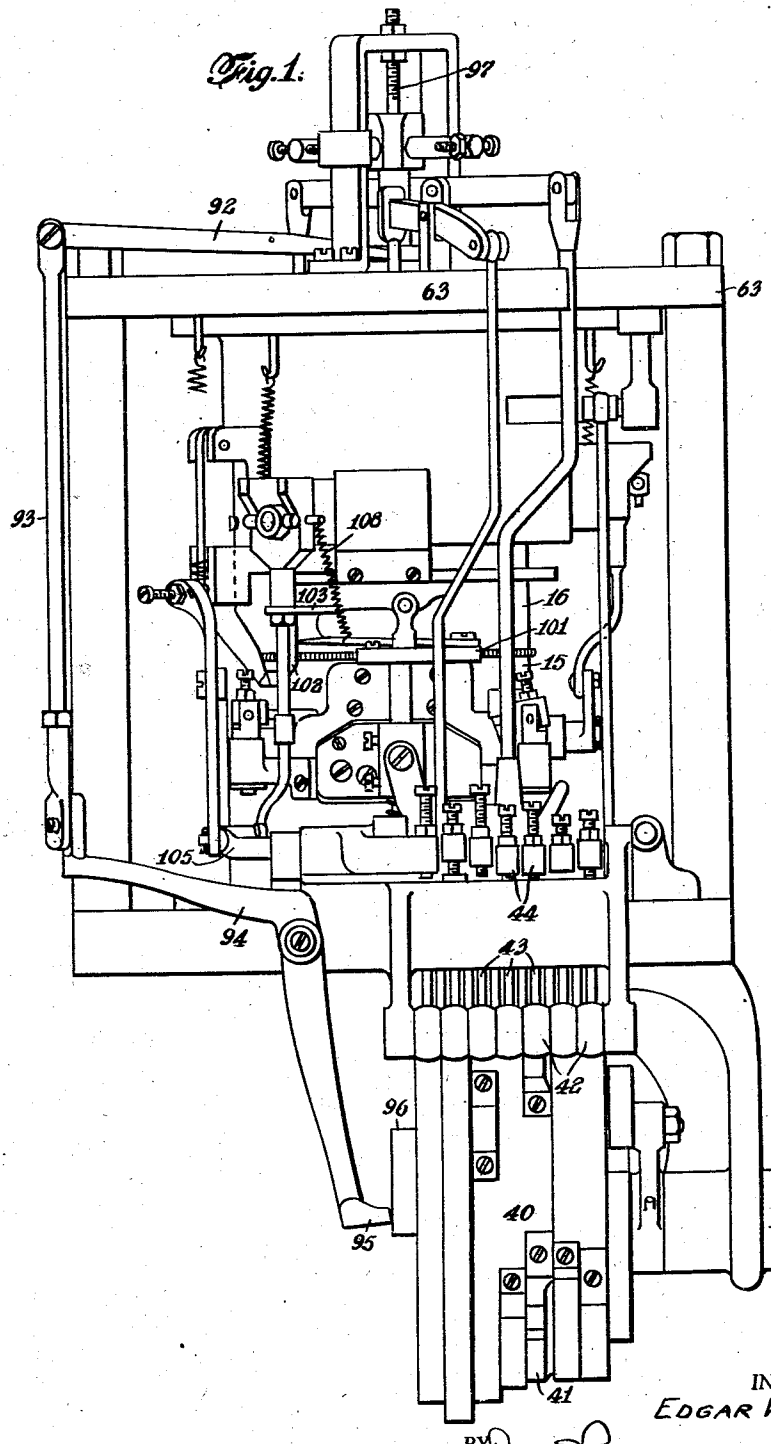
Feb. 27, 1945. E. W. CLARKE 2,370,449

CIRCULAR KNITTING MACHINE

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Fig. 1.



INVENTOR.
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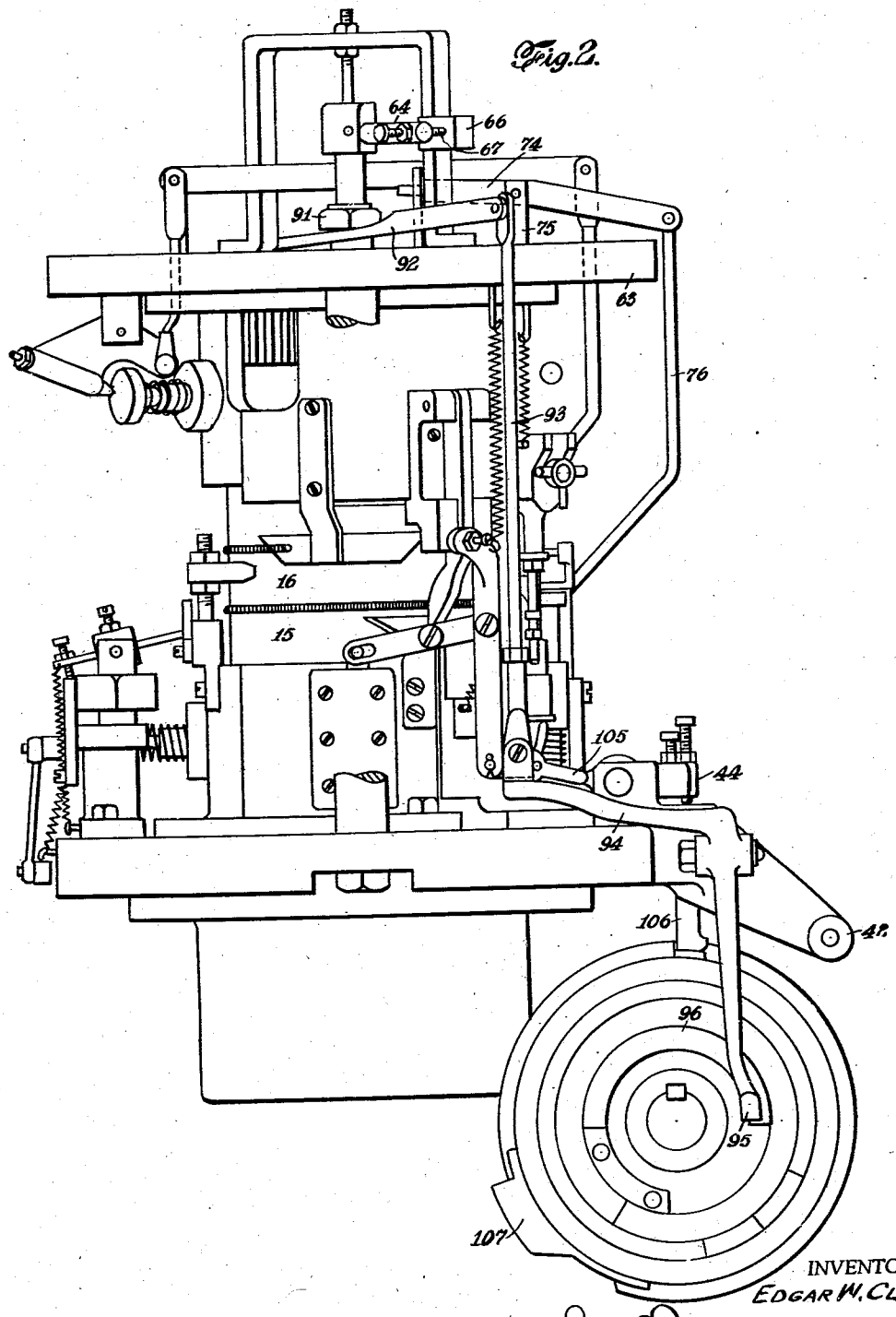
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CIRCULAR KNITTING MACHINE

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Fig. 2.



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CIRCULAR KNITTING MACHINE

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Fig. 3.

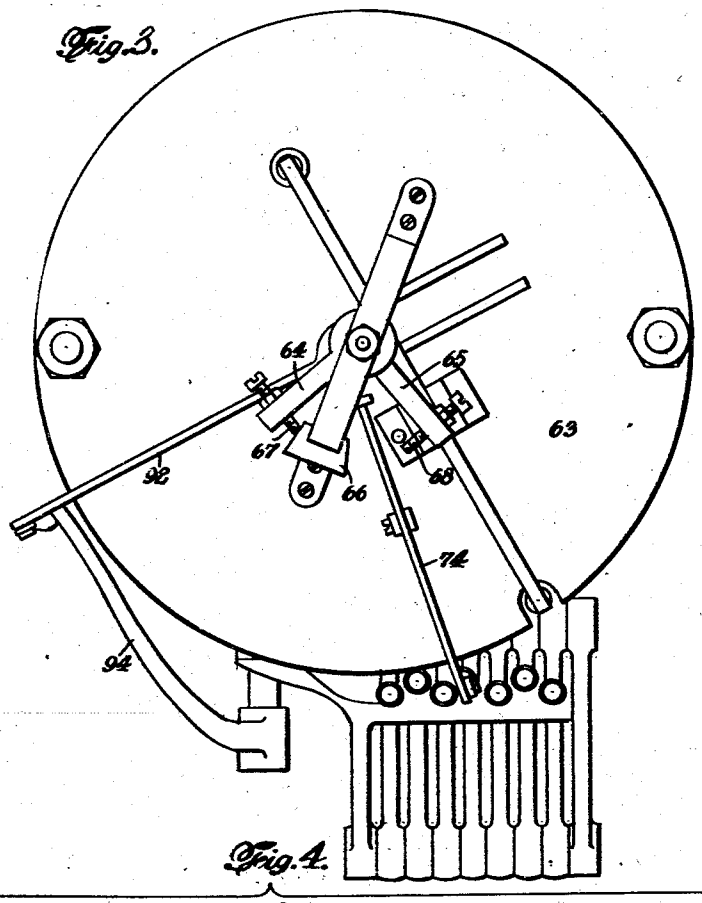
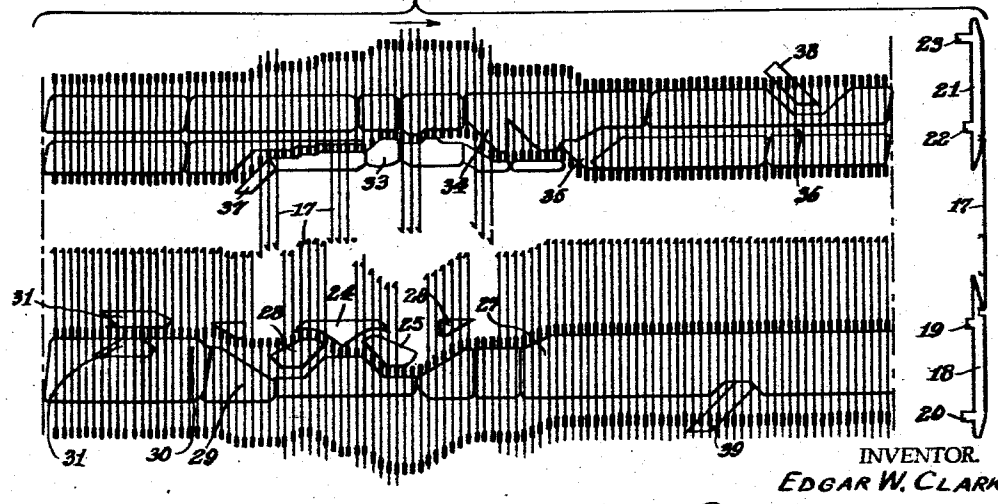


Fig. 4.



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CIRCULAR KNITTING MACHINE

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Fig. 5.

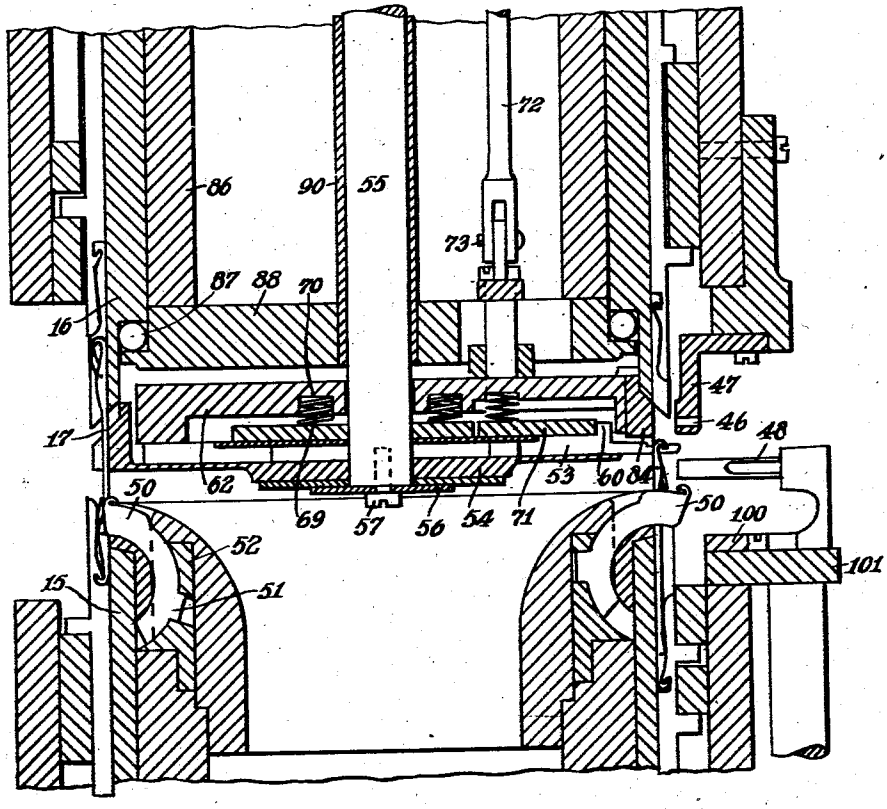
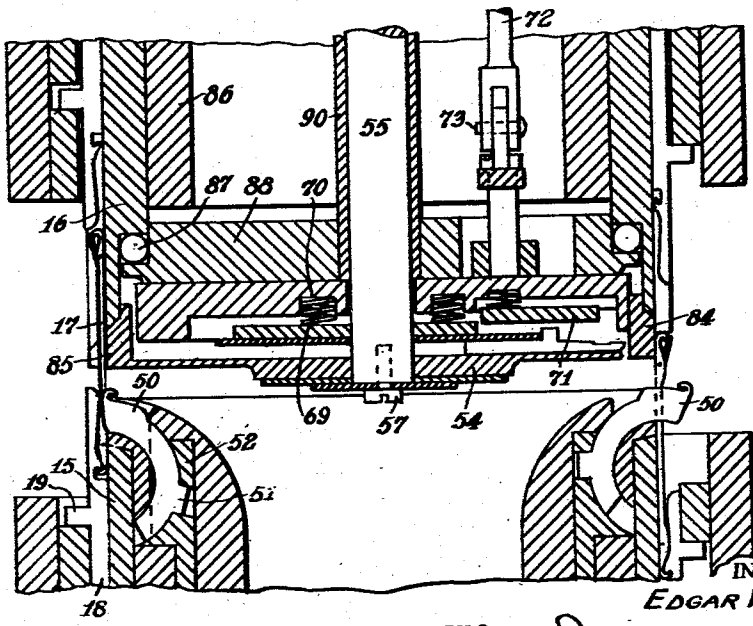


Fig. 6.



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CIRCULAR KNITTING MACHINE

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Fig. 7.

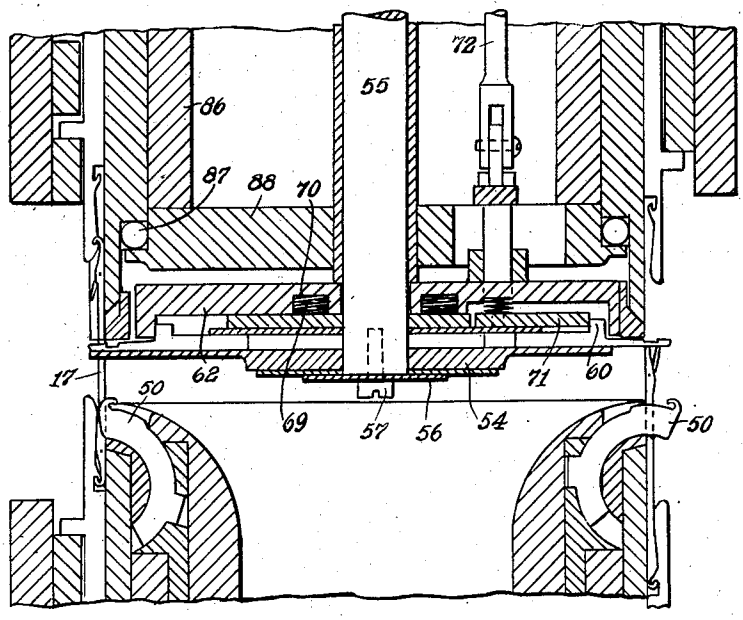


Fig. 8.

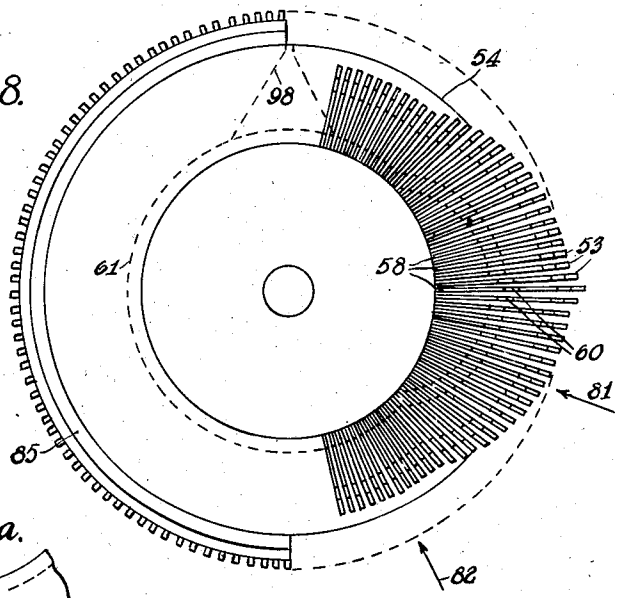
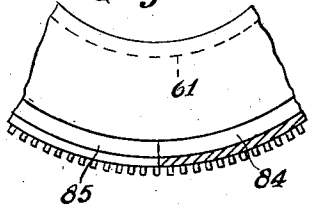


Fig. 8a.



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Feb. 27, 1945. E. W. CLARKE 2,370,449

CIRCULAR KNITTING MACHINE

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Fig. 9.

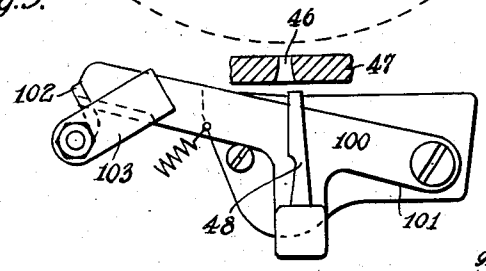


Fig. 11.

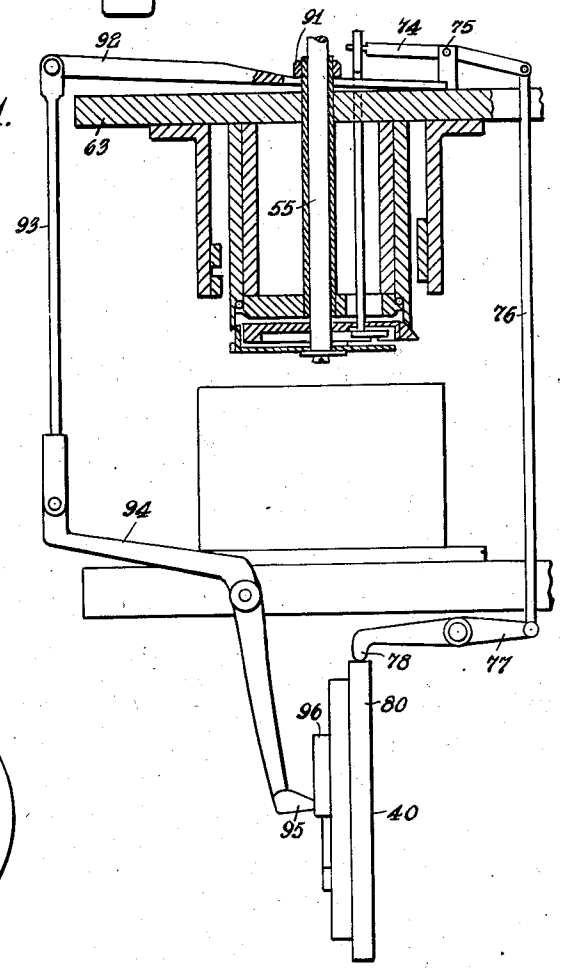
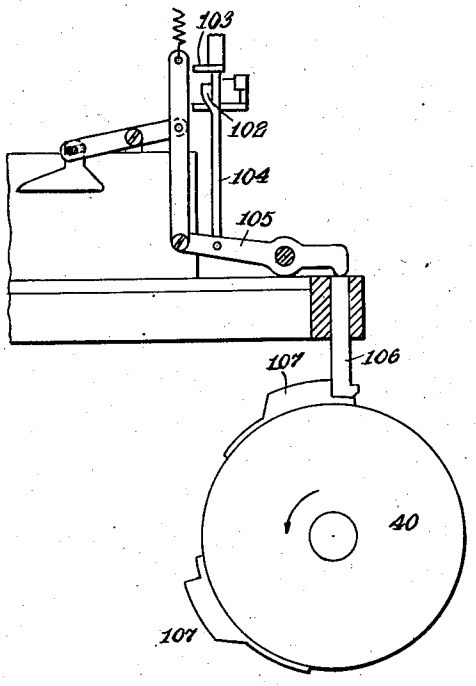


Fig. 10.



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Feb. 27, 1945. E. W. CLARKE 2,370,449

CIRCULAR KNITTING MACHINE

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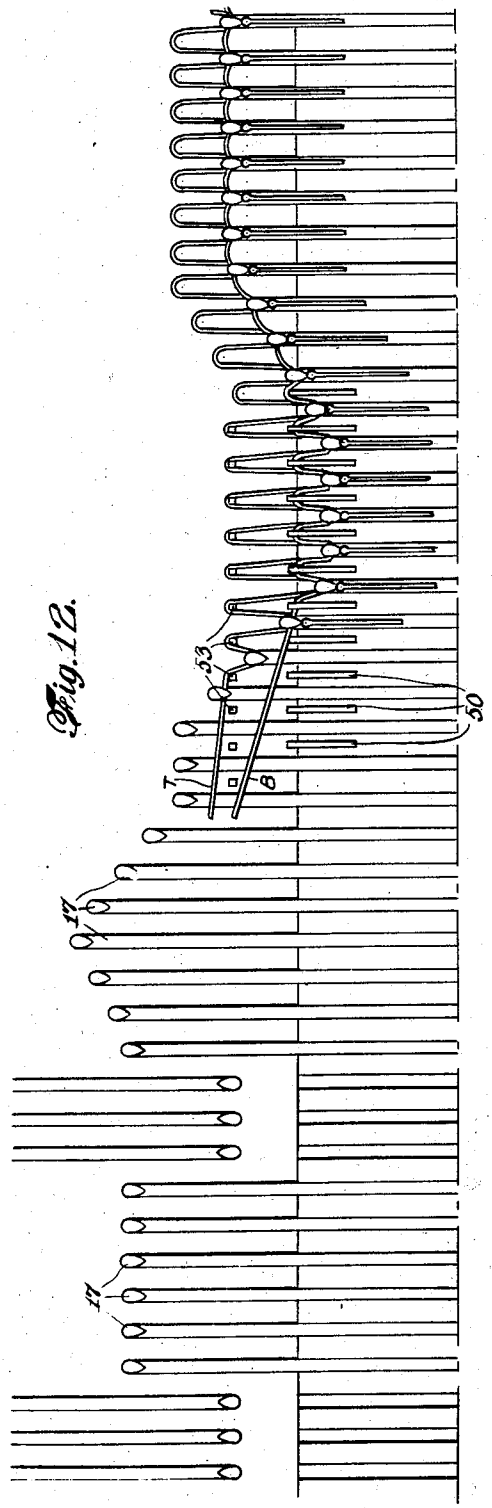


Fig. 12.

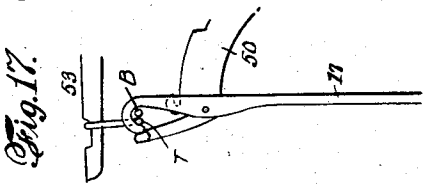


Fig. 17.

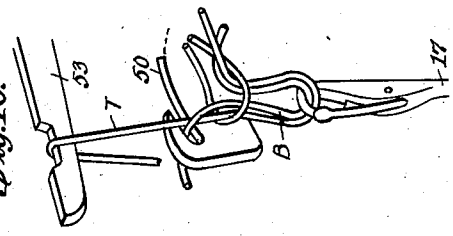


Fig. 16.

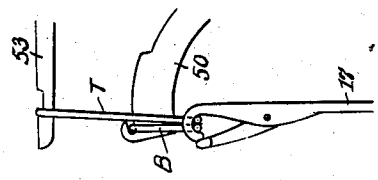


Fig. 15.

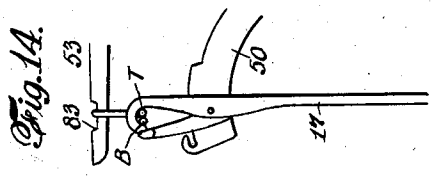


Fig. 14.

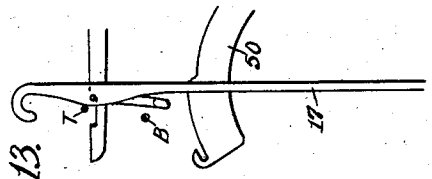


Fig. 13.

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Feb. 27, 1945. E. W. CLARKE 2,370,449

CIRCULAR KNITTING MACHINE

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Fig. 19.

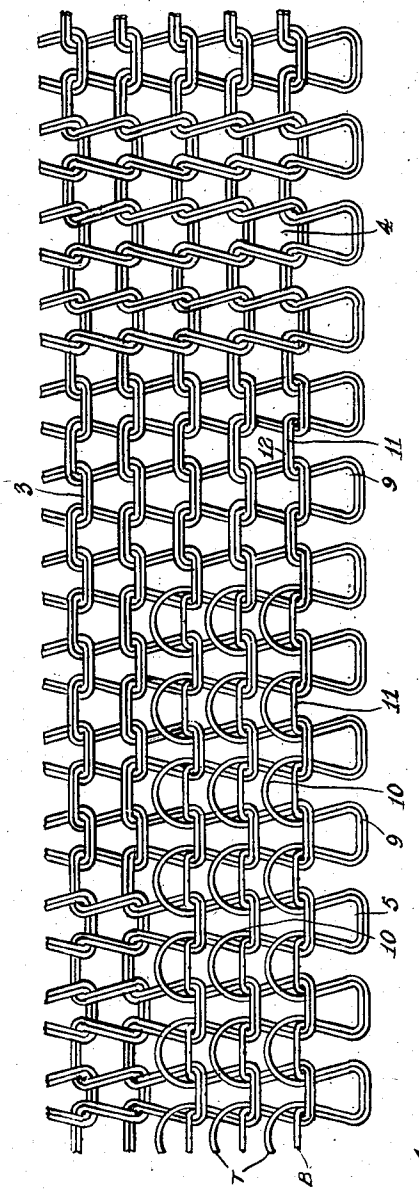
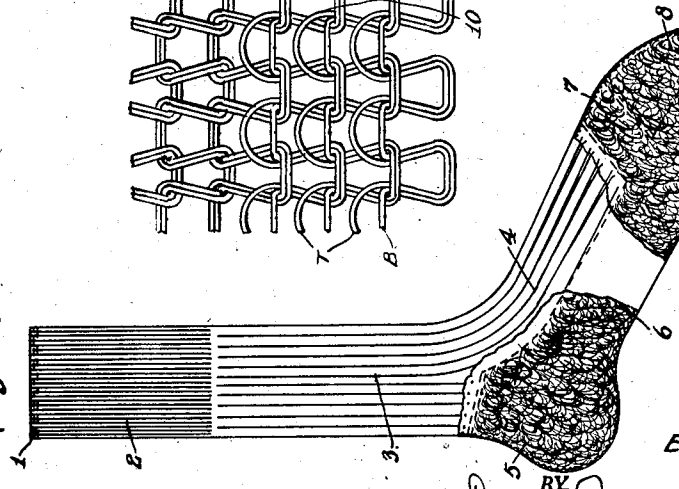


Fig. 18.



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Patented Feb. 27, 1945 2,370,449

UNITED STATES PATENT OFFICE

2,370,449

CIRCULAR KNITTING MACHINE

Edgar W. Clarke, Hamilton, Ontario, Canada, assignor to Interwoven Stocking Company, New Brunswick, N. J., a corporation of New Jersey

Application August 7, 1942, Serial No. 453,993

25 Claims. (Cl. 66—14)

My invention consists in the novel features hereinafter described, reference being had to the accompanying drawings which illustrate one embodiment of the same, selected by me for purposes of illustration, and the said invention is fully disclosed in the following description and claims.

My invention relates to a circular knitting machine for knitting terry fabric. Such fabric is produced by feeding two threads to the needles of a knitting machine, and drawing longer loops of one thread than of the other, so that the long loops hereinafter referred to as terry loops protrude on one surface of the fabric and provide a soft cushioning effect. For example, the two threads may be fed to the needles and knitted with the needle loops of the threads in plated relation, but with the sinker loops of one thread longer than the corresponding sinker loops of the other thread to form the terry loops. The terry loops may or may not be combed or brushed so as to separate the fibres and comingle them in a soft matted condition on the surface of the fabric. The invention is particularly applicable to the knitting of articles of hosiery wherein the heel, sole and toe portions may be formed of terry fabric to provide greater softness and resiliency while the leg and instep may be formed of rib knit fabric including broad rib or Links-Links fabric.

It has heretofore been proposed to produce terry fabric by means of a circular knitting machine provided with sinkers having shoulders at different levels, the main knitting thread being drawn over a lower shoulder and the terry thread over a higher shoulder, whereby the sinker loops of the terry thread are longer than those of the main knitting thread and form the projecting loops of the terry fabric. The use of a two level sinker to produce terry fabric necessitates a change in the sinker wave, as it may adversely affect the operation of the machine, for example, in knitting portions of fabric where terry is not desired. Moreover, the length of the terry loops obtainable with this arrangement is strictly limited, particularly in a machine where there is a restricted space for operation of the sinkers, as in a machine having co-axial needle cylinders. A further difficulty encountered is that since the upper shoulder over which the terry thread is drawn and the lower shoulder over which the body thread is drawn are on the same sinker, they must necessarily be moved in or out together and hence movement of the sinker has to be a compromise between that desired for the long terry loops and that required for knitting the body thread. No independent movement of the two shoulders is possible.

It is an object of the present invention to overcome these difficulties and provide a circular knitting machine which will produce terry fabric having long terry loops and at the same time will accurately control the plating of the body thread and the terry thread so that the desired thread will appear on the surface of the fabric. In accordance with the invention the terry loops are produced by instrumentalities located above the sinkers, and operated independently thereof, whereby the said instrumentalities can be moved in or out as desired, without interfering with the normal operation of the sinkers. These instrumentalities hereinafter referred to generically as "bits" are adapted to project out between the needles in such manner as to separate a plurality of threads fed to the needles so that one thread is fed below the bits and another thread above the bits. Upon manipulation of the needles to receive and knit both of said threads, the sinker loops of one thread are drawn over the sinkers, while longer sinker loops of the other thread are drawn over the bits. The long loops of thread drawn over the bits constitute the terry loops of the fabric. Where reference is made to feeding one thread above the bits, and another thread below, it will be understood that additional threads may be fed to the needles, as desired.

The present invention makes it possible to produce longer terry loops on a co-axial cylinder knitting machine than could be obtained with special sinkers having shoulders at two levels. As the lower end of the upper cylinder must be spaced only a slight distance above the upper end of the lower cylinder to produce satisfactory rib fabric, the space between the two cylinders is strictly limited and prevents using sinkers having shoulders sufficiently spaced to produce long terry loops. However, by having terry forming bits associated with the upper cylinder, and cooperating with the needles operated in the lower cylinder to form the terry loops, loops of any desired length can be obtained. Moreover, the independent operation of the terry bits makes it possible to utilize them to separate the terry and the body threads and to control the accurate plating of these threads without interfering with the operation of the sinkers.

It is a further object of the invention to provide a co-axial cylinder machine that will produce both terry fabric and rib knit fabric including broad rib and Links-Links fabric, so that it

will produce, for example, an article of hosiery having an anti-ravel edge, a top portion formed of rib knitting, leg and instep portions formed of rib-knitting with a different stitch structure from the top, and heel, sole and toe portions of terry fabric. A further object of the invention is to produce a knitted article of hosiery having heel, sole and toe portions composed of a plurality of threads knit in plated relation with one thread knit to form loops which are longer than the corresponding loops of the other thread and leg and instep portions composed of the same threads knit in plated relation to form rib knit fabric in which corresponding loops of the respective threads are of substantially the same length.

In accordance with the invention these objects are obtained with a machine which is of relatively simple construction and operation and in which those parts requiring occasional replacement are readily accessible without dismantling the machine. Other objects and advantages of the invention will be understood from the following description and claims in conjunction with the accompanying drawings which illustrate an embodiment selected to illustrate the invention.

In the drawings,

Fig. 1 is a front elevation of so much of a knitting machine as is necessary to illustrate the invention.

Fig. 2 is a side elevation taken from the left hand side of Fig. 1.

Fig. 3 is a top plan view.

Fig. 4 is a diagrammatic view showing the cam for operating the needles and sliders which are shown schematically in side elevation at the right hand side of the figure.

Fig. 5 is a fragmentary vertical section showing adjacent portions of the upper and lower cylinders with the terry loop forming mechanism in operative position.

Fig. 6 is a view similar to Fig. 5 but with the terry mechanism inoperative.

Fig. 7 is a view similar to Fig. 5 showing a modification.

Fig. 8 is a plan view showing the dial carrying the bits for forming the terry loops.

Fig. 8a is a fragmentary plan view corresponding to a portion of Fig. 8, and showing abutting ends of the verge section.

Fig. 9 is a fragmentary plan view with certain parts in section showing the thread feeding mechanism.

Fig. 10 is a schematic view of mechanism for moving one of the thread feeds.

Fig. 11 is a schematic view showing means for moving the terry loop forming mechanism into and out of operative position.

Fig. 12 is a schematic view showing the operation of the needles, sinkers and bits in forming the terry fabric.

Fig. 13 to Fig. 17 are fragmentary views illustrating diagrammatically the successive steps in forming the stitch structure of the fabric.

Fig. 18 represents an article of hosiery made in accordance with my invention.

Fig. 19 represents the stitch structure of a section of fabric in said article.

In Fig. 18 there is shown an article of hosiery produced in accordance with my invention and having an anti-ravel edge 1, a top portion 2 formed of rib knit fabric, a leg portion 3 and an instep portion 4, both formed of rib knit fabric which is preferably different from that of the top portion, and a heel portion 5, sole 6, toe band 7 and toe 8, all formed of terry fabric. The stitch structure of the fabric is shown in Fig. 19 wherein the upper portion of the figure represents a section of the leg 3; the lower left hand portion of the figure represents a section of the heel 5 and the lower right hand portion of the figure represents a section of the instep 4. The leg 3 and instep 4 are composed of rib knit fabric being shown as 6 x 3 rib, while the heel 5, together with the sole 6, toe band 7 and toe 8 are formed of terry fabric. In the terry portion of the fabric, a body thread B and a terry thread T are knitted in such manner that needle loops 9 are formed of both threads in plated relation, while the sinker loops are drawn separately so that the sinker loops 10 of the terry thread T are substantially longer than the sinker loops 11 of the body thread B and constitutes the terry loops of the fabric. The term "needle loop" is used herein to designate the lower portion of the stitch, i. e., the portion engaged by the needle in forming the stitch, while "sinker loop" is used to designate the upper part of the stitch, whether drawn over a sinker or other instrumentality. It will be seen that there is a terry loop 10 corresponding to each sinker loop 11 of the body thread B so that a dense, soft terry fabric is provided. To avoid obscuring the stitch structure, the terry loops are shown shorter than they would ordinarily be in carrying out my invention. Preferably, the terry loops should be at least twice as long as the sinker loops 11 of the body thread. In the instep portion 4, and the leg 3, the same threads B and T are knitted in plated relation to form rib knit fabric in which corresponding loops of the respective threads are of substantially the same length. Hence, in the rib portion of the fabric, the sinker loops 12 of the terry thread T are of substantially the same length as the sinker loops 11 of the body thread B. The toe band 7 may be formed of terry fabric only on the sole half thereof, or all the way around, as shown.

In knitting the socks shown on a circular knitting machine having superimposed coaxial cylinders, the top portion 2 is knitted with every other needle in the upper cylinder to produce a 1 x 1 rib or with different needle arrangements to produce any rib desired. Upon completion of the top portion, certain needles are transferred from one cylinder to the other to leave groups of six needles in the lower cylinder, alternating with groups of three needles in the upper cylinder. The needles operating in the lower cylinder form outwardly facing stitches constituting the outer ribs of the fabric, while the needles in the upper cylinder form inwardly facing stitches constituting the inner ribs. It will be understood that rib fabric other than 6 x 3 rib can be obtained by suitable transfer of the needles. When the upper portion of the heel 5 is reached, the needles on the "instep" side of the cylinder remain in position to continue rib knitting while consecutive needles on the "sole" side of the cylinder are all positioned on the lower cylinder, and the instrumentalities for forming the long terry loops come into operation to produce the terry fabric of the heel. The latter group of needles which up to this point have been producing rib knitting, must now produce terry fabric. Moreover, during the knitting of the sole 6 and instep 4, one group of needles knits terry fabric while another group of needles knits rib fabric so that part of each course is terry, and the remainder is rib. Although the terry fabric thus extends only part way around the article, there are no

loose ends of terry thread at the line where the terry fabric and rib fabric meet, and it is not necessary to cut and bind the terry thread in each course in passing from terry fabic to rib fabric, since the terry thread is continuous and is knitted in plating relation with the body thread in the rib knit portion of the fabric. When the toe band 7 is reached, the needles on the instep side of the cylinder are transferred to the lower cylinder, and if it is desired to produce terry fabric all the way around the toe band, the terry bits on the instep side of the cylinder come into the operation. The two groups of bits dispose respectively on the sole side and on the instep side of the cylinder, thus come into operation at different times. In knitting the heel 5 and toe 6, the machine is operated by oscillating the needle cylinders so as to knit first in one direction, and then in the opposite direction. Both the body thread B and terry thread T are fed in each direction of rotation and are knit to form fabric having terry loops in each wale of each course so that a dense terry fabric is provided in the heel and toe portions.

In accordance with my invention, the plating of the two threads can be accurately controlled both in the terry and the non-terry portions of the fabric so that the desired thread forms the outer face of the fabric. For example, if a wool thread and a cotton thread are used, the wool thread can be made to form both the terry loops and also the outer face of the fabric so that the fabric has the appearance of being wool on both sides, while the cotton thread is concealed and forms a strong body for the fabric. Alternatively, the body thread can be made to form one face of the fabric, and the terry thread the other face. If desired, the plating may be varied in different portions of the fabric, for example, to obtain a design effect. Plating of the threads is accurately controlled by operation of the mechanism for forming the terry loops, as will be more fully explained below.

In Figs. 1 to 17 of the drawings, there is shown so much of a knitting machine as is necessary to illustrate my invention. The invention is shown by way of example embodied in a knitting machine of the type in which superimposed co-axial needle cylinders are provided with needles having hooks at both ends, suitable transfer mechanism being also provided for shifting the needles from one cylinder to the other whereby all of the needles may be assembled in the lower cylinder for the production of circular plain knitting, or alternate needles or groups of needles may be transferred from the lower cylinder to the upper cylinder to produce rib knitting. The particular machine shown in the drawings is of the general type manufactured by William Spiers, Ltd., of Leicester, England, and certain standard parts which are not necessary to an understanding of the invention have been omitted for the sake of clearness.

The machine illustrated has a lower needle cylinder 15 (Figs. 1, 2 and 5), an upper needle cylinder 16 and a circular series of needles 17 having a hook and latch at each end and operable in either cylinder. When in the lower cylinder, the needles are operated by sliders 18 engaging the lower hooks of the needles, and having knitting butts 19 and transfer butts 20 adapted to engage needle operating cams. Preferably, the sliders operating the needles on the "sole" side of the cylindrs, i. e., the side on which the heel, sole and toe of an article of hosiery are knit have short knitting butts while the sliders for needles on the opposite side of the cylinder i. e., the "instep" side have long knitting butts. When in the upper cylinder, the needles are operated by similar sliders 21 having knitting butts 22 and transfer butts 23 engaging suitable cams.

The cams for operating the needles are shown in Fig. 4 where the direction of movement of the needles and sliders relative to the cams when the machine is operated by continuous rotation is from left to right, as indicated by the arrow. The needles operating in the lower cylinder pass through a knitting wave as shown, being drawn down by center cam 24 and stitch cam 25 to draw loops of thread fed to the needles and cast off previously drawn stitches and being then raised by riser cam 26 and clearing cam 27 to a clearing position wherein the newly drawn loops are placed under the latch. When the cylinder is rotated in the opposite direction as when oscillated in knitting the heel and toe, the lower cylinder needles are drawn down by center cam 24 and a heel stitch cam 28 and are thereafter raised to clearing position by heel riser cam 29 and heel clearing cam 30. During the knitting of the heel and toe, the lower cylinder needles on the instep side of the cylinder, i. e., the long butt needles are raised by switch cams 31 to an inactive position in which they hold their stitches while the knitting butts of the respective sliders pass above center cam 24. The switch cams 31 are movable vertically from the inoperative position shown in Fig. 4 to a higher operative position for raising the long butt needles.

The cams for operating the needles in the upper cylinder comprise a stitch cam 33 and clearing cam 34. The upper cam block is also provided with a welt cam 35 which is withdrawn to allow the knitting butts of the sliders to pass through an idle track 36 so that the upper cylinder needles will hold their stitches without knitting during the knitting of welt courses on the lower cylinder needles, and with a switch cam 37 operable in conjunction with lower cylinder switch cams 31 to render the needles on the instep side of the cylinder inactive during the knitting of the heel and toe. There are also provided an upper transfer cam 38 and a lower transfer cam 39 which are movable inwardly and outwardly and act on transfer butts of different lengths to transfer needles from one cylinder to the other as desired.

The movable cams such as the transfer cams, welt cam and switch cams are moved into and out of operative position by suitable mechanism for example, under the control of a pattern drum 40 which is intermittently racked around during the knitting of the article and has cams such as cam 41 acting through pivoted arms 42 and tappets 43 on rocker arms 44 which are connected by suitable mechanism with the respective cams. As the control of such cams is well known in the art, it will not be described in further detail.

Adjacent the upper and lower stitch cams, there is provided a feeding station for feeding thread to the needles. At this feeding station the body thread B and terry thread T are fed in spaced relation so that the instrumentalities for forming the terry loops of the terry fabric can come between them and separate the two threads. In the particular arrangement shown, the feed for the terry thread T is provided by a hole or slot 46 in latch guard 47 and the feed for

the body thread B comprises a feed finger 48 (Fig. 9).

The lower cylinder is provided with sinkers 50 (Fig. 5) or equivalent instrumentalities disposed between successive needles and adapted to cooperate with the needles in forming stitches. The sinkers are shown as having butts 51 which are acted on by sinker cam 52 to move the sinkers between an inner position shown at the left hand side of Fig. 5, and an outer position shown at the right hand side of said figure.

In accordance with the present invention, the instrumentalities cooperating with the needles to form the long terry loops comprise a series of bits 53 (Fig. 5) associated with the upper cylinder. The bits 53 are located directly above the sinkers 50 so as to project out between successive needles when the needles are in position to receive thread fed at the feeding station. The relation of the bits to the thread feeds is such that the bits project between the two threads so that the terry thread T is fed above the bits while the body thread B is fed below the bits and between the bits and the sinkers. Where reference is made to feeding one thread above and another thread below the bits, it is not necessary for one thread feed to be above and the other below the level of the bits, but only for the threads to be fed in at least slightly separated relation to one another and in such relation to the bits and needles that one thread is received above the bits and the other below. The needles operating in the lower cylinder are raised high enough to receive both the body thread B fed above the sinkers but below the bits and the terry thread T fed above the bits. When the needles are drawn down by the stitch cam, loops of body thread are drawn over the sinkers while loops of the terry thread are drawn over the bits, as shown in Figs. 12 to 16. Fig. 12 represents diagrammatically the passage of the needles through the knitting wave, and shows how the terry thread T is fed to the needles above the bits while the body thread B is fed to the needles below the bits. Fig. 13 shows the relative positions of the needle, sinker, bits and threads at the feeding station. Fig. 14 shows a needle beginning to draw a loop of the terry thread over the bits 53 and receiving the body thread B in the hook of the needle. Fig. 15 shows the needle drawn down to draw a loop of the body thread over the sinkers and a much longer loop of the terry thread over the bits. Fig. 16 is a perspective view of the parts in the same position as in Fig. 15 and shows how the new stitch loop is drawn down through the previous stitch. It will be seen that the needle loops of the body thread B and the terry thread T are drawn in plating relation while the sinker loops are drawn separately with the sinker loops of the terry thread much longer than the sinker loops of the body being shown approximately twice as long. If desired, the sinkers 50 may be set lower to increase still further the difference in length of the terry loops and the sinker loops of the body thread.

The terry bits 53 are illustrated as being moved between an inner retracted position and an outer position in which the bits project out beyond the needle circle to separate the terry thread and the body thread as described above. The bits are moved out as they reach or approach the thread feeding station and are retracted to release the terry loops after loops of the terry thread and body thread have been drawn by the needles, as illustrated in Figs. 15 and 16. While the bits 53 or equivalent instrumentalities may be supported in any desired manner, they are shown as being carried by a dial 54 mounted adjacent the lower end of the upper cylinder, and hence above the upper end of the lower cylinder. In the arrangement shown, the dial is supported at the lower end of a shaft 55 extending down through the upper cylinder, being held on said shaft by washers 56 and screw 57. The bit dial 54 is rotatable with the cylinder and is provided with radial grooves 58 in which the bits 53 are slidable in and out. The path traveled by the bits is illustrated in Fig. 8 which shows the dial in plan. If it is desired to knit terry fabric only in the heel, sole and toe portions of a sock, the bits 53 need be provided on only one side of the dial corresponding to the sole side of the needle cylinders as shown in Figs. 5 and 8.

As illustrated in Figs. 5 and 8, the bits 53 are projected and retracted by means of butts 60 engaging a cam track 61 in a cam 62 located above the dial 54. The cam 62 is held against rotary movement by being secured to shaft 55. The shape of the cam track 61 is indicated in dotted lines in Fig. 8. As the dial 54 carrying the bits 53 is rotated with the needle cylinder while the cam 62 is held against rotation the bits 53 are moved in and out by action of the cam on the butts 60. The cam 62 is positioned in predetermined angular relationship with respect to the feeding station to project and retract the bits at the proper time. Thus the terry forming instrumentalities 53 are inserted between the threads from inside the needle cylinder and are movable in and out independently of the sinkers. Optimum operation of both the sinkers and the bits 53 is hence possible.

When the needle cylinders are turned alternately in opposite directions as in knitting the heel and toe, the relative positions at which the bits are projected and the point at which the threads are fed to the needles must be shifted upon reversal of the direction of rotation to assure proper separation of the threads. In the arrangement shown in the drawings, this is accomplished quite simply by oscillating the bit cam 62 when the machine is operated by reciprocation. At its upper end and above the top plate 63 of the machine the shaft 55 carrying cam 62 is provided with a pair of arms 64 and 65 (Figs. 1, 2 and 3) adapted to engage a buffer block 66. The angular spacing between the arms 64 and 65 permits the shaft 55 and hence cam 62 to oscillate through a predetermined angle which is preferably adjustable by means of abutment screws 67 and 68. The cam is oscillated within the limits determined by arms 64 and 65 by providing a frictional drag between the cam and the needle cylinder or an element rotating therewith. As shown in Fig. 5, the cam 62 is provided with a friction plate 69 pressed against the upper face of the bit dial 54 by springs 70. Upon reversal of the direction of rotation of the needle cylinders and dial 54, the cam 62 is carried with the dial by friction plate 69 until stopped by one of arms 64 or 65.

In order to be able to knit non-terry fabric all around the cylinder, for example, in knitting the top or leg of a sock, provision is made for rendering the terry bits 53 inoperative. This may be accomplished by raising the bit cam 62 out of engagement with the butts 60 of the bits. In the arrangement shown in Figs. 5 and 6, cam 62 is provided with a movable section 71 which is raised instead of raising the whole cam. The means for raising the movable cam section from

an operative position (Fig. 5) to an inoperative position (Fig. 6) is shown diagrammatically in Figs. 5 and 11 and comprises a link 72 attached to the cam section and connected to one end of a rocker arm 74 pivotally mounted at 75 on the top plate of the machine. The link 72 has a flexible joint 73 to permit oscillation of cam 62 as described above. The other end of rocker arm 74 is connected by a link 76 with a pivoted cam follower 77 having a nose portion 78 adapted to engage a cam 80 on the pattern drum 40. When the nose of the cam follower rides up on cam 80 the cam section 71 for projecting the bits 53 is raised to inoperative position. The timing is such that cam section 71 is raised when the bits are in retracted position, i. e., when the butts are in the circular part of cam track 61 (Fig. 8).

Alternatively, the bits can be rendered ineffective to produce terry loops by shifting the relative position of the thread feeding station and the point at which the bits are projected so that the bits come out too late to separate the threads. In Fig. 8 the relative position of the thread feeding station with respect to the point at which the bits are projected is indicated by an arrow 81. If the relative position of the thread feed is shifted to a point represented by arrow 82, the bits do not come out until after both threads have been drawn down by the needles. The bits are hence ineffective to separate the threads and loops of both threads are drawn over the sinkers so that no terry loops are formed. The shifting of the relative position of the feeding station and the point at which the bits are projected can be effected by moving the buffer block 66 (Fig. 3) to permit bit operating cam 62 to turn farther than is permitted during oscillation of the needle cylinder.

The bits 53 serve not only to form terry loops but also to control accurate plating of the threads. As will be seen from Figs. 12 and 13, the hook of the needle engages the terry thread T first and draws a partial loop thereof over bits 53 before the body thread T is engaged by the hook. By drawing the bit back slightly just as the hook of the needle engages the body thread the terry thread T is drawn to the back of the hook and when stitches are drawn will form the outer face of the fabric. Alternatively, if the bit 53 is pushed out slightly as the hook engages the body thread B, the terry thread will be forced to the front of the hook (Fig. 17) so that thread B lies behind thread T, and the outer face of the fabric will hence be formed by the body thread B. Plating can thus be accurately controlled. The bits may be provided with notches 83 to give the bits a better purchase on the thread in controlling plating.

When needles are operated in the upper cylinder as occurs in knitting rib fabric, there must be provided a knocking over edge which serves the same purpose as the sinkers in the lower cylinder to engage the previously drawn stitches and cause them to be cast off when new loops are drawn by the needles. The lower edge of the upper cylinder wall ordinarily serves this function and is commonly referred to as a verge. The verge may be integral with the cylinder or may be in the form of a separate ring having needle grooves aligned with the needle grooves of the cylinder. As the terry bits 53 are preferably projected at a level above the lower edge of the verge, in order to form long terry loops the problem arises as to how to prevent interference between the bits and the verge. The problem is complicated by the fact that during the knitting of the sole and instep of a sock such as that shown in Fig. 18, the terry bits must be in operative position on one side of the needle cylinder to form a terry sole, while the verge must be in operative position on the other side of the cylinder to knit a ribbed instep. In the embodiment of the invention shown in the drawings, this problem is solved by splitting the verge into two sections so that the verge section 84 on the sole side of the cylinder can be raised out of the way of the bits while the verge section 85 on the instep side of the cylinder remains at proper level for producing rib knitting. As shown in Figs. 5, 6 and 11, the verge section 84 is secured to or integral with the upper needle cylinder 16 which is rotatable about a bearing sleeve 86 and is supported by a vertical ball bearing 87 carried by a bearing plate 88. The bearing plate is secured to the lower end of a sleeve 90 which surrounds the vertical shaft 55 carrying the bit dial 54 and bit cam 62 and extends up above the top plate 63 where it is provided with a collar 91. The collar is engaged by a bifurcated lever 92 bearing at one end at the top plate and having the other end connected by a link 93 to a rocker arm 94 having a nose portion 95 adapted to engage the cam 96 on the pattern drum 40. When the nose of the rocker arm rides up upon cam 96 the upper needle cylinder and hence the attached verge section 84 on the sole side of the cylinder is raised up out of the way of the bits 53 so that the latter can be projected out to form terry loops (Fig. 5). However, during the knitting of the top and leg portions of the sock where there is no terry, the upper needle cylinder and verge section 84 are lowered (Fig. 6) so that the two sections of the verge are at the same level. It will be understood that the vertical movement of the upper needle cylinder does not affect the length of the stitches drawn, as the stitch length is controlled by the distance the needles are drawn up by stitch cam 33 which of course does not move with the cylinder.

The other verge section 85 is carried by the bit dial 54 and remains at a constant level. As the ends of verge section 85 abut the ends of verge section 84 carried by the upper needle cylinder (Fig. 8a) the bit dial 54 is made to rotate with the cylinder and the needle grooves of the verge section 85 and of the cylinder are maintained in alignment. The split verge thus forms a simple and effective means for driving the bit dial 54 in synchronism with the needle cylinders. The height of the dial and hence of verge section 85 can be adjusted by an adjustment screw 97 at the top of shaft 55 by which the dial is carried in order to have the two sections of the verge at exactly the same level when verge section 84 is in its lower position. The adjustment screw 97 can also be used to change the length of the terry loops, it being understood that the length of the loops is determined by the distance the bits are located above the sinkers of the lower cylinder. In this event the vertical position of the upper needle cylinder carrying verge section 84 can also be adjusted to bring the two verge sections at the same level when knitting the top and leg.

An important feature of my invention from the point of view of construction and maintenance of the machine, is that the dial 54, bits 53 and bit operating cam 62 are assembled as an integral unit on shaft 55 and can be removed from the machine without danger of losing the bits or dis-

turbing the relation of the set parts. Moreover, the cam track 61 in the bit operating cam 62 is formed to provide a gate 98 (indicated in dotted lines in Fig. 8) through which the bits can be removed and replaced without dismantling the machine.

If it is desired to knit terry all around the fabric, for example in the toe band of the sock shown in Fig. 18 instead of only on the sole half of the fabric, terry bits are provided all the way around the cylinder. Such an arrangement is shown in Fig. 7. It will be understood that in this event, provision must be made to avoid interference between the terry bits and the verge on the instep side of the cylinder. This may be done by making both sections of the verge raisable preferably independently, so that in knitting the sock of Fig. 18 the verge on the sole half of the cylinder can be raised when knitting the heel and sole while the verge on the instep side is not raised until the toe band 7 is reached. Alternatively, the verge portion of the cylinder wall may be apertured by cutting holes or notches therein so that the terry bits may come out through the cylinder wall, as indicated at the left hand side of Fig. 7. In some instances it may be desired to use the terry bits as a knocking over edge or verge for the upper cylinder needles, in which event the bits are manipulated so that the outer ends thereof are aligned with and substantially flush with the wall between the needle grooves of the cylinder at the knocking over point. With this arrangement the bits cooperate with the lower cylinder needles to form terry loops and cooperate with upper cylinder needles in the manner of a verge to cause previously drawn stitches to be cast off, thus serving a dual purpose.

In the embodiment shown in the drawings, the feed finger 48 for feeding the body thread B is movable downwardly and in closer to the needle circle during the knitting of the heel and toe than during the knitting of circular work. The feed finger is carried on an arm 100 pivotally mounted at one end on a supporting member for limited movement up and down and also in and out relative to the needle circle. The other end of arm 100 is engageable by an inclined cam surface 102 for moving the finger inwardly and an abutment 103 for moving the finger downwardly, both the cam surface and abutment being carried by a rod 104 movable up and down by a rocker arm 105 (Fig. 10). The rocker arm 105 is actuated by a tappet 106 engageable with cams 107 on the pattern drum 40. As shown in the drawings Figs. 2 and 10, the rocker arm 105 also operates the upper and lower switch cams 37 and 31 as these cams are also moved at the start and finish of the heel and toe. A spring 108 is provided for moving the feed finger 48 up and out when released by upward movement of rod 104 (Figs. 1 and 10). The movement of the feed finger to one position for knitting circular work and to another position for reciprocating work further assures accurate plating of the threads at all times, and avoids any possibility of the body thread being missed by any of the needles upon oscillation of the needle cylinder during the knitting of the heel and toe.

The operation of the machine will be understood from a brief description of the steps in making an article of hosiery such as that shown in Fig. 18. The socks are preferably produced by string work with a number of ravel courses of plain knit fabric referred to as a looper's edge between successive socks in the string. To produce the welt or anti-ravel edge 1, alternate needles are transferred to the upper cylinder and at least one course of 1 x 1 rib is knit. The welt cam 35 (Fig. 4) is withdrawn to render the upper cylinder needles inoperative, while a number of welt courses, for example, four or five are knit on lower cylinder needles only, whereupon the welt cam again goes in to close the welt and the knitting of 1 x 1 rib is resumed. The 1 x 1 rib knitting is continued until a sufficient length of the top portion 2 has been produced, whereupon the transfer cams 38 and 39 act on selected needles to position groups of six consecutive needles in the lower cylinder alternating with groups of three consecutive needles in the upper cylinder for the 6 x 3 fabric of the leg. During the knitting of the welt, top and leg, the terry bits 53 remain inactive.

When the heel portion 5 is reached, a needle transfer is effected so that on the sole side of the cylinder, consecutive needles are positioned in the lower cylinder, while the needles on the instep side remained positioned for 6 x 3 rib. At about the same time, the upper cylinder is raised to raise verge section 84 on the sole side of the cylinder, and the movable section 71 of bit operating cam 62 is lowered to operative position to cause the bits 53 to be projected out between the threads fed at the feeding station. Preferably one or more circular courses are knit before the needle circle begins oscillation to produce the fashioned portion of the heel. During the oscillation of the cylinder, the needles on the instep side of the cylinder are rendered inactive by control of the switch cams 31 and 37, and the feed finger 48 for the body thread feed is held in and down by the cam surface 102 and the abutment 103 (Fig. 10). When the heel is completed and circular knitting resumed, the feed finger 48 is allowed to move up and out under action of spring 108 and the switch cams are operated to cause needles on the instep side of the cylinder to resume knitting. During the knitting of the instep 4 and sole 6, the needles on the sole side of the cylinder cooperate with bits 53 to produce long terry loops of the terry thread T while on the instep side no bits are projected, and hence, the body thread B and terry thread T are knitted in plated relation. This condition is represented in Fig. 12 where it will be seen that the needles at the right hand side of the figure are producing terry fabric, while the needles at the left hand side are positioned for producing the 6 x 3 knitting of the instep. When the toe band 7 is reached, all the remaining upper cylinder needles are transferred to the lower cylinder, and if it is desired to produce terry fabric all around the toe band, the bits on the instep side of the cylinder (Fig. 7) come into operation. The toe like the heel, is produced by reciprocation of the needle cylinder, using only the needles on the sole side of the cylinder, the needles and bits on the instep side being rendered inoperative. Upon completion of the toe, all of the terry bits 53 are retracted so that the machine will produce the plain knit looper's edge above referred to. Before going into the welt of the next sock, the upper cylinder and the attached section 84 of the verge are lowered to bring the two sections of the verge to the same level.

It will be seen that the invention thus provides a novel method of producing terry fabric whereby instrumentalities located above the needle cylinder and operated independently of the sinkers are projected between the needles

to separate the terry thread and body thread and to cooperate with the needles in forming long terry loops.

What I claim and desire to secure by Letters Patent is:

1. In a knitting machine having coaxial needle cylinders with needles operable in either cylinder and means for feeding thread to the needles, the combination with means for manipulating consecutive needles in the lower cylinder to draw needle loops of thread fed by said feeding means, of instrumentalities associated with the upper cylinder and cooperating with the needles in the lower cylinder to form sinker loops of said thread.

2. In a knitting machine having coaxial needle cylinders with needles operable in either cylinder and means for feeding thread to the needles, the combination with means for manipulating consecutive needles in the lower cylinder to draw needle loops of thread fed by said feeding means, of instrumentalities projecting outwardly from the upper cylinder and cooperating with needles in the lower cylinder to form sinker loops of said thread, and means for retracting said instrumentalities to release said sinker loops.

3. In a knitting machine having coaxial needle cylinders with needles operable in either cylinder and means for feeding a plurality of threads to the needles, the combination with means for manipulating needles in the lower cylinder to draw needle loops of thread fed by said feeding means, of sinkers associated with the lower cylinder and cooperating with needles in the lower cylinder to form sinker loops of one of said threads, and instrumentalities associated with the upper cylinder and cooperating with needles in the lower cylinder to form sinker loops of another of said threads.

4. In a knitting machine having superposed needle cylinders, needles operable in either cylinder and sinkers associated with the lower cylinder, the combination of outwardly projecting bits associated with the upper cylinder, thread feeding means adapted to position one thread above and another thread below said bits, and means for manipulating needles to receive both threads and to draw loops of one thread over said bits and draw loops of said other thread over the sinkers.

5. In a knitting machine having superposed needle cylinders, needles operable in either cylinder, and sinkers associated with the lower cylinder, the combination of means for feeding two threads in spaced relation to one another, a series of bits associated with the upper cylinder, means for moving the bits outwardly to cause them to project between the said two threads, means for manipulating needles to receive both of said threads and to draw loops of one thread over the sinkers and draw loops of the other thread over said bits, and means for retracting the bits to release the last mentioned loops.

6. In a knitting machine having superposed needle cylinders, needles operable in either cylinder and sinkers associated with the lower cylinder, the combination of a dial associated with the upper cylinder and rotating therewith, bits carried by said dial and movable between an inner retracted position and an outer position in which said bits project outwardly beyond the needle circle, means for feeding a thread above said bits and another thread below said bits, cams for manipulating the needles to draw loops of one thread over the bits and to draw loops of the other thread over the sinkers and cam means for moving the bits outwardly to receive the thread and inwardly to release the loops drawn over said bits.

7. In a knitting machine having coaxial needle cylinders, needles operable in either cylinder and means for driving the needle cylinders alternately in opposite directions, the combination of thread feeds for feeding two threads in spaced relation a series of bits associated with the upper cylinder, means for moving said bits outwardly to separate said threads and to cooperate with the needles to produce longer sinker loops of one of said threads when the threads are knitted, and means for shifting the relative positions of the point at which the bits are moved outwardly and the points at which the threads are fed upon reversal of the direction of rotation of the needle cylinders to obtain proper separation of the threads in each direction.

8. In a knitting machine having coaxial needle cylinders, needles operable in either cylinder and means for driving the needle cylinders alternately in opposite directions, the combination of thread feeds for feeding two threads in spaced relations, a dial associated with the upper cylinder and rotating therewith, a series of bits carried by said dial, a cam for moving said bits outwardly to separate said threads and to cooperate with the needles to produce longer sinker loops of one thread than of the other thread, and means for oscillating said cam upon reversal of the direction of rotation of the needle cylinders to shift the point at which the bits are moved outwardly.

9. In a knitting machine having coaxial needle cylinders and needles operable in either cylinder, the combination of thread feeds for feeding two threads in spaced relation, a dial associated with the upper cylinder and rotating therewith, a series of bits carried by said dial, a cam for moving said bits outwardly to separate said threads and to cooperate with the needles to produce longer sinker loops of one thread than of the other thread, and means for shifting said cam to render said bits ineffective to separate said threads.

10. In a knitting machine having coaxial needle cylinders and needles operable in either cylinder, the combination of thread feeds for feeding two threads in spaced relation, a series of bits associated with the upper cylinder and movable between a retracted position and an outer position in which said bits project outwardly beyond the needle circle to separate said threads and cooperate with the needles to produce longer sinker loops of one thread than of the other thread, a cam for moving the bits outwardly, and means for rendering said cam inoperative and maintaining the bits in retracted position.

11. In a knitting machine having coaxial needle cylinders, needles operable in either cylinder and a verge associated with the upper cylinder, the combination of thread feeds for feeding two threads in spaced relation, a series of bits associated with the upper cylinder and movable between a retracted position and an outer position in which said bits project outwardly beyond the needle circle to separate said threads, and means for raising one section of the verge to permit bits to project out beneath it while maintaining another section of the verge at a level to cooperate with needles in the upper cylinder to draw stitches.

12. In a knitting machine having coaxial nee-

dle cylinders and needles operable in either cylinder, the combination of a dial associated with the upper cylinder and rotatable therewith, a series of bits carried by said dial and a verge cooperating with needles in the upper cylinder to draw stitches, one section of said verge being carried by said dial and another section of said verge being carried by the upper needle cylinder.

13. In a knitting machine having a needle cylinder, needles operable in said cylinder and sinkers operable between consecutive needles, the combination of a dial above the needle cylinder and rotatable therewith, bits carried by said dial and movable between an inner retracted position and an outer position in which said bits project out between the needles, means for feeding a thread above said bits and another thread below said bits, means for manipulating the needles to receive both threads and draw loops of one thread over the sinkers and longer loops of the other thread over said bits, with the needle loops of both threads drawn in plating relation, and means for moving said bits to determine the relative position of the threads in hooks of the needles to control the plating of said threads.

14. In a knitting machine having a needle cylinder, needles operable in said cylinder, and means for rotating the needle cylinder alternately in opposite directions, the combination of a dial above the needle cylinder and rotatable therewith, bits carried by said dial and movable between an inner retracted position in which said bits project out between the needles, a cam for projecting and retracting said bits, a feeding station for feeding a thread above said bits, and another thread below said bits means for manipulating the needles to take and knit both of said threads in each direction of rotation of the needle cylinder, and means for shifting said cam upon reversal of rotation to control the point at which said bits are projected.

15. In a knitting machine having coaxial needle cylinders and needles operable in either cylinder, the combination of a dial, a series of bits carried by said dial and movable from an inner retracted position and an outer position in which said bits project out between the needles, a cam for projecting and retracting the bits, and a shaft extending down through the upper needle cylinder and supporting the dial, bits and cam, said dial, bits and cam and shaft being removable from the cylinder as a unit.

16. In a knitting machine having coaxial needle cylinders, needles operable in either cylinder and sinkers associated with the lower cylinder, the combination of means for feeding a plurality of threads to the needles, instrumentalities associated with the upper cylinder and cooperating with needles in the lower cylinder to draw longer sinker loops of one thread than of another thread, the needle loops of both of said threads being drawn in plating relation, and means for manipulating said instrumentalities to control the plating of said threads.

17. In a knitting machine having coaxial needle cylinders and needles operable in either cylinder, a series of instrumentalities associated with the upper cylinder and cooperating with needles in the lower cylinder to produce tubular seamless terry fabric part way around the needle circle, a second series of instrumentalities associated with the upper cylinder and cooperating with the balance of the needles in the lower cylinder, to produce terry fabric the rest of the way around the needle circle, and means for separately controlling said series of instrumentalities to render one or both series inoperative.

18. In a knitting machine having coaxial needle cylinders and needles operable in either cylinder, a series of instrumentalities associated with the upper cylinder and cooperating with needles in the lower cylinder to produce terry fabric on one side of the needle cylinder while needles on the other side of the needle cylinder are operated to produce rib fabric, means for rendering said instrumentalities inoperative and means for manipulating the needles to produce rib fabric all the way around the needle cylinder.

19. In a knitting machine having coaxial needle cylinders and needles operable in either cylinder, bits associated with the upper cylinder and adapted to project out between consecutive needles, means for feeding a thread above said bits and another thread below said bits, means for manipulating consecutive needles on one side of the needle circle in the lower cylinder to receive both of said threads and cooperate with said bits to produce terry fabric, means for positioning selected needles on the other side of the needle circle in the upper cylinder with intervening needles in the lower cylinder, and means for manipulating the needles on said other side of the needle circle to take said threads and knit them in plated relation to produce rib fabric.

20. In a knitting machine having coaxial needle cylinders with needles operable in either cylinder and means for feeding thread to the needles, the combination with means for manipulating needles in the lower cylinder to draw needle loops of thread fed by said feeding means, of instrumentalities projecting out through the wall of the upper cylinder and cooperating with needles in the lower cylinder to form sinker loops of said thread.

21. In a knitting machine having a needle cylinder, needles operable in said cylinder and means for selectively rotating or oscillating said cylinder, the combination of a dial above the needle cylinder and rotatable therewith, bits carried by said dial and adapted to project out beyond the needle circle, a thread feed for feeding a thread above said bits, a thread feed for feeding another thread below said bits, and means for moving at least one of said thread feeds closer to the needle circle when the needle cylinder is operated by oscillation.

22. In a knitting machine having coaxial needle cylinders with needles operable in either cylinder and means for feeding thread to the needles, the combination with means for manipulating needles in the lower cylinder to draw needle loops of thread fed by said feeding means, of instrumentalities associated with the upper cylinder and cooperating with needles in the lower cylinder to form sinker loops of said thread, and a gate for removing and replacing said instrumentalities without dismantling the machine.

23. In a knitting machine having coaxial needle cylinders with needles operable in either cylinder and means for feeding thread to the needles, the combination with means for manipulating needles in the lower cylinder to draw needle loops of thread fed by said feeding means, of instrumentalities associated with the upper cylinder and cooperating with needles in the lower cylinder to form sinker loops of said thread and cooperating with needles in the upper cylinder to cast off previously drawn stitches.

24. In a knitting machine having coaxial needle cylinders, needles operable in either cylinder, means for feeding a plurality of threads to the needles, a sectional verge associated with the upper cylinder and adapted to cooperate with needles in the upper cylinder to draw stitches, instrumentalities cooperating with needles in the lower cylinder to draw longer loops of one thread than of another thread to form terry fabric, means controlling the operation of said instrumentalities and the needles to produce terry fabric on one arcuate section of the needle cylinder and non-terry rib knit fabric on another section, and means for raising one section of said verge to permit operation of said instrumentalities to produce terry fabric while maintaining another section of the verge at a level to cooperate with needles in the upper cylinder to draw stitches.

25. In a knitting machine having a rotatable needle cylinder, a circular series of needles operable in said cylinder, a sinker ring inside the needle circle, a circular series of sinkers carried by said sinker ring and disposed between consecutive needles, a dial disposed inside the needle circle coaxially with the needle cylinder and rotatable therewith, bits carried by said dial and movable between an inner retracted position and an outer position in which consecutive bits project out between consecutive needles, a feeding station for feeding a thread above said bits and another thread below said bits, cams for manipulating the needles to receive both threads at said feeding station and draw loops of one thread over the sinkers and longer loops of the other thread over said bits, and means for moving said bits independently of the sinkers to project the bits outwardly at said feeding station.

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