A. GAGNÉ & J. W. SHAW.

CIRCULAR KNITTING MACHINE.

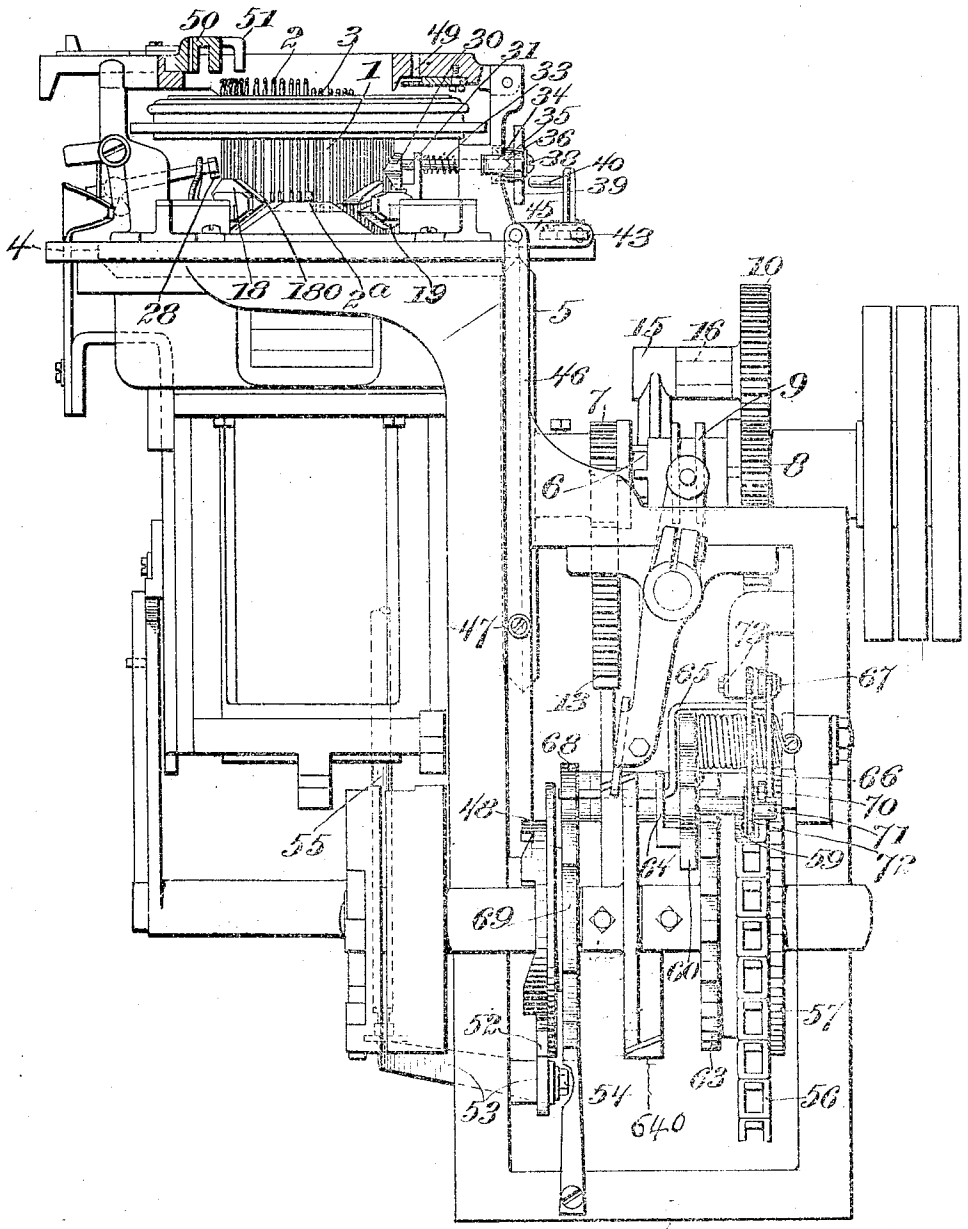
APPLICATION FILED AUG. 8, 1910.

1,040,183.

Patented Oct. 1, 1912.

6 SHEETS—SHEET 1.

Fig. 1.



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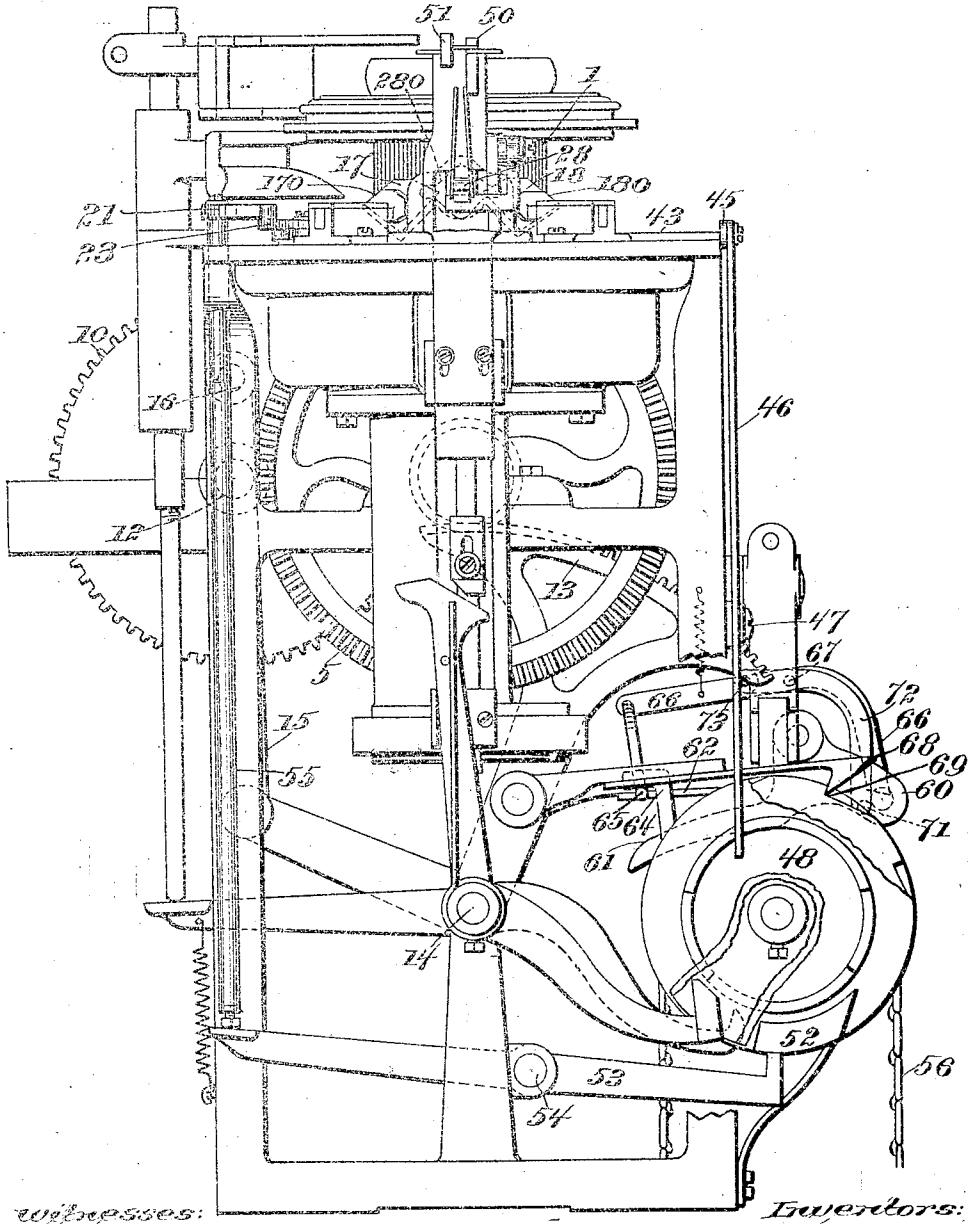
6 SHEETS—SHEET 2.

Fig. 2.



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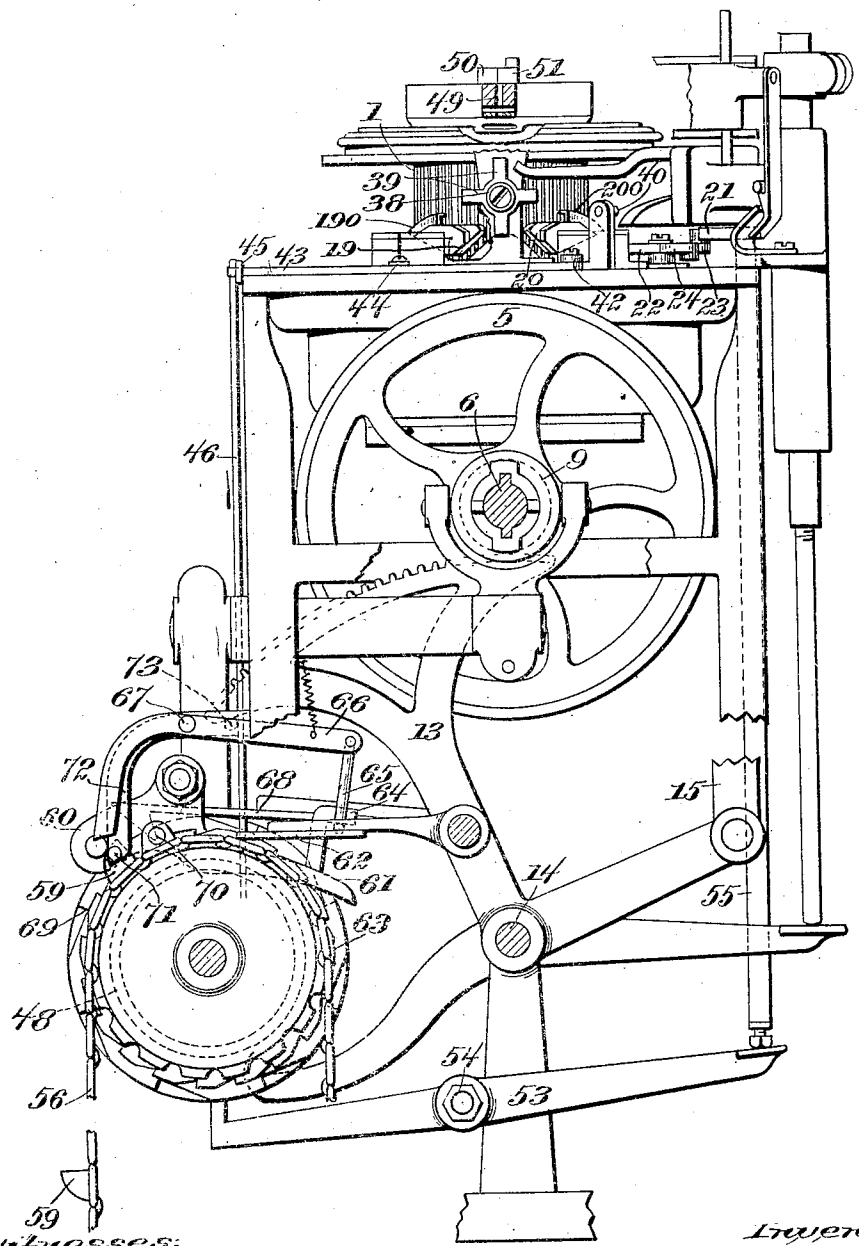
6 SHEETS—SHEET 3.

Fig. 3.



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6 SHEETS—SHEET 4.

Fig. 4.

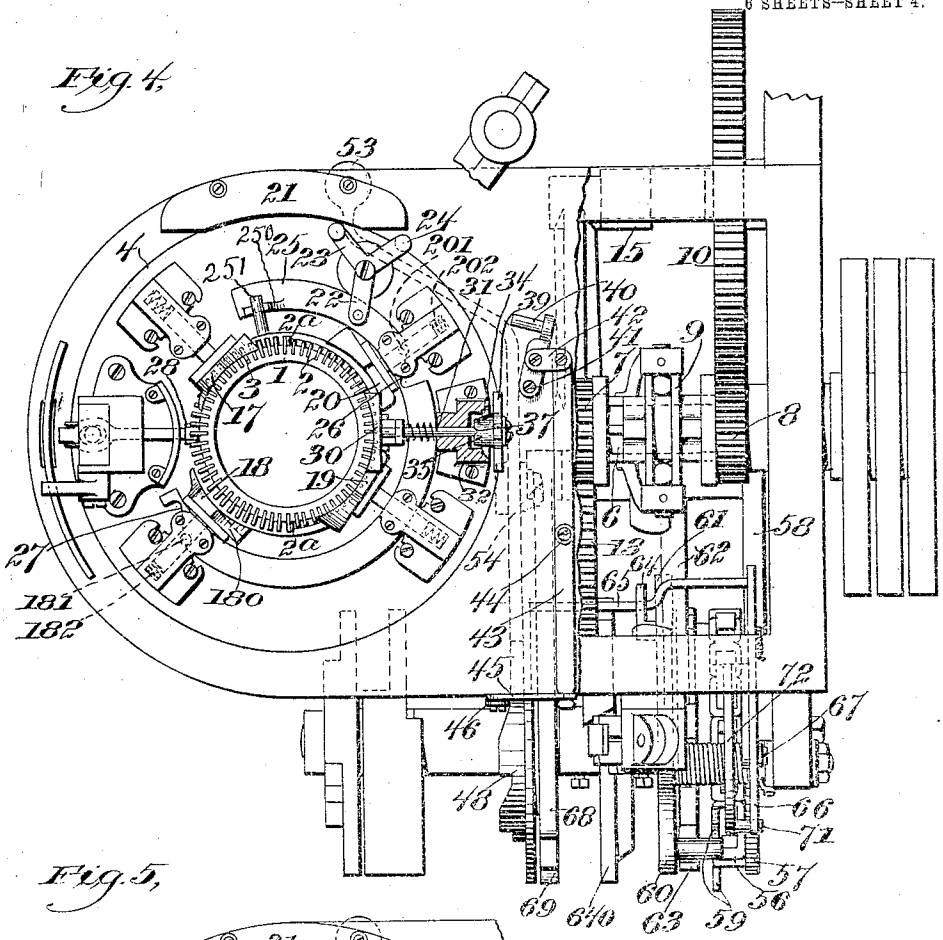
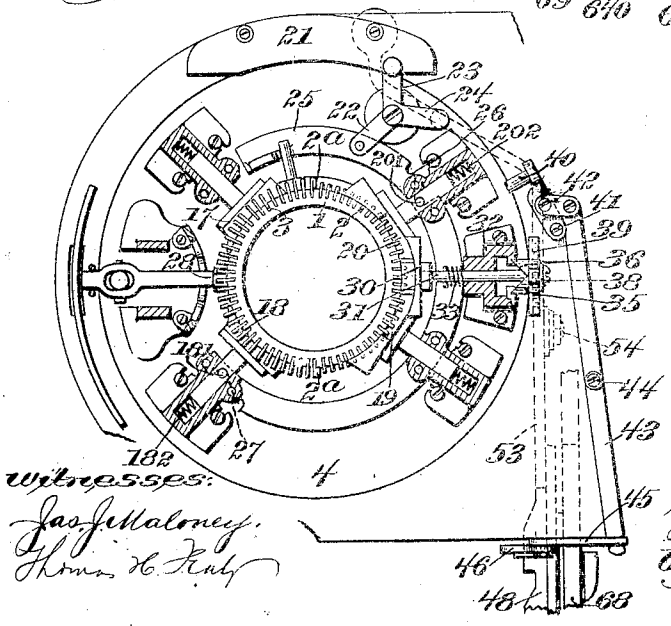


Fig. 5.



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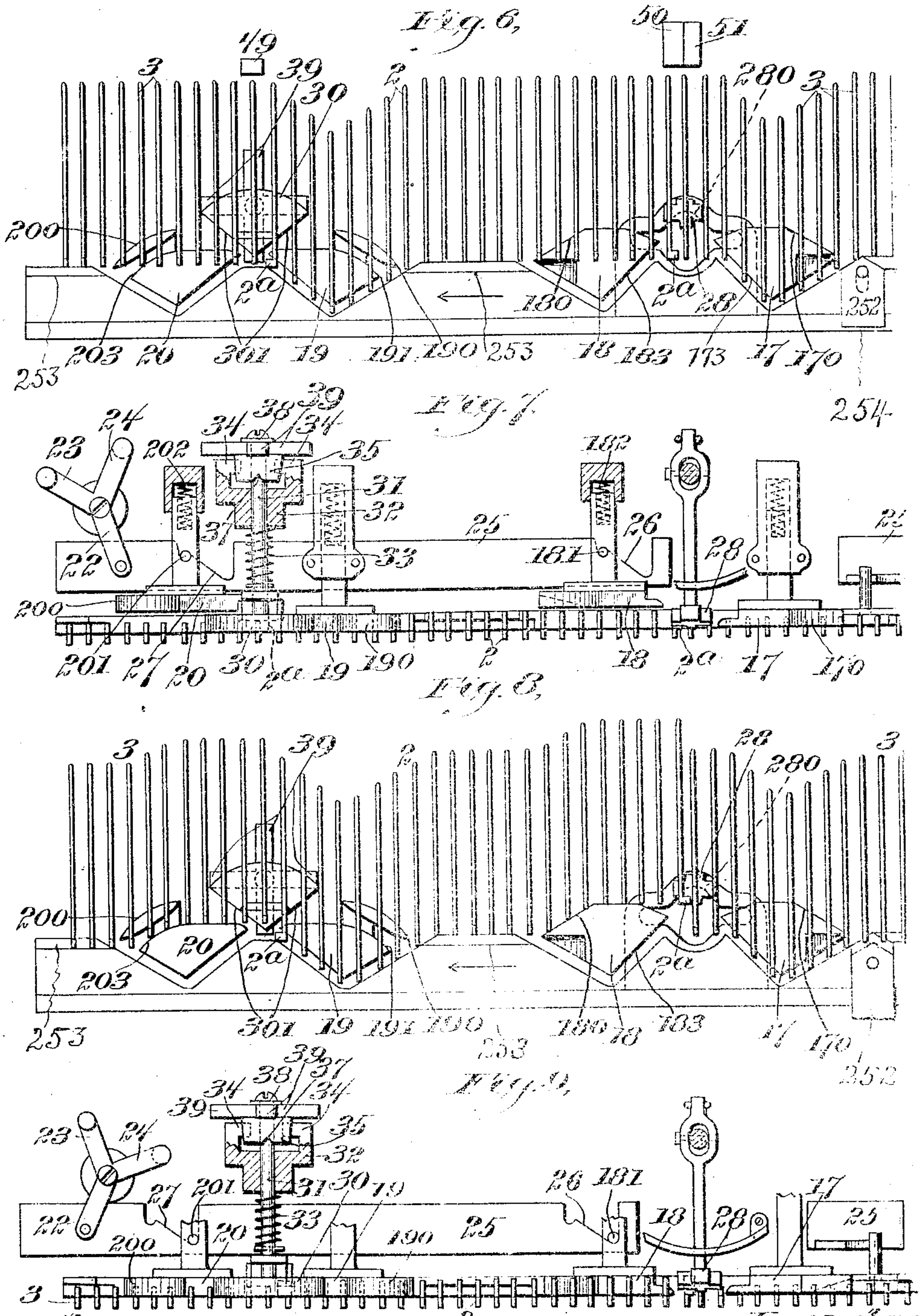
CIRCULAR KNITTING MACHINE.
APPLICATION FILED AUG. 8, 1910.

1,040,183.

Patented Oct. 1, 1912.
6 SHEETS—SHEET 5.



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CIRCULAR KNITTING MACHINE.

APPLICATION FILED AUG. 3, 1910.

1,040,183.

Patented Oct. 1, 1912.

6 SHEETS—SHEET 6.

Fig. 10.

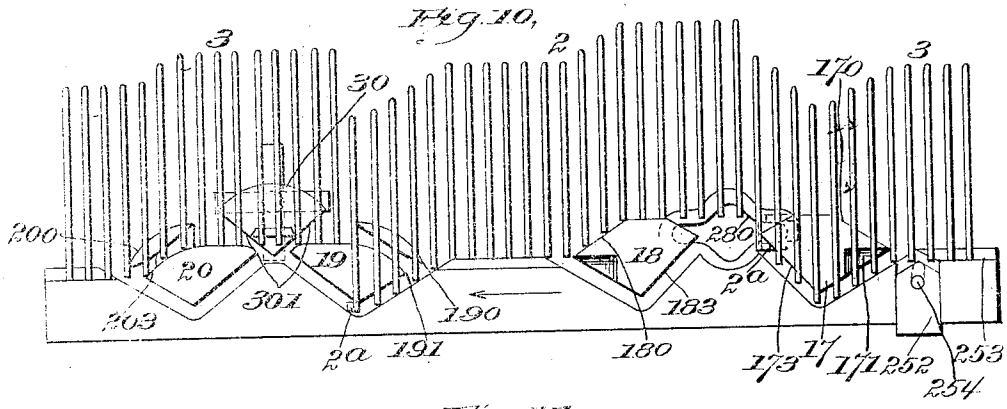


Fig. 11.

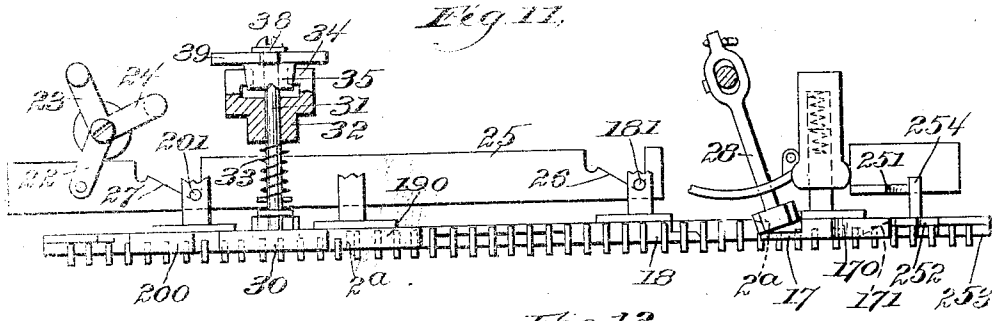


Fig. 12.

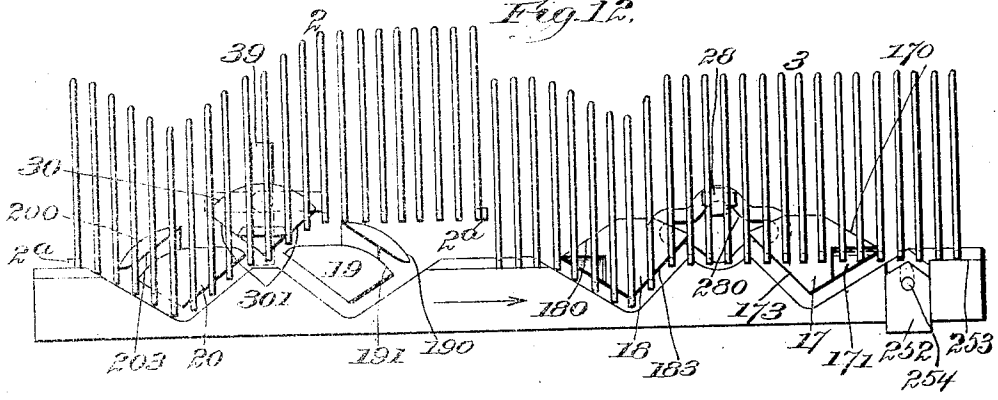
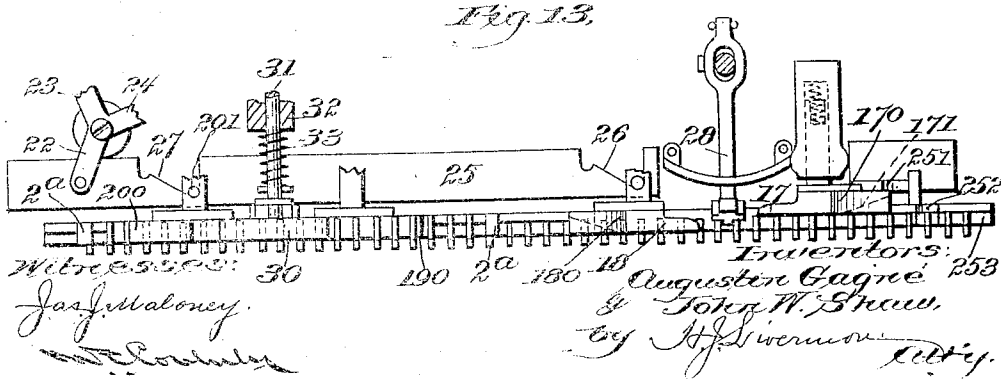


Fig. 13.



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UNITED STATES PATENT OFFICE.

AUGUSTIN GAGNÉ, OF CENTRAL FALLS, AND JOHN W. SHAW, OF PAWTUCKET, RHODE ISLAND, ASSIGNORS TO BLACKSTONE STOCKING COMPANY, A CORPORATION OF RHODE ISLAND.

CIRCULAR-KNITTING MACHINE.

1,040,183. Specification of Letters Patent. Patented Oct. 1, 1912.

Application filed August 8, 1910. Serial No. 576,098.

To all whom it may concern:

Be it known that we, AUGUSTIN GAGNÉ and JOHN W. SHAW, residents, respectively, of Central Falls, county of Providence, State of Rhode Island, and of Pawtucket, county of Providence, State of Rhode Island, have invented an Improvement in Circular-Knitting Machines, of which the following description, in connection with the accompanying drawings, is a specification, like letters on the drawings representing like parts.

The present invention relates to a knitting machine, and is embodied in a novel construction and arrangement of the stitch forming cams, whereby two courses are knit at each revolution; and also in novel means for selectively controlling the needles during the knitting of the heel and toe.

A further feature of the invention relates to means whereby the circular knit portion of the stocking can be composed of different colored threads such, for example, as white and black, the foot of the stocking being preferably the part which is thus knit, so as to produce what is known as a split foot stocking.

In carrying out the invention for the purpose of producing a split foot stocking, the reciprocating knitting operation which is utilized in forming the heel and toe is carried on throughout the foot, and the machine is provided with needle controlling devices and thread feeding mechanism which operate in such a way that substantially half the needles will knit a thread of one color, while the other half of the needles knit a thread of another color. For this purpose, the long and short butt needles, which are commonly employed so that half of them can be thrown out of operation during the knitting of the heel and toe, are similarly employed for the knitting of the foot, the difference in the length of butts admitting of the selective operation whereby half the needles can be caused to operate on one thread, and half on the other.

In order to form the stitch along the line where the color changes, it is necessary to interlock the threads, and, in accordance with the present invention, one or more of the needles are employed as suture needles which operate on both threads in completing each course. The invention is shown as embodied in a machine of the type described in Letters Patent No. 629,503, dated July 25, 1899, to Joshua D. Hemphill, in which the consecutive removal and restoring of the short butt needles for narrowing and widening in knitting the heel and toe are provided for by a picker finger which lies in the path of the needle butts so as to be engaged thereby and moved in the rotation of the cam cylinder along an inclined plane or cam surface so as to push the needles up or down according to a preliminary adjustment which is taken care of by pattern mechanism; and the same picker finger is utilized to cause the operation of the suture needles.

The machine embodying the invention is provided with two main cams having stitch forming surfaces at the same sides in the direction of rotation; these cams being permanently fixed with relation to the needle cylinder, so that the stitch forming surfaces are always in the path of the long and short butt needles and capable of operating on both. These two cams, which may be called the main cam, because they are not at any time shifted from their original positions, are provided at the sides opposite the stitch forming cam surfaces with switch cam surfaces which are adapted to operate selectively upon the long and short butt needles when the direction of movement has been changed. During the circular knitting operation, therefore, these two main cams operate on all the needles, and a thread feed is provided adjacent to each of the cams, so that two courses are knit at each revolution.

The machine is further provided with means for changing the level of the short butt needles with relation to that of the long butt needles when the reciprocating movement begins, so that during the first movement of these main cams in the direction opposite to that of the rotary knitting direction, the long and short butt needles are selectively operated upon by the switch cams which are on different levels, the long butt needles being moved upward to an in-

active position, while the short butt needles are carried over one of the main cams, but restored to a position to be acted upon by the stitch forming surface of the other main cam when the direction of movement changes. In order, however, that the short butt needles may be caused to knit during the movement in each direction, and to knit on the same thread, it is necessary that they should be acted upon by another stitch forming surface adjacent to the main cam where the thread guide is located, and that they should be carried, as above stated, out of the path of the stitch forming surface of the other main cam which is adjacent to the other thread guide. For this purpose, the machine is provided with two supplemental shiftable cams which lie adjacent to the two main cams, each being the same in shape and configuration as the main cam to which it is adjacent, but reversed as to the position of its stitch forming and switch cam surfaces.

During the knitting of the heel and toe, one of the main cams and one of the supplemental cams coöperate in causing the short butt needles to knit, and in maintaining the long butt needles in the inoperative position; while the other main cam and the other supplemental cam coöperate in keeping all of the needles above the position in which they can be engaged by the stitch forming surfaces of those cams.

In employing the machine for knitting a so-called split foot stocking, a third pattern controlled switch cam is employed, this cam being located between those of the main and supplemental cams which are inactive during the knitting of the heel and toe, and being so positioned as to engage the long butt needles only and to cause them to be placed in a position to be engaged by the stitch forming surfaces of the aforesaid cams at each reciprocating movement. During the knitting of the foot, therefore, where different colored threads are employed, the short butt needles are acted upon by one of the main and one of the supplemental cams, while the long butt needles are operated upon by the other main and the other supplemental cam, the thread guides, as previously stated, being located one between one main and one supplemental cam, and the other between the other main and the other supplemental cam. For knitting the foot in yarns of different colors two thread guides are employed adjacent to one pair of cams, said guides carrying threads of different colors, and being shiftable in position, so that either can deliver its thread to the exclusion of the other.

The suture needles which operate on both threads at each operation are provided with long butts and are located at the ends of the group of long butt needles, and are, therefore, brought at the end of each reciprocation into engagement with the picker finger which operates in the usual way during the widening and narrowing, and are thereby drawn down so as to engage the stitch forming surfaces of the main and supplemental cams which operate during this period upon the short butt needles.

A very neat seam is formed where the different threads adjoin by using one needle only to act at each operation on both threads, and in view of the fact that, in the Hemphill machine the picker finger is so adjusted as to act on two needles at once in bringing them down into the path of the cams, a special needle having a thickened butt is employed at each end of the line of long butt needles, so that the picker finger will act on that needle only, instead of on two adjacent needles.

In cases where it is desired to make the seam with a line of white stitches in the black, and a line of black stitches in the white, one of the long butt needles can be interposed between the last two short butt needles at each end of the line thereof, the interposed needle being the one, in this case, which acts on both threads, being moved into the path of the short butt needle cam by the picker finger.

Figure 1 is an elevation, partly in section, of a machine embodying the invention, with the main supporting base omitted; Fig. 2 is a similar elevation, taken on a plane at a right angle to that of Fig. 1; Fig. 3 is an elevation of the machine taken from the side opposite to that shown in Fig. 2; Fig. 4 is a plan view, partly in section; Fig. 5 is a similar plan view showing the parts in a different position; Fig. 6 is a developed view of the cam-ring, showing the position of the needles during the circular knitting operation; Fig. 7 is a plan view, partly in section, of the parts shown in Fig. 7; Figs. 8 and 9 are views corresponding to Figs. 6 and 7, showing the position of the needles relative to the cams during the two-color or "split foot" knitting. Figs. 10 and 11 are views corresponding to Figs. 8 and 9, but showing the cam ring as having traveled a sufficient distance to cause the operation of the picker finger on the suture needle; Figs. 12 and 13 are views corresponding to Figs. 8 and 9 showing the action of the needles during the split foot knitting when the cam ring is traveling in a direction opposite that indicated in Figs. 6 to 11.

As previously stated, the invention is shown as embodied in a machine of the type shown and described in the Hemphill patent above cited, the needles being contained in vertical grooves formed in the outside of a needle cylinder 1, the said needles consisting of long butt needles 2 and short butt needles 3, the long butt needles occupying substan-

tially one-half of the needle cylinder, and the short butt needles occupying the other half.

In the preferred construction shown in the plan view (Fig. 4) the last long butt needle at each end of the row is a special needle provided with a wide butt, the purpose of which will be hereinafter described in connection with the description of the operation of the picker in forming the so-called split foot. The machine is provided with a rotatable cam-ring 4 which has cams to operate on the butts of the needles, the said ring being mounted and constructed substantially as in the Hemphill machine, and arranged to be given a rotary or reciprocating movement through a gear wheel 5 which is mounted on a shaft 6 which is arranged to be rotated or reciprocated through the agency of gears 7 and 8 which are free to rotate on the shaft but are adapted to be connected one at a time with the shaft through the agency of a sliding clutch member 9. The gear 8 is provided with a driving pulley and is continually in mesh with a rotating gear 10 having a bearing at 12, Fig. 2. The other gear 7 is in mesh with a reciprocating segment 13 pivoted at 14 and connected through a link 15 with a wrist pin 16 on the gear 10. The gear 8 and the gear 10 are rotated continuously while the machine is in operation, and the gear 7 is reciprocated continuously through the segment 13, so that by shifting the clutch 9, the shaft 6 and the cam ring 4 will be rotated or reciprocated in response to the movement of the gear to which it is clutched. The above construction is substantially the same as that described in the Hemphill patent, above cited, and does not enter into the present invention. For the circular knitting operation, the machine is provided with the main cams 17 and 19 which are fixed with relation to the needle cylinder and are so positioned that during the rotary knitting operation the left hand stitch forming surfaces of these cams operate on all the needles, as clearly shown in Fig. 6, so as to knit two courses at each revolution.

Adjacent to the cams 17 and 19 are thread guides, the thread guide 49 being located near the cam 19, while the two thread guides 50 and 51, which are capable of being shifted so that threads of different colors can be delivered to the needles at that point, are located near the cam 17. In the normal operation, during the rotary knitting which forms the leg of the stocking, threads of the same color are delivered through the thread guides, so that the leg is of one color throughout. During the knitting of the heel and toe, the short butt needles only are employed, and the long butt needles are put out of operation at this time through the agency of switch cam surfaces formed on the main knitting cams, in conjunction with similar switch cam surfaces formed on supplemental cams 18 and 20 which, at this period of the operation, are moved toward the needle cylinder so as to engage the needles as the cam ring reciprocates.

The machine is further provided with means for changing the level of one set of needles with relation to that of the other at this period in the operation, so that the switch cams which are associated with the stitch forming cams are capable of operating selectively on the long and short butt needles.

As shown in Fig. 6, the inclined planes formed in the cam ring up which the needles ride after they have been drawn down by the stitch forming cams, terminate in a ledge, a portion of which always underlies the butts of the long butt needles, there being, however, a secondary portion indicated by the reference numeral 253, which is cut away to allow the short butt needles to remain at a lower level during the travel of the ring. In the rotary knitting operation, the short butt needles are guided to the upper level by means of an elevating switch 252, the inclined surface of which projects across the cut portion of the ledge and extends upward to the top of said ledge. When, however, the change is to be made from rotary to reciprocating knitting, the said switch 252 is withdrawn or lowered, as shown in Fig. 8, and the short butt needles, in the final movement of the ring, are only carried to the level of the portion 253 of the ledge, so that they stand slightly below the level of the long butt needles which are carried upward to the upper level regardless of the position of the switch 252. When, therefore, the cam ring starts in the direction opposite to that indicated by the arrow in Figs. 6 and 8, the long butt needles ride over the switch cam surface 170 of the main cam 17, while the short butt needles pass under the said surface, as indicated in Fig. 12, the cam 17 having an inclined recess 171 and being spring pressed against the needle cylinder so that it can yield and allow the short butt needles to pass across its face without being moved away from the level in which they stand (see Fig. 12). This operation carries the long butt needles entirely above the stitch forming cams, but the short butt needles are brought into engagement with the stitch forming surface 183 of the adjacent supplemental cam 18, as shown in Fig. 12, so that they are caused to knit during that movement of the cam ring. When the cam ring moves in the opposite direction, the short butt needles travel across the face of the supplemental cam 18, and are caused to knit through the operation of the stitch forming cam surface 173 of the main cam 17. Throughout this part of the opera-

tion there is nothing in the path of the long butt needles which are moved upward out of the way by the cam surfaces 170 of the main cam 17 as the cam ring travels in one direction, and by the cam surface 200 of the supplemental cam 20 as the cam ring travels in the opposite direction, so that they are rendered inoperative, as is usual in this type of machine.

In order to prevent the main cam 19 and the supplemental cam 20 from operating on the short butt needles during this part of the operation, said cams are provided with switch cam surfaces 191 and 203, respectively, which are below the switch cam surfaces which act upon the long butt needles, but lie in the path of the short butt needles. These surfaces lift the short butt needles so that they pass over the stitch-forming cams, as shown in Fig. 10, and are restored to their lower level where they will be properly acted upon by the cams 17 and 18, by the under surfaces of the long-butt switch cams 190 and 200. During this part of the operation, the picker finger 28 acts in the normal way upon the short butt needles for the narrowing and widening.

When the split foot is to be knit, it is necessary to bring the long butt needles into operation and to cause these needles to operate on one thread while the short butt needles operate on another thread. If, for example, the foot is to be black and white, the thread guides 50 and 51 are shifted so that the white thread, for example, is delivered to the short butt needles in place of the black thread which was employed in knitting the double course leg. At the same time, the thread guide 49, which is arranged to deliver a black thread remains in position, and it is only necessary to bring the other set of needles, that is, the long butt needles, into operation to knit the other thread in the foot. To operate the long butt needles, the main cam 19 and the supplemental cam 20 are employed, the operation being as follows: As previously described, the long butt needles, up to this period, have remained at the upper level without movement during the knitting of the heel which is accomplished by the action of the short butt needles only. To bring the said long butt needles into operation during the knitting of the foot, a supplemental cam 30 having inclined surfaces 301 (Fig. 8) is employed, the said cam being moved inward toward the cam ring a distance sufficient to engage the long butts, but not to engage the short butts which travel across the face of said cam, as clearly shown in Figs. 8 and 10. In the reciprocating movement of the cam ring, therefore, the long butt needles which stand at the level shown in the middle part of Fig. 12, are engaged by the surface 301 and carried downward thereby to a position where they are engaged by the stitch forming cam surface of the supplemental cam 20. When the cam ring moves in the opposite direction, the long butt needles are correspondingly brought down so as to be engaged by the stitch forming cam surface of the main cam 19, so that the said needles knit on the thread which is delivered through the guide 49 at each reciprocation. The short butt needles continue knitting on the thread delivered to them, as previously described in connection with the knitting of the heel and toe, without being affected by the cams 19 and 20 because they travel across the same, being cleared by the surfaces 191 and 203, and not being affected by the cam surfaces 301. In the same way, the long butt needles are carried upward to the top of the cam ledge, so that they ride over the switch cam surfaces 180 and 170, according to the direction of movement, and are, therefore, not acted upon by the stitch forming cams 17 and 18. The suture needle or needles, however, which operate twice, that is, once on each thread at every course, are acted upon at this period by the picker finger, as clearly shown in Figs. 10 and 11. As will be seen from these figures the last needle in the line of long butt needles is engaged by the picker finger and drawn down thereby, so that it joins the short butt needles in their knitting operation, as clearly indicated in Fig. 10. The suture needle, however, at the end of this single operation, is restored to its normal level, because its butt projects over the top of the ledge, regardless of the position of the switch 252, thereby being placed in position to operate normally when it reaches the main and supplemental cams 19 and 20.

The pattern mechanism which controls the operation of the supplemental cams 18 and 20 may be described as follows: A stationary cam surface 21 is mounted on the frame of the machine and is capable of standing in two horizontal planes, being shifted from one to the other through the action of the pattern mechanism which will be hereinafter more fully described. This cam lies in the path of a lever having three arms 22, 23, 24, the arm 22 being connected with a slide 25 which has upon it two cam surfaces 26 and 27 which act on projections 181, 201, connected with guides for the cams 18 and 20, which cams are normally spring-pressed toward the needle cylinder by means of spiral springs 182, 202. At the time of the shift from circular knitting to reciprocating knitting, the cam surface 21 is moved downward into the path of a projection on the arm 24, so that the said projection strikes the cam surface and is moved from the position shown in Fig. 4 to the position shown in Fig. 5, carrying with it the slide 25, and releasing the cams 18 and 20, and the projections which control them slide

down the inclined surfaces 26 and 27 in the member 25 allowing the cams to come into close proximity with the needle cylinder so as to act on the needles, as hereinbefore described.

The shifting cam 18 is substantially the same as the shifting cam shown in the Hemphill patent above referred to, the said cam and the cam 17 having upper inclined surfaces 180 and 170, respectively, which engage the long butt needles during the reciprocating operation, and move them upward to the position shown in Fig. 8, so that they are not engaged by the cam surfaces 183 and 173. In this way, the long butt needles are put out of operation during that portion of the reciprocating knitting which forms the heel and toe. The same cams, however, are caused to operate upon the short butt needles so as to cause them to knit during this part of the operation. When the shift is made from the circular knitting to the reciprocating knitting, the switch 252 is lowered, as shown in Fig. 8, so that the short butt needles 3 do not run above the level of a supplemental ledge 250, and are, therefore, slightly below the cam surfaces 170 and 180 which operate on the long butt needles.

In order to permit the short butt needles to pass the cams 17 and 18, the said cams are provided with recesses 174 and 184 having inclined walls which engage the ends of the short butts whereby the cams are pushed out of the way against the stress of the cam springs shown in Fig. 7, thus allowing the short butts to pass behind one cam and be engaged by the knitting cam surface of the other, according to the direction in which the cam ring is moved. The cams 19 and 20 do not enter into this part of the operation at all since the long butt needles stand wholly above these cams, while the short butt needles are acted upon by the upper cam surfaces 191 and 203, and thereby caused to clear the knitting cam surfaces below. After clearing these surfaces, the short butt needles are restored to position to be acted on by the cams 17 and 18 through the agency of the under surfaces of the cam projections 190 and 200. The short butt needles then continue to knit at each reciprocating movement of the cylinder in the usual way.

The cam 30 is shown as mounted on the end of a rod 31 having a bearing in a block 32 on the cam ring, there being a spring 33 interposed between the bearing and the cam tending to press the said cam into its operative position with relation to the needle cylinder. The bearing member is provided at its outer end with two projections 34 which coöperate with a rotary cam member 35 having deep cam grooves 36 (Fig. 5) and shallow cam grooves 37, Fig. 4, at a right angle thereto. The cam rod 31 projects through the cam member 35 and is provided with a head or shoulder 38 at its outer end, so that the spring 33 tends to hold the cam member 35 in engagement with the cam projections 34. It will be seen from Figs. 4 and 5 that if the cam member is rotated a quarter turn, it will be pulled outward through the operation of the cam surfaces 36, from the position shown in Fig. 4, to that shown in Fig. 5, after which it will be held by the shallow cam grooves 37. Thus, a quarter turn of the cam member 35 will withdraw the cam 30 from its operative position while another quarter turn will restore it thereto. In order to operate the cam, therefore, the cam member 35 is provided with four radial arms 39 any one of which is adapted to be engaged by a movable projection 40 shown as a finger mounted on an arm pivoted at 41 on the frame of the machine, and connected by means of a link 42 with a lever 43 pivoted at 44 and connected through a link 45 with a lever 46 (see Fig. 1) pivoted at 47. The said lever engages at its lower end with a cam wheel 48 which is under the control of the pattern chain, as will be hereinafter described, the said cam wheel being adapted to make a portion of the rotation at the right time so as to oscillate the lever 46 and move the finger 40 into and out of the path of one of the radial arms 39, on the cam member 35.

The operations of the machine, as thus far described, will be best understood by reference to Figs. 6 to 13. Referring to Fig. 6, which indicates the cam ring and the needles in their positions relative to each other during the ordinary circular knitting operation, the long butt needles 2 and the short butt needles 3 are shown as standing at substantially the same level, and being lowered and raised to perform the knitting operation by the stitch forming cam surfaces of the main cams 17 and 19, as they travel continuously, in the direction of the arrow. The thread guides 49, 50 and 51 are carried by the cam ring and located, as shown in Fig. 6, adjacent to the knitting cams, the guides 49 and 50 being arranged to carry threads of the same color, the guide 51, which carries the thread of another color, being withdrawn from the path of the needles during the circular knitting operation. With the leg of the stocking being knit in a solid color, therefore, the knitting is carried on simultaneously at two points, so that two courses are knit at each revolution. When the shift is to be made into the heel, the thread guide 50 is withdrawn, and the thread guide 51 moved into position to deliver the thread of another color, preferably white, the shift at the same time being made from the circular to the reciprocating operation of the cam ring, as previously described. At the same time, the supplemental cams 18 and 20 are allowed to move toward the needle cylinder

into operative position through the agency of the slide 25, and in the reciprocating movements of the ring, the switch cam surfaces 170 and 180 of the cams 17 and 18, and the switch cam surfaces 190 and 200 of the cams 19 and 20 engage the butts of the long butt needles and throw all of the long butt needles upward beyond the influence of the knitting cams (see Figs. 10 and 12). The switch 252 is also moved from the position shown in Fig. 6 to that shown in Fig. 8, so that, in the last movement of the cam ring in the direction of the arrow in these figures, the short butt needles 3 will not be lifted beyond the level shown in Fig. 8. As the cam ring travels in the opposite direction, therefore, beginning the reciprocating motion, the short butt needles will be below the switch cam surfaces 170, 180, 190 and 200, so that when the cam ring begins to reciprocate and makes its first movement in the direction of the arrow, Fig. 12, the short butt needles will ride across the face of the cam 17 and be engaged by the stitch forming surface 183 of the cam 18, and caused to knit at that point. In the return movement of the cam ring, the short butt needles will ride across the face of the cam 18 and be caused to knit by the stitch forming cam surface 173 of the cam 17. At the same time, the switch cam surfaces 191 and 203 of the cams 19 and 20 will engage the short butt needles and cause them to ride over the said cams, the under surfaces, however, of the long butt needle switch cams serving to carry the short butt needles back to the lower level at each reciprocation of the ring. During this part of the operation, therefore, the main and supplemental cams 19 and 20 are inoperative, so far as relates to a knitting operation, although the switch cams associated with these cams coöperate with both sets of needles to keep them from entering into the knitting operation. During this part of the operation, the picker finger 28 operates in the usual way to lift and lower the short butt needles during the narrowing and widening operations, respectively, the machine, in this respect, being substantially the same as the prior Hemphill machine except that the switch cam surfaces associated with the main and supplemental stitch forming cams are used to clear the long butt needles, instead of the special switch employed for that purpose in the prior construction. When the heel has been finished, the reciprocating movement is continued, instead of being changed to the circular movement, and the long butt needles are then brought into operation through the agency of the supplemental switch cam 30, so as to operate on the thread delivered through the thread guide 49. Referring especially to Fig. 12, the cam 30 at this period of the operation has been moved toward the needle cylinder, and the engaging surfaces 30i of the said cam project inward to a sufficient extent to engage the long butts without, however, engaging the short butts, so that the short butt needles can travel freely past the face of the cam 30, as shown in Figs. 8 and 10. The long butt needles, however, which stand at the level shown at the left hand side of Fig. 12, having been lifted to that level by the upper switch cam surfaces above described, will be engaged by the cam 30 and drawn downward to a position in which they are operated upon by the stitch forming surfaces of the cams 19 and 20, according to the direction of rotation of the cam ring.

In order to join the two threads, it is necessary to make an interlocking stitch or suture where the knitting of one thread leaves off, and that of the other begins. This is accomplished by causing one of the needles at each end of one set to operate twice during each course, first on one thread, and then on the other thread. To accomplish this, the picker finger 28, which is normally used for widening and narrowing, is arranged to operate once at the end of each revolution to draw down one of the long butt needles, so as to bring it into the path of the short butt knitting cams from which it has been previously cleared by the cam surfaces 170 or 180.

Under normal conditions, the picker finger which is designed to draw down two needles at once, and lift up one during the widening operation, would normally act upon the two long butt needles at the end of the line, thus causing two of the needles to operate on each thread in each course. This will accomplish the purpose, or the same purpose may be accomplished by placing one of the long butt needles between the last two short butt needles at the end of the line, either one of these stitches being practical, the latter in some cases being desirable, if it is desired to form a narrow stripe along the line where the two different colored threads adjoin. When, however, it is desired to bring the black and white in sharp contrast with no line of either color encroaching on the other, provision is made whereby one only of the long butt needles is caused to operate on both threads. This construction is illustrated in Figs. 6 to 9, the last long butt needle at each end of the line being provided with a thickened butt 2^a which arrests the picker finger 28 and prevents the same from engaging the next needle of the series.

The operation of the picker finger is best illustrated in Figs. 8 and 10, in which the cam ring is supposed to be moving in the direction of the arrow, and the long butt needle at the end of the series is just in engagement with the picker finger. This long butt needle has previously performed its

normal knitting operation through the action of the cam 19, and with the others has been thrown upward out of the path of the short butt knitting cam 17, by means of the clearing cam surface 180. It is, however, engaged, as shown, by the picker finger which travels with the cam ring, and in arresting the movement of the picker finger carries the said finger down the cam surface 280, the finger thus drawing the needle 2^a down to the level of the short butt needles as shown in Fig. 10 so that it will knit therewith under the influence of the cam 17. The long butt needle at the opposite end will be operated in the same way during the movement in the reverse direction and brought into engagement with the stitch forming surface of the supplemental cam 18, so that a double stitch is formed where the two threads adjoin, making a perfect union between the two.

The cam wheel 48, through which the cam 30 is operated, is also arranged to operate the knitting cams 18 and 20, and for this purpose is provided with a cam surface 52, adapted to operate on one end of the lever 53, pivoted at 54, the other end of said lever supporting a rod 55, to the upper end of which is fastened the cam surface 21.

The shifting of the various cams above described is accomplished through the agency of the pattern chain 56 which is operated by a ratchet 57 and pawl 58 carried by the segment member 13, these parts being omitted from Fig. 3, since they form no part of the present invention and would tend to obscure the new parts which are best shown in that figure. The pattern chain is substantially like that used in the prior Hemphill construction having at proper intervals cam projections 59 which operate upon the lever 60, having a surface 61 which normally supports the pawl 62 reciprocated by the segment member 13, out of engagement with the teeth of the cam driving ratchet wheel 63. The said ratchet wheel is adapted to operate a shifting member 640 which operates the clutch member 9 which has been previously described as operating to change the movement of the cam ring from rotary to reciprocating. In the present construction, this change takes place only once during the knitting of a complete stocking, since the reciprocating movement of the cam ring is continued throughout the heel, foot and toe.

When the shift from circular to reciprocating knitting is to take place, one of the lugs 59 will tip the lever 60, as best shown in Fig. 3, thus lowering the surface 61, so that the pawl 62 can operate the cam driving ratchet 63. Just before the shift to reciprocating knitting, the knitting cams 18 and 20 are arranged to be pushed into operative position, and this is accomplished by rotating the cam wheel 48. For this purpose, the lever 60 is provided with an upwardly projecting hook 64 which engages a link 65 connected with a lever 66 which lever is pivoted at 67, and adapted to support a pawl 68 which operates on the cam wheel 48 when said pawl is allowed to drop into engagement with the ratchet teeth 69, so that the cam surface 52 is rotated away from the end of the lever 53, thus allowing the cam surface 21 to drop and to operate the knitting cams 18 and 20, as previously described. The shift from rotary to reciprocating knitting is produced, therefore, during the reciprocating movement of the member 13 in one direction, while the cams 18 and 20 are operated through the reciprocating movement thereof in the opposite direction.

The additional cam 30 which has been previously described as adapted to control the long butt needles during the knitting of the foot, remains in its operative position throughout the knitting of the leg although it performs no function during that part of the operation and must be removed from the path of the long butt needles at the beginning of the heel, restored at the end of the heel, and again moved out of the way at the beginning of the toe. The operation above described follows the shift from rotary to reciprocating knitting, and, for this purpose, the pattern chain is provided with additional projections 70 which are in a different plane from the projections 59, and arranged to engage a projection 71 on the lever 72 pivoted at 73.

The projection 71 lies under the end of the lever 66, so that as the projection 70 reaches the said projection 71 it will rock the lever 66 and lower the pawl 68, causing the lever 46 to operate in the manner previously described, so as to shift the cam 30.

The needle-level controlling switch 252 is controlled simultaneously with the supplemental cams 18 and 20, through the agency of the slide 25. As shown in Figs. 7 and 9, the said slide is provided with a cam surface 251, which coöperates with a projection 254 from the switch. In the movement of the slide from the position shown in Fig. 7 to the position shown in Fig. 9, the projection rides down the inclined cam surface, and the switch drops to the lower level. When the slide 25 moves in the opposite direction to withdraw the supplemental cams, the switch 252 is lifted, so that all the needles rise to the same level.

What we claim is:

1. In a knitting machine, the combination with a needle cylinder provided with a set of long butt needles and a set of short butt needles; of a cam ring; means for producing a rotary and reciprocating movement of said cam ring; a main cam fixed

with relation to said ring and having at one side a stitch forming cam surface, and at the opposite side a switch cam surface; means for changing the level of one set of needles with relation to that of the other when the motion of the cam ring is changed from rotary to reciprocating, whereby the needles of one set are acted upon by said switch cam surface to the exclusion of the other; a supplemental cam similar to the main cam, but having the stitch forming and switch cam surfaces oppositely disposed; and means for moving said supplemental cam into operative position with relation to the needle cylinder when the movement is changed from rotary to reciprocating.

2. The combination with the needle cylinder provided with a set of long butt needles and a set of short butt needles; of a cam ring provided with two main cams and a thread guide adjacent to each of said cams, each of said main cams having a stitch forming cam surface at one side in the direction of rotation, and switch cam surfaces at the opposite side on different levels; supplemental cams adjacent to said main cams, and being provided with similar stitch forming and switch cam surfaces, but oppositely disposed; means for changing the level of the short butt needles with relation to the level of the long butt needles when the movement of the cam ring is changed from a rotary to a reciprocating movement, whereby said long and short butt needles are selectively controlled by the switch cam surfaces; and means for moving the supplemental cams into operative relation to the needle cylinder when the movement is changed, whereby the switch cams are adapted to operate selectively during the movement of the cam ring in each direction.

3. The combination with the needle cylinder provided with a set of long butt needles and a set of short butt needles; of a cam ring provided with two main cams fixed with relation to the cylinder, the said cams having stitch forming surfaces at the same side in the direction of rotation adapted to engage all the needles; switch cam surfaces on each of said main cams at the side opposite the stitch forming cam surfaces adapted to engage and lift the long butt needles; an inclined switch cam surface on one of said cams only to admit of the passage of the short butt needles across the face of said cam without changing their level; a switch cam surface on the other main cam adapted to raise the short butt needles above the point of contact with the stitch forming cam surface; supplemental cams corresponding to said main cams and having their stitch forming surfaces and their switch cam surfaces oppositely disposed with relation thereto; means for moving said supplemental cams into operative relation with the cylinder at the beginning of the reciprocating movement; and means for changing the level of one set of needles with relation to that of the other at the same time.

4. In a knitting machine, the combination with the needle cylinder provided with sets of long and short butt needles; of a cam ring; a main knitting cam fixed with relation to said cam ring and having a stitch forming cam surface in the path of the butts of all the needles; two switch cam surfaces at the opposite sides of said main cam on different levels; means for changing the level of the long butt needles with relation to that of the short butt needles when the movement of the cam ring is changed from rotary to reciprocating, whereby the switch cam surfaces operate selectively on the long and short butt needles; a supplemental cam corresponding to said main cam and having its stitch forming and switch cam surfaces oppositely disposed; and another switch cam located between the main and supplemental cams adapted to be moved into the path of the long butt needles only, whereby the short butt needles cross the face of said switch cam and the long butt needles are brought down into engagement with the stitch forming surfaces of said main and supplemental cams.

5. The combination with the needle cylinder provided with a set of long butt needles and a set of short butt needles; of a main knitting cam having a stitch-forming cam surface at one side and an elevating cam surface at the opposite side, and a recess having an inclined surface below said elevating cam surface; means for changing the level of one set of needles with relation to that of the other set; a supplemental cam having the characteristics of the main cam, but with its stitch forming and switching surfaces oppositely disposed; and means for operating said supplemental cam and the level-changing means, whereby the cams and the needles are so disposed that the short butt needles cross the face of one of said cams, and are caused to knit by the other, while the long butt needles are carried across the tops of both cams.

6. The combination with a main knitting cam provided at one side with a downwardly inclined surface adapted to engage all of the needles during the rotary movement of the cam ring, and at the opposite side with an upwardly inclined surface adapted to engage the long butt needles only during the movement in the opposite direction; of a supplemental cam adjacent to said fixed cam and having correspondingly inclined surfaces oppositely disposed to those of the fixed cam; and a picker finger located between said cams and adapted to

draw down a needle raised by the upper inclined surface of one of said cams into position to be operated upon by the lower inclined surface of the other cam.

7. The combination with a needle cylinder provided with a set of long butt needles and a set of short butt needles; of a cam ring; means for producing a rotary or reciprocating movement of one of said parts relatively to the other; main cams provided at one side with stitch-forming surfaces and at the opposite side with switch-cam surfaces on different levels; a cam ledge having upwardly inclined surfaces to lift the needles after the stitch-forming operation, the surface of said ledge having two levels, the upper of which is separated from the cylinder so as to be engaged by the long butt needles only; an elevating switch to carry the short butt needles to the upper level during the rotary movement; and means for removing said switch when the change is made to reciprocating movement, whereby the needles stand at different levels and are selectively controlled by the switch cam surfaces.

8. The combination with a needle cylinder provided with a set of long butt needles and a set of short butt needles; of a cam ring; means for producing a rotary or reciprocating movement of one of said parts relatively to the other; a main cam provided at one side with a stitch-forming surface, and at the opposite side with a recess, the face of the cam in said recess being inclined inward toward the needle-cylinder; means for yieldingly holding said cam in its operative position, whereby a needle butt entering the recess will move the cam away and travel across the face of the cam, the cam then returning so that its stitch forming surface is restored to operative position; an elevating switch surface above said recess; a supplemental cam corresponding to said cam, but having its stitch forming and switch-cam surfaces oppositely disposed; means for moving said supplemental cam into operative position when the reciprocating movement begins; and means for changing the level of the long and short butt needles at the same time; whereby the elevating switch-surfaces of said cams clear the long butt needles and prevent them from knitting, while the short butt needles are operated by the stitch-forming surfaces of said cams.

9. The combination with a needle cylinder provided with a set of long butt needles and a set of short butt needles; of a cam ring; means for producing a rotary or reciprocating movement of one of said parts relatively to the other; a main cam provided at one side with a stitch-forming surface, and at the opposite side with a recess, the face of the cam in said recess being inclined inward toward the needle-cylinder; means for yieldingly holding said cam in its operative position, whereby a needle butt entering the recess will move the cam away and travel across the face of the cam, the cam then returning so that its stitch forming surface is restored to operative position; an elevating switch surface above said recess; a supplemental cam corresponding to said cam, but having its stitch-forming and switch-cam surfaces oppositely disposed; means for moving said supplemental cam into operative position when the reciprocating movement begins; means for changing the level of the long and short butt needles at the same time, whereby the elevating switch-surfaces of said cams clear the long butt needles and prevent them from knitting, while the short butt needles are operated by the stitch-forming surfaces of said cams; a picker-finger located between said cam to raise and lower the short-butt needles for narrowing and widening.

10. The combination with a needle cylinder provided with a set of long butt needles and a set of short butt needles; of a cam ring; means for producing a rotary or reciprocating movement of one of said parts relatively to the other; a main cam provided at one side with a stitch-forming surface, and at the opposite side with a recess, the face of the cam in said recess being inclined inward toward the needle-cylinder; means for yieldingly holding said cam in its operative position, whereby a needle butt entering the recess will move the cam away and travel across the face of the cam, the cam then returning so that its stitch forming surface is restored to operative position; an elevating switch surface above said recess; a supplemental cam corresponding to said cam, but having its stitch-forming and switch-cam surfaces oppositely disposed; means for moving said supplemental cam into operative position when the reciprocating movement begins; means for changing the level of the long and short butt needles at the same time, whereby the elevating switch-surfaces of said cams clear the long butt needles and prevent them from knitting, while the short butt needles are operated by the stitch-forming surfaces of said cams; a picker-finger located between said cams to raise and lower the short-butt needles for narrowing and widening; a second main cam having at one side two elevating switch cam surfaces on different levels and at the opposite side a stitch-forming cam surface; a corresponding supplemental cam having its switch cam and stitch forming surfaces oppositely disposed; a depressing cam located between said second main and supplemental cams; and means for moving said depressing cam into the path of the long butt needles only.

11. The combination with the needle cyl-

inder provided with a set of long butt needles and a set of short butt needles, of a cam ring; means for producing a rotary or reciprocating movement of one of said parts relatively to the other; main cams provided at one side with stitch forming surfaces and at the opposite side with switch cam surfaces on different levels; a cam ledge having upwardly inclined surfaces to lift the needles after the stitch forming operation, the surface of said ledge having two levels, the upper of which is separated from the cylinder so as to be engaged by the long butt needles only: an elevating switch to carry the long butt needles to the upper level during the rotary movement; supplemental cams adjacent to the main cams and each corresponding in shape to the main cam to which it is adjacent, but having its stitch forming and switch cam surfaces oppositely disposed; pattern controlled mechanism common to said supplemental cams and said short butt needle elevating switch for lowering said switch and moving said supplemental cams into operative position at the same time; a depressing cam located between one of the main and one of the supplemental cams; means for moving said depressing cam into the path of the long butt needles only; and a picker finger located between the other main and the other supplemental cam.

12. The combination with the needle cylinder and the cam ring; of main cams positioned to operate on all the needles during the rotary movement of the cam ring, one of said cams having upper switch cam surfaces at different levels adapted to lift both the long and the short butt needles during the movement of the cam ring in the opposite direction; switch cam surfaces on the other main cam adapted, respectively, to raise the long butt needles and allow the short butt needles to maintain their level; supplemental cams adjacent to the main cams and having corresponding stitch forming and switch cam surfaces; means for bringing said supplemental cams into operative position at the beginning of the reciprocating movement of the cam ring; means for changing the level of the long and short butt needles at the same time; a depressing cam located between the main and supplemental cams to raise all the needles; means for moving said depressing cam into the path of the long butt needles only to carry said long butt needles to a position to be acted upon by the stitch forming surfaces of said cams; a picker finger located between the other main and the other supplemental cam; and a long butt needle at each end of the set of long butt needles having a thickened butt to be operated upon by said picker finger.

13. In a knitting machine, the combination with a stationary needle cylinder provided with a set of long butt needles and a set of short butt needles; of a cam ring; means for rotating or reciprocating the said cam ring; main knitting cams carried by said ring and being provided with stitch forming surfaces adapted to engage all the needles during the rotation of said cam ring in one direction, there being a lifting cam surface at the opposite side of one of said cams adapted to engage the long butt needles; means whereby the short butt needles are left at a lower level than that of the long butt needles, whereby they will not be engaged by said lifting cam surface; two elevating cam surfaces on the other of said cams at different levels; supplemental cams corresponding in shape to the main cams aforesaid, the cam surfaces of said supplemental cams being oppositely disposed to those of the main cams; means for bringing said supplemental cams into operative position with relation to the cam ring when the movement of said cam ring is changed from rotary to reciprocating; a depressing switch located between the main and supplemental cams which elevate both sets of needles; means for moving said depressing cam into the path of the long butt needles only; and means for withdrawing the said depressing cam from its operative position during the knitting of the heel and toe.

14. The combination with the main knitting cams adapted, during the rotary movement of the cam ring, to operate on all of the needles; elevating switch cam surfaces on different levels at the opposite side of one of said main knitting cams adapted to operate, respectively, on the long and short butt needles during the movement of the cam ring in a direction opposite to that of its normal rotation; switch cam surfaces on different levels at the opposite side of the other main cam; supplemental cams corresponding in shape to the fixed cams, respectively, and adapted to be brought into operative relation during the reciprocating knitting; a depressing cam located between the fixed and movable cams which have the two elevating switch cam surfaces whereby the said main and the said supplemental cams operate on the long butt needles only; and means for changing the level of the long butt needles with relation to that of the short butt needles.

15. The combination with the main and supplemental cams having stitch forming and switch cam surfaces, substantially as herein described; of a depressing cam for the long butt needles located between one of said main cams and the corresponding supplemental cam; a spring to operate said depressing cam; a rotary cam member operat-

ing against the action of said spring, and provided with radial projecting portions; a finger adapted to be moved into the path of said radial projecting portions; and a pattern mechanism controlling the operation of said finger.

In testimony whereof, we have signed our names to this specification in the presence of two subscribing witnesses.

AUGUSTIN GAGNÉ.
JOHN W. SHAW.

Witnesses:
LELLAN J. TUCK,
EDITH M. BROMLEY.