Jan. 17, 1939. J. LAWSON ET AL 2,143,952

FULL FASHIONED CIRCULAR KNITTING MACHINE

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FIG. 1.

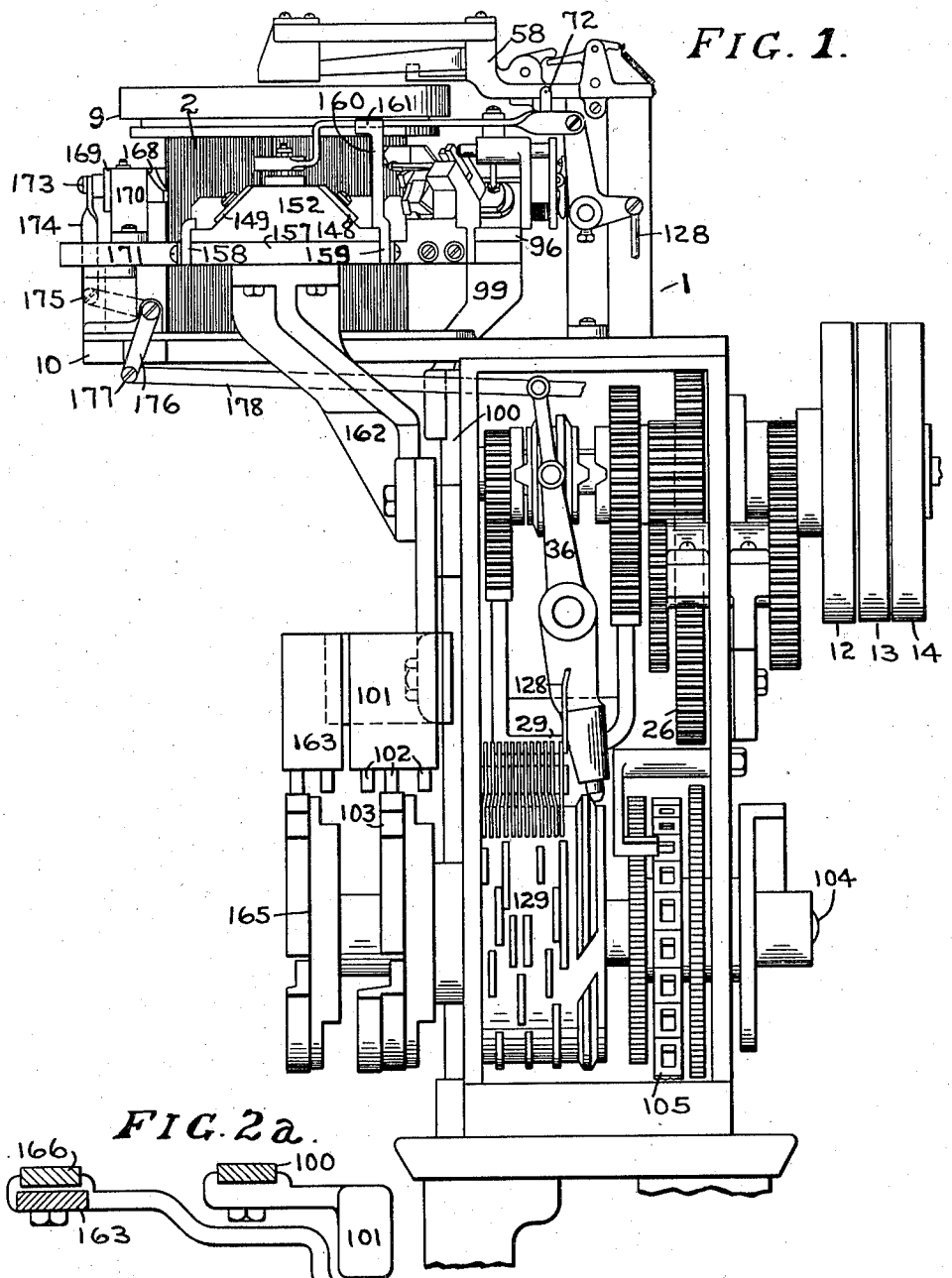


FIG. 2a.

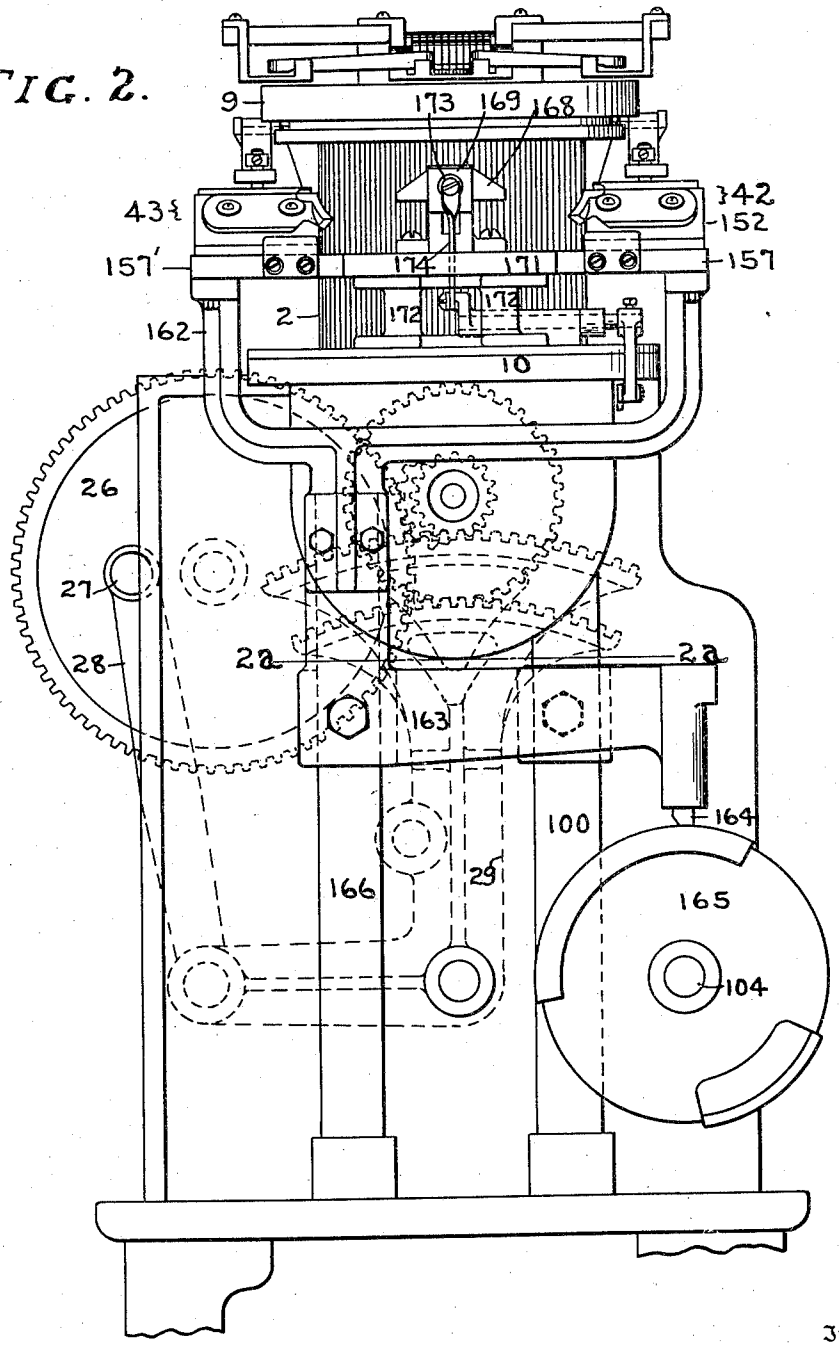
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ROBERT H. LAWSON
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FULL FASHIONED CIRCULAR KNITTING MACHINE

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FIG. 2.



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FULL FASHIONED CIRCULAR KNITTING MACHINE

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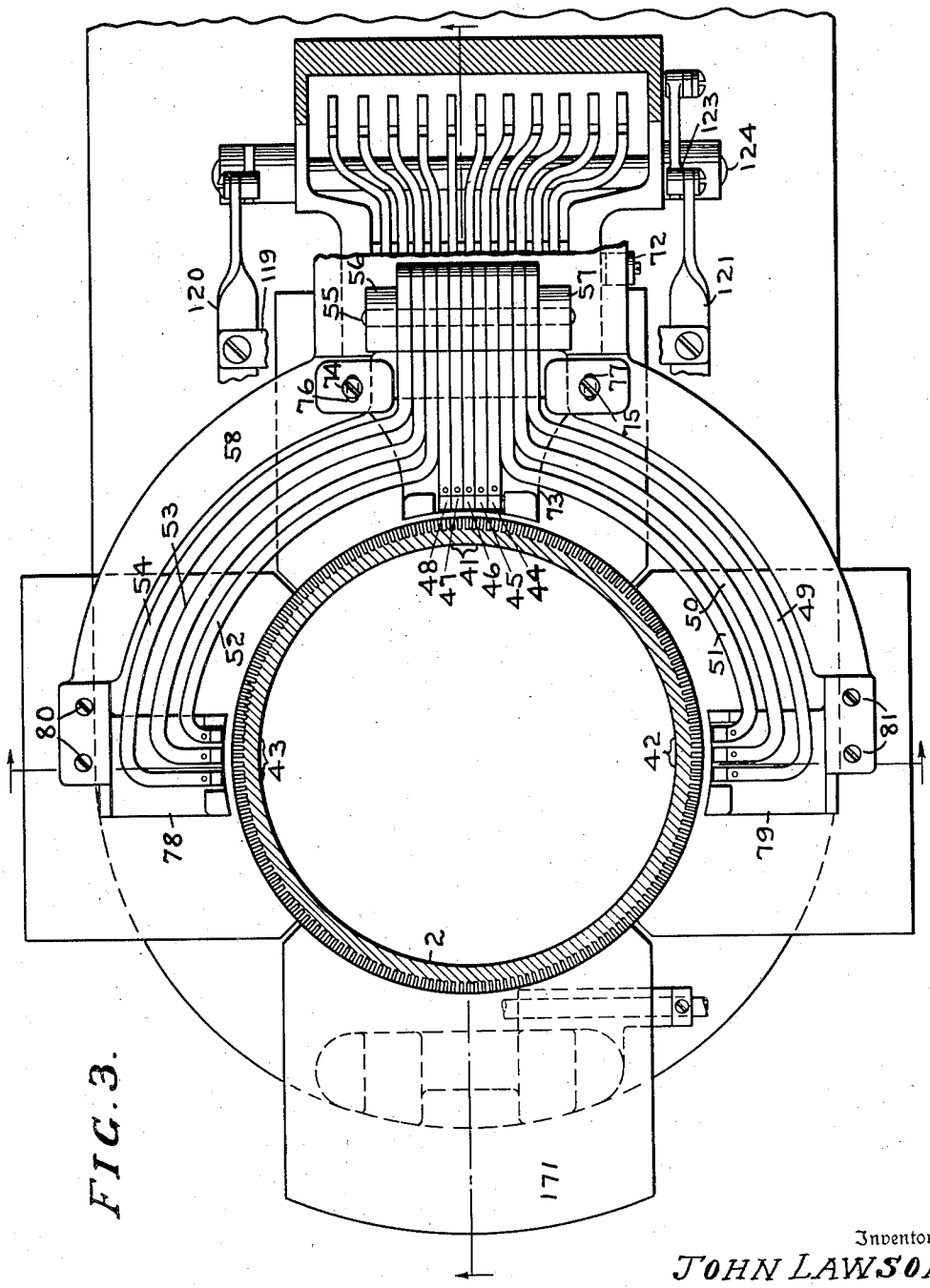


FIG. 3.

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FULL FASHIONED CIRCULAR KNITTING MACHINE

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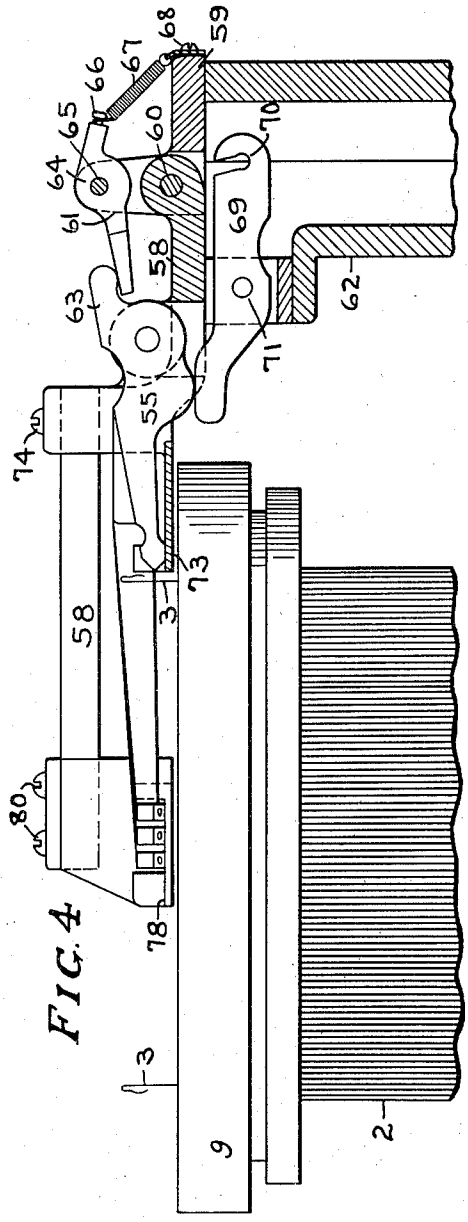


FIG. 4.

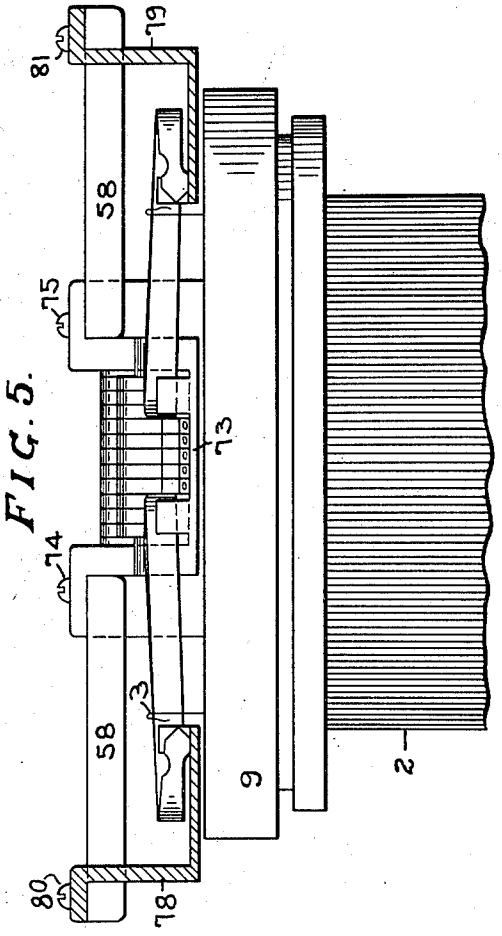


FIG. 5.

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FULL FASHIONED CIRCULAR KNITTING MACHINE

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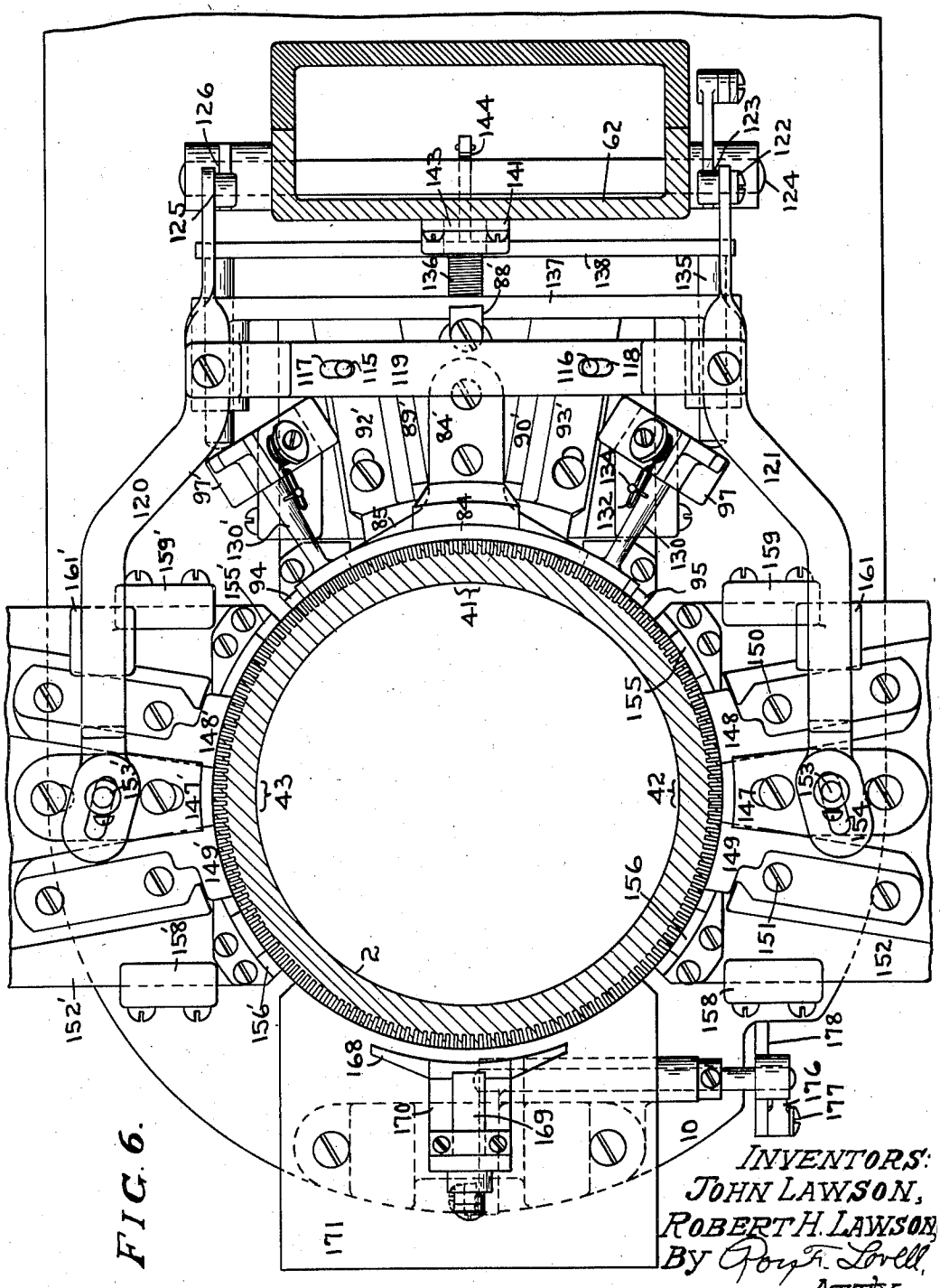


FIG. 6.

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FIG. 7.

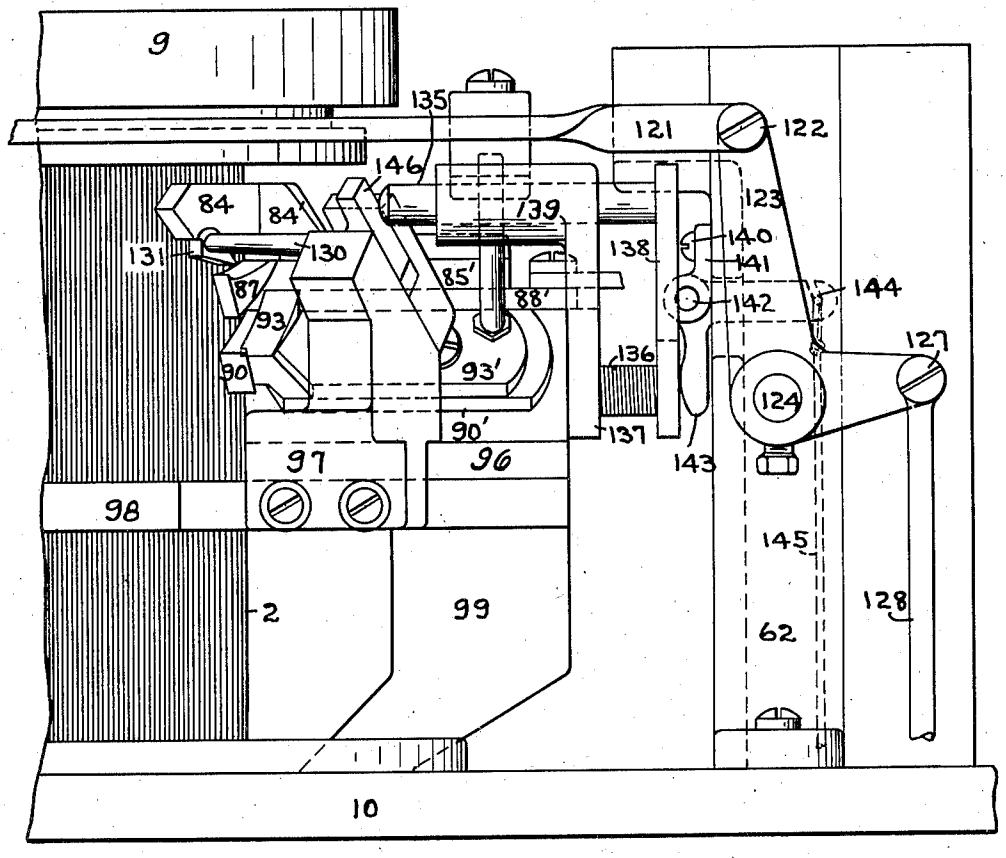
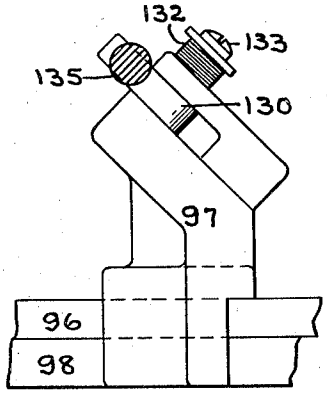


FIG. 8.



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FIG. 9.

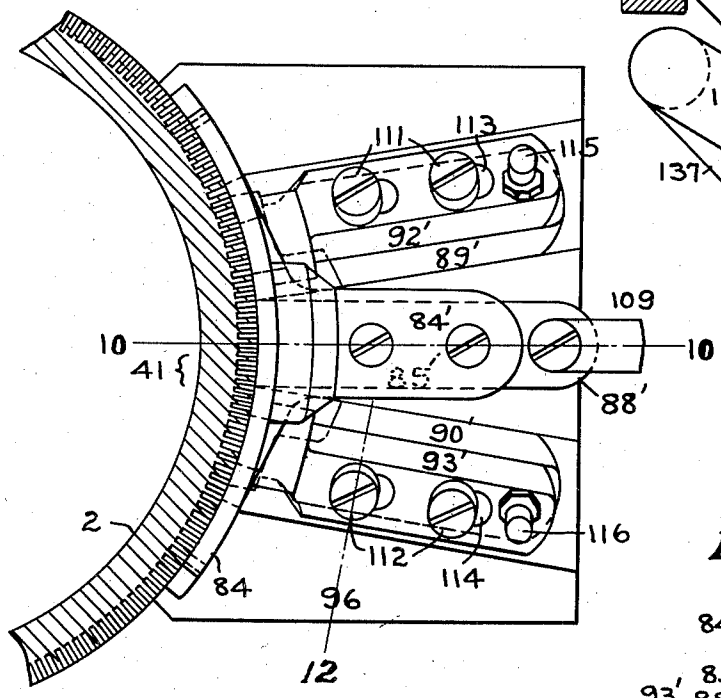


FIG. 11.

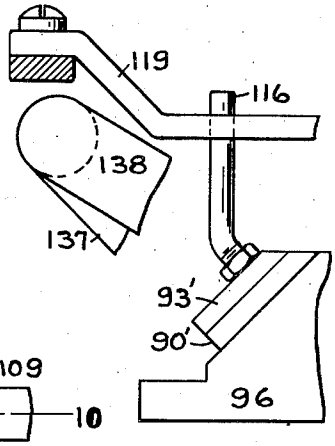


FIG. 12.

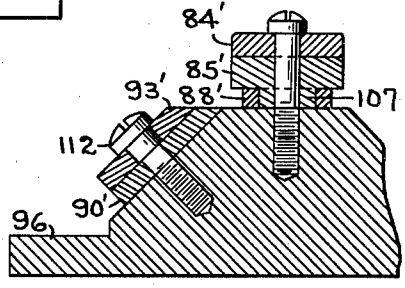
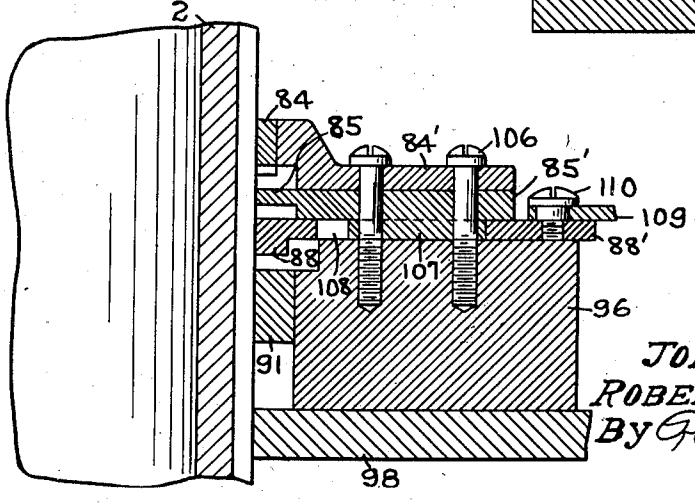


FIG. 10.



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FULL FASHIONED CIRCULAR KNITTING MACHINE

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FIG. 14.

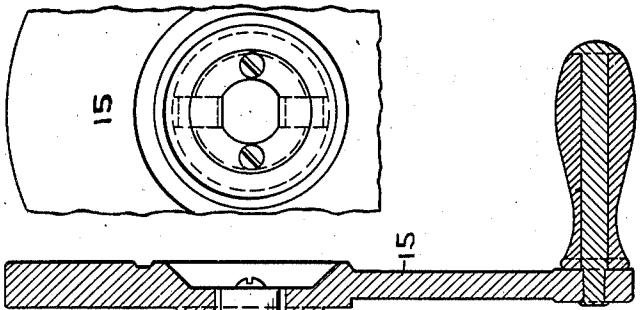
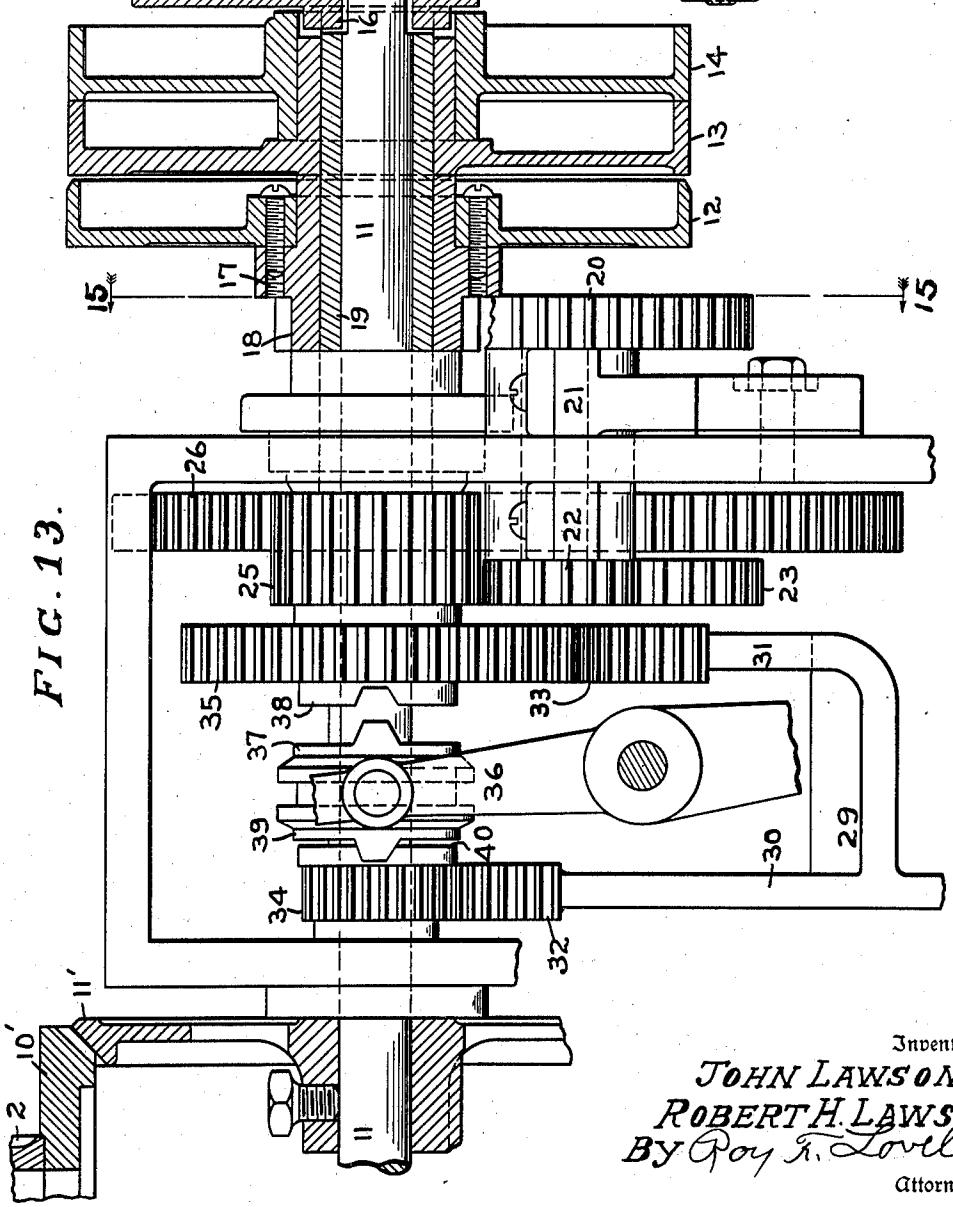


FIG. 13.



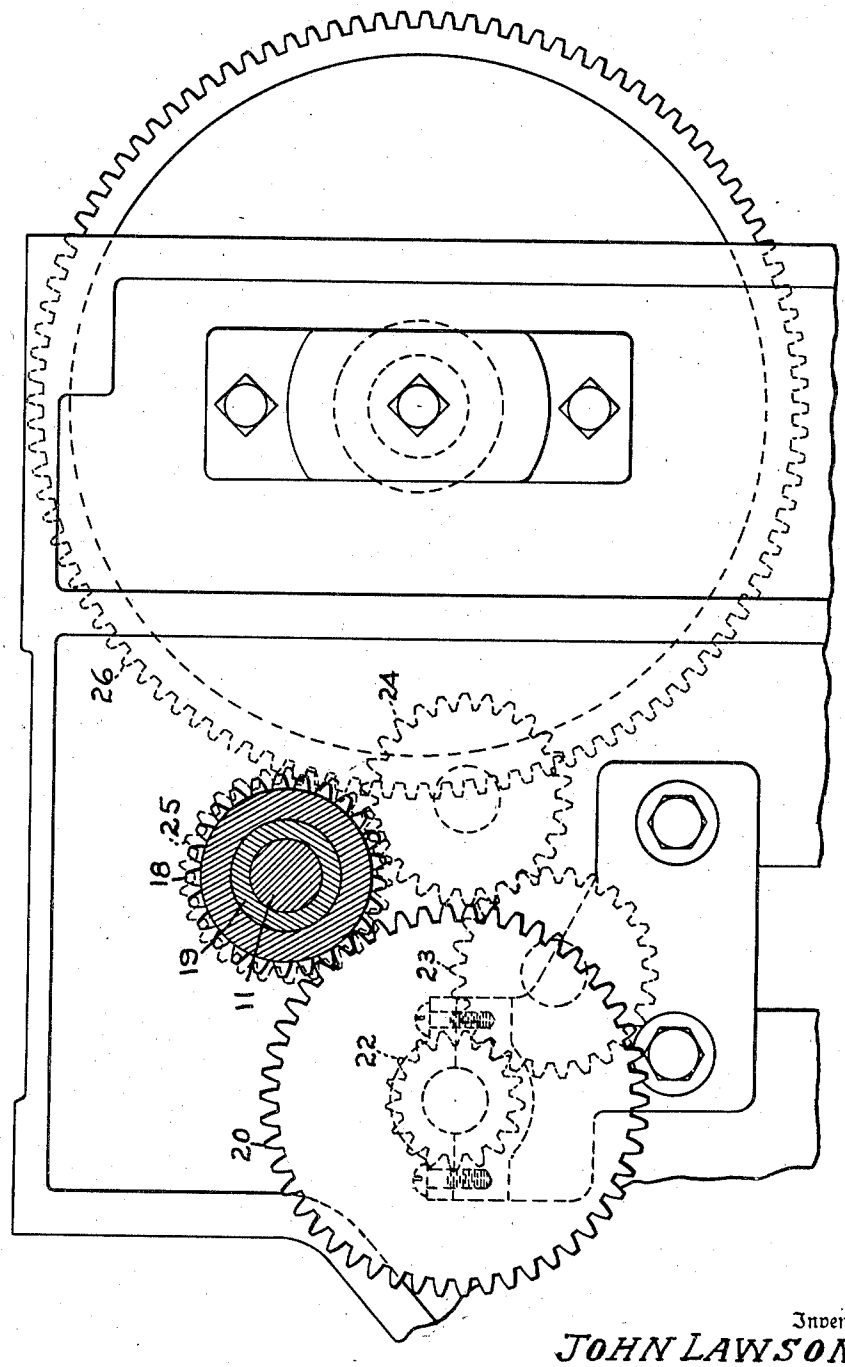
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FULL FASHIONED CIRCULAR KNITTING MACHINE

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FIG. 15.



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FULL FASHIONED CIRCULAR KNITTING MACHINE

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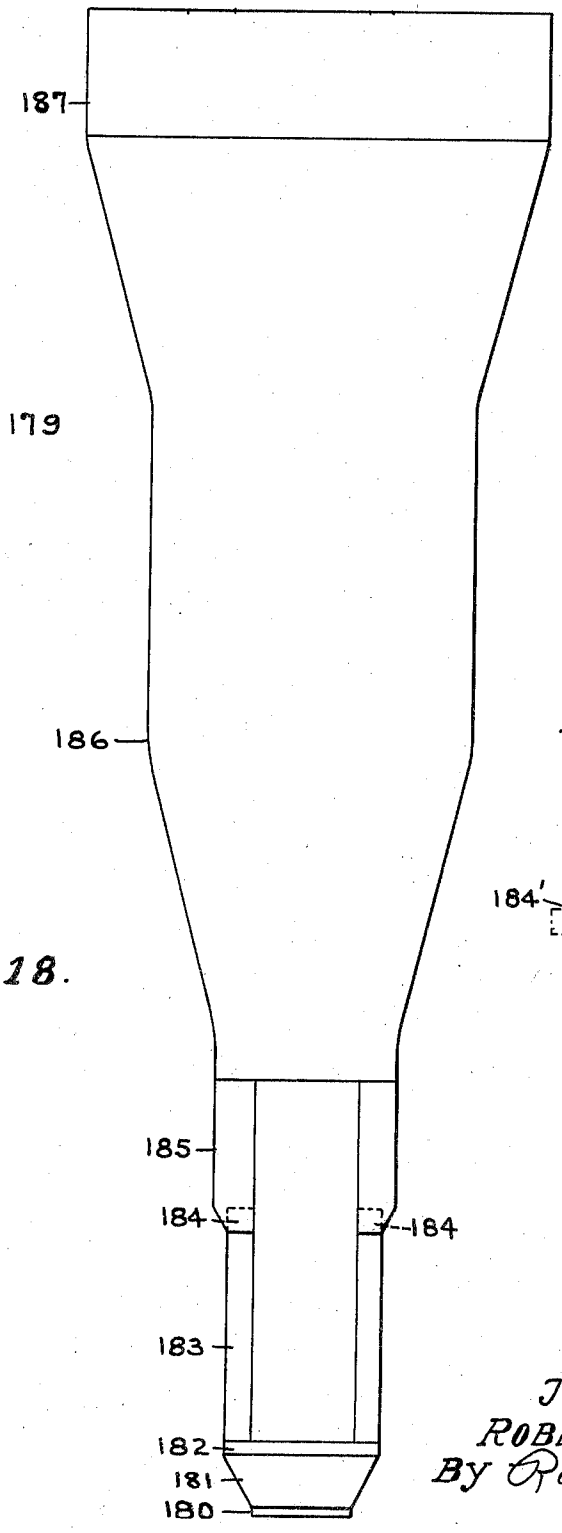


FIG. 16.

FIG. 17.

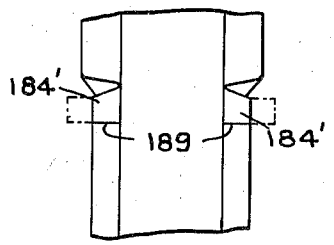
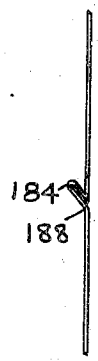


FIG. 18.



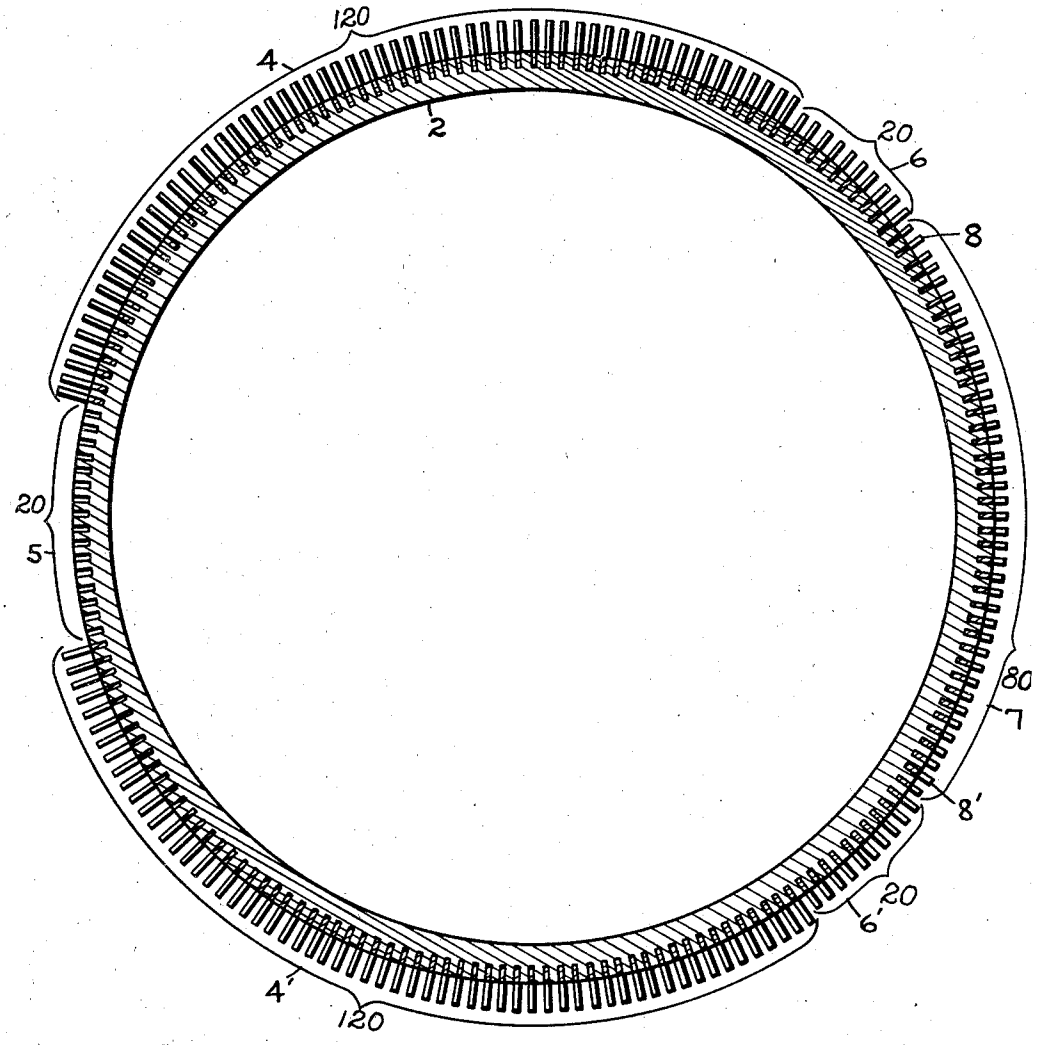
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FULL FASHIONED CIRCULAR KNITTING MACHINE

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FIG. 19.



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FULL FASHIONED CIRCULAR KNITTING MACHINE

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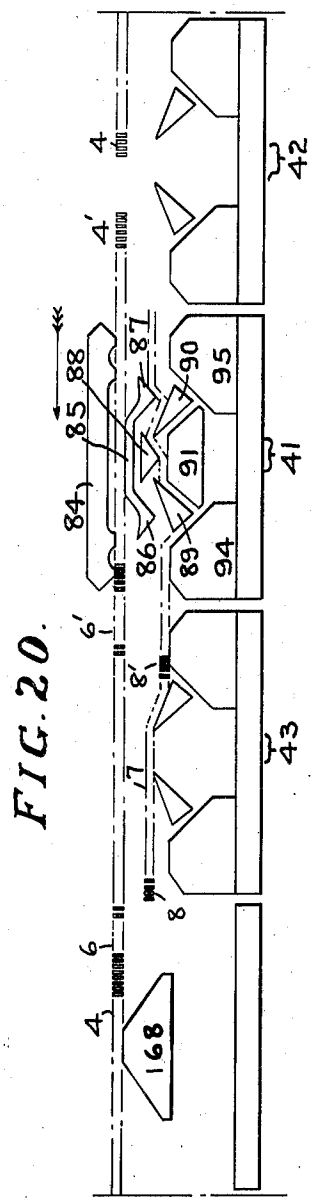


FIG. 20.

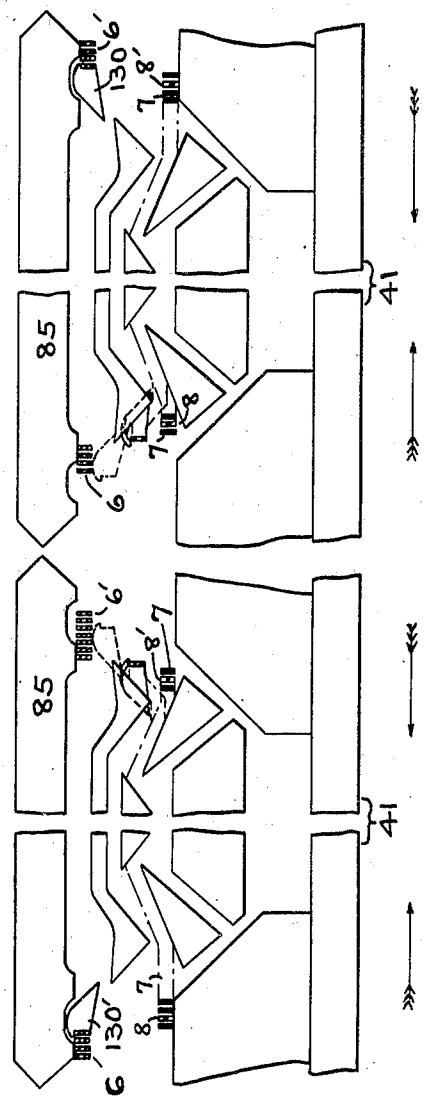


FIG. 23. FIG. 24a. FIG 23a. FIG. 24.

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Jan. 17, 1939. J. LAWSON ET AL 2,143,952

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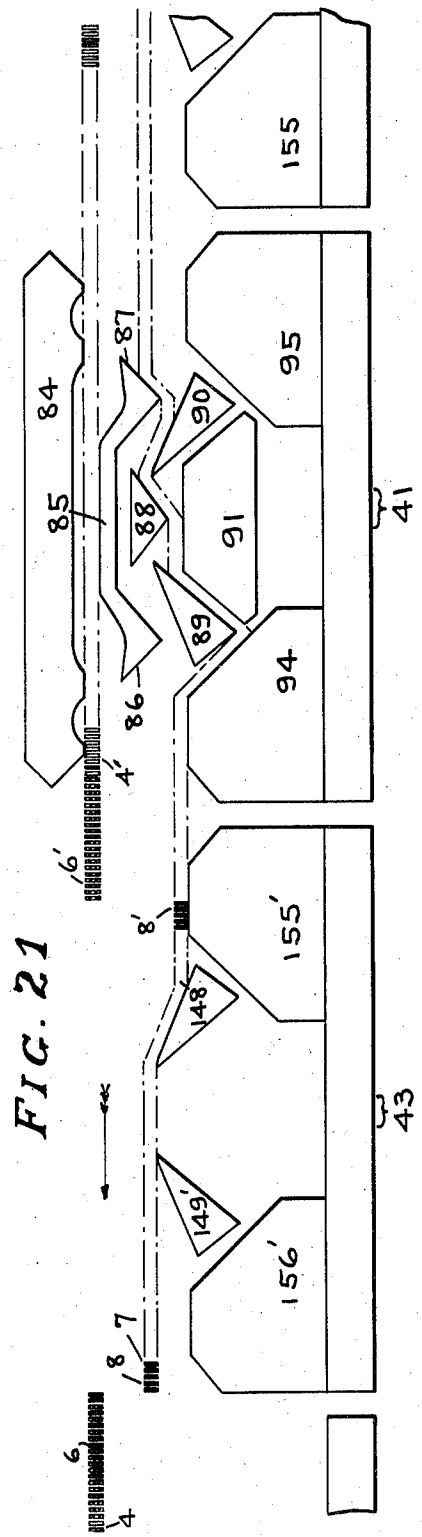


FIG. 21.

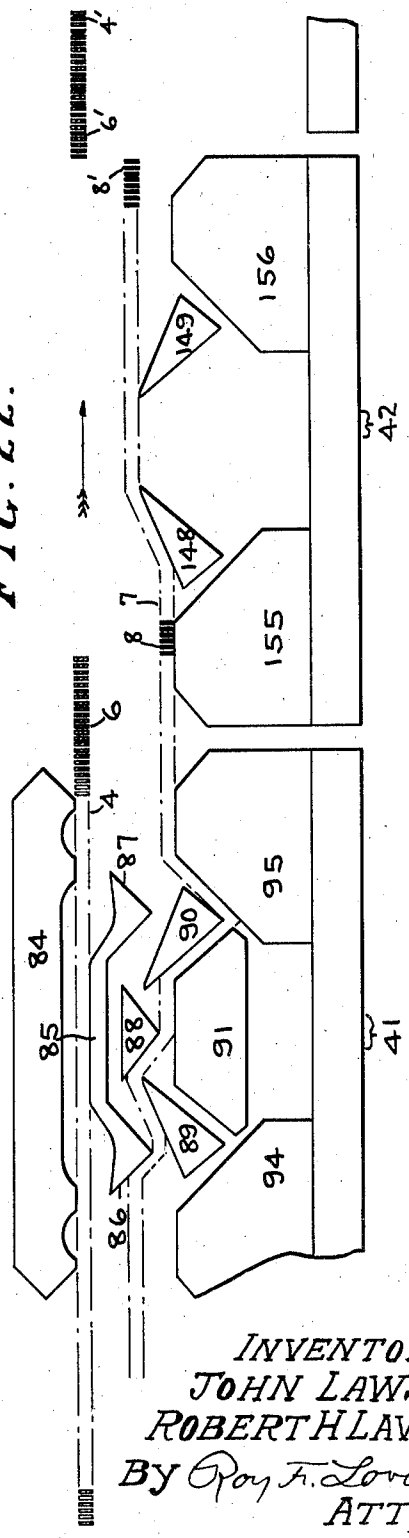


FIG. 22.

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FULL FASHIONED CIRCULAR KNITTING MACHINE

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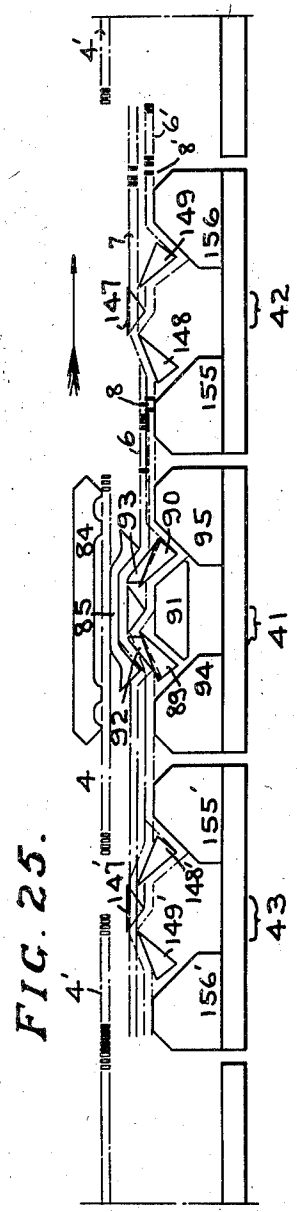


FIG. 25.

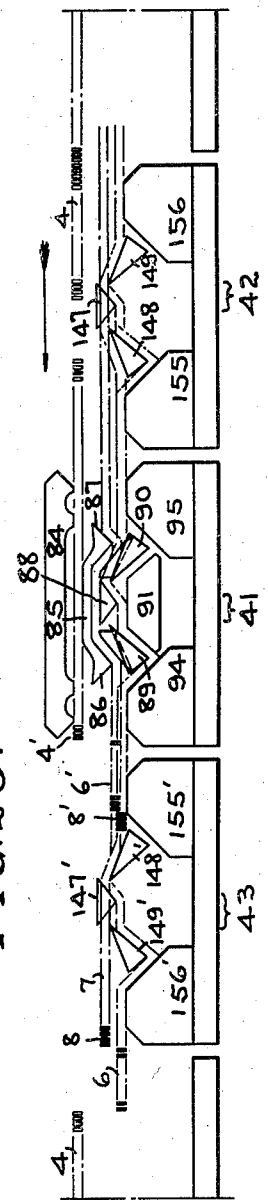


FIG. 26.

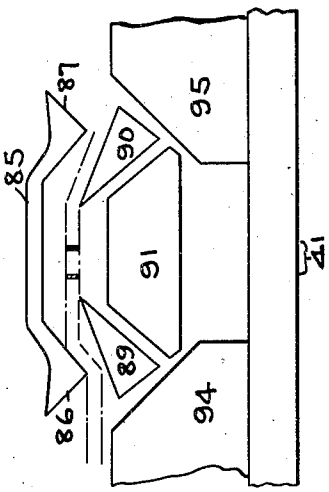


FIG. 27.

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Patented Jan. 17, 1939 2,143,952

UNITED STATES PATENT OFFICE

2,143,952

FULL FASHIONED CIRCULAR KNITTING MACHINE

John Lawson, Bristol, and Robert H. Lawson, Pawtucket, R. I., assignors to Hemphill Company, Central Falls, R. I., a corporation of Massachusetts

Application September 6, 1932, Serial No. 631,844

21 Claims. (Cl. 66—43)

This invention relates to a new improved stocking or half hose as well as to methods of and mechanisms for knitting the same. As hereinafter to be more fully described the stocking or half hose is, preferably, to be knitted on a machine of the type disclosed in the patent to Hemphill, 933,443, Sept. 7, 1909, although the invention may be practiced on other types of knitting machines.

In the drawings:

Fig. 1 is a view in front elevation showing a knitting machine adapted to knit a stocking in a manner hereinafter to be more fully described.

Fig. 2 is a view in side elevation of the machine shown in Fig. 1;

Fig. 2*a* is a detail view taken on line 2*a*—2*a*, Fig. 2;

Fig. 3 is a plan view and partly in section;

Fig. 4 is a fragmentary, elevational view partly in section;

Fig. 5 is a view similar to Fig. 4 but taken at right angles thereto;

Fig. 6 is a plan view similar to Fig. 3 but with certain parts removed and showing the various cams for controlling the movements of the needles;

Fig. 7 is an enlarged fragmentary view showing more in detail the mechanism shown at the right of Fig. 1 and above the circular base;

Fig. 8 is a fragmentary view of the pick block, i. e., the support for one of the two widening picks which effect the widening of the fabric in a manner hereinafter to be described;

Fig. 9 is a fragmentary plan view showing the needle actuating cams at the main feed station;

Fig. 10 is a view in vertical section taken along the line 10—10, Fig. 9;

Fig. 11 is a fragmentary detail view of a portion of the mechanism shown in Fig. 7;

Fig. 12 is a fragmentary view in section taken along the line 12, Fig. 9;

Fig. 13 is a view partly in section showing the driving connections between the belt pulleys and the main shaft of the machine, which shaft drives the needle cylinder;

Fig. 14 is a fragmentary view showing a portion of the hand wheel shown in Fig. 13;

Fig. 15 is a view showing a gear train;

Fig. 16 is a view of a stocking blank knitted in accordance with methods hereinafter to be described;

Fig. 17 is a view showing a portion of the fabric blank shown in Fig. 16 after a cutting operation has been performed;

Fig. 18 is an edge view of the fabric shown in Fig. 16;

Fig. 19 is a sectional view of the needle cylinder showing the arrangement of long butt, medium long butt, medium short butt, and short butt needles used to effect the knitting of the stocking blank, Fig. 16;

Fig. 20 is a more or less diagrammatic view showing the long and medium long butt needles having been elevated to an inoperative position preparatory to the knitting of waste courses on the short butt needles at the main feeding station;

Fig. 21 is a view similar to Fig. 20 and showing the short butt needles only knitting at the main feeding station, the view showing the needles at the end of one reciprocating stroke;

Fig. 22 is a view similar to Fig. 21 but showing the needles at the end of their movement in the direction of rotation of the needle cylinder opposite to that indicated in Fig. 21;

Figs. 23, 23*a*, 24 and 24*a* show the widening picks in operation;

Fig. 25 is a view showing the needles knitting split work and at the end of the movement of the needle cylinder in the direction indicated by the arrow;

Fig. 26 is a view similar to Fig. 25 but showing the needles at the end of the other or reverse stroke of the needle cylinder; and

Fig. 27 is a fragmentary view, the center guard cam at the main feeding station being in a retracted position, the medium long butt needles at such time knitting at the two auxiliary or side feeding stations.

The knitting machine which is indicated generally by the numeral 1, is provided with a needle cylinder 2 slidable within the tricks or grooves of which are spring beard or other needles 3, which needles, Fig. 19, consist of two groups 4, 4' of one hundred and twenty long butt needles which groups of needles are separated at one end by a gap or space 5 in the needle cylinder. At the other end of each long butt series are positioned twenty medium long butt needles 6, 6'. Between the two sets of needles 6 and 6' are positioned eighty short butt needles 7 which include two medium short butt needles 8 and 8' the latter being suture needles or needles that join the fabric sections knitted by the needles 7 at the main feeding station and by the medium long butt needles 6 and 6' at the auxiliary feeding stations, the joining of the three fabric sections being effected in a manner hereinafter to be more fully described. Surmounting and movable with the needle cylinder is a sinker head 9 within which are mounted sinkers (not shown) which sinkers function in the usual manner to assist in the formation of stitches. The needle cylinder 2 is mounted for reciprocatory movements within a so-called circular base 10 and to effect such movements a bevel gear 10' (Fig. 13) is affixed to the lower portion of the needle cylinder. To one end of the driving shaft 11 of the

machine is affixed a bevel gear 11' which meshes with and drives the bevel gear 10'.

In Figs. 1, 2, 13, 14 and 15 means are shown for imparting operating movements to the needle cylinder and otherwise controlling the operations of the machine. At one end of the machine (Figs. 1 and 13) are shown a pulley 12, a pulley 13, and a loose pulley 14 mounted upon a shaft 11. Loosely mounted upon the shaft 11 adjacent to one end thereof is a hand wheel 15 which may be operated manually to turn the shaft 11 by means of the clutch connection 16. The pulley 12 as by means of screw 17 is connected to a spur gear 18, the hub of which loosely surrounds an inner sleeve 19 which in turn is mounted upon the shaft 11. The teeth of the gear 18 mesh with the teeth of a gear 20 fast to a shaft 21 which is supported in bearings in the frame of the machine. To the other end of the shaft 21 is fixed a gear 22 which meshes with an idler gear 23 which in turn meshes with a gear 24. The gear 24 meshes with a gear 25 which is fast to the sleeve 19. The teeth of the gear 25 are wide and in addition to meshing with the teeth of the gear 24 they also mesh with the teeth of the "104" gear 26. Projecting laterally from one face of the gear 26 (Fig. 2) is a stud 27 to which is pivoted a link 28 which at its other end is pivotally connected to a bell crank lever which constitutes the so-called quadrant 29 which quadrant lever is provided with two arms 30 and 31 (Fig. 13) integral with which are segmental gears 32 and 33 respectively. The gear 32 meshes with a small gear 34 and the gear 33 meshes with a relatively large gear 35. When the driving belt is shifted from pulley 13 to pulley 12 as when beginning the knitting of the leg of the stocking after the knitting of split work, a clutch lever 36 which is pivoted intermediate its ends to a suitable part of the machine frame, is shifted from a position where the clutch face 37 of a clutch connected to lever 36, and slidable on shaft 11, is in engagement with a companion clutch face 38 forming part of the gear 35, to the position shown in Fig. 13 where the other clutch face 39 of the clutch connected to the lever 36 is in engagement with the clutch face 40 forming part of gear 34. The shifting of the clutch lever 36 in the manner aforesaid is coincident with the shifting of the belt (not shown) from the pulley 13 to the pulley 12. It will be seen from inspection of Fig. 13 that the segmental gear 33 is mounted on a shorter arm than is the segmental gear 32 and as a consequence thereof the arc through which the quadrant lever 29 swings imparts a relatively short throw to the segmental gear 33, and consequently to shaft 11, which is desirable during the knitting of split work when the needles are not required to reciprocate through approximately one and one-third times the distance measured by the circumference of the needle cylinder which is desirable when knitting the leg of the stocking. On the other hand, the segmental gear 32 being mounted upon a relatively longer arm and the meshing gear 34 being smaller than the gear 35, the shaft 11 is reciprocated through a greater arc and consequently the needle cylinder is reciprocated through approximately one and one-third revolutions thereof. Furthermore, the gear trains connecting the gears 32, 33 and their respective pulleys cause the needles to travel relatively to their operating cams at approximately the same speed when split-work is being knitted as when the leg is being knitted.

The driving connections between the pulleys and the needle cylinder and other operating parts of the knitting machine, just referred to, have been described by way of example only, it being understood that any suitable form of driving connection may be adopted either with a single driving pulley operating at all times or with any desired number of driving pulleys.

In Figs. 1–6 inclusive are shown three feeding stations, including a main feeding station 41 and supplemental feeding stations 42 and 43. At the main feeding station are shown five thread or yarn levers 44, 45, 46, 47 and 48; at supplemental feeding station 42 are shown yarn levers 49, 50 and 51; and at feeding station 43 are shown yarn levers 52, 53 and 54. All of the said yarn levers are mounted upon a common pivot pin 55 which itself is supported by two upstanding ears or lugs 56, 57 projecting upwardly from the yarn lever bracket or plate 58. As most clearly shown in Fig. 4, the plate 58 is pivoted to a supplemental yarn carrying bracket or plate 59 by means of a pin 60 itself mounted in lugs such as 61 upstanding from the plate 59, which plate is affixed to the yarn lever box 62. Each of the yarn levers hereinbefore mentioned is provided with an extension 63 the underside or face of which is normally engaged by means of an arm of a lever 64 which is pivotally mounted upon a pin 65 itself supported by lugs such as 61. The other arm of each lever 64 has connected thereto a pin or screw 66 to which is connected one end of a coil spring 67, the other end of such spring being connected as at 68 to the plate 59. As will be evident from inspection of Fig. 4 of the drawings, springs 67, levers 64, etc., tend to cause their respective yarn levers to remain in the operative position shown in Fig. 4. If it be desired to raise a yarn lever to an inoperative position, a lever such as the lever 69, Fig. 4, is rocked by means of a wire (not shown) which engages in a notch 70 and causes the lever 69 to be rocked upon its pivot 71 thereby elevating the other end of such lever which by engaging the underface of the yarn lever causes the feeding end thereof to be elevated to an inoperative position.

Spring actuated detents such as 72 (Figs. 1 and 3) may be provided to engage in recesses in the side faces of the plate 58 so as to lock or retain the said plate in its operative position shown in Fig. 4.

The free ends of the yarn levers are provided with eyelets through which the threads or yarns pass to the needles 3. The yarn levers 44, 45, 46, 47 and 48 rest upon plate 73 when in an operative position. Said plate 73 is a part of the bracket 58 and performs the function of the usual mouthpiece at the main feeding station, being adjustably connected to bracket 58 by means of screws 74, 75 passing through elongated slots 76, 77. Bracket 58 is semi-circular in shape as shown in Fig. 3, the ends terminating in plates 78, 79 which constitute mouthpieces for the auxiliary feeding stations. The yarn levers 49–54 inclusive, as shown, are curved from their pivoted ends to their thread or yarn feeding ends, which are turned inwardly, i. e., toward the needle cylinder. As most clearly shown in Figs. 3, 4 and 5, the plates 78 and 79 are attached by means of screws 80, 81 to the ends of arms constituting portions of the plate or bracket 58.

In Figs. 1, 2, 6–12 inclusive and Figs. 20–27 inclusive, are shown cams, etc. for determining the character of fabric to be knitted. Cooperating with the yarn levers at the main feeding station 41 are a series of cams 84, 85, 86, 87, 88,

89, 90, 91, 92, 93, 94 and 95 the outwardly extending plates or extensions of the cams, which plates are referred to respectively by the numerals 84', 85', 88', 89', 90', 92' and 93', being connected to and carried by a cam block 96 which together with a pick block 97 is fastened to a cam ring or plate 98. Attached to and depending from the cam ring or plate 98 is a bracket 99 which is connected to a bar 100 (Fig. 1) which is supported for sliding movements in any suitable manner. Connected to the sliding bar 100 in any suitable manner is the main fashioning bracket 101 which is provided with a series of cams or lugs as 102 adapted to be engaged by cams such as 103 for the purpose of determining the length of stitch to be knitted at the main side or feeding station of the machine. The cam 103 is rigidly mounted upon and turns with the main drum shaft 104.

The shaft 104 is periodically advanced in any desired manner the advancing movements of the said shaft being controlled through the instrumentality of a pattern chain 105 common to Banner machines.

Cams 84, 85 and 88 (Fig. 10) are retained in position on the cam block 96 as by means of screws 106 which rigidly connect the cams 84 and 85 in position adjacent to the needle cylinder, the screws 106 passing through extensions 84' and 85' of the respective cams. Screws 106 also pass through a plate 107, preferably integral with plate 85', which plate is received within a slot 108 provided in the extension 88' of the cam 88, the plate 107 acting as a stop to limit the sliding movements which are imparted to the cam 88 by means of any suitably operated link 109 which is pivotally connected to the free end of the extension 88' as by means of a screw 110. The plate 107 also serves to maintain the cam plate 85' at a sufficient elevation to prevent the binding of the cam plate 88' by the screws 106. The cam plates 89' and 90' are retained in a fixed position with respect to the cam block 96 as by means of shouldered screws 111 and 112 respectively, the shoulders of which screws engage the upper faces of the respective cam plates 89' and 90' as shown in Fig. 12. The upper portions of the screws 111 and 112, above the shoulders thereof, are received within the slots 113 and 114 in the respective cam plates 92' and 93', thereby permitting the said plates 92' and 93' or either of them to be moved radially to and from a position adjacent to the needle cylinder. In order to effect the radial movement of the cams 92 and 93 their extensions are provided with upstanding pins 115 and 116 respectively, which are received within elongated slots 117 and 118 (Fig. 6), respectively, the said slots being provided in a transversely extending bar 119 to the ends of which links 120 and 121 are connected intermediate their ends. As will be seen most clearly by referring to Fig. 7 the link or lever 121 is pivotally connected at 122 to bell crank lever 123 which latter is rigidly connected to a pin 124 which passes through the yarn lever box 62. At the other side of the yarn lever box the link 120 is pivotally connected at 125 to a link 126 which at its lower end is also rigidly connected to the pin 124, bearings for the pin 124 being provided by the yarn lever box 62. The other arm of bell crank lever 123 is pivotally connected at 127 to a depending link 128 which (Fig. 1) at its lower end is connected to a lever to be acted upon by one or more suitable cams carried by a drum 129 which latter turns with the main cam shaft 104. The mentioned cams on the drum 129 permits a suitable spring (not shown) to act upon the cams 147, 147' hereinafter to be described as well as the cams 92 and 93 to position the said cams adjacent to the needle cylinder at the beginning of split work knitting, the mentioned cams on the cam drum 129 causing the cams 147, 147', 92 and 93 to be retracted at the completion of split work knitting. During the knitting of split work the bell crank lever 123 is actuated during each complete back and forth traverse or reciprocation of the needle cylinder, the periodic actuation being effected by any suitable means (not shown) preferably controlled from the quadrant 29.

In Figs. 1, 6, 7 and 8 are shown the construction of the widening picks and the means for operating the same; in Figs. 23, 23*a*, 24 and 24*a* their operation is illustrated. The pick block 97 to which reference has hereinbefore been made is duplicated at the other side of the main cam block being there indicated by the numeral 97'. As the operation of the two widening picks is identical excepting that they are operative on reverse strokes of the needle cylinder, the construction and operation of but one pick will be described. The windening pick 130 is provided with a narrow notch 131 said notch being of a width to receive a single needle butt so as to pick down single needles only during the widening or fashioning of the stocking blank. The pick is pivotally mounted in the pick bracket 97 in the manner shown in Fig. 8, and a spring 132 which encircles the post or screw shank 133 has one end thereof connected to a pin 134 (Fig. 6) upstanding from the shank of the pick 130, the spring 132 tending to maintain the pick 130 in the elevated, operative position shown in Fig. 7. The pick 130 is shown, Fig. 7, seated within a recess provided in the lower face or edge of the cam 84 in which position the recess 131 is in the path of the advancing needle butts which are acted upon in a manner hereinafter to be more fully described. As hereinbefore stated the spring 132 retains the pick in the position shown in Fig. 7 and at the completion of each one of the several fashioning operations it is necessary that the pick 130 be moved to an inoperative position, i. e., where it will not act upon the advancing needle butts. For the purpose of withdrawing the pick 130 from the position shown in Fig. 7, means are provided consisting of a pin 135 which normally is maintained in a retracted position by means of a spring 136 which at one end engages the outer face of a recessed plate 137 and at its other end engages an adjacent face of a plate 138. To the upper end of the plate 138 the pin 135 is fixed passing from the said plate in the direction of the needle cylinder and through a long bearing in tube 139 which constitutes the upper portion of the plate 137. The bearing 139 provides a suitable means for guiding the movements of the pin to and from a position adjacent to the pick 130. Connected to the yarn lever box 62 as by means of screws 140 is a bracket 141 which carries a pin 142 upon which is mounted a bell-crank lever 143 one arm thereof being in engagement with the outer face of the plate 138. The other arm of the bell-crank lever is notched as at 144 within which notch is seated a depending wire or other link 145 which link 145 is suitably connected to a lever in turn acted upon by a cam carried by the drum 129. When it is desirable to withdraw the pick 130 from the operative position shown in Fig. 7, the link 145 is moved downwardly through the connections just described, whereupon the bell-crank lever 143 is rocked and

the plate 138 is moved inwardly, i. e., toward the needle cylinder and against the compression tension of the spring 136. Inward movement of the plate 138 carries the pin 135 against an angularly extending arm 146 of the pick 130, the result being that the pick 130 is rocked upon its pivot and against the tension of the spring 132. The pivotal movement imparted to the pick 130 retracts the said pick from its operative position shown in Fig. 7, the pick then remaining in its inoperative position until it is desirable to renew the widening of the fabric when the link 145 is permitted to rise, thereby releasing the pick 130 and permitting the spring 132 to move the pick to the position shown in Fig. 7.

The cams at the feed station 42 are duplicated at the feed station 43 and in the following description the cams at the feed station 42 only will be described, the corresponding parts at the feed station 43 being indicated by corresponding and prime reference characters. The construction and operation of the cams at the auxiliary feed station 42 are shown in Figs. 1, 2, 6, 20, 22, 25 and 26. The center guard cam 147 is positioned between two side, stitch drawing cams 148 and 149 which latter cams are stationarily mounted with respect to the needle cylinder as by means of screws 150 and 151 which screws pass through the cams 148 and 149 and into threaded engagement wtih the block 152. Upstanding from the cam 147 is a pin 153 which passes through a slot 154 provided in the outer end of the arm 121 hereinbefore described. It will be evident from the construction shown in Fig. 6 that the withdrawal of the cams 92 and 93 occasions the withdrawal of the cam 147 as well as its counterpart 147' at the auxiliary side 43. Fixed cams 155, 156 are positioned adjacent to the cams 148, 149 respectively the said cams 155, 156 having the function of the cams 94 and 95 at the main feeding station, namely, that of restoring needles to a partially elevated position after they have been fully retracted by a stitch drawing cam.

As most clearly shown in Figs. 1, 2 and 6 the cam block 152 is attached at both ends thereof to a plate 157 as by means of cleats 158 and 159, screws passing through the cleats and into the plate 157. The cleat 159 extends upwardly from the block 152 as at 160 terminating in a horizontally extending portion 161 provided with a groove which slidably receives and guides the rod or link 121.

For the purpose of adjusting or changing the lengths of the stitches to be knitted by the needles at the auxiliary feeding stations 42, 43 the plates 157, 157' are fastened to a bracket 162 which in turn is connected to a right-angled bracket 163, the depending end of which has adjustably mounted therein cams or followers 164 which are periodically engaged by means of cams carried upon a disc or drum 165 which disc or drum is rigidly mounted upon the shaft 104 and turns therewith. The brackets 162, 163, etc. are connected to a rod 166 slidably supported in suitable brackets.

Midway between the auxiliary feed stations 42 and 43 and directly opposite the main feed station 41 there is positioned a cam 168 which is moved to the position shown in Figs. 1, 2 and 6 immediately upon completion of the last course of the widening portion of the leg and prior to the beginning of the knitting of the next stocking on the short butt needles only, the cam 168 immediately after moving the long butt needles to an inoperative position as aforesaid, being retracted to such a radial position as not to be in the path of the long butts. As clearly shown in Figs. 1, 2 and 6, the cam 168 is rigidly connected to a block 169 which is mounted for vertical movements between uprights constituting a bracket 170 which uprights are fastened to a plate 171 in turn supported by and connected to the circular base 10 as by means of uprights 172. Connected to the outer face of the block 169 as by means of a screw 173 is a link 174 which passes through the plate 171 and at its lower end is pivotally connected at 175 to a bell-crank lever 176, the lower end of which is pivotally connected at 177 to a link 178 which is automatically controlled at desired times by suitable cams upon the drum 129, the connections between the link 178 and drum 129 not being shown.

In Figs. 16, 17 and 18 views of the stocking blank knitted in accordance with the methods hereinafter to be more fully described is shown. The selvaged stocking blank which is indicated generally by the numeral 179 consists of a few waste courses 180 knitted at feeding station 41 upon the eighty short butt needles 7 indicated in Fig. 19; a fashioned toe 181 knitted at station 41 upon said needles 7 and the needles 6 and 6', the butts of which are indicated in Fig. 19; a ring toe 182 knitted at station 41 upon the needles 6, 6' and 7; a split-foot portion 183 knitted upon the same needles 6, 6' and 7 at all three feeding stations 41, 42, 43; heel tabs 184 which are knitted by the needles 6 and 6' at the auxiliary feeding stations only, the main feeding station not knitting at this time; split fabric 185, knitted as is the split-foot portion 183, which constitutes a portion of the ankle in the completed stocking, during the knitting of the initial courses of which portion 185 some of the long butt needles 4 and 4' are picked down to an active position in a manner hereinafter to be more fully described; a leg 186 which is knitted at the main feed station 41 only and during the knitting of which leg portion additional needles 4 and 4' are moved to the active knitting level; and finally a garter top 187 which is knitted with the full complement of needles at feeding station 41 only. Subsequently to the knitting operations just briefly referred to the tabs 184 are severed at 188, Fig. 18, whereupon the resultant tabs 184' are turned at right angles to the position shown in Fig. 17, the tabs being thereafter sewed to the foot portion of the fabric along the lines 189, the extreme ends of the tabs 184' which are represented in dotted lines, Fig. 17, then being severed from the fabric. After removal of the waste courses 180 the edges of the fashioned blank 179 are brought together and sewed thus completing the stocking.

Operation

In Figs. 20–27 inclusive the various knitting operations insofar as the needle actuation is concerned are shown more or less graphically or diagrammatically. In Fig. 20 the long butt needles 4, 4' and the medium butt needles 6, 6' are shown as having been elevated, the needles being at the limit of their stroke in the direction of the arrow. While the short butt needles 7 alone are knitting at the main feed station 41 as indicated in Fig. 20, the waste courses 180 are being knitted. Figs. 21 and 22 show the paths of the active and inactive needles during the knitting of the waste courses.

Immediately following the knitting of the waste courses 180 the courses constituting the toe 181 are knitted during the knitting of which

all the needles 6 and 6' are restored to the active, knitting level by means of the picks 130, 130', one such needle being restored to knitting position by a pick, preferably but not necessarily, during the knitting of each course. The action of the picks 130, 130' is diagrammatically illustrated in Figs. 23, 23a, 24 and 24a. As shown in Fig. 23 a leading needle of the series 6 is about to be restored to the active, knitting level. After engaging the adjacent face of the pick 130' defined by the notch 131', continued movement of the needle cylinder, causes the butt of the needle 6 to move the pick in the direction of the arrow, Fig. 23, whereupon the pick, being mounted upon an inclined axis, moves in a downward direction as indicated in Fig. 23a, the needle finally joining the active needles thereafter to knit in conjunction with such active needles. The action of the other pick 130 is shown in Figs. 24 and 24a, the pick 130 acting upon a leading needle of group 6'.

To avoid the possibility of the picks picking end needles at each side of the gap 5, it is desirable to insert dummy jacks in the slots of that portion of the needle cylinder designated by the said numeral 5. To accomplish the desired purpose, jacks may be used which are similar to the so-called dummy jacks referred to in the description of the Lawson Patent #1,458,833, June 12, 1923, attention being particularly called to the description in the said Lawson patent beginning with line 106, page 6.

Subsequently to the knitting of the courses 181 a few ring toe courses 182 are knitted at the main feeding station 41 only, the widening picks 130, 130' being at such time inactive.

Following the knitting of the courses 182, the side, auxiliary center guard cams 147, 147' are moved to an active position adjacent to the needle cylinder, as shown in Fig. 6, by means of the arms 120, 121 which are actuated from the pattern drum 129 in a manner hereinbefore described. Simultaneously with the moving of the cams 147, 147' to an active position adjacent to the needle cylinder, the pin and slot connections 115, 116, 117, 118 cause the cams 92 and 93 to be moved to the active position indicated in Figs. 25 and 26 whereupon the split sole portion 183 of the stocking is knitted. During the knitting of the split sole portion of the fabric, the needles 7 knit the instep of the stocking with one thread or yarn, being actuated or controlled by the cams constituting the main or primary feeding station 41; the needles 6 being actuated by the cams included or comprising part of the auxiliary feeding station 43; and the needles comprising the set 6' being actuated by cams at the auxiliary feeding station 42. During the knitting of split fabric it is essential that the fabrics knitted at the said feeding stations 42 and 43 be joined with the fabric knitted at the feeding station 41 and to accomplish this purpose suture needles 8 and 8' are provided which are specially actuated so as alternately to knit at the main feeding station and at an auxiliary feeding station. In Fig. 25 the needles are shown at the end of their traverse in the direction indicated by the arrow, whereas in Fig. 26 the needles are indicated at the end of traverse in the other direction likewise indicated by an arrow in said figure. The needles 7 (exclusive of the needles 8 and 8') are short butt needles and knit at the main feeding station 41 only and during both the direction of traverse indicated in Fig. 25 and that indicated in Fig. 26, the cams 147 and 147' being in a semi-retracted position, i. e., in a position where they do not engage the short butts of the needles 7; consequently such short butts move past the auxiliary cams without being actuated. The needles 6 and 6' knit at their respective feeding stations only, being elevated above the stitch drawing cams at the main feeding station 41 by means of the mentioned cams 92 and 93, and not reaching the auxiliary feeding station at which they do not knit, all as indicated in Figs. 25 and 26.

The joining of the fabrics knitted at the feeding station 43 to the fabric knitted at the feeding station 41 which joining has hereinbefore been mentioned, is accomplished by causing the needle 8 to knit one course at the auxiliary feed station 43, then to be elevated above the knitting cams by the cam 92 at the main feed station 41, such needle stopping short of the cams at the feed station 42 as indicated in Fig. 25; and during the next course of knitting occasioned by the needles moving in the direction of the arrow, Fig. 26, causing the needle 8 to pass by the cam 93 and knit at the main feeding station 41, such cam 93 as well as the cams 92, 147 and 147' being moved to a semi-retracted position, i. e., where they engage the butts of the needles 6 and 6' but do not engage the butts of the needles 8 and 8', the retraction of cam 147' permitting needle 8 to pass station 43 without knitting. Likewise the fabric sections knitted at feeding stations 41 and 42 are joined by needle 8', Fig. 25, which starts from a position between the cams at the feeding station 43 and the cams at the feeding station 41 and thereafter moves in the direction of the arrow, Fig. 25, being elevated above the cams at the main feeding station 41 by the cam 92 continued rotation of the needle cylinder causing such needle to knit at the auxiliary feed station 42, Fig. 25. While the needles are moving in the direction of the arrow, Fig. 26, the butt of the needle 8' is not depressed by the center guard cam 147, such cam having been moved to a semi-retracted position as just described. Continued rotation of the needle cylinder in the direction of the arrow, Fig. 26, causes the needle 8' to knit at the main feeding station 41, the cam 93 having been moved to a semi-retracted position as just described. The cycle is completed when the needle 8' moves to a position between the cams at the feeding station 41 and those at the feeding station 43.

The tabs 184 are knitted by the needles 6, 6' knitting at their respective stations 42, 43. During the knitting of the said heel tabs, the needles 7 are idle but hold their stitches, the center cam 88 being withdrawn at that time.

Following the knitting of the split foot portion 183 and heel tabs 184, a portion of the ankle is knitted being constituted by split work 185, during the knitting of initial courses of which some long butt needles 4, 4' are picked down to join the needles 6, 6' respectively.

Following the knitting of the split ankle portion 185, split work is discontinued by withdrawing the cams 147, 147', Fig. 6. At the same time cams 92, 93 are withdrawn as a consequence of which all the needles in action knit at the feeding station 41 during reciprocations in both directions. The leg 186 of the stocking is fashioned, as indicated in Fig. 16, by picking down long butt needles 4, 4'. Finally the top or welt 187 is knitted by all the needles knitting, as just described, at the feeding station 41.

Subsequently to the knitting of the stocking, the tabs 184 are cut along the line 188 and are

then turned outwardly at right angles as illustrated in Fig. 17 and sewed at 189, Fig. 17.

The heel tabs are knitted on the medium long butt needles 6 and 6' at the feeding stations 42 and 43. At this time the needles 7 which are short butt needles pass idly through the main cam block as illustrated in Fig. 27, the center cam 88 being automatically withdrawn at this time. The heel tabs will thus be formed as separate tabs or loops of fabric as illustrated in Fig. 18 and the needles 7 will merely retain their loops, the instep fabric being temporarily discontinued while the said tabs are being knitted. As previously explained these tabs are cut along line 188 and are pulled out or turned at right angles as illustrated at Fig. 17. At the time the stocking is to be seamed up and completed the edges of the tabs 184 that are adjacent to the lines defining the suture in the split foot portion are the edges that are sewed at 189.

Whenever it becomes necessary to elevate the bracket 58, the same can be swung upon its pivot 60 upon releasing the spring actuated detents 72 from engagement with the recesses in the side faces of the bracket 58.

During the knitting of the split fabric the needle cylinder reciprocates through arcs of approximately 180 degrees more or less; and while knitting the leg of the stocking at one feeding station the needle cylinder rotates during each stroke of knitting through about one and one-third revolutions. To avoid possible double knitting upon the same needles due to the extent of the reciprocations of the needle cylinder, suitably controlled cams may be provided, an example of which is disclosed in the patent to Hilscher #1,831,773, November 10, 1931. However, the lengths of the reciprocating strokes of the needle cylinder depend somewhat upon the character of fabric to be knitted and may be varied at will and may be lessened by increasing the size of the needle cylinder.

The present invention in a broader aspect comprehends the knitting of a thread or yarn by several sets of needles, one such set, e. g., one hundred and ten long butt needles at each side of the machine while knitting one thread or yarn at one of the cam blocks during split-foot knitting being continuously in an inactive position; another set of needles, e. g., the remaining ten long butt needles being inactive during the knitting of some courses but active during the knitting of other courses; another set of needles, e. g., the medium long butt needles being active and knitting during a plurality of courses; another set of needles, e. g., the suture needles being alternately active (knitting) and inactive; and still another set of needles, e. g., the short butt needles, being inactive throughout the knitting of the said plurality of courses. Furthermore, still another aspect of the invention comprehends the knitting of a thread or yarn by several sets of needles, one such set, e. g., one hundred and twenty long butt needles on each side of the machine, being inactive during the knitting of a plurality of courses; another set of needles, e. g., the medium long butt needles, being inactive throughout the knitting of said plurality of courses; another set of needles, e. g., the suture needles being alternately active (knitting) and inactive throughout said plurality of courses; and still another set of needles, e. g., the short butt needles, being active (knitting) throughout the knitting of said plurality of courses.

Although the invention has been hereinbefore described as being applied to a knitting machine of the type wherein the needle cylinder rotates or reciprocates with respect to the needle actuating cams, it is to be understood that the invention is applicable to a machine of the type wherein the needle cylinder is stationary and the cams rotate or reciprocate with respect thereto. Furthermore, although the invention is disclosed by the drawings as being applied to a so-called circular machine, reciprocations of the needles or cams may occur along straight lines instead of along curved lines.

Preferably the leg and instep of the stocking are knitted with the same yarn, and likewise the portions of the split fabric knitted at the auxiliary feed stations are knitted with the same yarns throughout split work knitting, although in either case the several yarn levers at the three feed stations 41, 42 and 43 permit the leg and instep, or the split work portions to be knitted with two or more yarns independently or in plating relation if desired.

Obviously the number of needles knitting at the several feed stations during split-foot knitting or at other times may be varied, the number of needles included in the several sets of needles shown in Fig. 19 being there indicated by way of example only.

Although the yarn guides shown at the several feeding stations are automatically, independently movable to and from a position where they feed thread or yarn to all or some of the needles of the knitting machine.

This application is a continuation as to all common subject matter of application Ser. No. 187,066, filed April 27, 1927.

Although the invention has been described in specific terms, it is to be understood that the invention is not intended to be limited otherwise than as by the scope of the appended claims themselves.

We claim:

1. A full fashioned, circular, independent needle, knitting machine having three sets of knitting cams, each set having a yarn guide or yarn guides, and means for rendering the knitting cams of at least one set temporarily inactive, so that yarn will not be supplied to the needles at such set.

2. A full fashioned, circular, independent needle, knitting machine having three sets of knitting cams, each set having a yarn guide or yarn guides, and means for rendering two of said sets of knitting cams temporarily inactive, whereby yarn will not be supplied to the needles at said two sets of knitting cams.

3. A full fashioned, circular, independent needle, knitting machine having three sets of knitting cams, each set having a yarn guide or yarn guides, and needles arranged in at least two sets having contrasting formations, whereby the needles may be selectively operated according to their formations at predetermined cams.

4. A full fashioned, circular, independent needle, knitting machine having three sets of knitting cams, each set having a yarn guide or yarn guides, and needles arranged in three sets having contrasting lengths of butts, whereby the needles may be operated at predetermined sets of knitting cams according to the length of the said butts.

5. A full fashioned, circular, independent needle, knitting machine having three sets of knitting cams, each set having a yarn guide or yarn guides, means for rendering the two oppo-

site sets of knitting cams temporarily inactive, a substantially circular set of needles arranged in three groups having at least three different lengths of butts, whereby the needles may be operated at the sets of cams according to their length of butts.

6. A full fashioned, circular, independent needle, knitting machine having three sets of knitting cams, each set having a yarn guide or yarn guides, whereby a fabric may be knitted having a split work portion, which portion is formed from three yarns of which each edge yarn is interconnected to the central yarn by a suture seam, and means for independently varying the stitch length upon the fabric knitted from the central yarn and upon the fabric portion knitted from the two edge yarns.

7. A circular, independent needle, full fashioned knitting machine operated by reciprocating knitting throughout, and having means to drive the machine through longer reciprocations at one portion of its movement than at another.

8. A circular, independent needle, full fashioned knitting machine operated by reciprocating knitting throughout, and having means automatically to drive the machine through different lengths of reciprocations at different parts of its operation.

9. A full fashioned hosiery, independent needle, knitting machine having a needle cylinder mounted for rotative movement, means to reciprocate said needle cylinder throughout the entire formation of the stocking, means to drive the needle cylinder through relatively short reciprocations for the formation of the toe, the foot, the heel and the instep, and means to drive the needle cylinder through markedly longer reciprocations during the formation of the leg.

10. A full fashioned hosiery, independent needle, knitting machine having a needle cylinder mounted for rotative movement, means to reciprocate said needle cylinder throughout the entire formation of the stocking, means to drive the needle cylinder through reciprocations each of which is approximately one-third to one-half of a complete revolution in the knitting of the toe, the foot, the heel and the instep, and means to drive the needle cylinder through reciprocations each of which is substantialy one and a third or more times a complete revolution for the knitting of the leg portion of the stocking.

11. An independent needle, circular, full fashioned hosiery knitting machine having a rotative member and two quadrants for imparting oscillating movements to said member of markedly different lengths of throw, whereby in one portion of the knitted article the rotative member has a markedly shorter movement than during the formation of another part of the article.

12. An independent needle, circular, full fashioned hosiery knitting machine having a rotative member and two quadrants which are of different radii, gearing for connecting each quadrant to the rotative member, and clutch means whereby either gearing may be connected to said rotary member.

13. A full fashioned, independent needle, circular knitting machine having a rotative needle cylinder, a drive shaft, two quadrants which are of different radii, and connections from said quadrants respectively to the needle cylinder driving means.

14. A full fashioned, independent needle, circular knitting machine having a rotative needle cylinder, a drive shaft, two quadrants which are of different radii, and connections from said quadrants respectively to the needle cylinder driving means, a clutch whereby either of said quadrants may be rendered functionally active, and automatic means for controlling the action of said clutch.

15. In a full fashioned, circular, independent needle, knitting machine three sets of knitting cams and three sets of yarn guides, one at each of said cam sets, all of said yarn guides being co-axially mounted, and means for automatically throwing any of said yarn guides at any of said sets of knitting cams into or out of action.

16. A circular, independent needle, full fashioned knitting machine having three sets of knitting cams, three sets of yarn guides for the needles of said sets of knitting cams respectively, means whereby two of the sets of knitting cams may be rendered inactive and whereby all the desired needles may then be caused to knit, at the remaining set of knitting cams, the needles having contracting lengths of butts, so as to be actuated at the respective sets of knitting cams according to their lengths of butts.

17. A full fashioned, circular, independent needle, knitting machine adapted to be reciprocated for the production of split work having three sets of knitting cams, each set having a yarn guide or yarn guides, and means for rendering the knitting cams of at least one set temporarily inactive, so that yarn will not be supplied to the needles at such set.

18. A full fashioned, circular, independent needle, knitting machine adapted to be reciprocated for the production of split work having three sets of knitting cams, each set having a yarn guide or yarn guides, and means for rendering two of said sets of knitting cams temporarily inactive, whereby yarn will not be supplied to the needles at said two sets of knitting cams.

19. A full fashioned, circular, independent needle, knitting machine adapted to be reciprocated for the production of split work having three sets of knitting cams, each set having a yarn guide or yarn guides, and needles arranged in at least two sets having contrasting formations, whereby the needles may be selectively operated according to their formations at predetermined cams.

20. A full fashioned, circular, independent needle, knitting machine adapted to be reciprocated for the production of split work having three sets of knitting cams, each set having a yarn guide or yarn guides, and needles arranged in at least three sets having contrasting lengths of butts, whereby the needles may be operated at predetermined sets of knitting cams according to the length of the said butts.

21. A full fashioned, circular, independent needle, knitting machine adapted to be reciprocated for the production of split work having three sets of knitting cams, each set having a yarn guide or yarn guides, means for rendering the two opposite sets of knitting cams temporarily inactive, a substantially circular set of needles arranged in three groups having at least three different lengths of butts, whereby the needles may be operated at the sets of cams according to their length of butts.

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