Feb. 2, 1932. T. H. JONES 1,843,641

CIRCULAR KNITTING MACHINE AND THE PRODUCTION OF FABRICS THEREON

Filed July 23, 1930 7 Sheets-Sheet 1

FIG. 1.

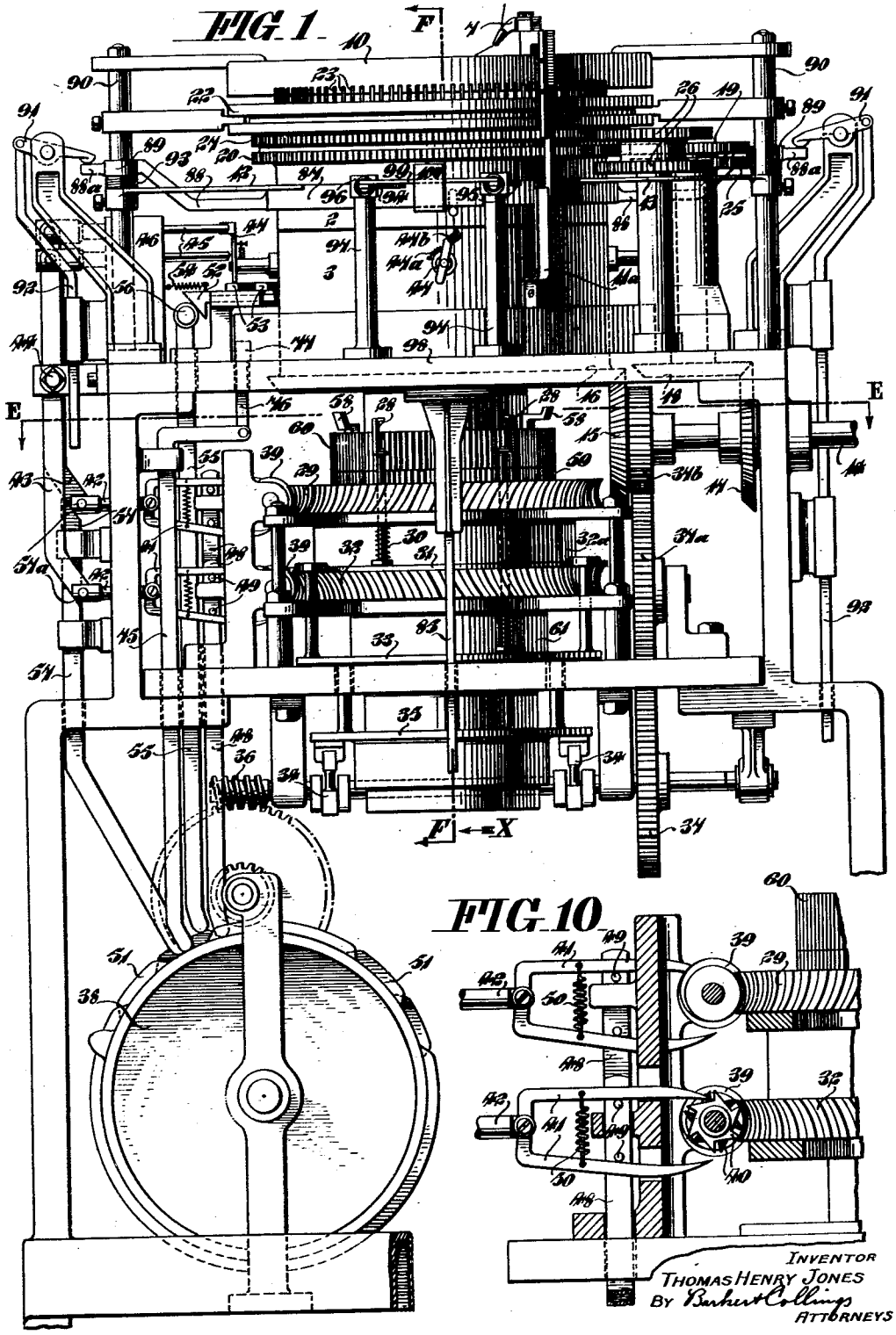


FIG. 10.

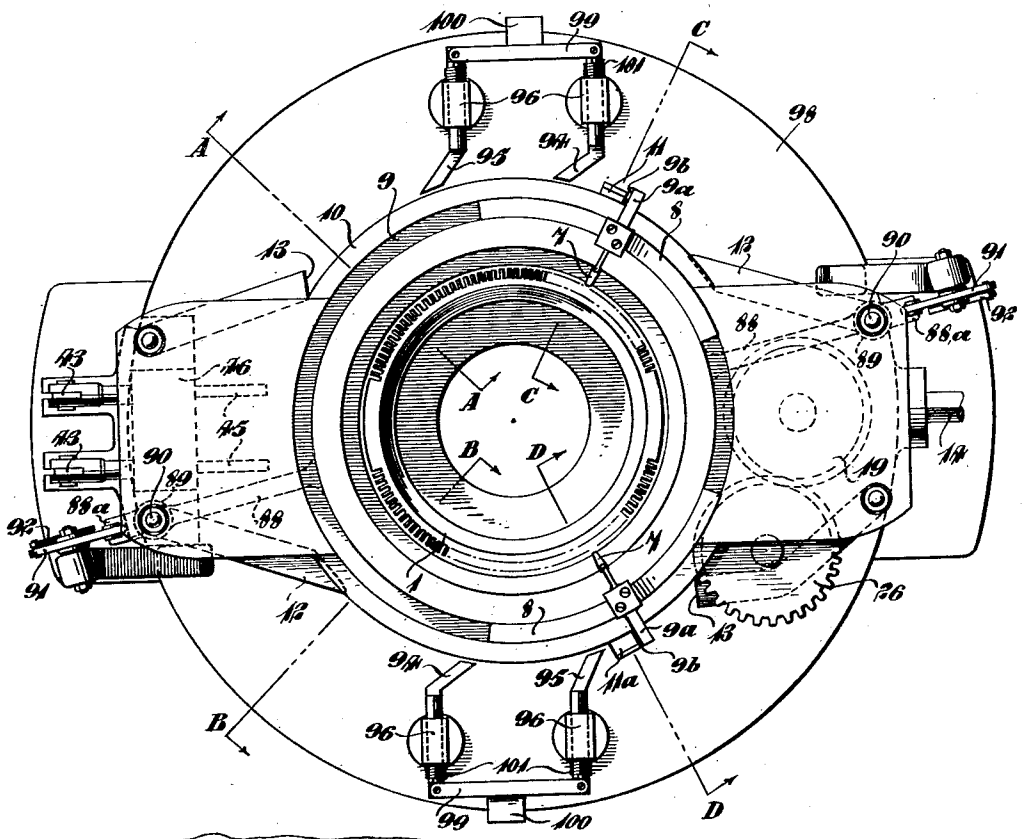
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Feb. 2, 1932. T. H. JONES 1,843,641

CIRCULAR KNITTING MACHINE AND THE PRODUCTION OF FABRICS THEREON

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FIG. 2.



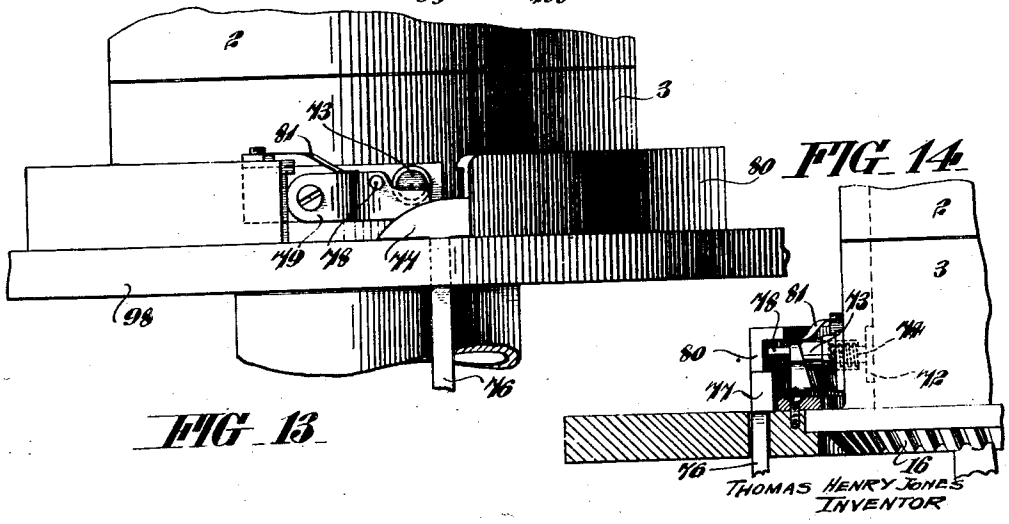


FIG. 13.

FIG. 14.

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CIRCULAR KNITTING MACHINE AND THE PRODUCTION OF FABRICS THEREON

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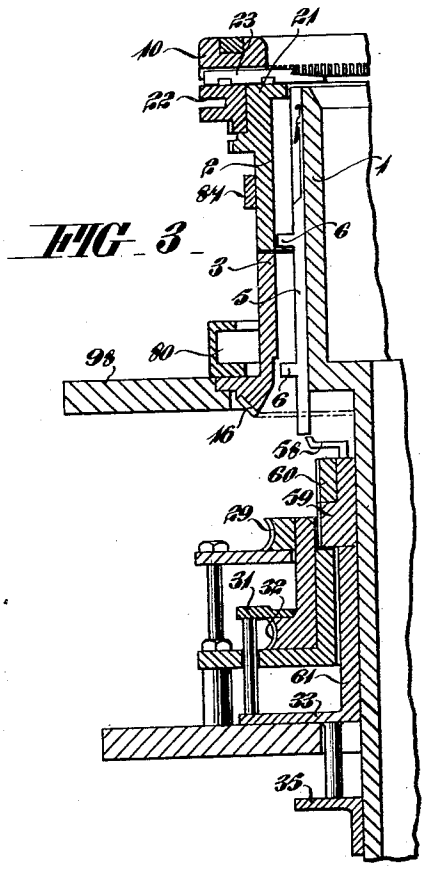


FIG. 3.

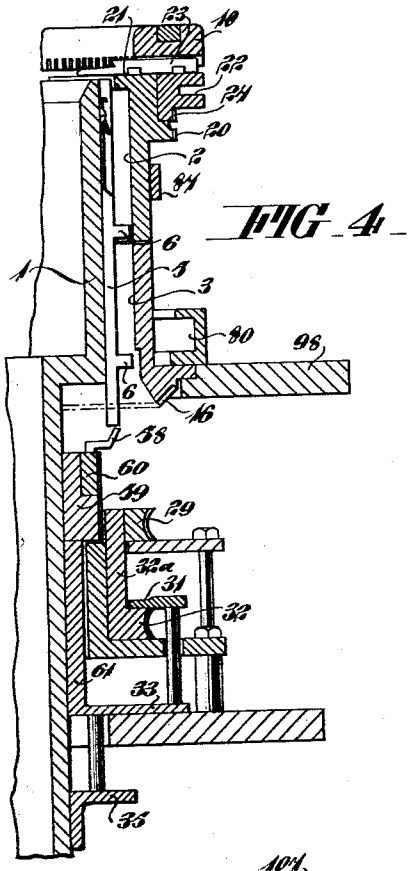


FIG. 4.

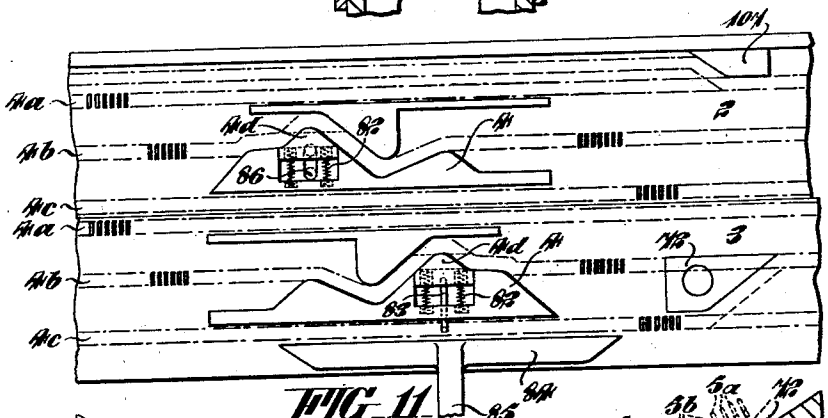


FIG. 11.

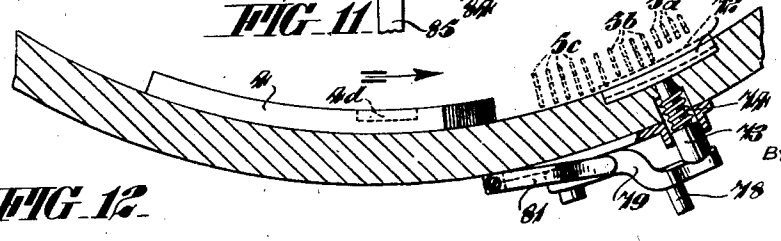


FIG. 12.

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CIRCULAR KNITTING MACHINE AND THE PRODUCTION OF FABRICS THEREON

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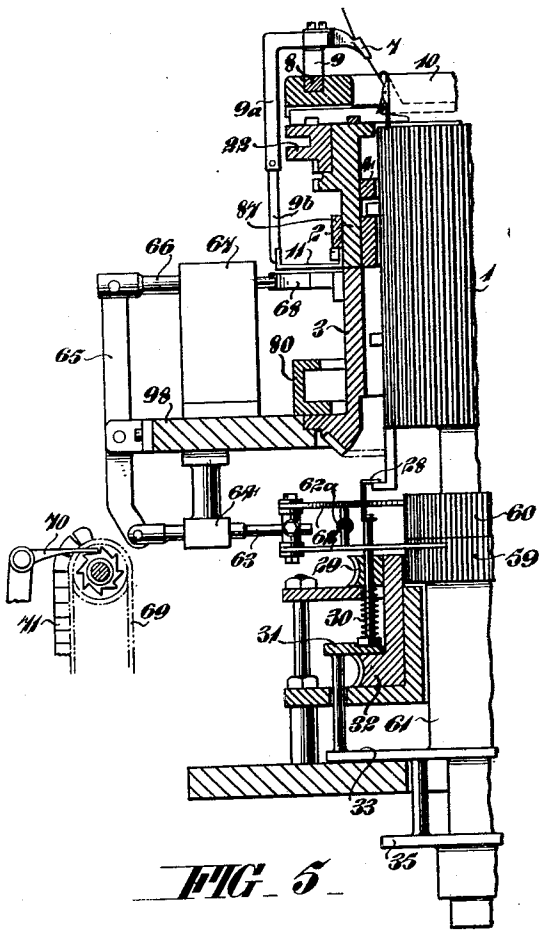


FIG. 5.

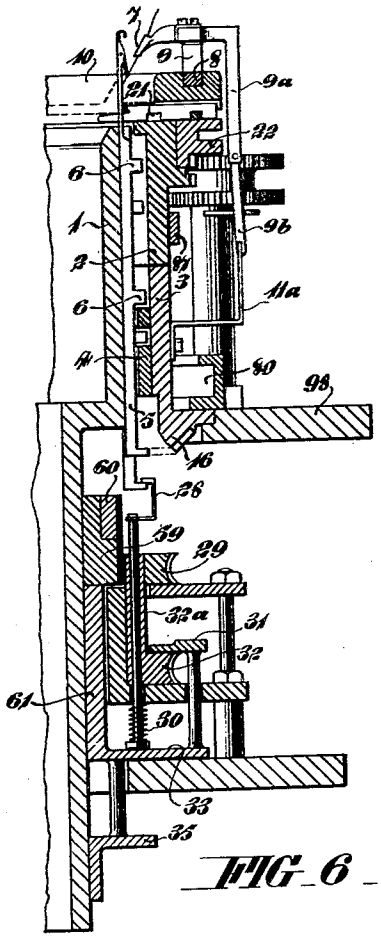


FIG. 6.

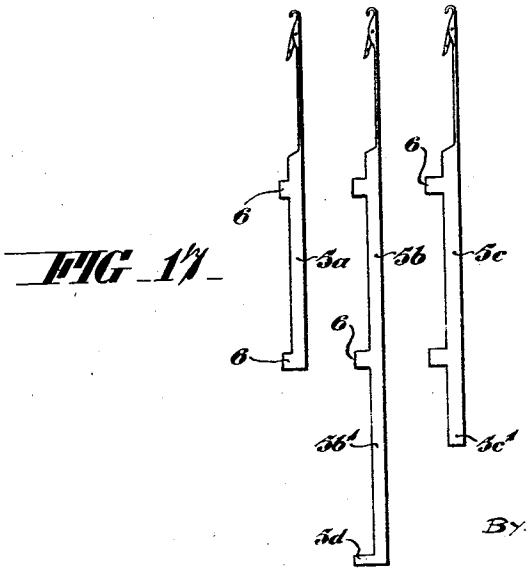


FIG. 17.

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CIRCULAR KNITTING MACHINE AND THE PRODUCTION OF FABRICS THEREON

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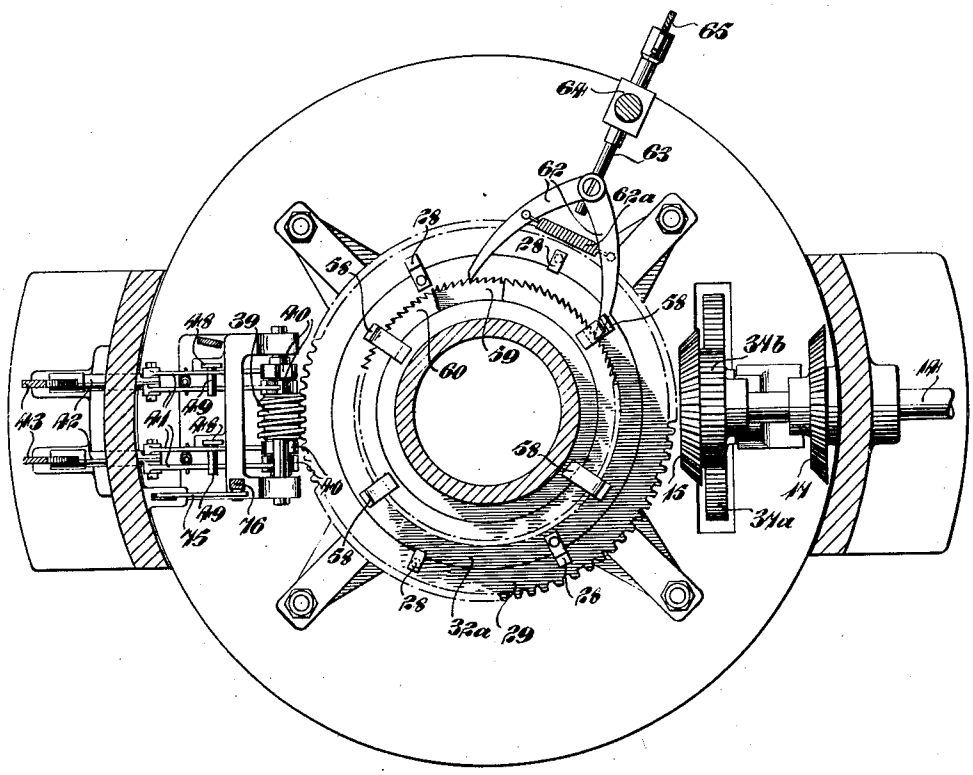


FIG. 4

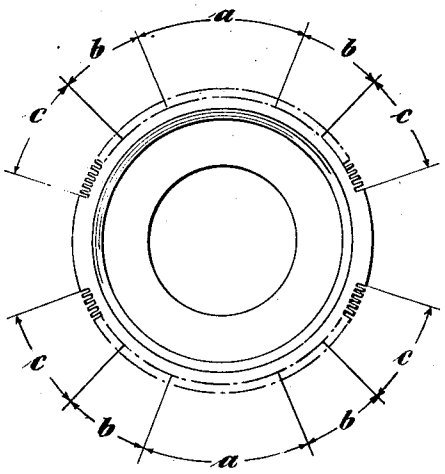


FIG. 18

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CIRCULAR KNITTING MACHINE AND THE PRODUCTION OF FABRICS THEREON

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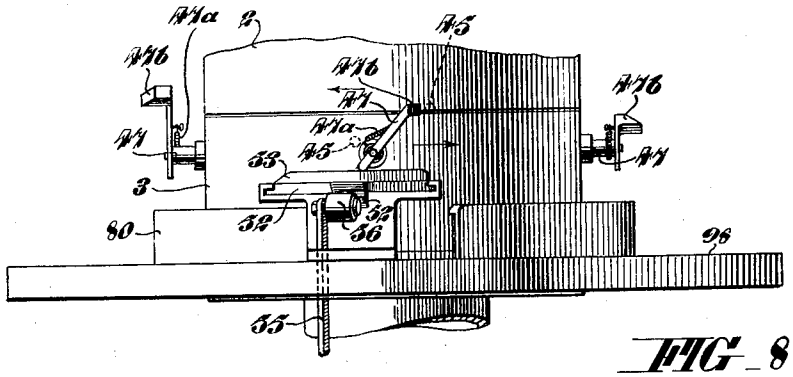


FIG. 8

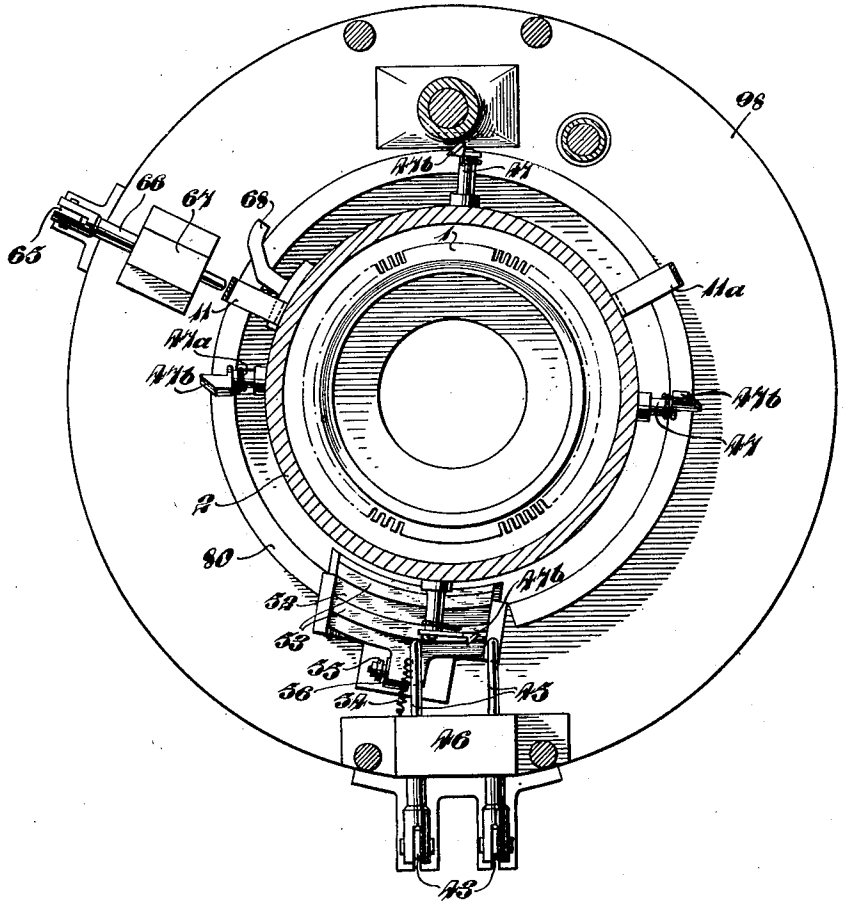


FIG. 9

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CIRCULAR KNITTING MACHINE AND THE PRODUCTION OF FABRICS THEREON

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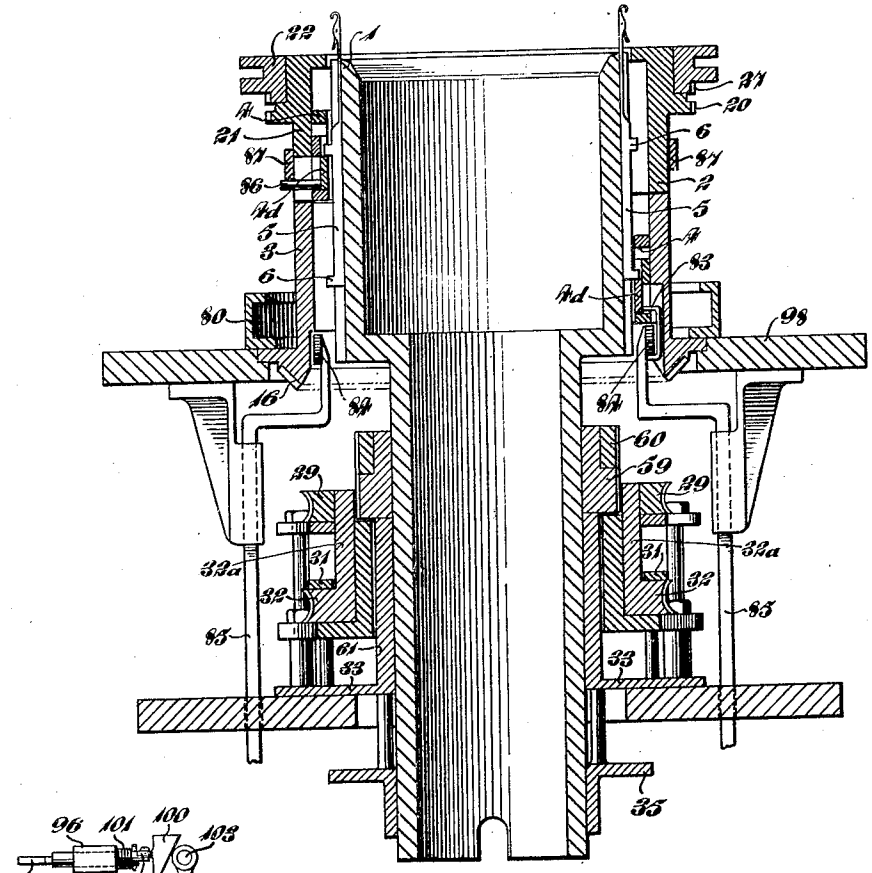


FIG 15

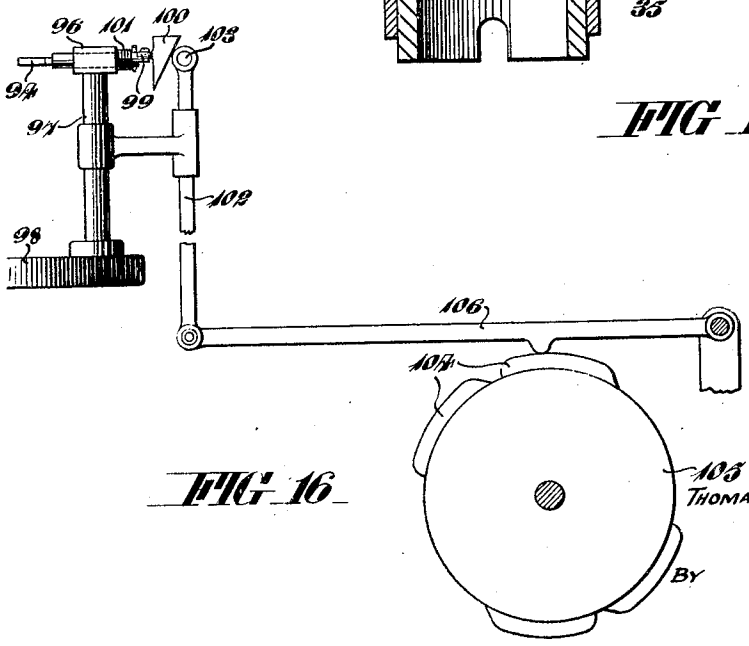


FIG 16

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Patented Feb. 2, 1932 1,843,641

UNITED STATES PATENT OFFICE

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CIRCULAR KNITTING MACHINE AND THE PRODUCTION OF FABRICS THEREON

Application filed July 23, 1930, Serial No. 470,176, and in Great Britain July 24, 1929.

This invention relates to improvements in circular knitting machines and the production of fabrics thereon, and has reference to that type of machine capable of producing selvedged fabric without reciprocation of the needle or cam cylinder.

An object of the present invention is to provide new or improved means for varying the shape and contour of the fabric or fabrics produced, and since such variation in shape is in the main effected by the operation of the needles a further object of the invention resides in the provision of new or improved means for controlling the needles, such control being particularly directed to the selective movement of the needles into and out of knitting operation.

Another object of the invention is to produce in a machine of the type referred to a one-piece stocking, or a plurality of stockings, comprising a foot having a pocket toe and heel and a shaped or fashioned leg, the pockets for the toe and heel being automatically formed on the machine.

The principal feature of the invention consists in the provision in a machine of the type set forth of means for selectively locating and maintaining for predeterminined periods the needles in either one of two inoperative positions. When in either of the inoperative positions the needles are not operated by the knitting cam.

The three races or paths of traverse comprise a knitting race in which the needles are operated upon by the knitting cams, an inoperative race into which needles are adapted to be projected while retaining loops thereon, and a second inoperative race into which needles can be withdrawn so that no thread will engage therewith. The needles are selectively moved from the operative race to an inoperative race and/or vice versa as required by means of elements movable laterally relatively to said needles, the displacement and operation of said needle-moving members being automatically effected from the main control drum of the machine.

In the employment of the machine for producing stockings, pocket heel and toe portions are formed by progressively moving needles of selected groups into an inoperative position without removing the thread loops therefrom and subsequently progressively moving said needles back into the knitting position, this being accomplished by picker elements adapted to coact with butts on said needles and operated to have a step by step motion laterally of said needles, i. e. around the machine; a widening or fashioning of the leg of the stocking being accomplished by automatically operated lifter elements functioning to raise needles in progression from a lower inoperative race to the knitting position.

For the purpose of more fully describing the nature of this invention reference will now be made to the accompanying drawings, wherein:—

Figure 1 illustrates in elevation a circular knitting machine in accordance with the present invention.

Figure 2 is a plan view of the machine.

Figure 3 is a vertical section through part of the machine on A—A of Figure 2.

Figure 4 is a vertical section through part of the machine on B—B of Figure 2.

Figure 5 is a part vertical section through part of the machine on C—C of Figure 2.

Figure 6 is a vertical section through part of the machine on D—D of Figure 2.

Figure 7 is a sectional plan on line E—E of Figure 1.

Figure 8 illustrates in elevation displaceable cam bits for controlling the step-by-step motion of the needle pickers when producing heel and toe pockets.

Figure 9 is a plan view of the arrangement shown in Figure 8.

Figure 10 is an enlarged detail view in elevation of suitable clawker mechanism through which step-by-step rotation of the picker carrying wheels is imparted from the cam bits shown in Figures 8 and 9, said clawker mechanism being also shown in Figures 1 and 7.

Figure 11 illustrates diagrammatically the needle cams and three needle races or paths of traverse in connection with each cam.

Figure 12 shows in sectional plan a needle cam with displaceable cam element for mov-

ing certain of the needles to the lower inoperative race when required.

Figure 13 is a side-elevational view and Figure 14 a part-sectional elevation of the means for effecting displacement of the auxiliary cam shown in Figure 12.

Figure 15 is a sectional elevation on line F—F of Figure 1, looking in the direction of arrow X.

Figure 16 is a detail view showing one method of operating additional deflectors for the thread guides.

Figure 17 shows suitable needles for use in the machine.

Figure 18 shows diagrammatically the areas within which the various types of needles operate.

In one method of carrying out the invention as illustrated in the drawings same will be described as applied to a circular knitting machine having a stationary needle cylinder 1, and two revolving cam boxes 2, 3 located one above the other and adapted to be driven round the cylinder in opposite directions at equal speeds.

Each cam box is provided with a stitch cam 4. As the cam boxes rotate in opposite directions the cams 4 pass each other twice in each revolution at two diametrically opposed points, and to allow for the passing of the cams the needle cylinder is at said points void of needles. Needles are fitted in both halves of the cylinder so as to produce simultaneously two pieces of fabric, but it is to be understood that fabric may be produced in one half of the machine only.

The needles 5 are provided with two knitting butts 6 spaced one above the other, the upper butt being adapted to engage with the cam 4 of the upper cam box 2 and the lower butt with the cam in the lower box 3, said needles being operated by first one cam and then the other, and the opposite rotation of the cams causing the successive operation of the needles to progress first in one direction and then in the other.

Yarn is fed to the needles by guides 7 carried by segmental members 8 which are adapted to travel within a circular channel 9 in the sinker carrier ring 10 or part associated therewith. Each yarn guide 7 has fixed therewith a cranked portion 9*a* depending downwardly on the exterior of the sinker ring, said crank 9*a* having pivoted at its lower part a depending finger 9*b* which is pivotally displaceable in a radial direction. On the cam boxes 2, 3 are radially projecting crank arms 11, 11*a*, (Figs. 5 and 6), the one arm projecting outwardly a short distance further than the other. The operation is such that the arm 11 on the upper cam box 2 engages the depending finger 9*b* and in so doing propels the thread guide around the needle bed until same has passed the needles on one side of the machine after which said depending finger coacts with the inclined face of a fixed deflector 12 which deflects said finger outwardly from engagement with the arm 11 and brings the guide to rest. Immediately afterwards the second crank arm 11*a* on cam box 3 coacts with the depending finger 9*b* and propels the guide round in an opposite direction across the aforesaid needles until said depending finger comes into contact with an inner bevelled face of a second deflector 13, which deflector moves the depending finger radially inwards to its original position. By this means the guide is propelled to and fro and yarn is fed first in one direction and then in the other across the needles. The operation just previously described is carried out in connection with the thread guide at each side of the machine, the deflectors 12 and 13 being furnished for each guide, and by this means it will be appreciated that two flat selvedged pieces of fabric are simultaneously knitted.

The drive of the two cam boxes in opposite directions at equal speeds is effected from the drive shaft 14, the lower box being driven through intermeshing gears 15, 16 and the upper box through intermeshing bevels 17, 18, the bevel 18 being carried by a short vertical shaft having a further gear 19 which meshes with a circumferential gear 20 associated with the upper cam box 2.

At the top of the needle cylinder is mounted a pair of sinker cam rings (Figs. 3, 4, 5 and 6), one of said rings 21 being associated with or formed integral with the upper part of the upper needle cam 2 and rotates in unison therewith, while the other sinker cam ring 22 encircles the ring 21 and is adapted to be rotated in an opposite direction. The sinkers 23 are mounted in a tricked carrier 10 fixedly secured above the sinker cam rings, and the arrangement is such that the two sinker cams are caused to pass each other at the same position as the afore-described needle cams i. e. at the parts void of needles.

The one sinker cam ring is, of course, driven in unison with the upper needle cam 2, the other sinker cam ring 22 being driven from a gear 25 on the spindle carrying the aforesaid gear 19 through the intermediary of gears 26 and 27, (Fig. 1).

As a particular embodiment the machine will be described for the simultaneous production of two selvedged fabric portions each comprising a complete stocking blank and each blank consisting of a foot portion embodying a pocket toe and pocket heel and a leg which is shaped or fashioned, and to this end each row of needles in each half of the machine is divided into five groups embodying a central group *a*, a comparatively small group *b* on each side of said central group and a further group *c* on each side of the said groups *b*, (Fig. 18), the needles appertaining to groups *a*, *b* and *c* being differently

constructed, that is to say, same have different sized butts for coacting with the stitch cams. For example, the needles 5*a* (see Figure 17) appertaining to each central group *a* have short butts 6, the needles 5*b* appertaining to each group *b* having medium sized butts somewhat longer than the butts on needles 5*a* and the needles 5*c* appertaining to each group *c* having full sized butts. Additionally the needles 5*b* are provided with lower extensions 5*b*1 having a butt 5*d* at the lower end adapted to be operated upon by picker elements hereinafter described, while the needles 5*c* also have a lower extension 5*c*1 advantageously approximately half the length of the lower extensions 5*b*1, but said extension 5*c*1 does not terminate in a butt. The extensions 5*c*1 on needles 5*c* are adapted to be operated upon by lifter elements as herein described.

The two needle cam rings or boxes 2 and 3 are each provided with three needle races 4*a*, 4*b* and 4*c*, each middle race 4*b* comprising an operative or knitting race, while the upper and lower races 4*a*, 4*c* are both inoperative races. The two central groups of needles 5*a* are continually maintained in the knitting position, that is to say the butts thereon always traverse the middle cam races 4*b*. The needles 5*b* appertaining to the groups *b* are provided for producing the pocket toe and heel portions and the knitting butts thereon are adapted to be moved from the middle or operative races 4*b* to the upper inoperative races 4*a* and vice versa during the production of the pockets. The needles 5*c* appertaining to the outer groups *c* are employed for shaping or widening the leg portions of the stockings and the knitting butts thereon are normally in the lower inoperative races 4*c* but are adapted to be moved progressively as desired into the operative races 4*b*.

To displace the pocketing needles 5*b* into and out of knitting position as required, picker elements 28 are advantageously employed, (Figs. 1, 5 and 6), a pair of pickers being provided for each half of the machine. One picker of each pair is carried by and vertically slidable within an annular worm wheel 29, the lower end of the stem of said picker being maintained by spring 30 in engagement with a lifting ring 31. The second picker of said pair of pickers is carried by and vertically movable within the sleeve portion 32*a* of a second worm 32, the lower end of the stem of said picker being maintained by another spring 30 upon a further lifting ring 33 which is secured to or associated with the aforesaid lifting ring 31 so as to move in unison therewith.

The pickers 28 of each pair are adapted in operation to be moved step by step towards and away from each other so as to bring same into engagement with the needles of groups *b* in succession and displace said needles either downwardly from the upper inoperative race to the knitting position or upwardly from said knitting position to the inoperative position and to this end the step by step movement of the pickers is effected by gradual rotation in opposite directions of the two worm wheels 29, 32. The vertical movement of the pickers in an upward direction is effected by crank members 34 coacting with an annular flange 35 which is associated with and adapted to move in unison with the aforesaid lifting rings 31, 33, said cranks being rotated in unison with the machine so that the lifting rings with the pickers rise and fall once during each cycle or revolution of the machine. The operation of the cranks may be effected through a worm 36 and intermeshing gears 37, 37*a* and 37*b* from the drive shaft 14.

The opposite rotation of the picker-carrying worm wheels 29, 32 is also advantageously effected to the extent of one needle during each complete cycle of the machine, and means for accomplishing this will now be described.

Meshing with each worm wheel 29, 32 is a suitably mounted worm 39, and secured on the spindle of each worm 39 is a pair of ratchet wheels 40 located side by side, the ratchet wheels being located at one end of the spindle of one worm and at the opposite end of the spindle of the other worm as shown in Figure 7. Associated with the ratchets 40 of each worm is a pair of clawker arms 41, the clawkers of each pair being spaced apart one below the other to such an extent that when the one or upper clawker coacts with a ratchet wheel the other or lower clawker is out of engagement. Pivotally connected to each pair of clawker arms 41 is a short rod 42 which is in turn pivotally connected to upwardly extending bars 43, the portions of said bars at the connection to the rods 42 being suitably inclined as shown in Figure 1. The upwardly projecting bars 43 are pivoted midway in their lengths at 44 on a fixed pivot and the upper end of each bar is pivoted to one of a pair of inwardly extending fingers 45 guided within a suitably fixed member 46. The inner ends of the fingers 45 are adapted to coact with suitable cam elements 47 (Figs. 8 and 9) projecting from the oppositely rotating cam boxes 2 and 3, and the arrangement is such that when a cam member 47 moves into contact with a finger 45 said finger is pressed radially outwards and through a centrally pivoted bar 43 causes a clawker 41 to move radially inwards and by its engagement with one of the ratchet wheels 40 rotate the worm 39 to an extent sufficient to traverse one of the worm wheels carrying the pickers to a distance of one needle. By suitably spacing the cam elements around the cam boxes

2 and 3 the worm wheels 29, 32 are rotated alternately the teeth of the worm wheels and coacting worms being so shaped as to effect rotation of said wheels in opposite directions.

If now the picker elements 28 are being operated to displace the needles appertaining to groups *b* successively into the upper inoperative race, the step by step movement of said pickers is so timed as to bring the cranked portions of said pickers beneath the lower butts 5*d* on the needles 5*b* at the time when the lifting rings 31 and 33 are being raised by the aforesaid crank mechanism. If, however, the needles 5*b* are being progressively moved from the upper inoperative race to the knitting position the butt engaging portions of the pickers must be moved into position over the butts 5*d* of the needles at the time when the pickers are being lowered; it being understood that the downward movement of the pickers is effected by the springs 30 and coincides with the downward movement of the lifting rings 31, 33.

In producing a heel or toe pocket in the stocking fabric, the pocketing needles 5*b* when raised to the inoperative position retain the thread loops thereon so that when such needles are again brought down to the knitting position such loops become intermeshed with fresh loops formed on the needles. Therefore it will be appreciated that the upward displacement of the pocketing needles is effected while the pickers are moved in one direction, for example away from each other, and the downward movement is effected when the traverse of said pickers is reversed, i. e. brought towards each other. To this end it will be seen that when the pickers have been traversed to the required extent in one direction means must be furnished for reversing the rotation of the worm wheels 29, 32 and this is accomplished by displacing out of engagement with the ratchet wheels 40 those clawker arms which have been coacting therewith and bringing into engagement with said ratchets the other or lower clawker arms which have previously been out of engagement; it being understood that the ratchet wheels with which the upper clawker arms engage have teeth which are cut in an opposite manner to those of the ratchet wheels engaged by the lower clawker arms.

The displacement of the clawkers to reverse the rotation of the worm wheels and picker elements may be effected by upwardly extending bars 48 guided for vertical motion in suitable bearings and each having a pair of lateral pins 49 which, upon vertical displacement of the bars, press the clawkers in one direction or the other as required. Springs 50 serve to retain the clawker arms in engagement with the pins 49, and the displacement of bars 48 may be effected and timed by a suitable cam bit 51 on the main control drum 38.

The projecting cam elements 47 (Figs. 8 and 9) on the rotating cam box are arranged in quadrature, two diametrically opposed elements being in operation at the same time so that the two worm wheels 29, 32 with pickers are rotated or shogged at each half revolution of the machine. When now the direction of motion of the said worm wheels and pickers is reversed to move the pocketing needles in an opposite direction it will be understood that the time at which such pickers are to be moved must be different from the time at which same are moved when the needles require to be displaced in an opposite direction, therefore means must be provided whereby that pair of cam elements 47 which function to shog the pickers in one direction must be thrown out of operation when said pickers are required to be shogged in the opposite direction and the remaining pair of cam elements which have previously been out of operation must be brought into operation.

For this purpose the several cam elements 47 are preferably pivoted members normally held by springs 47*a* in a position where the cam portions 47*b* will not engage the projecting pins 45, and in order to move said cam elements to a position for engagement with said pins a radially sliding member 52 is provided having two spaced cam rises 53, which sliding member when moving in one direction against the influence of a spring 54 brings one of said cam rises to a position where same engages with two diametrically opposed pivoted cam elements 47 which latter are pivoted to a position wherein the cam portions 47*b* thereon coact with the pins 45. When in this position the remaining two diametrically opposed cam elements 47 travel freely round without coacting with the pins 45. When, however, the sliding member 52 is permitted to move radially outwards under the influence of the spring 54 the other cam 53 on the slide is brought into a position where same will coact with the second diametrically opposed pair of pivoted cam elements 47, and cause same to be engaged by the pins 45, the first mentioned pivoted cam elements then moving freely around without coacting with either of said cams 53 and without being engaged by the pins 45. By arranging the pivoted cam elements 47 in quadrature it will thus be seen that the shogging of the pickers 28 can be so timed as to bring same either into a position over the pocketing needle butts 5*d* or during the lowering of the pickers, or beneath said butts during the upward movement of the pickers. The sliding movement of the cam-bearing member 52 against the spring 54 may be effected by the upward thrust of a vertically slidable bar 55 from a suitable cam rise on

the main drum 38, a roller or truck 56 on the upper end of said bar coacting with the bevelled face on the slide 52.

The picker members above-described are operated during the production of the pocket toe and heel portions of the stocking fabric, and after producing said pockets the mechanism for traversing said pickers is suitably bluffed or put out of action. One method of accomplishing this is by means of a vertically guided sliding bar 57 the lower end of which is adapted at the required times to ride upon suitable cam rises on the drum 38 so as to raise said bar and by means of a bevelled upper portion 57*a* coacting with similarly bevelled or cranked portions at the lower ends of the clawker operating bars 43, press inwardly the clawker carrying spindles 42 so as to force the clawkers inwardly beyond the ratchet wheels 40 and draw radially outwards the pins 45 at the upper ends of said bars 43. In this way the pins 45 are moved to a position wherein none of the pivoted cam members 47 will coact with same.

When the pocketing needles 5*b* are lifted to the inoperative position by the pickers 28, a comparatively short downward motion requires to be imparted to said needles preparatory to their being again lowered into operation so as to permit of the cranked portion of the pickers subsequently coacting with the upper side of said butts 5*d* to lower the needles. To this end a small cam piece 107 is conveniently provided immediately above the upper cam race 4*a* in the upper cam box 2, (Fig. 11) which cam 107 as the box rotates coacts with the upper knitting butts on the raised pocketing needles and lowers same to the extent required to be engaged by the pickers.

After the foot portion of the stocking has been produced embodying the toe and heel pockets lifter elements 58 are brought into action progressively to raise the widening needles 5*c* appertaining to groups *c* so as to move the knitting butts thereon from the lower inoperative cam races 4*c* to the middle knitting races 4*b*, thus producing a gradual widening of the fabric in the leg portion thereof.

A pair of lifting elements 58 is provided on each side of the machine, (Figs. 1, 3 and 4), one element of each pair being fixed to a circumferentially toothed ring 59 and the other element of each pair being fixed to a second circumferentially toothed ring 60 accommodated within an annular recess on the first-named ring 59. These two lifter rings 59, 60 are mounted upon a sleeve 61 formed as an integral portion of the previously described lifter rings 31, 33 which are operated by the cranks 34; the arrangement being such that the toothed rings 59, 60 carrying the lifter elements 58 are raised and lowered once during each revolution of the machine.

It will be understood that to produce a gradual widening of the fabric the elements 58 must be gradually moved further apart, and to do this intermittent rotation is imparted to the toothed rings 59, 60 in opposite directions, such rotation taking place immediately prior to the lifting motion of the rings to raise the needles so as to bring the elements 58 into position beneath the successive needles to be raised.

To impart the requisite intermittent rotation to the rings 59, 60 in opposite directions, a pair of pivoted clawker arms 62 are employed, (Fig. 5) said arms being held by a spring 62*a* in engagement with the ratchet teeth on the rings 59, 60, one clawker arm on each ring. The two clawker arms are carried by a radially projecting pin 63 guided within a fixed bracket 64 and pivoted at its outer extremity to the lower end of a centrally pivoted upstanding arm 65 the upper end of said arm being pivotally connected to a further pin 66 slidably guided in a bearing 67 and adapted to coact at its inner extremity with a cam piece 68 secured to and projecting radially outwards from the lower cam box 3. Thus at each revolution of the cam box 3 the cam member 68 functions to press outwardly the pin 66 against suitable spring resistance and in doing so the clawkers 62 operate to rotate the lifter rings 59, 60 in opposite directions to the extent of one needle. The intermittent shogging movement of the lifter elements 58 is timed to take place immediately prior to the lifting of the rings 59, 60 carrying said elements.

The opposite movement of the lifting elements is continued until the desired width of fabric is attained after which such movement is stopped by bluffing the clawker mechanism operating on the lifter rings and moving the radial pin 66 to a position wherein the cam member 68 will not coact therewith. This bluffing mechanism may embody a travelling chain 69 (see Figure 5) which is intermittently traversed through pawl and ratchet mechanism 70, high links or the like 71 on said chain being at the required time brought into engagement with the lower end of the arm 65 so as to press said end inwardly and draw the upper end of same outwardly.

After the completion of a stocking blank the needles 5*c* appertaining to groups *c* are all returned from the operative to the inoperative position so as to move the knitting butts thereon into the lower cam races 4*c*. This is advantageously accomplished by means of a running-down cam 72 (see Figures 11 to 14) mounted in the lower cam box 3, said cam being carried by a pin 73 which projects radially to the exterior of the cam box. Normally this cam is forced outwardly by a suitable spring 74, but when the needles 5*c* are to be lowered such cam is pressed inwardly so as to cause the long knitting butts

on said needles to coact with an under inclined face of the cam, thus drawing all of said needles successively down into the lower inoperative race ready to be again raised by the before-described lifter elements 58.

The pressing inwards of the running-down cam 72 is automatically effected at the required time from the main control drum 38 through the intermediary of an upwardly extending sliding bar 75 adapted at its lower extremity to coact with a suitable cam rise on said drum, the upper end of said bar 75 having connected thereto a vertically guided arm 76 having a cam-faced head 77. This head 77 when the bar 75 is raised comes into the path of a pin 78 on a small pivoted arm 79 travelling round with the cam box 3 and causes said pin to rise to a position where same will ride upon the upper face of a fixed annular ring 80 located around the lower part of the cam box 3 and suitably spaced therefrom. The inner face of the pivoted arm 79 is bevelled or inclined as shown in Figure 14 and said inclined face coacts with the outer extremity of the cam pin 73 so that when the arm 79 is lifted the inclined face thereof causes the cam pin and cam carried thereby to be pressed inwardly to the position indicated in dotted lines in Figure 12. It will be understood that the cam is pressed inwards during a complete revolution of the cam box 3, after which the pivoted arm 79 is lowered by spring 81 and the cam is returned to its normal position by its spring 74.

In connection with the production of stockings and socks it has been found expedient, as previously described, to commence manufacture at the toe, and it has also been found expedient to incorporate the French type of foot in which the seam is located centrally of the sole. In this type of foot it will be appreciated that one half of each pocket is knitted on each side of the foot portion, said halves being subsequently seamed up to form complete pockets when the fabric of the foot is folded and seamed.

In one method of producing this type of foot the two halves of each pocket may be produced separately in succession, and during the production of said pocket halves the needles 5*a* appertaining to the central groups *a* are prevented from taking thread and knitting. In doing this the thread guide is caused to have a restricted traverse to and fro over a distance corresponding substantially to that occupied by the pocketing needles at one side of the central group *a* until one half of the pocket is produced, after which said guide is caused to traverse to and fro over the group of pocketing needles on the opposite side of said group *a*, it being understood that in the production of each half pocket knitting commences on all of the needles of one group *b* and said needles are successively raised to the inoperaive cam races 4*a* and subsequently successively lowered to the operative or knitting position by the action of picker elements such as before-described. Preferably the raising of the needles 5*b* commences at that needle which is located adjacent to the central group *a*.

In order to prevent needles 5*a* of the central group from knitting during the production of the pockets each knitting cam 4 is provided with a vertically displaceable cam portion 4*d* the width of which is only a fraction of the full width of the cam 4 (see Figures 11 and 12). When this displaceable cam portion 4*d* is lowered the comparatively short butts on the needles 5*a* will not be engaged by the peak portion of the cam 4 but will continue to travel along the knitting race without being raised to take thread. The knitting butts on the pocketing needles 5*b* are however of sufficient length to coact with the cam 4 and be operated thereby even when the small displaceable cam piece 4*d* is lowered.

The small cam bits 4*d* are preferably retained in their normal or raised position by spring or springs 82. One method of lowering the cam bit 4*d* appertaining to the lower cam 3 is by providing on said cam bit a depending wire or strip element 83 of crank formation (Figs. 11 and 15) which may be accommodated within a recessed portion of the cam box, a cam bar 84 being at the required time raised to a position wherein as the cam box rotates the lower cranked portion of the element 83 coacts with a bevelled end of the cam bar 84 and rides along beneath said bar. In doing this the cam bit 4*d* is pulled down against the influence of the springs 82 and the short butt needles 5*a* traverse along the cam without being raised at the peak thereof. The cam bars 84 are of sufficient length to ensure the cam bit 4*d* being depressed for the required length of time in the revolution of the cam box to ensure that the needles 5*a* appertaining to group *a* do not receive thread. The cam bars 84 may be carried at the upper extremity of vertically guided rods 85 to which vertical motion is transmitted at the required time from the main cam drum 38 or from a subsidiary drum or drums through the intermediary of suitable link and lever mechanism. The cam bit 4*d* appertaining to the upper cam box 2 carries a pin 86 (Fig. 15) which projects through an opening in the cam box to the exterior thereof; and in order to depress this cam bit at the required time a ring member 87 is employed encircling the cam box immediately above the projecting pin 86. By lowering the ring 87 it will be appreciated that the cam bit 4*d* is lowered against the spring resistance and the short butt needles 5*a* are not raised by the stitch cam to take thread.

The depression of the ring 87 may be effected by providing said ring with radially extending arms 88 at diametrically opposed

positions, (Fig. 1) said arms having sleeve portions 89 encircling suitable fixed pillars 90 the outer extremities 88*a* of said arms 88 being operated upon by short centrally pivoted levers 91 which are operated through vertically guided rods 92 from the main cam drum of the machine or a subsidiary drum or drum as through suitable lever mechanism. When the rods 92 are raised the levers 91 press downwards the extremities 88*a* of the ring arms 88 against the resistance of suitable springs 93 encircling the pillars 90.

In order to restrict the traverse of the thread guides to the required distance to produce each pocket half in succession further guide deflectors 94, 95 are advantageously installed, said guides being preferably arranged in simultaneously operable pairs at diametrically opposite positions on the machine as illustrated in Figures 1 and 2. These deflectors are conveniently mounted to slide radially of the machine within sleeves 96 at the upper end of posts 97 on the machine flange 98, the deflectors 94, 95 of each pair being connected by a cross piece 99 carrying a cam plate 100. Springs 101 normally serve to retain the deflectors in a retracted position, i. e. out of the path of the thread guiding depending fingers 9*b*, and when it is desired that the traverse of the guides be restricted to a distance equal or approximately equal to that occupied by one of the pocketing needle groups *b*, said deflectors are depressed inwardly by the vertical displacement of a rod 102 having a roller or truck 103 at its upper and coacting with the cam plate 100.

Referring to Figure 2 wherein the subsidiary deflectors 94, 95 are shown as being projected inwardly to their operative position it will be seen that the thread guides 7 are only capable of reciprocatory motion between a fixed deflector 13 and a movable deflector 95 on one side of the machine and between a fixed deflector 12 and a movable deflector 94 on the opposite side of the machine, and when so disposed pocket halves are produced in the fabric at the one side edge thereof. If now the subsidiary deflectors are withdrawn to permit of the guides traversing past same and are immediately again projected, the guides will then have reciprocatory motion on the other side of said subsidiary deflectors and pocket halves will be produced at the opposite side edge of the fabric.

The movement of the subsidiary deflectors may be timed and controlled from cam pieces 104 on a rotating drum 105, a lever member 106 being adapted to coact with said cam pieces and said lever being pivotally or otherwise connected to the aforesaid vertically displaceable rod 102. Other means may, however, be provided for operating the subsidiary deflectors. For example said deflectors may be electrically operated through the intermediary of suitable solenoids which are energized and de-energized at the required times.

In a modified method of producing a French foot with pocket portions for the heel and toe, the before-described subsidiary deflectors may be dispensed with, in which case the two halves of each pocket would be simultaneously produced as the thread guides 7 would traverse the full width of the fabric at each course. In such arrangement however the central group of needles *a* would be rendered inoperative during the production of the pockets as before-described.

In the arrangement where the halvs of each pocket are produced in succession means are advantageously incorporated whereby the picker elements 28 appertaining to the pocketing needles on the one side of each central group of needles *a* are bluffed, i. e. retained inoperative until the pickers appertaining to the pocketing needles on the opposite side of said central group have completed their operation, when said last-named pickers are bluffed and the inoperative pickers brought into operation. To accomplish this all that is necessary is to incorporate means whereby the clawkers 41 functioning to transmit step by step motion to one of the picker carrying worm wheels 29 or 32 are maintained inoperative while the clawkers appertaining to the other picker carrying worm wheel operate and vice versa.

In the embodiment of the present invention disclosed herein the cams that operate the needles are adapted for continuous rotation relative to the needle-carrying means. It is essential to the operation of the machine in carrying out the present invention, that one of the said parts—the needle-carrying means or the cams for operating the needles—should be rotatable relative to the other. But it is largely immaterial which be the rotatable one and which one maintained stationary as it is well known in this art that arrangements for effecting the rotation of either may be embodied in the machine as circumstances or preferences may suggest. That embodiment of the invention which is considered to be the most practical is illustrated but it is not intended thereby to limit the invention to the specific showing in this case, nor beyond the scope of the claims wherein the invention is stated.

I claim:—

1. In a circular knitting machine for producing selvedged fabric, the combination with needle-carrying means and knitting cams, one of which is rotatable relative to the other, of means for continuously rotating one of the said parts and means for selectively locating and maintaining for predetermined periods the needles in either of two inoperative positions where same are unaffected by the knitting cams.

2. In a circular knitting machine adapted

for the production of selvedged fabric the combination of needle-carrying means, knitting cams, one of these being rotatable relative to the other, and means whereby continuous rotation is imparted to one of the said parts, the needle cams being formed with three races or paths of traverse for the needles, said races comprising a normal knitting race in which the needles are operated upon by the knitting cams, an inoperative race into which needles are adapted to be projected without removal of thread loops therefrom and a second inoperative race into which needles are adapted to be withdrawn so that no thread will engage therewith.

3. In a circular knitting machine adapted for the production of selvedged fabric the combination with needle-carrying means and knitting cams,—one rotatable relative to the other, of picker elements, said picker elements operating to move selected of the needles upwardly out of the knitting position without casting thread loops from their stems, said picker elements also operating to return said selected needles to the knitting position, and lifter elements operating to raise selected of others of the needles from a lower inoperative position to the knitting position.

4. A circular knitting machine as claimed in claim 3 and in which the picker elements function to produce pocket or bag portions in the knitted fabric and the lifter elements function to vary the width of the knitted fabric.

5. A circular knitting machine comprising, in combination, a non-rotating needle cylinder, a pair of needle cam boxes encircling said cylinder and adapted for continuous rotation in opposite directions at equal speeds, the needles being operable by the cams of each box, thread feeding means, needle picker elements, means for imparting vertical reciprocation to said pickers, means for intermittently traversing the pickers circumferentially of the machine, said pickers operating at predetermined intervals to displace selected needles with thread loops thereon to a position with their knitting butts above the path of the knitting cams and subsequently to return same to the knitting position, needle lifter elements, means for intermittently traversing said lifters circumferentially of the machine, and said lifters functioning at predetermined intervals to raise selected needles into a knitting position from a position wherein their knitting butts are below the path of the knitting cams.

6. A circular knitting machine as claimed in claim 5, with this distinction, that the needle picker elements operate upon equal groups of needles located one on each side of a central needle group unaffected by the pickers and that the needle lifter elements operate upon needles located at the outer side of each picker-operated group.

7. A circular knitting machine comprising in combination a non-rotating needle cylinder, two needle cam boxes rotating in opposite directions about said cylinder at equal speeds, the needles being operable by the cams of each box, three types of needles employed in the machine, thread feeding means, needle picker elements, means for imparting vertical reciprocation to said pickers, means for intermittently traversing the pickers circumferentially of the machine, said pickers operating on one of the three types of needles employed in the machine so as to displace same with thread loops thereon out of the knitting position and subsequently return same to the knitting position, needle lifter elements, means for intermittently traversing said lifters circumferentially of the machine, said lifters operating on a second of the three types of needles to raise same from an inoperative to a knitting position, and the third of the three types of needles being unaffected by both the needle pickers and lifters.

8. A circular knitting machine as claimed in claim 5 and having in addition a pair of annular members within which the needle picker elements are vertically slidable, means for rotating said annular members step by step in opposite directions and means for reversing the rotary motion of the annular picker carriers.

9. A circular knitting machine as claimed in claim 5 and including crank mechanism operating to impart to the picker elements a rising and falling motion once during each cycle of the machine.

10. A circular knitting machine as claimed in claim 5 and including a pair of annular members carrying the needle lifter elements, means for imparting simultaneous and opposite rotation to said lifter carriers and crank mechanism for imparting rising and falling motion to said lifter carriers.

11. A circular knitting machine comprising, in combination, a non-rotating needle cylinder, a pair of needle cam boxes encircling said cylinder, means for rotating said cam boxes continuously in opposite directions at equal speeds, the cams of each box operating upon the needles, thread feeding means, needle picker elements, a pair of annular picker carriers within which said pickers are vertically slidable, means for rotating said picker carriers step by step in opposite directions, means for reversing said rotary motion of the picker carriers at predetermined intervals, crank mechanism for imparting rising and falling motion to the picker elements slidable in said annular carriers, said pickers operating at predetermined intervals to displace selected needles with thread loops thereon to a position with their knitting

butts above the path of the knitting cams and subsequently to return said needles to the knitting position, needle lifter elements, a pair of annular carriers for said lifters, means for intermittently rotating said carriers with lifters simultaneously in opposite directions about the machine, crank mechanism for imparting to the annular carriers for the needle lifter elements a rising and falling motion once during each cycle of the machine, said crank mechanism being the same as that which imparts vertical reciprocation to the needle picker elements, said lifters functioning at predetermined intervals to raise selected needles into a knitting position from a position wherein their knitting butts are below the path of the knitting cams, and means for automatically discontinuing the intermittent rotary motion imparted to the picker carriers and the lifter carriers at predetermined times during the operation of the machine.

12. A circular knitting machine as claimed in claim 11 and in which the picker carriers are encircled by worm wheels having coacting worms which are operated by pawl and ratchet devices to impart intermittent rotation to the picker carriers.

13. A circular knitting machine as claimed in claim 11 and in which the picker carrying members are intermittently rotated in opposite directions through lever mechanism from cam elements which project radially from and travel round with one of the needle cam boxes.

14. A circular knitting machine as claimed in claim 11 and including four radially projecting pivoted cam elements on one of the rotating cam boxes spaced at intervals of 90°, two diametrically opposed pivoted cam elements being operable at one time intermittently to operate pawl and ratchet mechanism which through the intermediary of worms and worm wheels effects rotation of the annular picker carriers in opposite directions, the remaining two diametrically opposed pivoted cam elements operating when the direction of rotation of the picker carriers requires to be reversed, and the selection for operation of either of the diametrically opposed pair of cam elements being effected by displacement of a cam member into and out of the track of said cam elements.

15. A circular knitting machine as claimed in claim 11 and including a cam member slidably displaceable against spring influence from a cam drum through the intermediary of vertically displaceable rod or lever mechanism, said slidable cam being movable into and out of the track of either of two diametrically opposed pairs of pivoted cam elements projecting radially from and rotating with one of the machine cam boxes, said radially projecting cam elements being movable on their pivots against the influence of springs and being adapted to coact with fingers projecting radially inwards from pivoted lever members so as to operate pawl and ratchet mechanism associated with said levers, said pawl and ratchet mechanism being adapted to operate worms coacting with worm wheels encircling the annular picker carriers so as to effect simultaneous and opposite rotation of said picker carriers, the direction of rotation of said carriers being determined by the location of the first named slidable cam member coacting with the pivoted cam elements.

16. A circular knitting machine comprising in combination a non-rotating needle cylinder, a pair of needle cam boxes, means for rotating said cam boxes continuously in opposite directions, the needles being operated by the cams of each box, thread feeding means, needle picker elements, a pair of annular picker carriers within which the pickers are vertically slidable, worm wheels encircling said carriers, worms coacting with said worm wheels, clawker mechanism associated with ratchets on said worms and operating to rotate the picker carriers step by step in opposite directions, said cawkers being operated through lever mechanism from radially projecting cam elements travelling round with one of the cam boxes, means operable from a cam drum for reversing the rotary motion of the picker carriers at predetermined intervals, crank mechanism for imparting rising and falling motion to the picker elements, said pickers operating at predetermined intervals to displace selected needles with thread loops thereon into an upper inoperative position and subsequently to return said needles to the knitting position, needle lifter elements, a pair of annular carriers for said lifters, the annular carriers for the lifters being encircled by toothed rings, clawker mechanism coacting with said toothed rings, said clawker mechanism being operated through lever mechanism from a radially projecting cam member travelling round with one of the needle cam boxes so as simultaneously to rotate the lifter carriers step by step in opposite directions, crank mechanism for imparting a rising and falling motion to the lifter carriers, said crank mechanism being the same as that which imparts vertical motion to the needle pickers, the needle lifters functioning at predetermined intervals to raise selected needles from a lower inoperative position into a knitting position, means for bluffing the rotary motion of the picker carriers and lifter carriers at predetermined times and a running-down cam which is radially projected into one of the cam boxes to coact with butts on the needles operated by the lifter elements so as to return said needles to the inoperative position.

17. A circular knitting machine as claimed in claim 16 and in which the movement to the

operative position of the running-down cam is effected by pivotal displacement against spring resistance of a pivoted arm having a bevelled face which coacts with a bevelled portion of a pin carrying said running-down cam, the pivotal displacement of said pivoted arm being effected from a cam drum and the said running-down cam being maintained in the operative position, i. e. projected into the cam box during one complete revolution of the machine.

18. The production on a circular knitting machine without reciprocation of the needle carrier or knitting cams of one or more stocking blanks having selvedged edges wherein pocket portions are formed for the heel and toe by progressively lifting to an upper inoperative position by means of picker elements a group of needles having thread loops thereon and subsequently progressively lowering said needles with loops to the knitting position by the same pickers, a shaped stocking leg portion being subsequently knitted by progressively raising needles from a lower inoperative position to a knitting position through the intermediary of needle lifter elements.

19. A circular knitting machine adapted for the production of stocking blanks having selvedged edges wherein pocket portions are formed for the heel and toe, each pocket being composed of two half pockets knitted in succession, one on one side and the other at the opposite side of the width of the foot portion, each half pocket being produced by progressively lifting to an upper inoperative position the groups of needles having thread loops thereon and subsequently progressively lowering said needles to the knitting position, thread feeding means, means for reciprocating said thread feeding means, deflector members for said thread feeding means and means whereby said deflector members are automatically projected to a position for limiting the traverse of the thread feeding means to a distance approximately equal to the length of that part of the needle bed occupied by the group of needles required for producing each half pocket.

20. A circular knitting machine as claimed in claim 19 with this addition that those needles which are located between the needle groups employed for the production of the pocket portions are provided with knitting butts which are shorter than those of the remaining needles, and each knitting cam is provided at its peak with a vertically displaceable portion which is normally retained raised by spring means and automatically lowered during the production of the pocket portions so as to permit of the short butt needles traversing the knitting cams without being raised thereby to take thread and clear their loops.

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