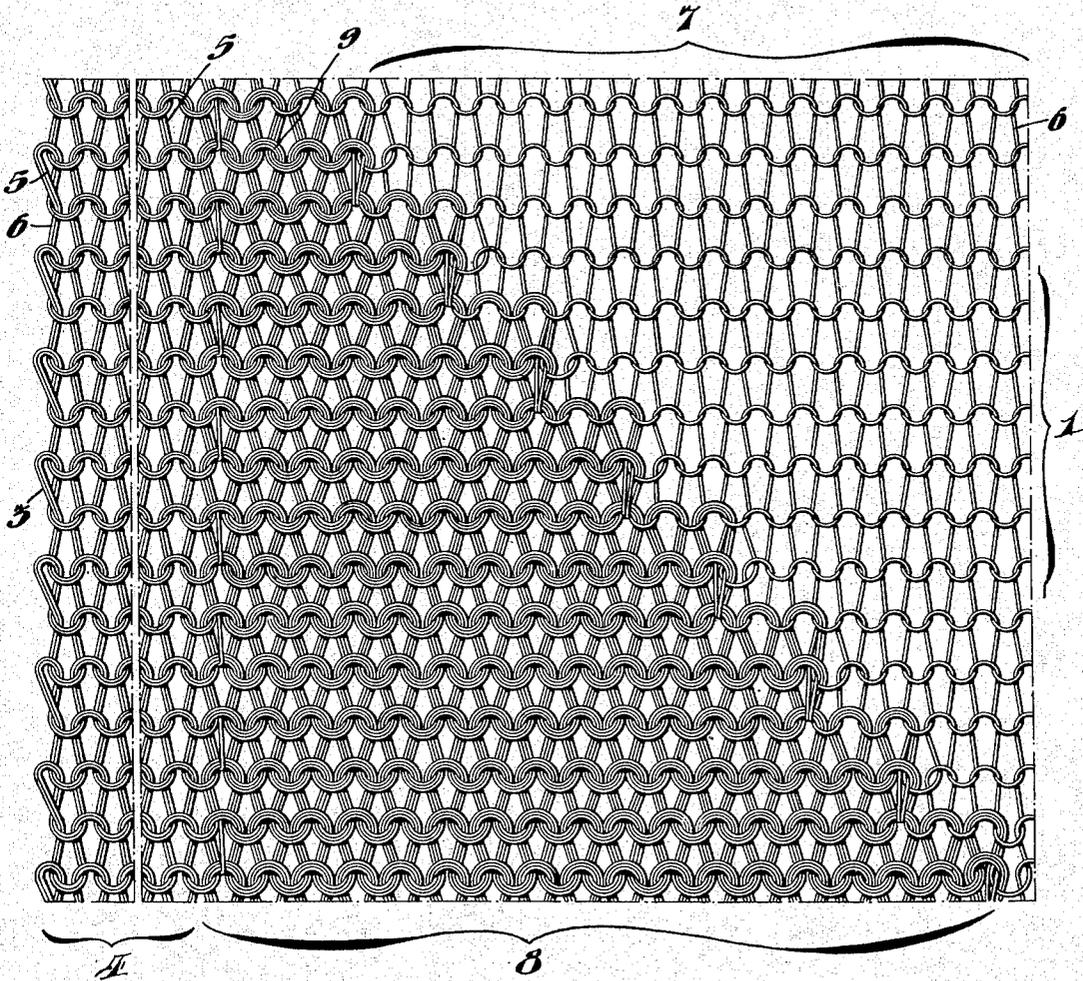
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MULTIPLE LOOP REGULATING MECHANISM

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FIG. 3.



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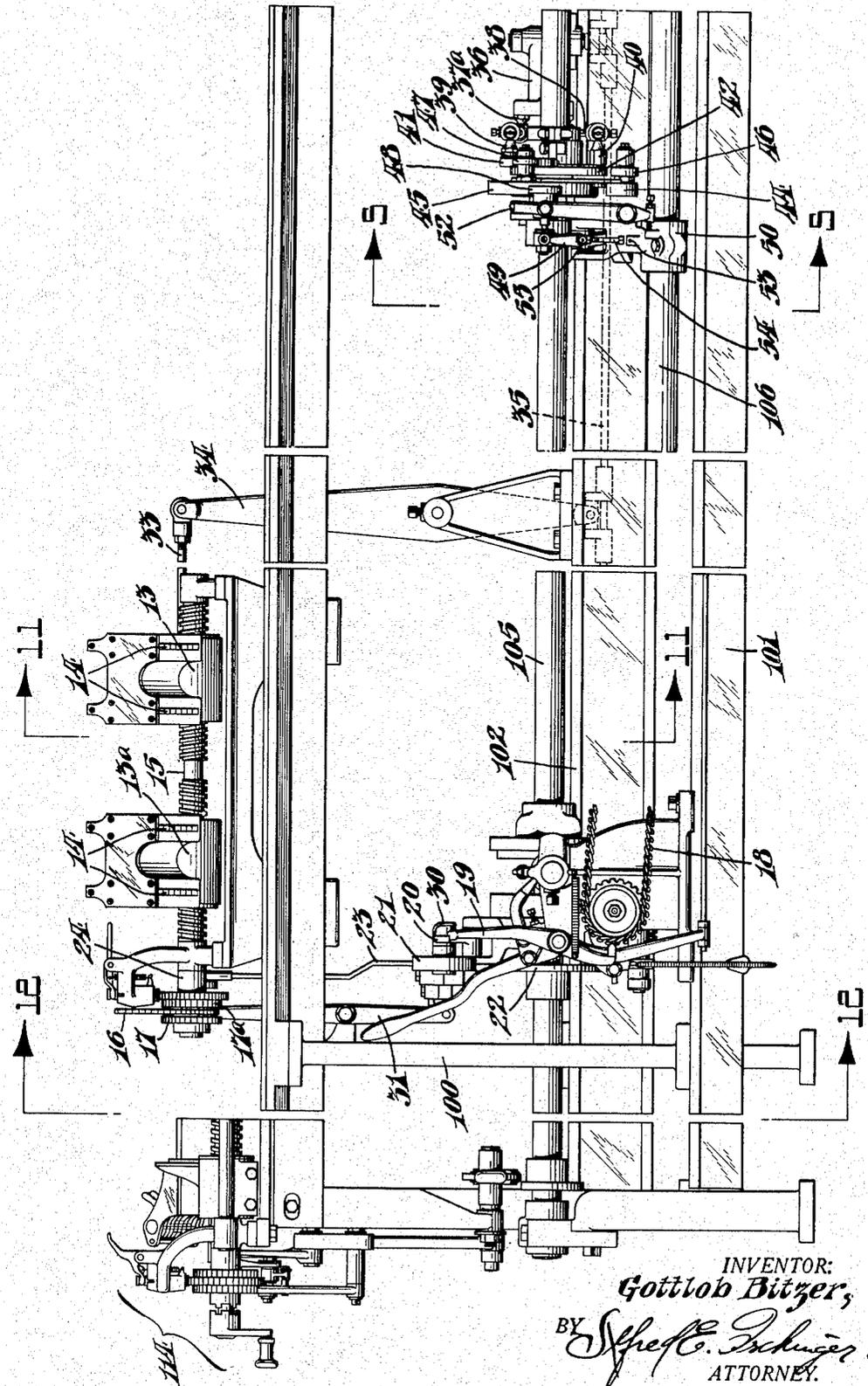
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MULTIPLE LOOP REGULATING MECHANISM

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Fig. 4.



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MULTIPLE LOOP REGULATING MECHANISM

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FIG. 5.

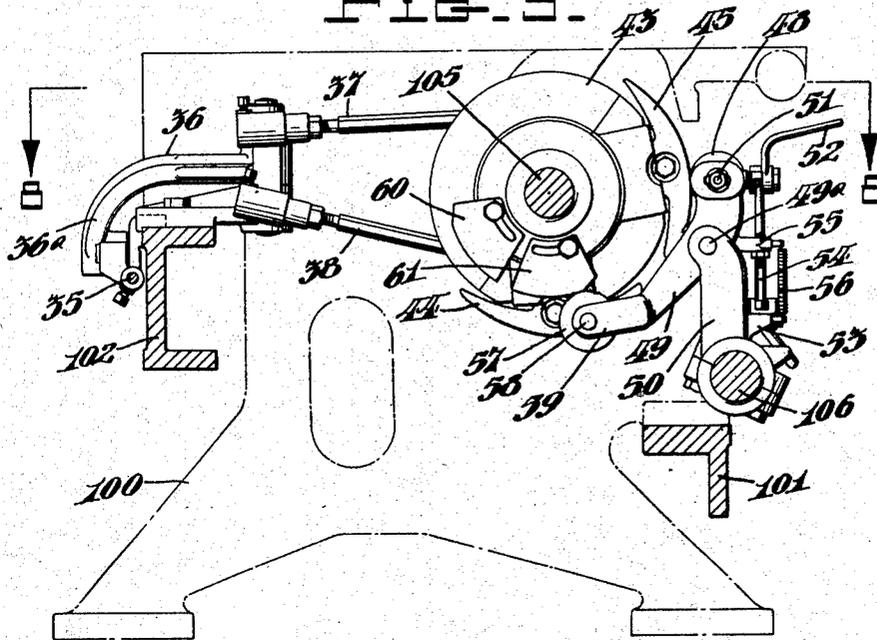


FIG. 6.

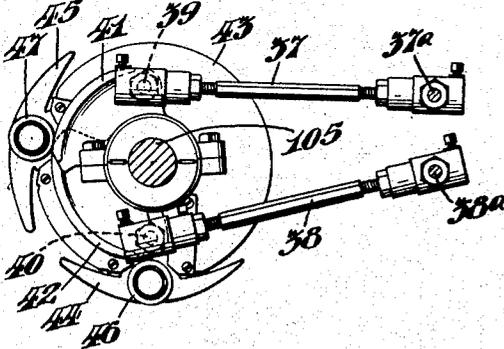


FIG. 7.

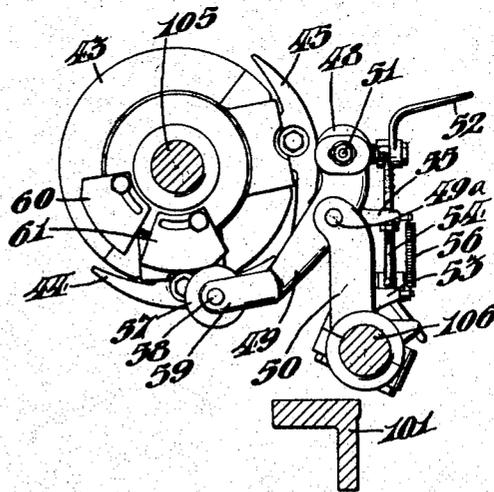
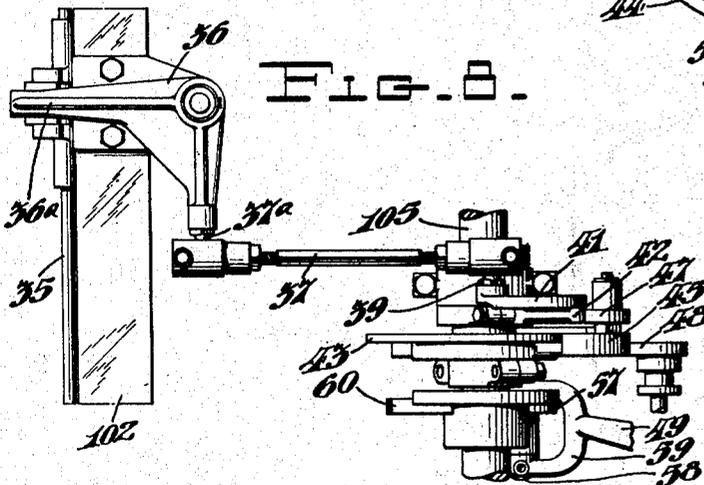


FIG. 8.



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MULTIPLE LOOP REGULATING MECHANISM

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FIG. 9.

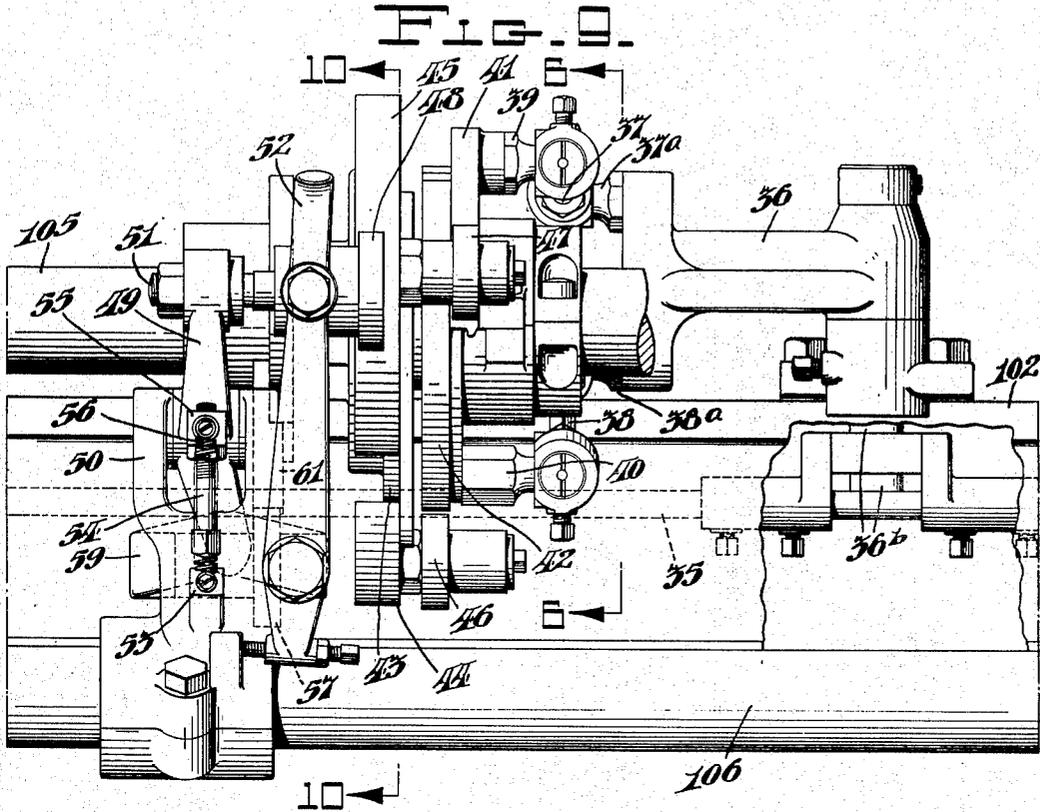


FIG. 11.

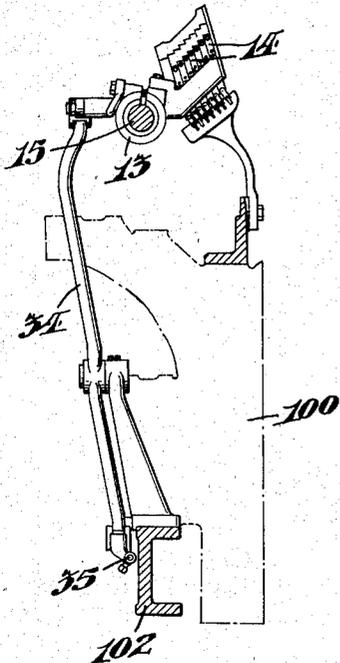
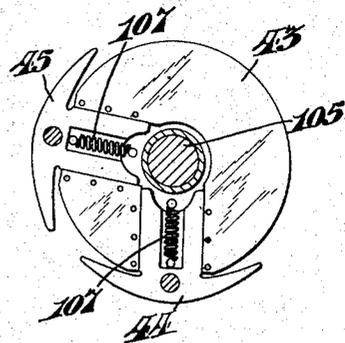


FIG. 10.



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MULTIPLE LOOP REGULATING MECHANISM

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FIG. 12.

FIG. 14.

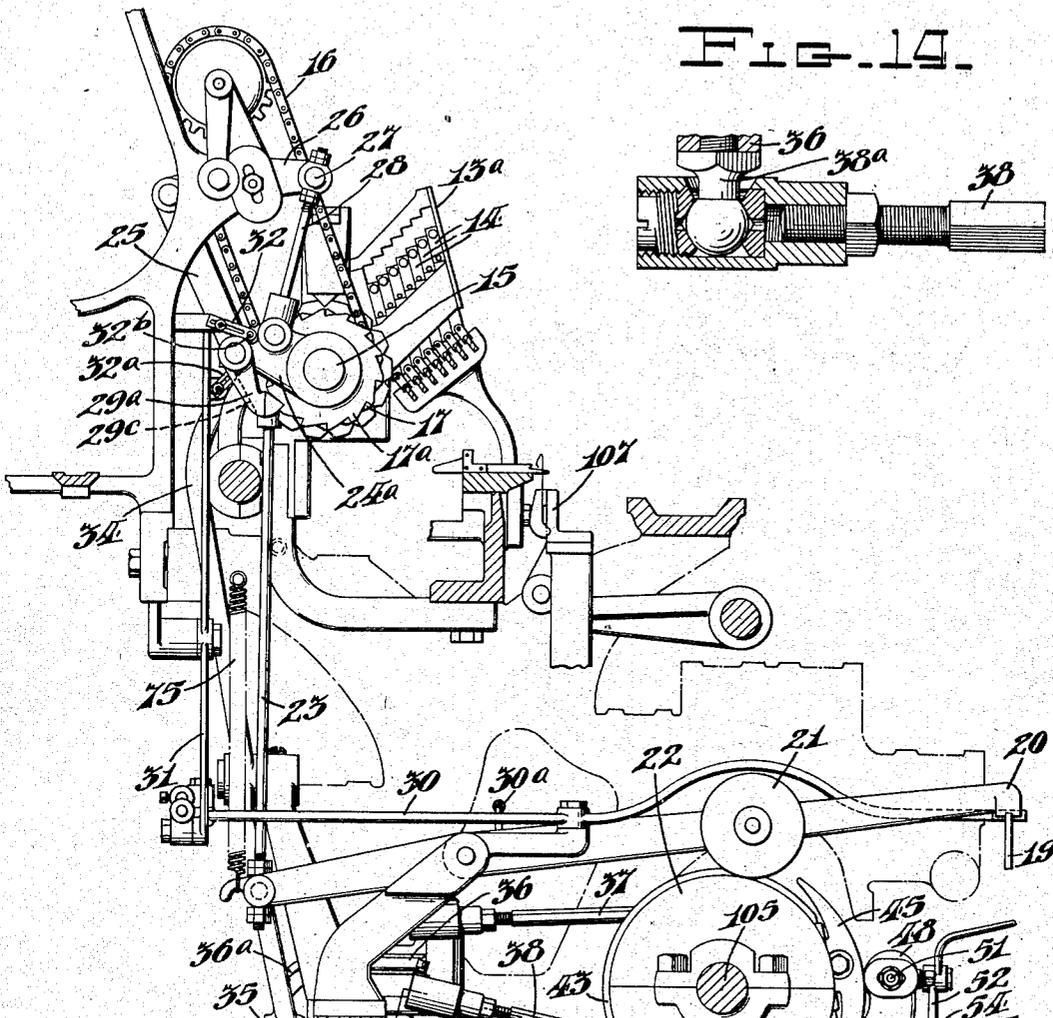
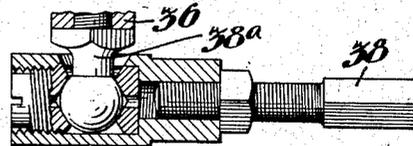
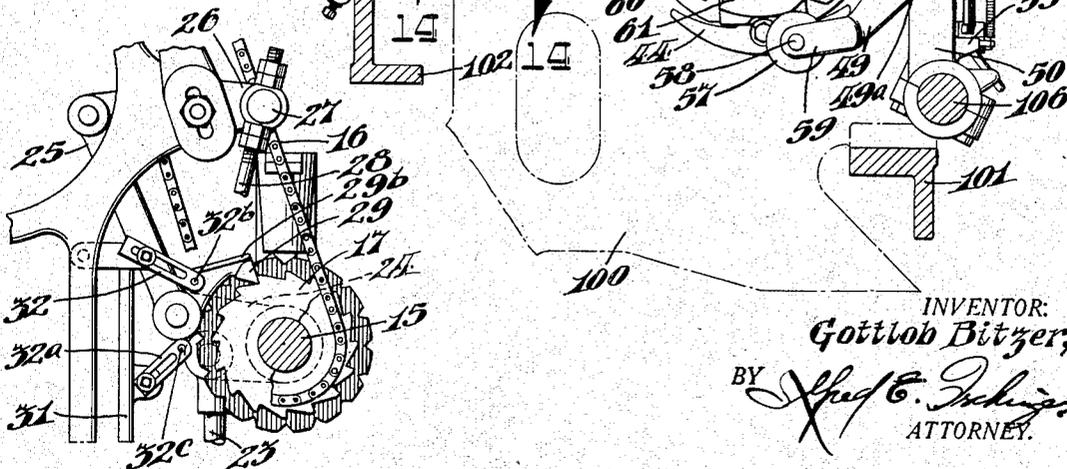


FIG. 13.



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MULTIPLE LOOP REGULATING MECHANISM

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FIG. 15.

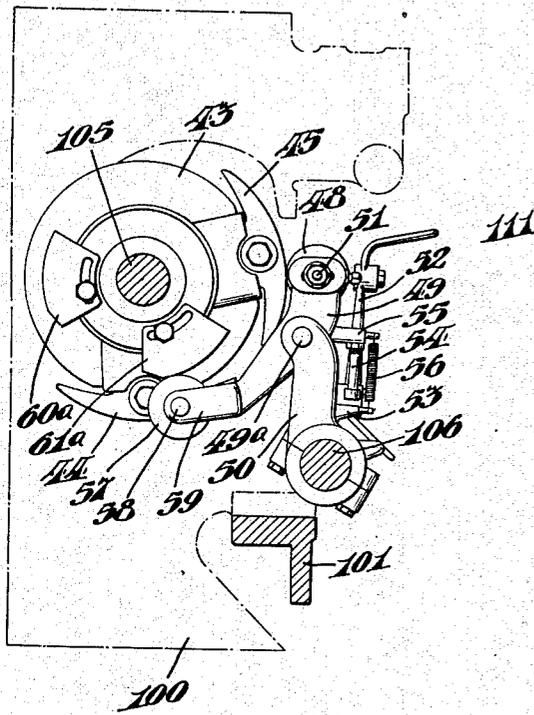
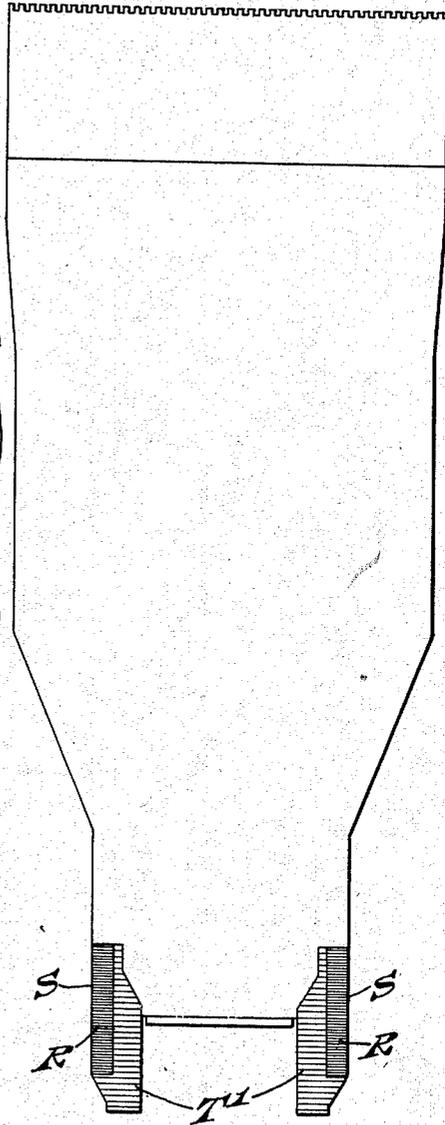


FIG. 16.



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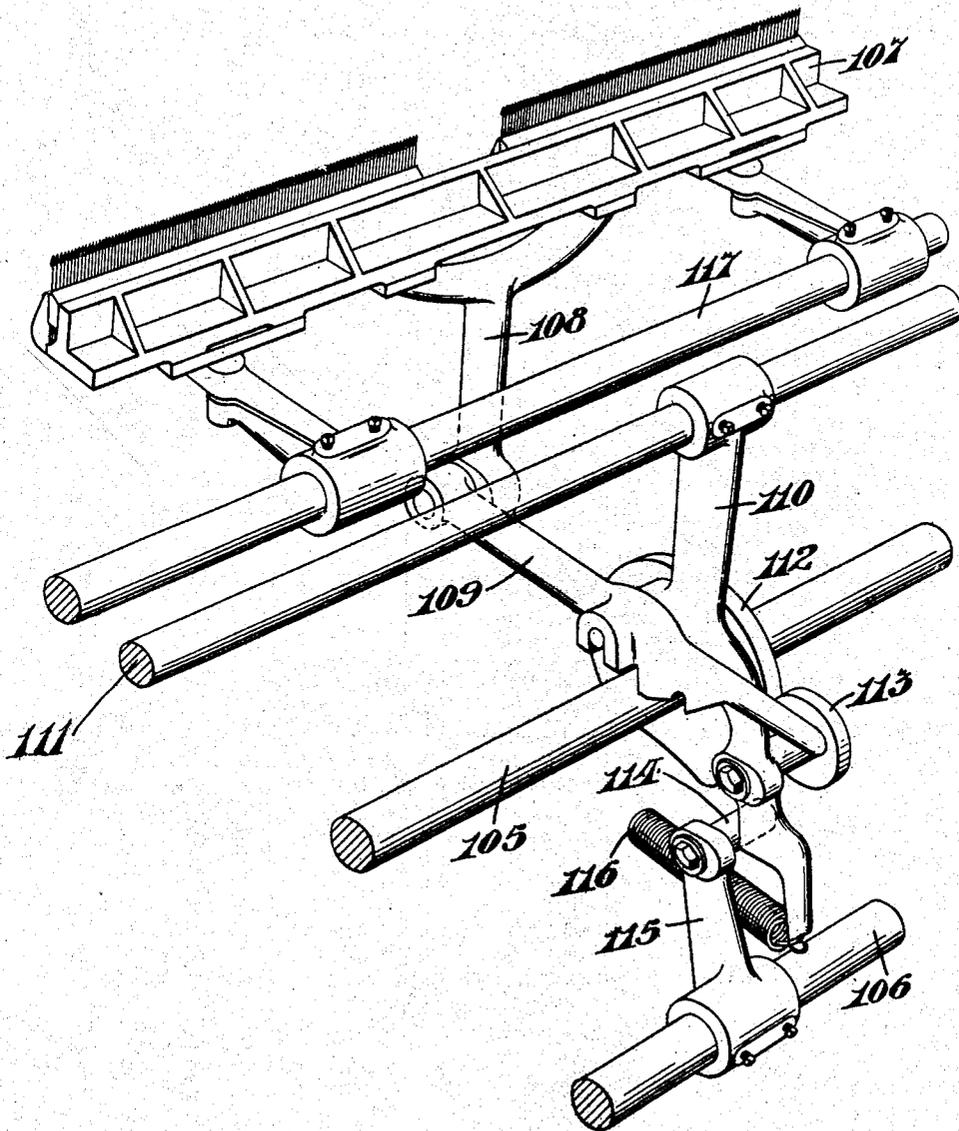
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MULTIPLE LOOP REGULATING MECHANISM

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FIG. 17.



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UNITED STATES PATENT OFFICE

2,125,831

MULTIPLE LOOP REGULATING MECHANISM

Gottlob Bitzer, Lincoln Park, Pa., assignor to
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corporation of Pennsylvania

Application December 29, 1937, Serial No. 182,178

20 Claims. (Cl. 66—82)

My invention relates to a mechanism for altering the length of knitted loops formed by a flat or full fashioned knitting machine.

It is common practise to increase the length of the loops of the body yarn in the portions of courses in which a reinforcing yarn is to be used, but special mechanism is employed for this purpose and difficulty has been encountered when it has been attempted to provide a double reinforcement in some area for the reason that an additional change in loop length per course was thereby required and the mechanisms commonly employed were not adapted to do this.

An object of my invention is to provide a simple and novel means whereby the action of known forms of loop regulating means of a flat knitting machine may be modified to increase the length of the loops formed when desired.

A further object of my invention is to provide a means whereby separate cam means may act cumulatively on the means for regulating the length of the loops of a course to provide a cumulative lengthening of the loops of a given course.

A still further object of my invention is to provide a simple and novel arrangement whereby one of two separate cam means may act on the loop regulating means in one portion of a given course and both may act on the regulating means in another portion of said course.

It is known to increase the length of the knitted loops in certain portions only of a course by a means responsive to the position of the inner stops for the plating yarn carrier bars or rods for lengthening the loops over the singly plated areas.

It is still another object to provide a simple means which can be added conveniently to a stop responsive loop lengthening mechanism to further increase the length of the loops over portions of the areas in which said mechanism is operative.

A further object is to provide a simple and efficient mechanism which can be economically manufactured and which is capable of ready adjustment for changing the length of a relatively shorter set of loops and is capable of quickly stepping up the loop length whenever desired without adjustment.

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, features of construction, and arrangements of parts in cooperative relationship, as hereinafter more particularly pointed out in the claims.

In the drawings, in which I have illustrated a fabric, a flat stocking blank and a stocking as well as a mechanism all in accordance with my invention:—

Figure 1 is an elevational view of a stocking within my invention;

Fig. 2 is an elevational view on a slightly reduced scale of a blank for making the stocking within my invention shown in Fig. 1;

Fig. 3 is a view on an enlarged scale of a portion of the blank shown in Fig. 2 enclosed by dot-and-dash lines thereon;

Fig. 4 is a front elevational view of a full fashioned knitting machine in accordance with my invention;

Fig. 5 is a sectional view taken substantially on the line 5—5 of Fig. 4 and looking in the direction of the arrows;

Fig. 6 is a fragmentary sectional view taken on the line 6—6 of Fig. 9;

Fig. 7 is a fragmentary view of certain parts shown in Fig. 5 and showing the particular cam arrangement used in making the foot portions of Figs. 1 and 2;

Fig. 8 is a plan view looking in the direction of the arrows 8—8 in Fig. 5, parts being omitted;

Fig. 9 is an elevation on a somewhat enlarged scale of the parts shown in Fig. 5, taken from the right of the figure, parts being broken away for purposes of illustration;

Fig. 10 is a fragmentary sectional view taken substantially on the line 10—10 of Fig. 9, looking in the direction of the arrows;

Fig. 11 is a sectional view taken substantially on the line 11—11 of Fig. 4, looking in the direction of the arrows, parts being omitted;

Fig. 12 is a sectional view taken substantially on the line 12—12 of Fig. 4, looking in the direction of the arrows;

Fig. 13 is a fragmentary view of a portion of Fig. 12, parts being broken away for purposes of illustration;

Fig. 14 is a fragmentary sectional view taken substantially on the line 14—14 of Fig. 12;

Fig. 15 is a view similar to Fig. 7 except that the cams of one set are spaced differently from those in the arrangement of Fig. 7;

Fig. 16 is an elevational view of a knitted leg blank within my invention made when using the cam arrangement of Fig. 15; and

Fig. 17 is a perspective view of a portion of the machine lying at the right of Fig. 4, parts being omitted, but illustrating well known means for connecting the regulating shaft with the needle bar.

The figures disclose various parts of a "Reading" full fashioned stocking-knitting machine embodying the invention in which for clearness only the parts necessary to an understanding of the invention are illustrated. The other parts and the operation thereof are well known in the art, as shown and described in the "Reading" Full Fashioned Knitting Machine Catalogues, copyright 1920, 1929 and 1935 and

published by the Textile Machine Works, Reading, Pennsylvania, and in a booklet entitled "Knitting Machine Lectures", published in 1935 by the Wyomissing Polytechnic Institute, Wyomissing, Pennsylvania, and further in two pamphlets entitled "The 'Reading' Full-Fashioned Knitting Machine", one copyrighted in 1935 by the Textile Machine Works, Reading, Pa., and containing articles 1 to 14 inclusive of a series reprinted from The Yarn Carrier and the other copyrighted in 1936 by said Machine Works, and containing articles 15 to 35 inclusive reprinted from The Yarn Carrier.

A fabric 1 made on a machine in accordance with my invention is shown in Fig. 3 in the process of being made. Such fabric is commonly used in full fashioned stockings and the portion of fabric shown in Fig. 3 appears also within the dot-and-dash rectangle on Fig. 2. As shown in Fig. 3, fabric 1 has a selvage edge 3 and a zone 4 alongside the selvage 3 containing a reinforcing thread or yarn 5 in addition to a body yarn 6. The loops in zone 4 are accordingly made slightly longer than those of the portion or area of fabric 1 containing only body yarn 6 so that the threads will run parallel and a smooth "plated" effect will be produced. Fabric 1 has also a zone 8 containing a second reinforcing or third thread 9 and the loops in zone 8 are longer in turn than those in zone 4 to provide for the desired smooth arrangement of the threads or yarns. In Figs. 1 and 2, the unshaded areas of stocking 10 and blank 11 are the same as area 7 in that they are composed of unreinforced body yarn while the lightly shaded areas of Figs. 1 and 2 are similar to or extensions of the zone 4 having two yarns per loop or a single reinforcing yarn and the more heavily shaded areas are similar to the zone 8 and have three yarns per loop or two reinforcing yarns, the lengths of the loops increasing with the number of yarns per loop. Also, the singly reinforced structure of zone 4 extends around the entire edge of a foot portion 12 of stocking 10 and blank 11 in a generally U-shaped zone F and in reinforced heel areas T, enclosing in part an unreinforced instep portion 12a while the doubly reinforced structure of area 8 occurs also throughout four triangular areas G—G and H—H on the inner edges of zone F, each of which has a right angle enclosed by zone F alone or by zone F and tabs T and areas G—G being larger and nearer the toe than areas H—H. A specifically different use of the fabric is shown in Fig. 16, in which reinforced heel zones or areas T', comprising upper heel and heel tab portions, of blank 111 are like areas T of Fig. 2 in being reinforced all over, but have doubly reinforced areas R—R of rectangular outline along their outer edges S. The shading in Fig. 16 is similar to that in Figs. 1 and 2, the lighter shading indicating two-thread areas and the heavier shading three-thread areas.

I anticipate that my invention will have its maximum application in stocking fabrics and it has come into considerable use in connection with the sole portion and the heels and heel tabs of stockings. In making a stocking 10 from a blank 11 the edges of the blank are seamed together in the usual way. Blank 111, of course, must have a foot-portion added thereto before it can be seamed up to make a stocking.

In carrying out my improved method of making fabric, I knit the fabric on a flat knitting machine which may be in general of an ordinary type, but necessarily having means for lay-

ing a sufficiently increased length of body yarn per needle or per loop in the remainder of the course to result in smoothly knitted fabric even in portions of the fabric having two reinforcing threads therein in addition to the body yarn.

In accordance with my apparatus invention, a flat knitting machine, preferably of the full-fashioned type, is provided with a novel means for making some of the knitted loops on one or both sides of the center of a course longer when desired. The energy for turning the regulating shaft of the machine is derived as usual directly from the main cam shaft but the operation is controlled by the position of a nut on the reinforced selvage attachment to determine the positions of the edges of the areas containing longer loops of body yarn and additional cam means are fixed to the cam shaft and arranged to act within the area in which the cam means of said attachment is active, the attachment being modified to cause the impulse of the additional cam means to supplement that of the cams ordinarily used in the reinforced selvage attachment and to permit the ordinary cams to function by themselves where desired.

Referring more particularly to Figs. 4 to 14 inclusive and Fig. 17, the full fashioned knitting machine shown therein comprises a frame 100 including a front beam 101 and a back beam 102 and on which is journaled a main cam shaft 105 (Fig. 4) having the ordinary regulating cam thereon (not shown) for rocking regulating shaft 106 whereby, by cooperation with an adjustable tappet means and connections therefrom, the regulating cam determines the length of the knitted loops during the knitting of the single yarn portions of a fabric by positioning a needle bar 107 (Fig. 12) the proper distance from the presser edge. A well known form of the connections whereby the position of the regulating shaft is determined by the ordinary regulating cam and the cam means particularly described hereinbelow is illustrated in Fig. 17. As the connections in Fig. 17 are the same as those in Fig. III of Patent No. 1,826,660 to Haines, dated October 6, 1931, such connections will be described only briefly. They comprise a lever 108 which is fixed to the needle bar 107 and extends downwardly therefrom to a pivot connection with a forwardly extending horizontally arranged link 109 the forward portion of which is pivotally supported at the lower end of an arm 110 parallel to lever 108 and fixed to and depending from a rock shaft 111. The ordinary presser motion is imparted to the needle bar 107 during the knitting portion of a given revolution of the main cam shaft 105 by a cam 112 which acts on a roller 113 operatively connected to arm 110. During the yarn laying portion of a given revolution of shaft 105, however, the position of arm 110 and therefore the horizontal position of the needles in bar 107 is determined by a pin 114 fixed at the upper end of an arm 115 fixed in turn to regulating shaft 106. The pin 114 is arranged to bear against a shoulder on a downward extension of arm 110 so that a clockwise motion of shaft 106 draws arm 110, link 109 and arm 108 forward to thereby throw the needles rearward toward the sinker bed and presser edge to increase the effect of the sinkers in laying yarn. A spring 116 moves arm 110 contrary to the movements produced by cam 112 and shaft 115. Vertical movement of the needles are produced by rock shaft 117 in the usual way. Shaft 106 is also controlled by a loose course cam (not

shown) on the cam shaft 105 forming part of a loose course motion or mechanism which can be thrown into and out of operation as desired to produce one or more loose courses at desired points in the knitting cycle.

Another or third mechanism operating on shaft 106 for affecting the length of the loops in reinforced areas is frequently supplied in Reading full-fashioned knitting machines. The principle of said third mechanism and an apparatus in accordance therewith are disclosed in U. S. Patent 1,793,669, issued February 4, 1931 and I have shown an embodiment of my novel arrangement in the drawings as a modification of a device of the type shown in said patent. Said third mechanism discloses a pair of nuts 13, 13a forming parts of the means for limiting the traverse of the yarn carrier bars for the yarn used in plating or splicing and including stops 14 for the yarn carrier bars, mounted on nuts 13 and 13a and arranged to be thrown either into or out of use. Other stops such as end stops, which are carried by usual narrowing heads 114, Fig. 4, cooperate with the stops 14 for limiting the traverse of the yarn carrier bars or rods. Nuts 13 and 13a are carried on a reversely threaded spindle 15 whereby they may be set and shifted as desired by turning spindle 15 either by a hand operated sprocket and chain device 16 or by an automatic means including a ratchet wheel 17 and a companion wheel 17a thereof to determine the width of the areas of the stocking to be reinforced. The automatic operation of wheel 17 and its companion 17a is controlled by the usual pattern chain 18 which is adapted to withdraw, by means of buttons placed on the chain at optional points, the supporting arm 19 from beneath a lever 20. The means shown for this purpose is similar to that shown in said Patent No. 1,793,669 and comprises the lever 20 carrying a roller 21 arranged, when the lever 20 is allowed to drop, to rest on cam 22 on shaft 105 and to be oscillated by spring 75 and cam 22 whenever the low spot on cam 22 passes beneath roller 21 to thereby reciprocate a vertical rod 23. Rod 23 connects at its lower end to lever 20 and at its upper end to an arm 24, Fig. 13, that is swivelled to oscillate on spindle 15 as an axis. The arm 24 connects pivotally to a lever 25 which is pivoted in turn to a rocker 26. A stud 27 is pivoted on rocker 26 and carries a collar to which is connected a rod 28 the lower end of which is enlarged to embrace a pivot on a second arm 24a. Arms 24 and 24a carry pawls 29 and 29a, respectively, shown as pivoted on the arms and arranged to cooperate with the teeth of wheels 17 and 17a to turn the spindle 15 in a clockwise or counterclockwise direction as desired, see Figs. 12 and 13. The direction of motion of the spindle 15, as determined by pawls 29 and 29a, is controlled by the chain 18. The means whereby chain 18 selects either pawl 29 or 29a to operate spindle 15 comprises a generally horizontal lever 30 pivoted on a vertical axis (Fig. 12), the forward end of lever 30 being arranged adjacent the upper end of arm 19 and a spring 30a being connected to lever 30 to hold its front end toward the left as viewed in Fig. 4. A low button on chain 18 moves arm 19 from beneath lever 20 but not far enough to cause arm 19 to touch lever 30. The lever 20 and rod 23 then operate spindle 15 by pawl 29 and spindle 15 rotates clockwise as viewed in Fig. 13. A high button on chain 18 throws the upper end of lever 19 sufficiently far

to the right (as viewed in Fig. 4) not only to release lever 20, but to throw the forward end of lever 30 to the right. As is also clear from Fig. 13, the rear end of lever 30 is thereby thrown to the left (as viewed from a position in front of machine) and the lower end of vertical lever 31, connected to the rear end of lever 30, is thereby thrown to the left and the upper end of lever 31 to the right and spindle 15 is operated by the pawl 29a to turn counterclockwise. The means whereby the interchange of pawls 29 and 29a is accomplished will now be described. The upper end of lever 31 has slotted plates 32 and 32a connected thereto and the outer ends of plates 32 and 32a carry pins 32b and 32c which contact one at a time, with cam flanges 29b and 29c on the pawls 29 and 29a, respectively, so that the movement of lever 31 can throw the plates 32, 32a and their pins to put one pawl into action and to throw the other one out. When the upper end of lever 31 lies, as shown, at the left as viewed in Fig. 4, the pin 32c on plate 32a is in position to ride along the cam flange 29c on pawl 29a when arm 24 is oscillated to throw pawl 29a against the action of a spring (not shown) and away from the teeth of wheel 17a on the up stroke of rod 23 and thereby to prevent it from catching and operating the wheel on the down stroke. Pin 32b, however, is away from the companion pawl 29 and the spring (not shown) of the pawl throws it against the teeth of wheel 17 to catch a tooth at the bottom of the down stroke of rod 23 to rack spindle 15a one tooth distance on the up stroke of rod 23. When the forward end of lever 19 is thrown to the right, as viewed in Fig. 4, by a high button on the chain 18, the upper end of lever 31 is also thrown to the right and the pin 32c on plate 32a withdrawn from the path of pawl 29a so that it racks spindle 15 counterclockwise. Simultaneously, the pin 32b is thrown into the path of the companion pawl 29 to disable its action. Pawl 29a therefore moves rack wheel 17a one tooth distance for each reciprocation of lever 20.

In the arrangement shown, nut 13 controls that portion of the stroke in which said third mechanism acts on regulating shaft 106. For this purpose the nut 13 is connected to a rod 33 pivoted to the upper end of a vertical lever 34 the lower end of which has a pivotal connection to one end of rod 35 (Figs. 4 and 11). The other end of rod 35 has a pivotal connection with a downwardly curved arm 36a of a bell-crank 36 by means of a fork and yoke connection 36b (Fig. 9). The other arm of crank or lever 36 is enlarged at the end farther from the pivot to provide room for two studs 37a and 38a having ball ends (Fig. 14) affording pivotal connections one with each of a pair of rods 37 and 38 (Figs. 5 and 6). At the ends remote from crank or lever 36, rods 37 and 38 are arranged to receive the ends of studs 39 and 40 (Fig. 6) respectively, which are similar to studs 37a and 38a and are fixed one on each of a pair of segmental control members or cams which appear at 41 and 42 in Fig. 8. Control members 41 and 42 are swivelled on cam shaft 105 so that their position relative to each other is fixed by the position of nut 13 and are adjacent a cam disk 43 fixed on shaft 105 and carrying cam pieces 44 and 45 which are mounted for movement radially of disk 43. Springs 107, 107 (Fig. 10) tend to draw pieces 44 and 45 toward the center of shaft 105. Cam pieces 44 and 45, however, carry studs on which are placed rollers 46 and 47 arranged respectively in the planes of control members 41

and 42 and arranged also to contact such members during the rotation of disk 43 to throw cam pieces 44 and 45 outwardly. The relative position of members 41 and 42 therefore determines the portions of the revolution of main cam shaft 105 in which cam pieces 44 and 45 are operative and the position of members 41 and 42 is determined by that of nut 13 which is determined in turn by the chain 18. The cam pieces 44 and 45, however, are arranged to act on regulating shaft 106 through a roller 48 journalled on a lever 49 pivoted at a point 49a intermediate its length to the end of an arm 50 fixed on shaft 106. Roller 48 is slidably mounted on a bolt 51 so that it can be thrown by a hand lever 52 as desired into or out of position to contact the cam pieces 44 and 45 during their revolution.

While the expansible cam blocks or members 44 and 45, the roller 48 and arm 50, or their equivalents, are all present in said prior patent, according to the present invention, I have interposed the above mentioned pivoted lever 49 between the roller 48 and arm 50. Pivoted lever 49, if its degree of swing were not limited, would prevent the transmission of an impulse from cam members 44 and 45 to arm 50 and shaft 106. I therefore have provided means to limit the swing of lever 49 on arm 50 when cam members 44 and 45 are being used in the ordinary way. Such means comprises a shoulder 53 arranged to act as a stop to limit the swing of lever 49 by contacting the end of a bolt 54 which is adjustably mounted on a shoulder 55 projecting from lever 49 in the same plane as stop 53. By adjusting bolt 54 to contact stop 53 sooner, the free swing of lever 49 for a given setting of cam members 44 and 45 is reduced and the resulting angular motion of arm 50 and shaft 106 increased. Obviously this result can be obtained also by inserting a gage or shim between stop 53 and bolt 54 or by placing a stop at any other point in the path of lever 49 on either side of the pivot thereof. A spring 56 connected at one end to lever 49 and at its other end to arm 50 normally biases the bolt 54 against stop 53. It will be seen that when lever 52 is thrown to the right as viewed in Fig. 9, roller 48 is in position to lengthen the loops in strips along both selvages to accommodate the extra thread for reinforcing the heel tabs.

Further as shown, the lever 49 has a second roller 57 at the end opposite roller 48 and a pin shaft 58 is fixed in a fork 59 to lie parallel to shaft 106 so as to carry roller 57. Also, in the arrangement shown, a pair of segmental cams 60 and 61 are so fixed on shaft 105 that when either of cams 60 and 61 are in position to contact roller 57 then cam member 44 or 45 is in position to contact roller 48 provided roller 48 has been thrown to the right by lever 52 as shown. In Figs. 5, 8 and 9, the roller 57 is shown in contact with cam 61 at the same time that roller 48 contacts cam piece 45. In the relative position shown in Figs. 5, 8 and 9, roller 57 acts as a temporary stop curtailing the free swing of lever 49 about its axis even more than it is limited by stop 53 and the arm 50 consequently is given a greater swing for a given setting of cam pieces 44 and 45 than when roller 57 is disengaged as is clear from Figs. 5 and 7. In Fig. 5, rollers 48 and 57 are on cams 45 and 61 respectively and arm 50 has been moved somewhat to the right as compared to its position when bolt 54 is resting on stop 53. The length of yarn pulled from the bobbin is thereby increased so long as roller 57 is in position to act as a stop for lever 49. The mechanism shown in

Figs. 5 and 7 has the additional cams 60 and 61 set so they act to increase the action of cams 44 and 45 throughout two zones each extending inwardly from the respective inner edges of the zone F nearly to the center line of the fabric. However, the action of cams 60 and 61 is dependent on that of cams 44 and 45 because, when roller 48 runs off its cam, there is nothing to prevent lever 49 from swivelling on its pivot 49a in a counter-clockwise direction (as viewed in Figs. 5 and 7) and thereby preventing the transmission of any impulse from cams 60 or 61 through roller 57 to arm 50. The inner edges of the areas G and H, Figs. 1 and 2, are determined by the position of nut 13 which determines by rods 37 and 38 the points at which rollers 46 and 47 of cams 44 and 45 run respectively off of and onto the shiftable cam pieces 41 and 42, thereby permitting cams 44 and 45 to draw in toward shaft 105 and to prevent such cams from having any effect in turning shaft 106 farther than would be done by the regular regulating cam used for the single yarn areas.

The cams 60a and 61a, Fig. 15, are set differently on shaft 105 from cams 60 and 61 so that the loops are lengthened enough for three threads per loop throughout two zones R—R of the reinforced heel areas T¹ (Fig. 16). The zones R—R are of an equal coursewise width less than the width of the areas T¹ which are of varying coursewise widths and, with the exception of the zones R—R, are of a two thread per loop construction. The upper heel portions of areas T¹ are separated by a central zone having only the body yarn or one yarn per loop. Other than in the setting of cams 60a and 61a, the mechanism of Fig. 15 is the same as that of Figs. 4 to 14, inclusive.

The knitted foot structure shown in Figs. 1 and 2 is often known as the cradle foot or inside reinforced sole. When it is desired to make the structure of Figs. 1 and 2, roller 48 is thrown into the plane of cams 44 and 45 by hand. Cams 44 and 45 thereupon act to swing arm 50 to the right as viewed in Fig. 5 to the degree required to form loops having the length needed for a single reinforcing thread for the portions of the yarn laying stroke represented by the widths of portions or areas F, F, the inner edges of which are parallel to the center line of the blank. Cam 60 is so placed as to strike roller 57 at the moment the yarn carrying finger for the body yarn reaches the inner boundary of the first portion F of the stroke to begin the first area H or G of said yarn laying stroke and cam 61 is set so as to run out from under roller 57 at the time said finger is at the inner boundary of the second area F to terminate the second area H or G reached in the same yarn laying stroke. The inclined or inner edges of areas H and G are determined and the widths of these areas determined as desired by the pattern chain by controlling, in the arrangement shown, the shifting of the nut 13 to move the cams 41 and 42 relatively to each other. Obviously, the connections for moving cams 41 and 42 can be attached to mechanism other than nut 13 without changing the principle of operation. As soon as the roller 46 of cam 44 runs off the non-rotating cam 41, roller 48 can swing to the left as viewed in Fig. 7 far enough to prevent lever 49 from having any effect on shaft 106 irrespective of cam 60 and the roller 57 and the length of the loops thereupon is determined by the ordinary regulating means or motion until cams 61 and 45 act together to make the second area H or

G in the course. The outer edge of the second area H or G is determined by the roller 57 running off cam 61 and allowing roller 48 and cam 45 to regulate the length of the loops in the second portion F lying between the second portion H or G and the selvage edge. In case cams 41 and 42 are drawn far enough toward the right as viewed in Fig. 6, no area G or H is formed. This occurs when nut 13 has been moved far enough to the right as seen in Fig. 4. At the end of the areas G, the mechanism shown is thrown out of action by moving roller 48 out of the plane of cams 44 and 45 by hand lever 52 and the length of the loops in the remainder of the foot of the blank is controlled by the ordinary loop regulating means.

The areas R—R of the blank, shown in Fig. 16, are usually referred to as "heel-in-heel" areas of a stocking. In the operation of the mechanism of Fig. 15 to make the blank of Fig. 16, the circumferentially shiftable but non-rotating cams 41 and 42 being in proper position and roller 48 having been shifted by hand into the plane of radially shiftable and rotatable cams 44 and 45, both pairs of rotating cams act in the same course to give arm 50 the maximum swing both at the beginning and the end of each course to produce the longest loops, as required for areas R. As soon as roller 57 has run off cam 60a, the arm 50 is permitted to swing back somewhat being held only by roller 48 and cam 44 to cause the needles to produce loops of somewhat less length suitable for areas T¹. The dividing lines between areas R and R are parallel to the center line of the blank due to the fact that cams 60a and 61a are fixed to the shaft. The inner edges of areas T¹, however, may be inclined as shown because the action of cams 44 and 45 can be terminated and begun at varying points in the period of coulliering by varying the positions of non-rotating cams 41 and 42 to change the points at which cams 44 and 45 draw radially inward toward the cam shaft enough to cease or to avoid acting on arm 50 and to change the point at which the cams 44 and 45 are pushed radially outward enough to begin acting on arm 50. Of course, the fabric of the upper portions of areas R (Fig. 16) can be knitted while using five yarn carriers and yarn carrier bars, but when the lower end of the central single-yarn area of blank III has been reached and the areas R and T¹ are continued in spaced tabs, six yarn carriers and yarn carrier bars are needed to provide the six yarns used per course in the lower portions of areas R. However, the mechanism of Fig. 15 should be thrown out of action by shifting roller 48 by hand lever 52 as soon as the knitting has reached the lower end of areas R. The ordinary loop regulating mechanism is then thrown in to complete the knitting of the heel tabs after areas R have been finished. It will be seen that the arrangements of Figs. 5 and 15 cannot both be used on the same machine at the same time, but areas R may be produced in the same stocking as areas H and G because the leg and foot portions of flat stocking blanks are usually made on separate machines. The relative position of cam members 41 and 42 shown in Fig. 6 is substantially that in which they are placed during the knitting of the portion corresponding to zone 4, Fig. 2.

It will be noted by way of recapitulation that the loops cannot be lengthened by my mechanism to the degree desired for two plating yarns

unless four conditions are fulfilled. The roller 48 must have been thrown into its right hand position, roller 46 or 47 must be on sector 41 or 42, roller 48 must be on cam 44 or 45, and roller 57 must be on cam 60 or 61.

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.

What I claim is:

1. In a flat knitting machine having a needle bar, carrier rods for body and plating yarns, and stops for said rods, in combination, means for moving the stops for the plating carrier rods, means controlled by said stop moving means for increasing the length of the loops when the plating carrier rods are in use, and supplemental means for cooperating with said means to further increase the length of two groups of loops of a course.

2. In a flat knitting machine having a needle bar, carrier rods for body and plating yarns, and stops for said rods, in combination, means for moving the stops for the plating carrier rods, means controlled by said stop moving means for increasing the length of the loops when the plating carrier rods are in use, and means for further increasing the loops of a course when desired and arranged to operate only when said first loop increasing means is in operation.

3. In a flat knitting machine, in combination, a cam shaft, means for moving the needle bar toward and from the presser edge to determine the length of the knitted loops, cam means on said shaft and a lever connected to said first means on which said cam means acts for acting on said means to increase the length of the loops in a portion only of a course, and additional cam means on said shaft arranged to act on said lever to additionally increase the length of the loops in a part only of the portion of a course in which said first means is effective.

4. In a flat knitting machine having a cam shaft, plating yarn carrier bars and stops therefor, in combination, a regulating shaft for determining the length of the knitted loops, means responsive to the position of the stops for the plating bars for acting on said shaft to increase the length of the loops in desired areas of the fabric being knitted, and means responsive to the angular position of said cam shaft for acting on said means to increase the length of the loops in portions only of said areas.

5. In a flat knitting machine having a cam shaft, in combination, a regulating shaft for determining the length of the knitted loops, means for acting on said shaft to increase the length of the loops in desired areas of the fabric being knitted, and means responsive to a cam on said shaft for acting on said means to increase the length of the loops in certain areas relative to those in said first areas.

6. In a flat knitting machine having a cam shaft, in combination, means for regulating the position of the needle bar during the period of laying the yarn to determine the length of the knitted loops, means arranged to receive an actuating impulse from the cam shaft for acting on said means to increase the length of said loops, and two cam means on said shaft arranged to act cumulatively on said second means to increase the length of the loops, said second means

arranged to be thrown out of receptive position as to both said cam means as desired.

7. In a flat knitting machine, in combination, a loop regulating shaft, means to change the angular position of said shaft including an arm fixed to the shaft, a lever pivoted on said arm having a cam follower on one end thereof, a cam for said follower, and an adjustable means for limiting the free swing of said lever with respect to said arm when it swings in the direction opposite to that in which it is turned by said cam.

8. In a flat knitting machine having plating yarn carrier rods and adjustable stops therefor, in combination, means for regulating the length of the knitted loops including a regulating shaft and connections whereby the length of the loops is controlled by the angular position of said shaft, cam means responsive to the position of the stops for the plating yarn carrier rods for operating said shaft to increase the length of the loops when said plating rods are in operation, and cam means dependent upon the action of said cam means and arranged to increase the length of the loops, during a portion only of a course, beyond that caused by said cam means.

9. In a flat knitting machine, in combination, a loop regulating shaft, means to change the angular position of said shaft and including an arm fixed to the shaft, a lever pivoted on said arm and arranged for limited free movement on its pivot, and two cam means arranged to act one on each end of said lever to cumulatively oscillate said shaft.

10. In a flat knitting machine, having yarn carrier rods and stops therefor, in combination, means for regulating the length of the knitted loops including a regulating shaft and connections whereby the length of the loops is controlled by the angular position of said shaft, a cam means for operating said shaft to form loops of a length suitable for singly reinforced fabric but for a portion only of a course, and a second cam means arranged to act only during a portion of the period in a course in which said cam means is active for operating said shaft to form loops suitable for doubly reinforced fabric.

11. In a flat knitting machine, in combination, a regulating shaft, means to change the angular position of said shaft including an arm fixed thereto, a lever pivoted to said arm, a stop for limiting the swing of said lever in one direction, a cam means operable during only a portion of a yarn laying period arranged to act on said lever near one end to force it against said stop to increase the length of the loops in a portion of a course, and a cam means arranged to act on said lever near the other end thereof during a portion only of the period said first means is active to further increase the length of the loops.

12. In a flat knitting machine having a cam shaft, and plating yarn carrier bars and stops therefor, in combination, a regulating shaft for determining the length of the knitted loops, an arm on said shaft, a lever pivoted on said arm, an abutment on said arm for limiting the free swing of said lever in one direction, means responsive to the position of said stops for acting on said lever to throw it against said abutment to turn said shaft in the direction to increase the length of the loops in desired areas of the

fabric being knitted, and a cam fixed to said cam shaft for acting on said lever only within the period said stop responsive means is in action to swing the lever away from said abutment and to further increase the length of the loops in portions of said areas.

13. In a flat knitting machine having a cam shaft, in combination, a loop regulating shaft, a cam member on said cam shaft movable radially thereof but in fixed angular relation thereto, a member connected to said regulating shaft for receiving an impulse from said cam member to turn it in the direction to increase the length of the knitted loops, plating yarn carrier bars, movable stops for said bars, means responsive to the position of said stops for moving said cam member radially of the cam shaft, and a second cam on said cam shaft arranged to act on said member within the period said radially movable cam member is capable, if in its outer position, of acting on said member.

14. In a knitting machine as set forth in claim 13, a means responsive to the position of the stops for the plating carrier bars including a sector shaped member swivelled on the cam shaft and arranged to throw the radially movable cam member outwardly whenever it passes the sector shaped member.

15. In a full fashioned knitting machine, in combination, a loop regulating shaft, an arm on said shaft, a lever pivoted on said arm at a point intermediate the ends of the lever, a cam shaft, and cams on said cam shaft arranged to act cumulatively substantially directly on said lever at points on opposite sides of its pivot for turning said regulating shaft.

16. The combination as set forth in claim 15 and in which the arm on the loop regulating shaft has a stop thereon to limit the swing of the lever in one direction.

17. The combination as set forth in claim 15 and in which the lever and the arm each has thereon a part of an adjustable stop means for limiting the swing of the lever in one direction.

18. In a full fashioned knitting machine, in combination, a loop regulating shaft, a cam shaft, two cam means on said cam shaft arranged to act cumulatively on said regulating shaft, and means for varying the period of action of one of said cam means.

19. In a full fashioned knitting machine, in combination, a loop regulating shaft, a cam shaft, two cam means on said cam shaft arranged to act cumulatively on said regulating shaft in the direction to increase the length of the knitted loops, and means for automatically varying the angular distance within which said cams have a cumulative action.

20. In a full fashioned knitting machine, in combination, a loop regulating shaft, a cam shaft, two cam means on said cam shaft arranged to act cumulatively on said regulating shaft in the direction to increase the length of the knitted loops, a plating yarn carrier bar and a movable stop therefor, means responsive to the position of said stop for varying automatically the angle through which one of said cam means is effective, and means whereby the other of said cam means become ineffective whenever said one means ceases to act.