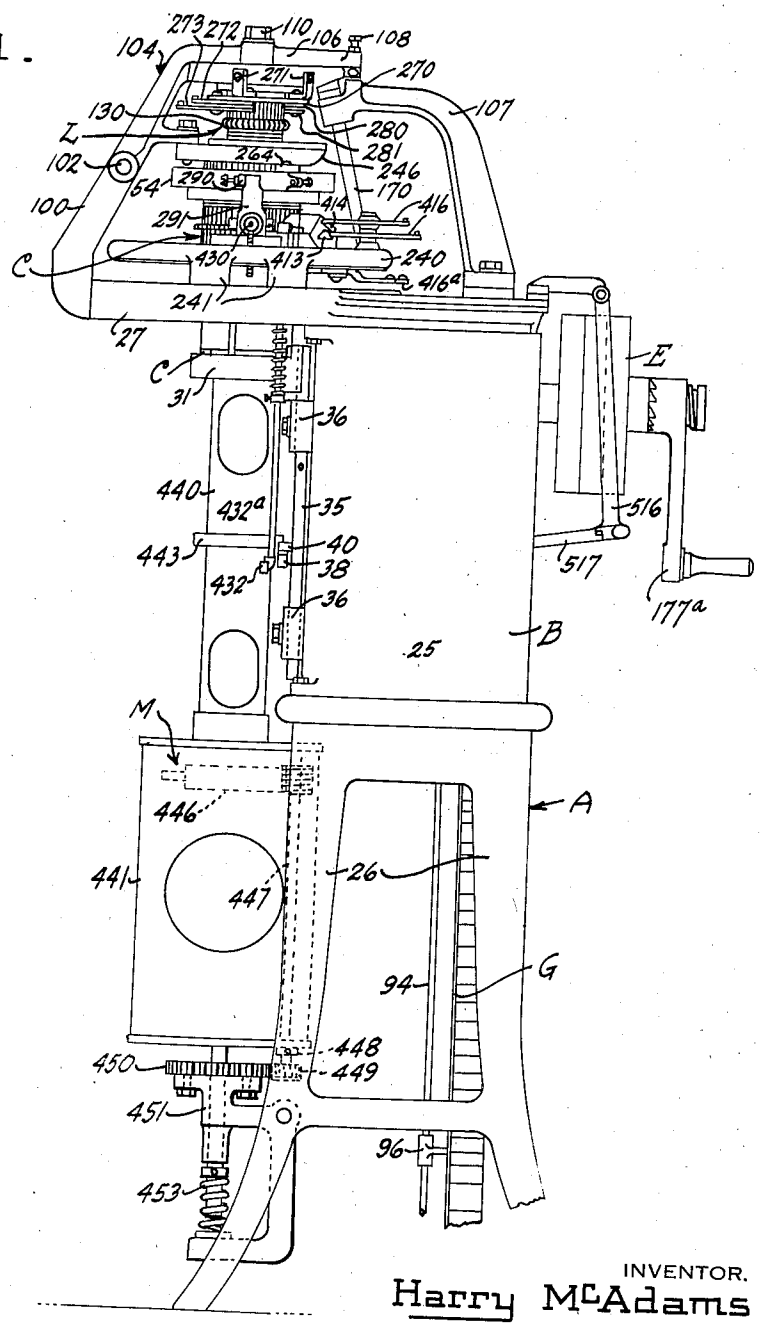
March 26, 1940. H. McADAMS 2,195,183

METHOD OF KNITTING SEAMLESS STOCKINGS AND THE LIKE IN STRINGWORK

Original Filed June 20, 1936 13 Sheets-Sheet 1

Fig. 1.



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METHOD OF KNITTING SEAMLESS STOCKINGS AND THE LIKE IN STRINGWORK

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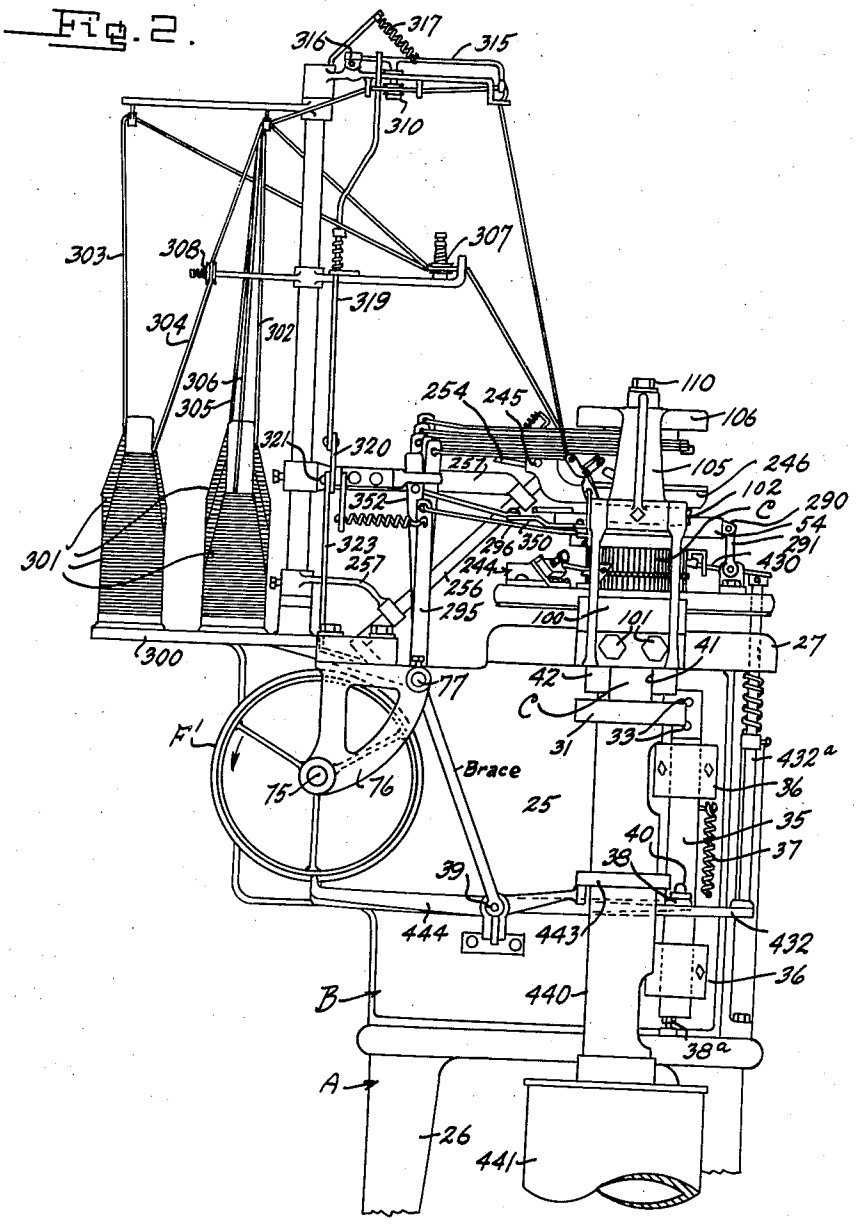
Fig. 2.



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METHOD OF KNITTING SEAMLESS STOCKINGS AND THE LIKE IN STRINGWORK

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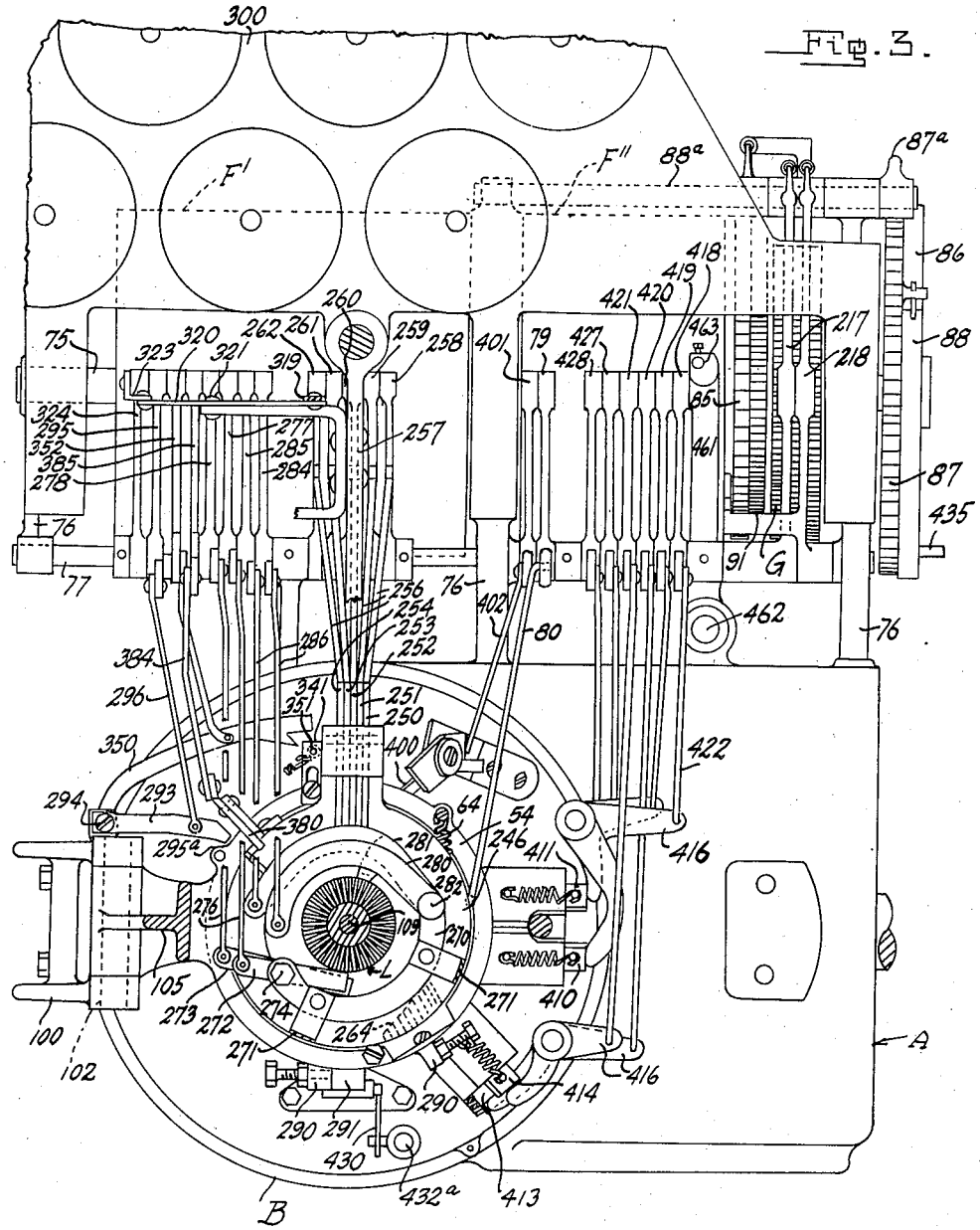
Fig. 3.



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METHOD OF KNITTING SEAMLESS STOCKINGS AND THE LIKE IN STRINGWORK

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Fig. 4.

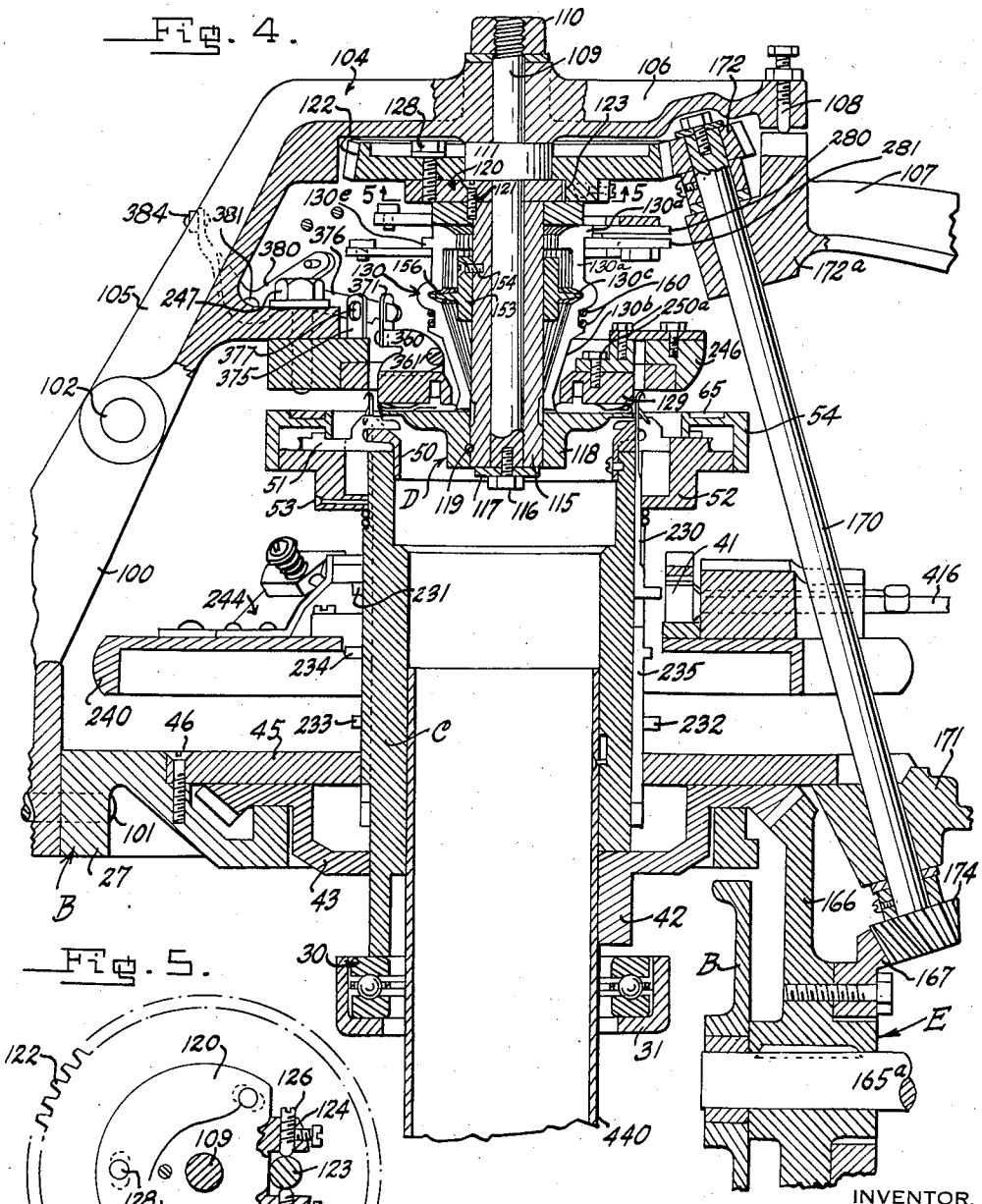

Fig. 5.

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Fig. 6.

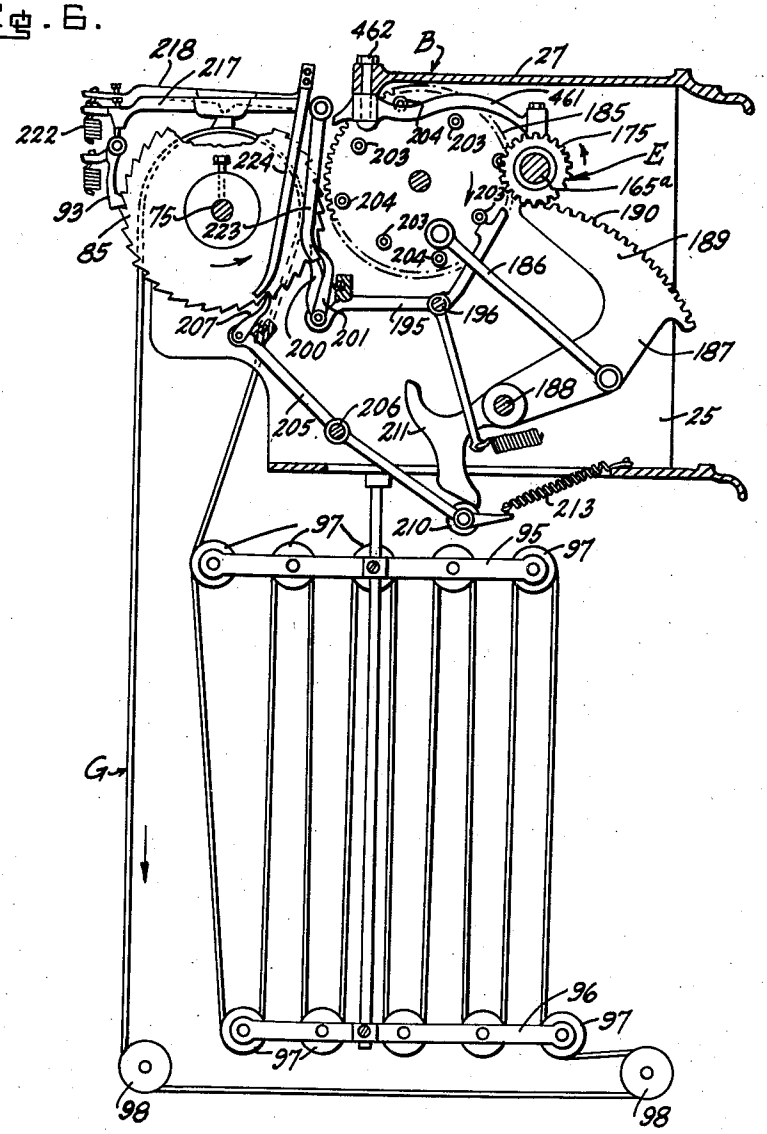

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Fig. 7.

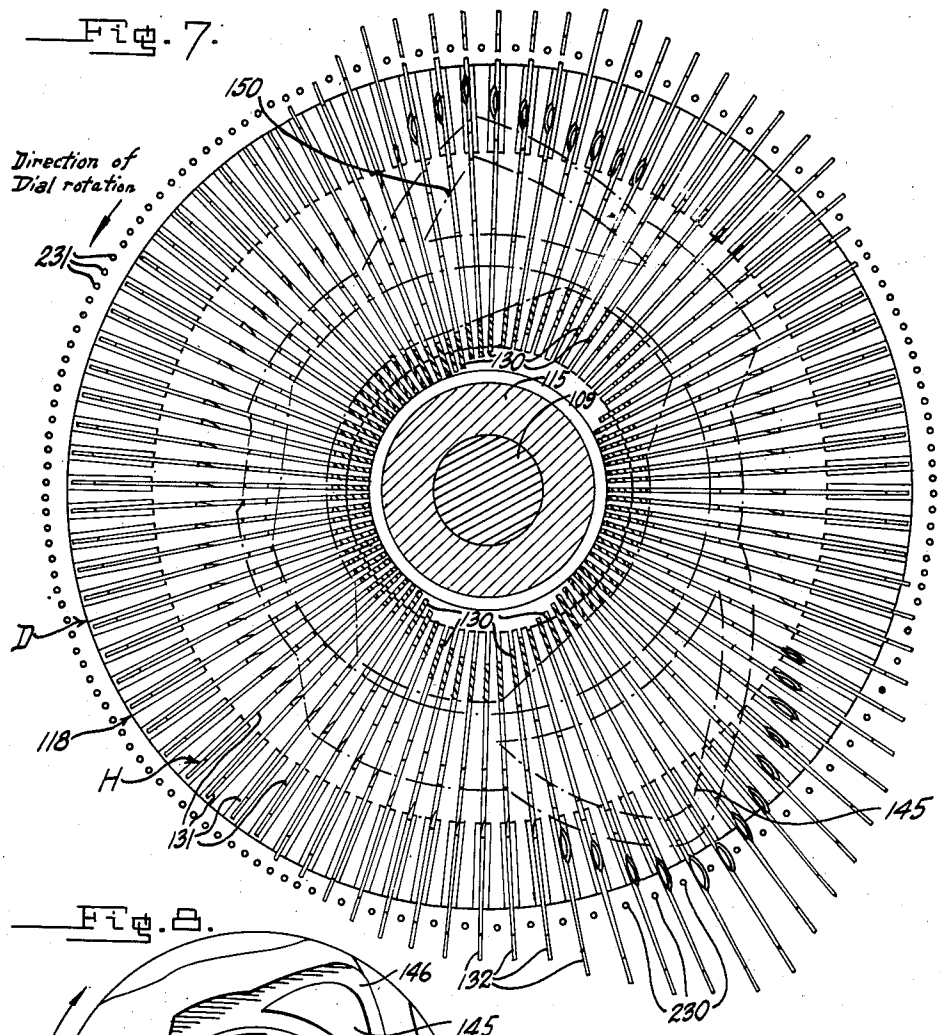
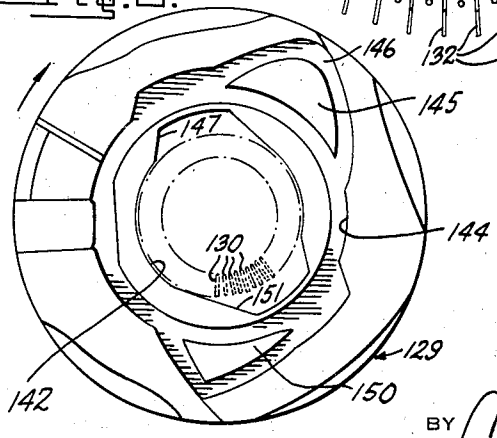


Fig. 8.



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METHOD OF KNITTING SEAMLESS STOCKINGS AND THE LIKE IN STRINGWORK

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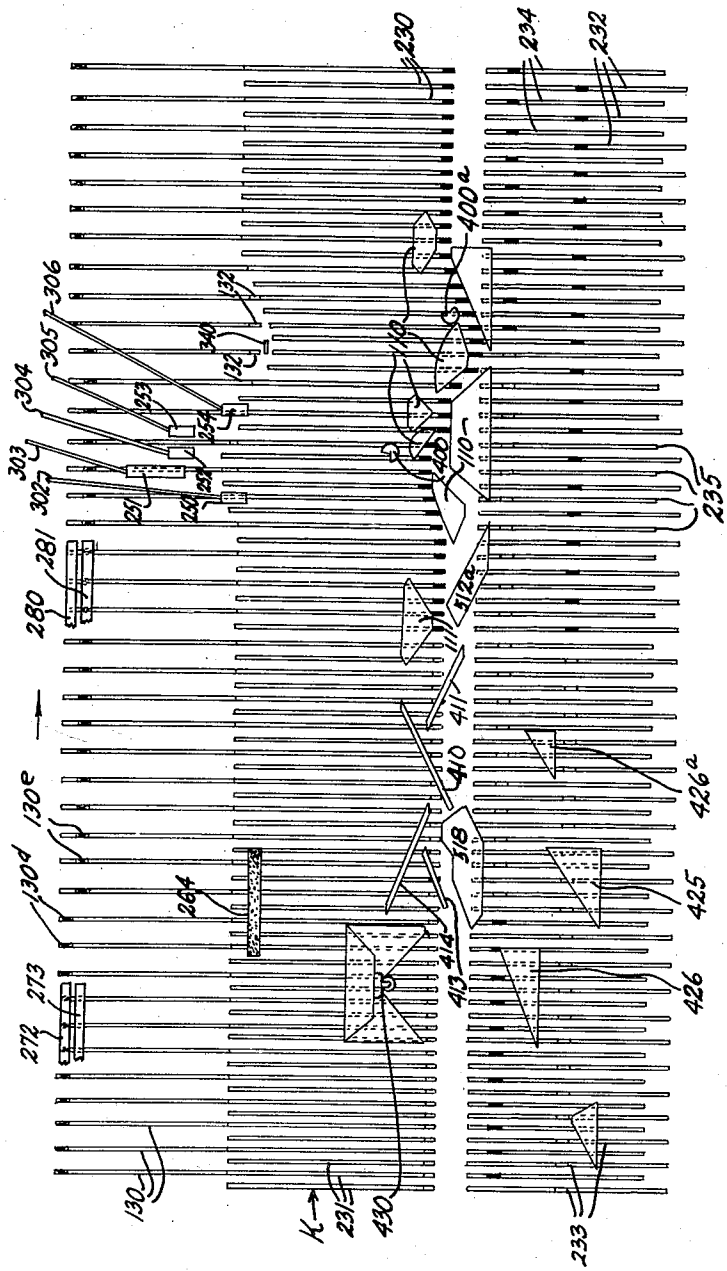

Fig. 5.

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METHOD OF KNITTING SEAMLESS STOCKINGS AND THE LIKE IN STRINGWORK

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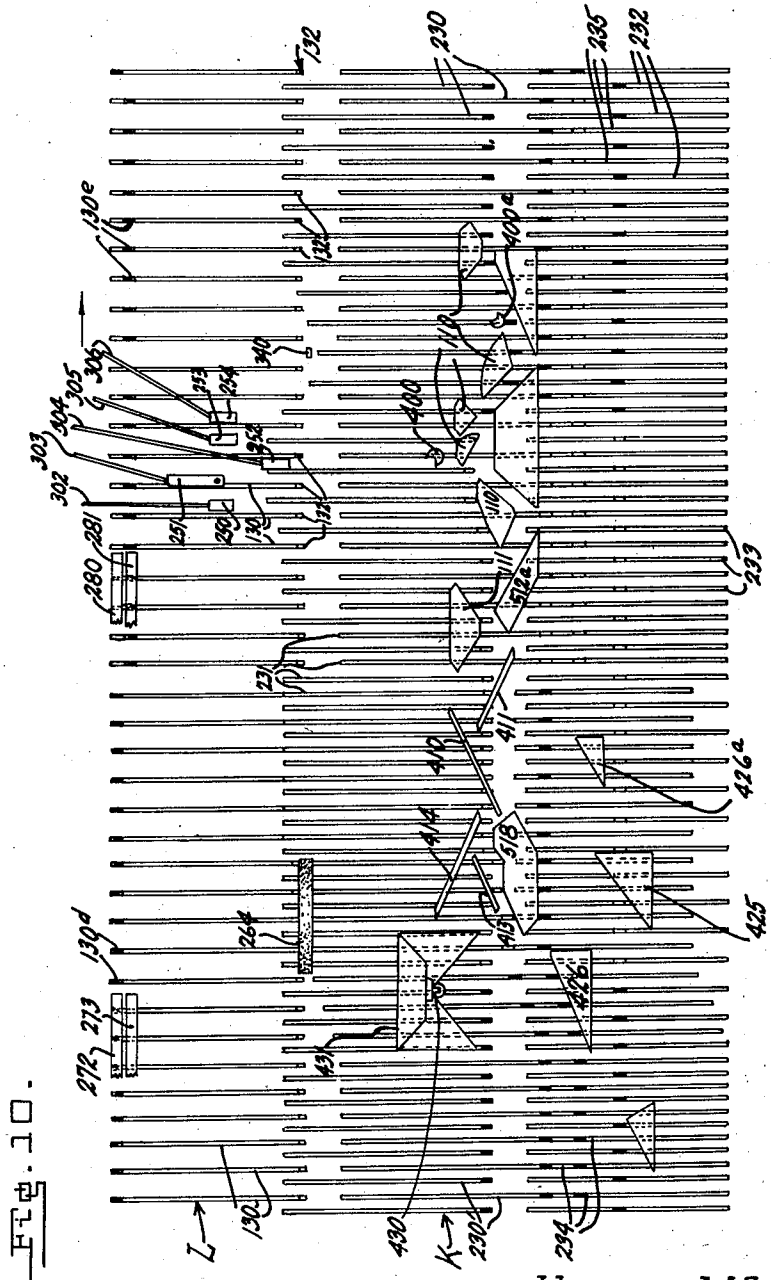

Fig. 10.

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METHOD OF KNITTING SEAMLESS STOCKINGS AND THE LIKE IN STRINGWORK

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Fig. 11.

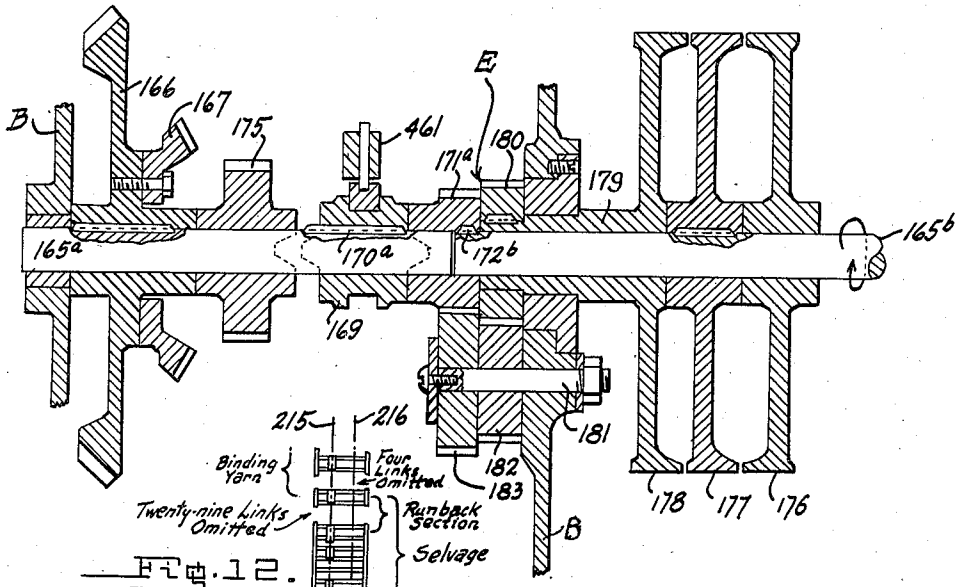


Fig. 12.

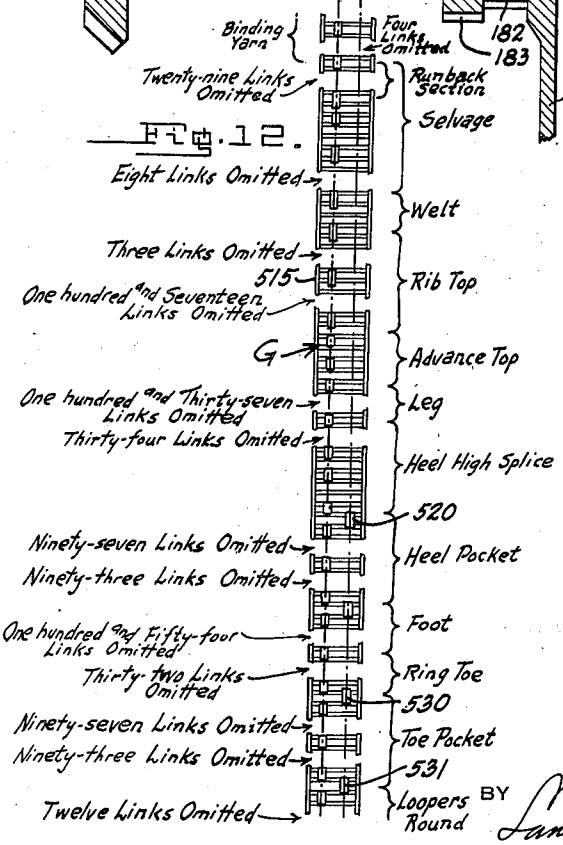
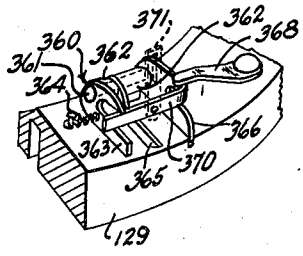


Fig. 23.



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METHOD OF KNITTING SEAMLESS STOCKINGS AND THE LIKE IN STRINGWORK

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Fig. 13.

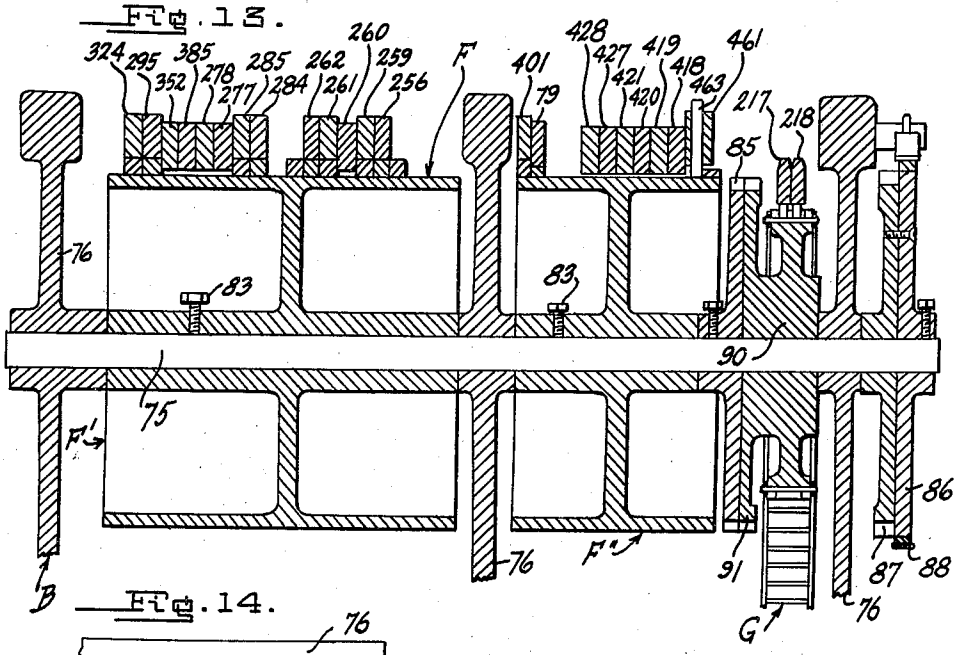
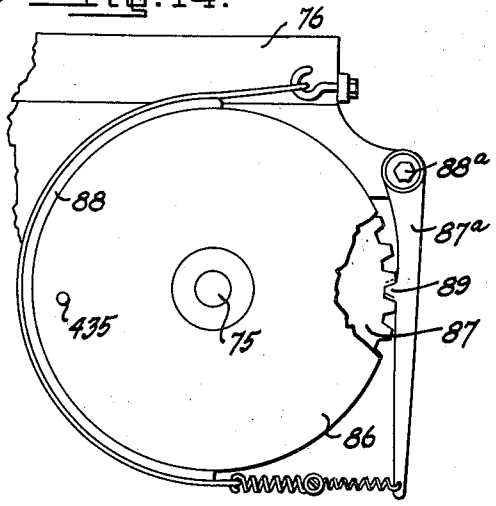


Fig. 14.



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METHOD OF KNITTING SEAMLESS STOCKINGS AND THE LIKE IN STRINGWORK

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Fig. 15.

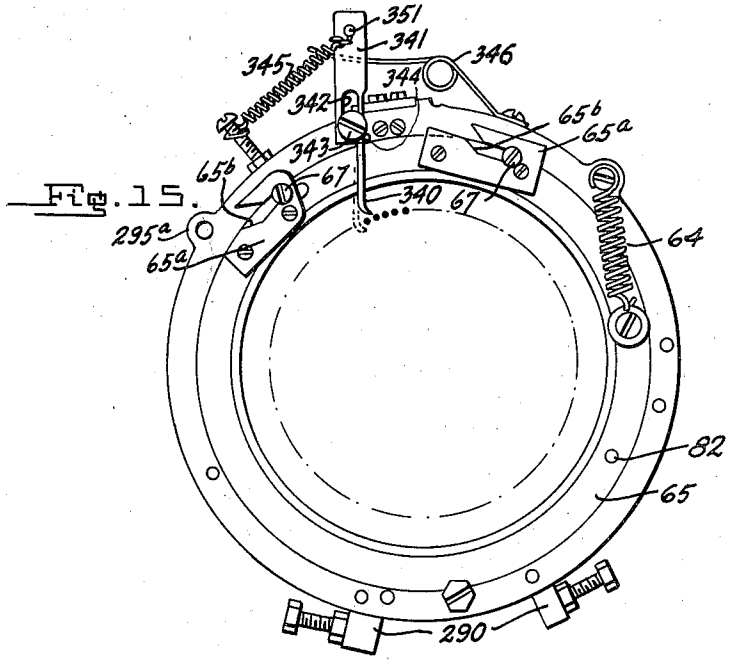
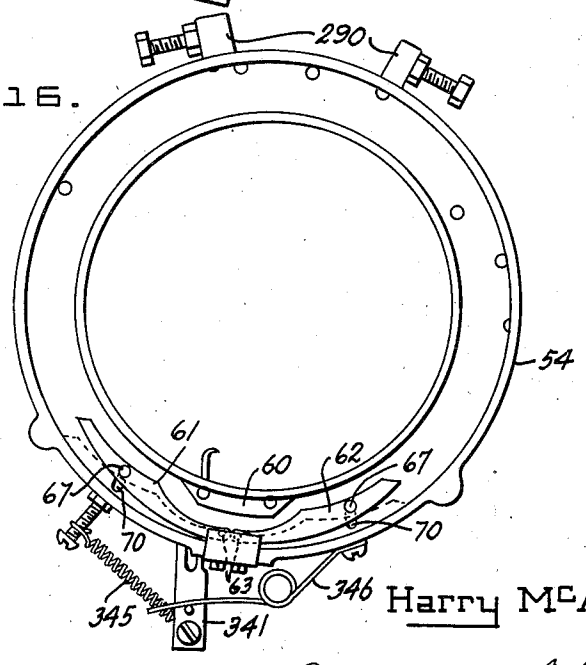


Fig. 16.



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METHOD OF KNITTING SEAMLESS STOCKINGS AND THE LIKE IN STRINGWORK

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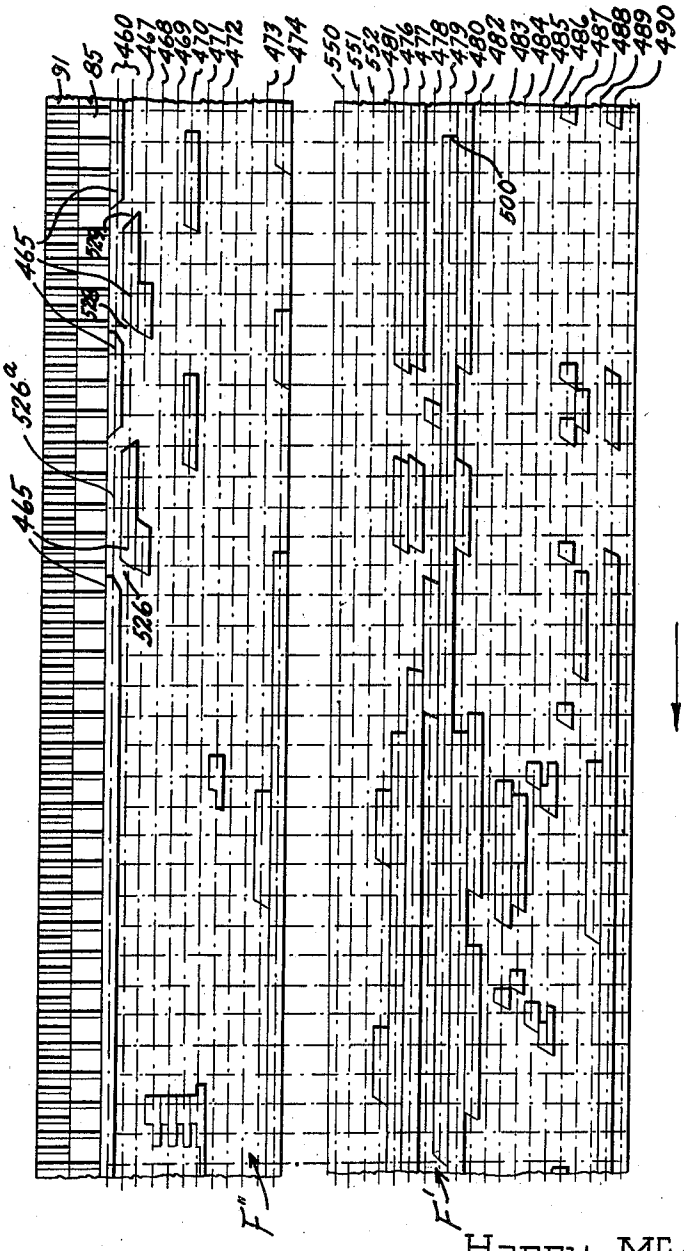

Fig. 17.

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METHOD OF KNITTING SEAMLESS STOCKINGS AND THE LIKE IN STRINGWORK

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Fig. 19.

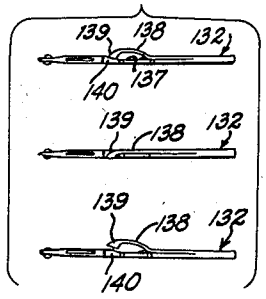


Fig. 20.

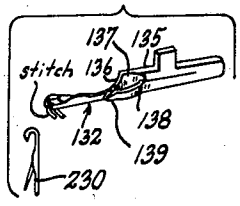


Fig. 18.

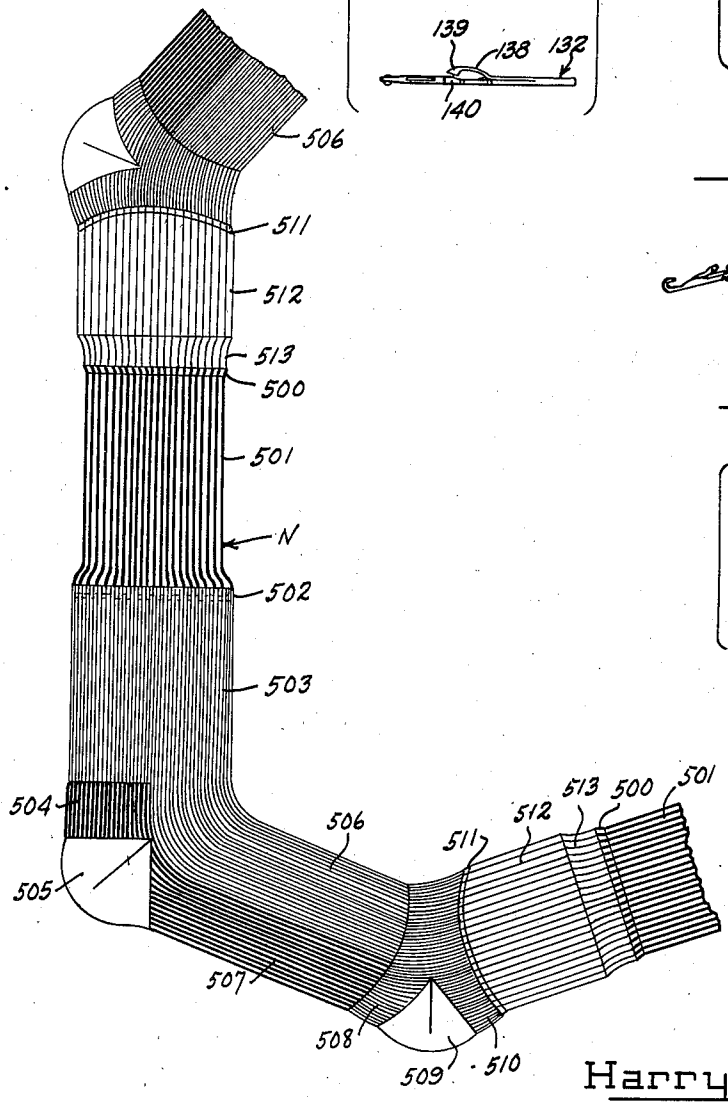


Fig. 21.

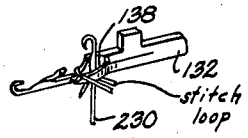
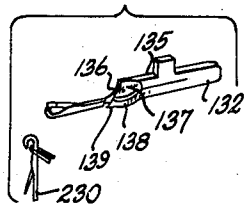


Fig. 22.



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Patented Mar. 26, 1940 2,195,183

UNITED STATES PATENT OFFICE

2,195,183

METHOD OF KNITTING SEAMLESS STOCKINGS AND THE LIKE IN STRINGWORK

Harry McAdams, Reading, Pa., assignor to The Nolde and Horst Company, Reading, Pa., a corporation

Original application June 20, 1936, Serial No. 86,420. Divided and this application December 9, 1937, Serial No. 178,996

2 Claims. (Cl. 66—1)

This invention relates to improvements in methods of knitting stockings in stringwork.

The present application is a division of my U. S. application Serial No. 86,420, filed June 20, 1936.

Other objects and advantages of this invention will be apparent during the course of the following detailed description.

In the accompanying drawings, forming a part of this specification, and wherein similar reference characters designate corresponding parts throughout the several views:

Figure 1 is a front elevation of the improved knitting machine.

Figure 2 is a side elevation of the improved knitting machine.

Figure 3 is a plan view of the improved knitting machine with a portion of the overhead structure above the dial of the knitting machine removed to better illustrate the means for controlling various cams of the knitting machine.

Figure 4 is a fragmentary vertical sectional view taken through the cylinder and dial construction of the knitting machine; showing the drive of the latter and the improved selective dial needle control arrangement.

Figure 5 is a sectional view taken substantially on the line 5—5 of Figure 4.

Figure 6 is a vertical sectional view taken through the drive and operating mechanism of the machine below the table top or bed of the machine; more particularly showing the means for driving the pattern chain and the pattern drum advancing pawls.

Figure 7 is a plan view of the needle lay-out in the bed of the dial of the machine, showing the dial needles projected at one position for rib knitting, and projected at another position for transfer of stitches therefrom to cylinder needles.

Figure 8 is a bottom plan view of the cam and cam groove arrangement in the dial cap.

Figure 9 is a developed view showing the cylinder needle, jack, and dial needle control finger lay-out of the knitting machine, as the parts will appear during the knitting of plain knitted work upon the machine.

Figure 10 is a developed view showing the cylinder needle, jack, and dial needle control finger lay-out of the knitting machine, as the parts will appear during the last part of the knitting of one and one rib and the first part of the transfer action of transferring stitch loops from dial needles to those alternate cylinder needles which are inactive during the knitting of rib work.

Figure 11 is a longitudinal cross sectional view taken through the main drive shaft of the knitting machine and more particularly showing the gearing arrangement for the different speeds of the machine and for oscillating or reciprocating drive of the cylinder.

Figure 12 is a diagrammatic fragmentary representation of the pattern control chain of the machine.

Figure 13 is a longitudinal cross sectional view taken through the main pattern drum; its shaft and the main pattern chain sprocket wheel.

Figure 14 is a fragmentary view showing a brake drum arrangement on the main pattern drum mounting shaft.

Figure 15 is a top plan view of my improved sinker cam cap for the machine, showing associated therewith an improved splice yarn control member which is used during rotary knitting to guide the splice yarn out of the way of the dial and dial needles.

Figure 16 is a bottom plan view of the sinker cam cap and more particularly showing improved means for rendering the sinker cams operative or inoperative.

Figure 17 is a developed view of the main pattern control drum and ratchet wheel drive arrangement.

Figure 18 is a fragmentary view of several stockings which may be knitted in stringwork upon the machine; the view showing one complete stocking and appended portions of other stockings at each end thereof, and also showing the nature of the various parts of the stocking and the joining means between the stockings.

Figure 19 is a series of views showing the bottom of the improved dial needle used with my machine; this dial needle being of the type set forth in my copending application Serial No. 68,526, filed March 12, 1936.

Figures 20, 21 and 22 are perspective views showing various steps in the cycle of transferring a stitch loop from a dial needle to a cylinder needle on the improved machine.

Figure 23 is a fragmentary perspective view showing an improved binder and cutter which may be mounted upon the dial of the knitting machine.

In the drawings, wherein for the purpose of illustration are shown preferred and modified embodiments of the improved knitting machine and the details thereof, the letter A may generally designate the improved knitting machine.

It includes a frame B having a rotary cylinder C and a dial D. Drive means E is provided for driving the cylinder C and bed of the dial D, and for operating a pattern control drum arrangement F and a pattern chain G. A set H of dial needles is provided and also a set K of cylinder needles. Selective means L is provided for operating the dial needles for various purposes, and a take-up mechanism M is provided for taking up the string of tubular fabric N as it is knitted.

The frame B of the machine includes a cabinet portion 25 within which the drive mechanism of the machine is mounted. The frame is supported upon suitable legs 26 or in other manner and it has a top table 27 which supports the cylinder for vertical movement.

The cylinder C is longitudinally slotted on the outer surface thereof for reciprocably receiving needles and jacks therein; the needles being mounted in the upper part of the cylinder and the jacks in the slots below the needles in the usual manner. An anti-friction bearing construction 30, shown in Figure 4 of the drawings, has a race directly supporting the lower end of the cylinder C; this anti-friction bearing 30 being supported in a ring-shaped cup 31. The cup 31 is suitably bolted or riveted as shown at 33 in Figure 2 of the drawings to the upper end of a vertically movable supporting bar 35. The bar rod 35 is slidably supported in suitable brackets 36 provided upon the frame of the machine. A spring 37, shown in Figure 2 of the drawings, normally holds the bar 35 downwardly, and at its lower end it may rest upon an adjusting screw 38a as shown in Figure 2. This cylinder supporting bar 35 may be elevated by means of a lever 38 which is pivoted at 39 on a frame bracket of the machine, as shown in Figure 2 of the drawings. The lever 38 is operated off of the section F' of the pattern control arrangement F, and at its other end the lever 38 may engage a pin 40 which is integral with the bar 35. A lug on the drum F' will depress the lever 38 at its drum end and thus elevate the cylinder in a manner which is apparent from the drawings.

The cylinder C at its lower end is upwardly slotted, as shown at 41 in Figure 2 of the drawings to receive therein sectors 42 of the ring gear 43 in which the cylinder C is movably mounted, as shown in Figure 4 of the drawings. The gear 43 is socketed in the supporting bed 27 of the frame B, as shown in Figure 4. A cap plate 45 is secured at 46 to the bed 27 for the purpose of maintaining the ring gear 43 rotatably in place. The gear 43 is of the bevel herring-bone type.

The top construction of the cylinder is rather conventional. It includes a top ring 50, for slidably supporting the sinkers 51. The sinker control arrangement further includes the sinker or web holding bed 52 which is keyed at 53 to the cylinder. The sinker cam ring 54 is mounted on the bed and of course is provided with movement limiting lugs 290 thereon, best shown in Figures 15 and 16 of the drawings, located at opposite sides of a stop post 291 (see Figure 1), as is usual in circular knitting machines of this general type. The sinkers 51 are of general construction and need not be further described, since their nature, function and construction is well understood in the art to which this invention relates. Reference in this connection may be made to U. S. patent #1,467,691. The sinker cam ring 54 has an annular channel in the undersurface thereof, in which the butts of the sinkers ride. In this channel the sinker cam ring 54 is provided with a sinker withdrawing cam 60 and sinker advancing cams 61 and 62. The advancing cams 61 and 62 are pivoted at their proximate ends at 63 and are adapted to be retracted at different operations throughout the knitting of the stocking. Means is provided to move the advancing cams 61 and 62 comprising a circumferentially movable ring 65 socketed in an annular channel in the top of the cam ring 54, as is shown in Figures 4 and 15 of the drawings. This ring 65 is provided with cams 65a, slotted to receive pins 67 of the cams 61 and 62 and having throw portions 65b to move the cams 61 and 62 to a retracted position. Cams 61 and 62 are advanced and retracted as the ring 65 is reciprocably moved in its channel on the sinker cam ring 54. A spring 64 normally maintains the cams 61 and 62 in sinker advancing position.

Referring now to the pattern control drum arrangement F, with reference to Figures 2, 3, and 13 of the drawings it will be seen that this drum arrangement is compactly located at the rear of the machine in an easily accessible and convenient location. It essentially consists of a shaft 75 rotatably supported and connected by brackets 76 to the frame of the machine; one of the brackets 76 being located intermediate the ends of the shaft 75 to give it central support. The drum arrangement includes the drum F' and the drum F'' and on these drums a circumferential series of lugs are provided for operating the various levers and parts of the machine. A compact and accessible arrangement of levers includes a shaft 77 which is pivotally supported by the brackets 76 of the machine; said shaft extending parallel with the drum and at a location between the drums and the cylinder, and on a level approximately in a line tangent to the top of the drums. On this shaft 77 are located bell crank levers which are pivoted for oscillative action thereon; the said bell crank levers having arm portions which operate at their ends on lugs on the drum, the opposite ends of said levers extending substantially vertical and having rod attachments with the different features of the machine to be operated. With reference to the sinker cam control ring 65 immediately above described, one of the levers 79 of the shaft 77 has the upper end of its vertical arm supporting a connecting rod 80; the opposite end of said connecting rod 80 being attached in a suitable opening 82 provided in the ring 65 (see Figures 3 and 15). Rocking of the lever 79 incident to operation of the drum F'' will cause movement of the ring 65 and throw the cams 61 and 62 into retracted position (see dotted lines in Figure 16).

The drums F' and F'' are keyed at 83 to the shaft 75, and the shaft 75 has also keyed therewith a ratchet wheel 85. To insure uniformity of movement advance of the shaft 75 at one side of the machine beyond the support 76 the shaft 75 is provided with a brake drum 86 and toothed detent wheel 87. A spring actuated pawl 87a is pivoted at 88a on the frame of the machine (see Figure 14). A tooth 89 is located in the recesses between the teeth on the wheel 87 to restrain too free advance of the shaft 87 except as hereinafter noted. A brake band 88 acts continuously on the drum 86 to prevent loose play in the shaft 75 and thus prevents the forward or backward movement of either of the

drums F' or F'' except as advanced by pawl mechanism to be hereinafter described. The shaft 75 is provided with a freely rotatable sprocket wheel 90 thereon around which the pattern chain G is trained. This sprocket wheel 90 has a suitable ratchet wheel 91 keyed or integrally connected as a part thereof, operating therewith, and located side by side with the shaft keyed ratchet 85 above described, as shown in Figure 13 of the drawings. The drum advancing ratchet wheel 85 has thirty-six teeth around the periphery thereof and the ratchet wheel 91 attached to the sprocket wheel 90 is provided with seventy-two teeth. In order to prevent loose advancing or retracting movement of these two sprocket wheels a detent 93 is provided on the machine (see Figure 6) which is broad enough to operate in the teeth recesses of both of these ratchet wheels 85 and 91 to maintain them in their proper relationship.

The pattern chain G is of course trained over the teeth on the sprocket wheel 90. This chain is relatively long since it is intended to provide in it one link for each knitted course throughout the length of the stocking or article being knitted. In order to accommodate the chain a special frame is provided consisting of a supporting standard 94, as shown in Figure 6 of the drawings, connected in depending relation from the machine frame, and having upper and lower support bars 95 and 96 respectively. These support bars each have a series of rotatable wheels or rollers 97 thereon around which the chain G is trained. The frame of the machine may additionally be provided with rollers 98 around which the chain G is trained as it comes direct from the sprocket wheel 90 prior to the zig-zag training of the chain over the rollers on the upper and lower support bars 95 and 96. As will be noted from Figure 1 of the drawings this chain is located in an out of the way relation at the rear of and beneath the frame of the machine, below the drive mechanism control box or compartment in the machine, as shown in Figure 1.

Referring to the dial construction D and the selective means L for operating the dial needles thereof, a very compact bracket or yoke construction is provided for supporting the dial mechanism over the cylinder in such manner that all of the parts of the same are readily accessible and so that the dial may be moved to an out of the way position with respect to the cylinder. This bracket or supporting yoke construction for the dial is generally of inverted U-shape formation. It includes a stationary bracket 100, at the left side of the machine, bolted at 101 to the machine bed 27 and extending upward diagonally towards the cylinder to a point about even with the top of the cylinder, where it pivotally supports at 102 a dial supporting arm 104. This arm includes a portion 105 which really forms an extension of the bracket arm 100 and is inclined diagonally towards the cylinder when the dial is placed over the cylinder. It further includes the horizontal supporting portion 106 which lies horizontally over the cylinder, as shown in Figure 4. The yoke construction for supporting the dial further includes the bracket arm 107 mounted on the bed of the machine at the opposite side from the bracket 100, as shown in Figure 1 of the drawings, and which extends diagonally upward inclined towards the cylinder and at its upper end is adapted to receive the free end of the dial supporting arm 104 in resting relation thereon; an adjusting screw 108 being provided on the end of the arm 104, for abutment with the upper end of the arm 107, to regulate the spacing of the dial above the cylinder when in knitting position.

The horizontal portion 106 of the dial bracket swinging arm 104 is provided with a non-rotatable depending shaft 109, shown in Figure 4 of the drawings, and which is bolted thereto at 110; an annular stop flange 111 being provided thereon to abut the under surface of the arm 106 and enable the shaft to be properly bolted into position. A rotatable sleeve 115 is mounted on the lower end of the shaft 109 in position to be axially aligned with the cylinder C when the swinging arm 104 is in the position shown in Figure 4 of the drawings. This rotatable sleeve 115 is maintained detachably on the shaft 109 at the lower end of the latter by means of a nut 116 and supporting washer 117, and it is on the lower end of this sleeve 115 that the dial bed 118 of the dial construction D is keyed, as by a detachable pin 119. The sleeve 115 at its upper end has a gear adjusting plate 120, keyed thereto at 121, as shown in Figure 4. A gear 122 is rotatably located in a recess or socket provided in the bottom surface of the swinging arm 104; said gear being centrally apertured to receive the flange 111 of the sleeve 115 as shown in Figure 4. This gear is adjustably keyed or attached to the adjusting plate 120 and of course the drive of the machine driving the gear 122 will thus drive the sleeve 115 and rotate the dial bed 118 therewith in synchronism with the cylinder C as will be subsequently described. The timed adjustment of the gear teeth relative to the drive shaft 115 is angularly secured by providing a depending lug 123 on the gear 122, as shown in Figure 5 of the drawings, which depends between two extensions 124 and 125 on the adjusting plate 120; adjusting screws 126 being provided on the plate extensions 124 and 125, in order to angularly adjust the gear 122 relative to the rotatable sleeve 115. In order to insure attachment of the gear to the plate 120 when the proper timing has been obtained bolts 128 may be tightened. These bolts 128 are screw threaded in sockets in the plate 120, as shown in Figure 5, and the gear 122 is provided with slots to receive the shanks thereof.

The dial construction includes the bed 118 and the stationary dial cap 129. This dial cap is in the form of a ring so that the lower ends of the dial needle actuating fingers 130 (comprising part of the selective means L for operating the dial needles) may engage the said dial needles either at the rear ends thereof or on special butt arrangements which may be provided on the dial needles in order to move them for accomplishing various operations.

Referring now to the dial bed construction 118, as is shown in Figure 7 of the drawings, the same is provided with slots 131 which reciprocably receive the needles 132 of the set H of dial needles.

The dial needles 132 are of the nature and construction set forth in my co-pending application Serial No. 68,526, filed March 12, 1936. They each include a body portion 135 having a shoulder 136 intermediate its ends behind the points where the latch closes. The needle has the usual hook end latch. Immediately rearwardly of the shoulder the body 135 is laterally recessed upwardly from the lower edge thereof, at 137. Facing this recess is a spring arm 138 which at its fore end is free of direct attachment to the needle and is provided with a lip 139

adapted to fit in the recessed portion 140 in the lower edge of the needle. The arm 138 is spring bowed as shown in the upper corner in Figure 19 of the drawings and faces the concaved recess 137 in the body of the needle to provide an eye which is vertically disposed when the dial needle is positioned in the dial bed. The head of the cylinder needle may readily slip into this opening notwithstanding that the cylinder needle is directly opposite the line of travel of the dial needle. The lip 139 prevents the stitch catching in the eye. The arm 138 compresses into the position shown in the middle view of Figure 19 when the dial needle is retracted in the groove of the dial bed. Upon projection of the needle the stitch catches against the shoulder 136 and is spread open by the arm 138 so that the cylinder needle may readily enter it as shown in Figure 21. The dial bed 118 has the grooves 131 widened at the fore ends thereof.

The dial cap 129 is best shown in Figures 4 and 8 of the drawings, and the dot and dash line application of the cams and cam grooves thereof with respect to the dial needles is shown in Figure 7. The dial cap has a central opening 142 to receive the lower ends of the dial actuating fingers 130. The dial needles are initially projected by the fingers 130 both for transferring stitches from dial needles to cylinder needles and at a second location to receive yarns when they are used in connection with the cylinder needles for knitting rib work. The dial cap 129 is provided with the dial needle butt receiving groove 144 which receives the dial needles when they are inactively positioned. The dial needles are projected into stitch transfer position by a cam 145, comprising part of the dial cap, when the butts of the needles 12 are thrown into the groove 146 surrounding this cam. Normally, the butts of the dial needles travel inactively in the groove 144. The dial needles are projected so that their butts will engage the cam 145 by the dial needle selector fingers 130. The opening 142 in the cap is widened at 147 to enable the lower ends of the fingers 130 to push the dial needles so their butts will engage against the cam 145, as shown in Figure 9 of the drawings. In the dial cap a second cam 150 is used to project the dial needles into yarn receiving relation for knitting rib work. The central opening 142 of the dial is cut away at 151 so as to enable the fingers 130 to project the butts of the dial needles into engagement with the cam 150.

The compact arrangement for mounting the dial needle selector fingers 130 comprises a supporting collar or member 153 keyed at 154 on the sleeve 115 intermediate the ends of the latter. This support 153 has an annular fulcrum flange 156 thereon for the fingers or members 130. These members 130 are provided with upper and lower portions 130a and 130b above and below the fulcrum point respectively which are disposed in an angular relation with respect to each other. When the fingers are mounted on the fulcrum flange 156 the upper portions 130a will be vertically positioned, and the lower portions 130b will be relatively convergent towards the axis of the shaft. The fingers 130 are bowed to provide fulcrum recesses 130c on the inner sides thereof which fit upon the fulcrum flange 156. In this manner the dial needle control members are arranged in close fitting annular relation and the lower ends thereof are normally positioned in the central opening of the dial cap. The lower ends are held in abutment with the sleeve 115 by means of compression springs 160 shown in Figure 4 of the drawings. In order to prevent lateral play of the fingers or members 130 suitable filler pieces may be placed betwen them. These filler pieces will of course be substantially the same shape as the members 130 except that they are not provided with butts or means for operating against the dial needles. The lower dial needle engaging ends of the members 130 may be shaped in any fashion suitable to the mode of operating against the dial needles. At their upper ends the fingers 130 may be provided with any desired arrangement of butts thereon. In the example shown in the drawings substantially one half of the members 130 are provided with butts 130d at an upper level and the remainder of the said dial needle control members 130 have butts 130e at a lower level. The upper level butts 130d are arranged, as shown in Figure 9, over substantially one half of the short butt cylinder needle section and substantially one half of the long butt cylinder needle section.

In the present invention the dial needle selector members 130 are adapted to project the dial needles merely at the stitch transfer and yarn receiving points. It is quite evident that the projection of the dial needles may be used for other purposes than herein enumerated. For instance, they could be selectively projected to take any desired arrangement of the yarns, such as patterning and wrapping yarns, etc.

Referring to the means E for driving the dial and cylinder, the drive shaft of the drive mechanism includes sections 165a and 165b, and a main drive shaft. They are not keyed together except through the intermediary of clutch mechanism to me subsequently described. The section 165a has a herring-bone bevel gear 166 which meshes with the cylinder gear 43 for drive of the said cylinder. The section 165a also has keyed therewith a smaller bevel herring-bone gear 167 which may be bolted directly to the gear 166. The beveled teeth on this gear 167 face directly opposite the bevel of the teeth on the gear 166 and are adapted to drive the diagonally disposed shaft 170. The shaft 170 is mounted in a suitable bearing 171 on the bed frame of the machine, and in a bearing 172a at the upper end of the dial supporting yoke arm or bracket 107. The upper end of the arm 170 is provided with a herring-bone bevel gear 172, which meshes with the teeth of the gear 122, and drives the latter. The lower end of the shaft 170 within the compartment of the cabinet of the machine below the bed is provided with a herring-bone gear 174 meshing with the teeth of the gear 167. These gears and parts are compactly associated and it is to be particularly noted that the arrangement eliminates the necessity of a horizontal counter shaft. The elimination of all gearing except direct connection between the drive shaft of the machine and the dial does away with unnecesasry back slap and loose play in the gears, so that it is possible to accurately regulate the relation of the dial needles to cylinder needles, and to effect the various delicate operating positions of the parts which are vitally necessary during the knitting of continuous strings of stockings of the character set forth in this application.

A clutch hub 169 is splined at 170a upon shaft section 165a, and adapted for selective clutching with either a spur gear 171a which is keyed directly to the shaft section 165b at 172b, or with the gear 175. A pulley 176 idles on the shaft section 165b, and said shaft 165b may also have

a hand crank thereon best shown at 177a, and used in the usual manner. The shaft section 165b has a second pulley 177 directly keyed to the shaft 165b. The third pulley 178 is rotatably mounted on the shaft section 165b by a sleeve section 179 integral therewith which bears in a wall of the frame B of the machine, as shown in Figure 11. This sleeve 179 at the inside of the drive gear cabinet of the frame has a spur gear 180 keyed directly therewith. A countershaft 181 is rotatably mounted on the wall of the frame B and it has thereon a pair of freely rotatable gears 182 and 183; the latter meshing with the teeth of the spur gear 171a. The gears 171a, 180, 182 and 183 comprise a compound high speed means for driving the shaft section 165a at a high speed. The direct drive of course rotates the cylinder at a lower speed. Meshing with and directly back of the gear 180 is a larger gear 185 (see Figure 6) which has a crank pitman 186 eccentrically pivoted thereto. A pivoting gear lever 187 is mounted intermediate its ends upon a shaft 188 below the main drive shaft assembly. It has a segment shaped end 189 provided with gear teeth 190 which mesh with the teeth of the gear 175. The latter is loosely mounted upon the shaft 165a. The lever 187 is reciprocated when the gear 185 is rotated, and thus oscillatively moves the gear 175. When the clutch hub 169 is in engagement with the gear 175 it can readily be seen that the cylinder will be reciprocated for knitting the heel and toe pockets.

Referring to the means for advancing the drum assemblage F, and to rotate the sprocket 90 in order to advance the main pattern chain G, a bell crank lever 195 is pivoted at 196 and operates off of roller lugs on the gear 185. These lugs hit the lever 195 at one end to throw pawls 200 and 201 which are on the other end thereof into respective advancing engagement with the teeth of ratchet wheels 91 and 85. Both of these pawls 200 and 201 are mounted on the lever 195 and are spring urged into engagement with the teeth of the ratchet wheels. There are eight lugs or rollers on the gear 185 which operate the lever 195. Four of them, designated at 203, are radially set back farther than the other four 204, so that the throw of the bell crank lever is greater when the rollers 204 are hitting the lever than when the rollers 203 engage it. The purpose of this will be subsequently described.

In the gear cabinet of the machine the lever 205 is pivoted at 206 intermediate its ends. At one end it has a pawl 207 operating against the teeth of the ratchet wheel 85. At its other end it has a roller 210 operating against a cam foot 211 which forms part of the oscillating lever 187, at the opposite side of the shaft 188 with respect to the segment 189. A spring 213 normally holds the roller 210 against the cam surface of the foot 211. Of course oscillation of the arm 187 will advance the pawl 207.

The chain G has two longitudinal series of lugs along it, arranged along the lines 215 and 216 designated in Figure 12 of the drawings. Levers 217 and 218 respectively pivoted at 219 and 220 on the shaft 77 are adapted for cooperation with the lugs along the lines 215 and 216 respectively of the chain G. As shown in Figure 6 of the drawings these levers 217 and 218 are normally held in engagement intermediate their ends with the chain, in the line of the lugs, by means of springs 222. The lever 217 is provided with an arm 223 thereon which normally holds the pawl 201 out of action. A lug on the chain G raises the lever 217 which will release the pawl 201 for action upon the ratchet wheel 85. The lever 218 is provided with an arm 224 which normally holds the pawl 207 out of action, but when a lug on the chain G lifts the lever 218 it will move the arm 224 out of action and permit the pawl 207 to advance the ratchet wheel 85.

The set K of cylinder needles includes long butt needles 230 and short butt needles 231. Below alternate long butt needles 230 there are provided jacks 232 having long butts at a lower level, and below alternate short butt needles there are provided jacks 233 having short butts at a lower level. Long butt jacks 234 have long butts at an upper level. They are positioned in an alternating relation with the cylinder needles, and similarly jacks 235 having short butts at the upper level (complementary to the jacks 234) are provided in alternating relation below the cylinder needles. These short butt upper level jacks 235 are spaced across the division line of the long and short butt needles, that is, half of them are in the long butt needle section and half of them in the short butt needle section, and that is also true for the upper level long butt jacks 234, for a purpose which will be subsequently described. It should be noted in this connection that the upper level short butt jacks 235 are located below cylinder needles which are inactive during rib knitting and which receive stitches from the dial needles actuated by those dial needle actuating fingers 130 having the butts 130e thereof at the lower level.

The frame bed 27 of the machine has a cam supporting ring or table 240, which is spaced above the bed 27 so that access may be had to cams or operating features which may be placed between the table 240 and the bed 27, shown in Figures 1 and 4 of the drawings. The table 240 may have supporting posts 241, as shown in Figure 1 of the drawings which are bolted to the bed 27. The table 240 supports main stitch cam block 244, shown in Figure 4 of the drawings; the widening pick attachment 430 shown in Figure 1 of the drawings, and other cam and cam operating levers to be subsequently described.

The machine is preferably provided with yarn feeds in the nature of the usual levers pivoted at 245 on the latch ring 246. This latch ring is bolted at 247 upon the swinging arm 105 of the dial supporting structure 104 (see Figure 4) and the dial cap 129 is in turn bolted at 250a to the latch ring to hold it against rotation.

The five yarn feed fingers are used for feeding plating, splice, top, binding, and lining yarns to the needles. The finger 252 which feeds yarn for the knitting of the rib top also is used to knit the heel and toe of the stocking. By reference to Figures 2 and 3 of the drawings it will be seen that these fingers 250 to 254 inclusive are swung into action by means of reciprocating push rods 256 (see Figure 2) supported by brackets 257 on the machine. These push rods 256 in turn are actuated by suitable levers 258, 259, 260, 261 and 262, for the fingers 250, 251, 252, 253, and 254 respectively. The levers 258 to 262 inclusive are pivoted on the shaft 77 and at their outer ends are raised by lugs on the drum F' for throwing the push rods 256 into engagement with the respective yarn fingers.

At the location of transfer of the stitches from dial needles to cylinder needles a brush 264 is located for throwing the latches of the needles open.

As before mentioned the dial needles are partially advanced by the selectors 130, both at the transfer and stitch actuating cams of the dial. In order to support the cams for selective actuation of these fingers 130 a segmental shaped supporting piece 270, as shown in Figures 1 and 3 of the drawings is mounted by means of brackets 271 attached to the skirt of the bracket 106 which supports the dial construction. Upper and lower levers 272 and 273 respectively are pivoted at 274 upon the supporting segment 270 for respective action upon the upper and lower level butts of the dial selector fingers 130. Thus, the lever 272 cams against the butts 130d and the lever 273 cams against the lower butts 130e. These levers 272 and 273 are respectively connected by rods 276 with levers 277 and 278. These levers 277 and 278 are pivoted upon the shaft 77 and are lugs actuated off of the drum F'. They are bell crank levers as can clearly be understood from Figures 2 and 3 of the drawings. The yarn receiving and stitch forming location on the dial for the dial needle actuating fingers 130 is provided with another pair of actuating levers 280 and 281 which are pivoted at 282 on the support 270. These levers are provided with cam portions for operating respectively on the upper butt and lower butt dial needle selector fingers 130. These levers 280 and 281 are thrown into and out of actuating relation by means of levers 284 and 285 respectively. These levers 284 and 285 are pivoted on the shaft 77 and have connecting rods 286 which connect them with the cam levers 280 and 281.

It was before mentioned that the sinker cams 61 and 62 are opened and closed at different operations throughout the stocking. Inasmuch as the sinker cap oscillates during reciprocation of the machine, as limited by the lugs 290 thereon engaging against the lug 291 (see Figure 3), it will be desirable to hold the sinker ring 54 against movement when it is desired to advance the cam ring 65 for throwing the sinker cams 61 and 62 to an inoperative position. To that end a lever 293 is pivoted at 294 upon the machine, as shown in Figure 3, which is adapted to engage against an offset 295a on the sinker cam ring 54. The lever 293 is actuated off of the lever 295 and the latter is pivoted upon the shaft 77 and actuated off of drum F'. It is connected by means of a rod 296 with the lever 293 above described.

The frame of the machine is provided with a bobbin supporting table 300 rearwardly of the lever arrangement which operates off the lugs of the drums F' and F''. On this table are supported bobbins 301 for feeding the various yarns to the feed fingers 250 to 254 inclusive. Figure 2 shows the arrangement of yarns. Plating yarn is indicated at 302, the splice yarn is indicated at 303, the heel, toe and rib top yarn is indicated at 304, the binding or selvage yarn is indicated at 305 and the lining yarn is indicated at 306. All of these yarns except the yarn 304 are fed through appropriate tensioners 307 and then extend to their respective feed fingers 250 to 254 inclusive.

The rib top yarn 304, which is also used in knitting the heel and toe has the normal tensioner 308 operating thereon, and it is provided with means for additional tensioning during knitting of the heel and toes. This means includes a conventional tensioner 310 having upper and lower plates between which the yarn passes. The lower plate is movably supported by an arm 315, shown in Figure 2 of the drawings, which is pivoted at 316 and normally spring urged at 317 into tensioning position. A connecting rod 319 is attached to the arm 315 and moves upwardly and downwardly to throw the tensioner into and out of action. The rod 319 is pivoted at its lower end to a lever 320 which in turn is pivoted at 321 upon a bracket of the frame of the machine, as shown in Figures 2 and 3 of the drawings. This lever 320 is connected by a rod 323 to one of the drum actuated levers 324. The drum actuating lever 324 is pivoted on the shaft 77 and lug actuated off the drum F' in order to throw the yarn tensioner 310 into or out of yarn tensioning position.

Means is provided to hold the splice yarn in an out of the way relation with respect to the dial during knitting of the high splice heel and double sole during rotary knitting, since otherwise the splice yarn would become entangled with the dial and the dial needles. This splice yarn guard consists of a finger 340, shown in Figure 15 of the drawings, which has a curved end facing the splice yarn feed finger. This guard 340 moves into and out of position across the cylinder needle line, as shown in Figure 15. In the position shown in Figure 15 it is out of action, and in its dotted position it is across the cylinder needle line and in position to engage the splice yarn and guide and maintain it below the dial in an out of the way relation until the splice yarn is taken by the needles which are intended to take it during the next rotational movement. This guard finger 340 enters across the needle line at the knitting wave opening in the cylinder needle set directly above the low point in the stitch cast-off cam, as shown in Figures 9 and 10 of the drawings.

The splice yarn finger 340 is mounted upon a movable supporting plate 341, slotted at 342. A screw or pin 343 on the cam ring 54 supports the splice yarn guide member for reciprocatory movement into its operative and inoperative positions. A pin 344 assists in guiding the movement of the splice yarn guide. A spring 345 normally urges an edge of the guide 341 against the pin 344, and a spring 346 normally throws the yarn guide to an inoperative position as indicated in the full line view of Figure 15 of the drawings. Referring to Figure 3 of the drawings in conjunction with Figures 15 and 16 it will be noted that a lever 350 is pivoted on the same pivot 294 as the lever 293; said lever 350 having a bifurcated end which engages a pin 351 on the splice yarn guide finger 340 for the purpose of advancing the splice yarn guide 340 into operative position as indicated in the dotted lines in Figure 15 of the drawings. This lever 350 is operated off of a lever 352 pivoted on the shaft 77, as shown in Figure 3.

A binder and cutter for cutting and holding the yarns is mounted upon the dial cap 129 of the machine. This binder and cutter is generally designated at 360 in the drawings. As shown in Figure 23 the binder and cutter includes a shaft 361 mountable by suitable brackets 362 on the dial cap 129. A binder arm 363 is spring urged at 364 for holding yarns after they are severed, and a loose pivoted binder 365 cooperates therewith. The shaft 361 is provided with a cutter bar 366 which operates in a depression in the dial cap to sever the yarn. This cutter is normally spring urged into cutting position by a spring 368. An extension arm 370 on the cutter bar 366 engages the arm 363 to lift

the latter when the cutter bar is moved to an open position. This extension 370 has a link 371 which is provided with an opening therein. The latch ring 246 is provided with a support 375 with which a yarn cutting operating lever 376 is pivoted as at 377; this lever 376 loosely extending into the link 371 for raising and lowering the cutter bar. The means for operating the lever 376 consists of a lever 380 shown in Figures 3 and 4 of the drawings, pivoted at 381 upon a suitable bracket mounted upon the latch ring; this operating lever 380 having a pin at its free end adapted to operate on the lever 376. The lever 380 is bell cranked, and at its opposite end it has a connecting rod 384 extending for connection to one of the drum actuated levers 385 which are pivoted on the shaft 77 and actuated by lugs off of the drum F''.

The narrowing pick 400, shown in Figure 3 of the drawings, is actuated off of a lever 401 pivoted on the shaft 77 and lug actuated off of the drum F''. A connecting rod 402 connects the bell crank lever 401 with the narrowing pick 400. Cylinder needle actuating cams 410, 411, 413, and 414 are provided, shown in Figures 9, 10, and 3, actuated off of levers 416 pivoted on the cam bed 240 of the machine. These cams 410, 411, 413 and 414 are respectively actuated off of drum actuated levers 418, 419, 420 and 421 which are pivoted upon the shaft 77 and are lug actuated off of the drum F''; the said bell crank levers 418 to 421 being connected by rods 422 with the various levers 416. A pair of jack actuating cams 425 and 426 are provided on the machine; the same being actuated off of levers 427 and 428 pivoted on the shaft 77 of the machine and actuated off the drum F''; the actuation of these cams being accomplished in the same manner as the cams 410 to 414 above described. These cams 425 and 426 are located in the space between the table 240 of the machine and the bed 27.

All of the rest of the jack and needle actuating cams, except those above described, are stationary.

The machine is provided with a widening pick finger 430 which slides along the inclined surfaces of the cam 431 to perform its picking operation. It is plunger actuated by a spring urged rod 432a, best shown in Figure 2 of the drawings and actuated off of the drum F' by a lever 422.

It is of course understood that the usual belt shipping mechanism 516 may be provided for throwing the machine out of operation at the completion of the knitting of a complete stocking, and to that end a lug 435 may be provided on the drum 86 to accomplish such action.

A work tube 440, shown in Figures 1, 2 and 4 of the drawings, may extend into the cylinder for receiving the string of stocking. It is provided with a lower enlarged receptacle portion 441 for receiving the string of stockings. A take-up which may be of conventional nature is supported in this portion 441 of the work tube and is rendered effective and ineffective by shifting and lowering the work tube. The lifting of the work tube will open the clutch and throw the take-up out of operation The work tube rotates with the cylinder. It is raised and lowered by the means shown in Figure 2 of the drawings. It is provided with an annular flange 443 which rests against a lever 444; the latter operating off the drum F', in order to throw the take-up into and out of operation.

The take-up may be of the nature set forth in my U. S. Patent #1,991,563. As specifically applied to this machine the take-up may include the usual pair of rollers 446, shown in dotted lines in Figure 1 of the drawings, between which the work passes. These rollers are driven by means of gearing on a shaft 447 which extends downwardly through the side of the receptacle 441 and at its lower end is provided with a clutch 448 adapted to engage or disengage with a gear 449. The latter is driven by means of a stationary gear 450 which is mounted upon a bracket 451 of the frame of the machine. Of course, as the receptacle 441 rotates, since the gear 450 is stationary, the gear 449 will revolve. When the clutch 448 is thrown into action the shaft 447 will rotate for operating the rollers 446. A spring 453 normally urges the work drum upwardly but its weight is sufficient to maintain the clutch 448 in clutching engagement with the gear 449. This spring somewhat relieves the weight which is required to be lifted by the lever 444.

Referring to the pattern drum arrangement as diagrammatically illustrated in Figure 17, the dot and dash lines represent the line of travel of the drum over various levers and parts of the machine. The numeral 460 which takes in two of these lines is the line of shift of the clutch lever 461 which is pivoted on the frame of the machine as shown at 462 in Figure 6 of the drawings. This lever is not pivoted on the shaft 77, but has a vertical axis, and at its end it has a pin 463 which may move, incident to the sloping edges of the cam lugs 465 on the drum F'', for the purpose of shifting the clutch hub 169. The parts are shown in Figures 3, 6 and 17 of the drawings.

On the drum F'' the dot and dash lines 467 operate the lever 418 in order to control the cam 410; the lugs along the line 468 operates the lever 119 to control the needle cam 411; the lugs along the line 469 actuate the lever 420 to control the cam 413; the lugs along the line 470 actuate the lever 421 in order to control the cam 414; the lugs along the line 471 actuate the lever 427 in order to control the cam 425; the lugs along the line 472 actuate the lever 428 in order to control the jack cam 426; the lugs along the line 473 actuate the lever 79 for the purpose of moving the cam shifting ring 65 in order to throw the sinker cams 61 and 62 into or out of action; the lugs along the line 474 actuate the lever 401 for the purpose of operating the narrowing pick 400 into out of the way positions. This line of lugs only actuates that narrowing pick which immediately faces the direction of rotation of the cylinder in order to get it out of the way of the needle butts. The inoperative position is shown in Figure 10 of the drawings. All of the above lugs are on the drum F''.

With respect to the drum F' the dot and dash lines 476, 477, 478, 479, and 480 respectively actuate the levers 258, 259, 260, 261, and 262 for controlling the feed of yarns off of the yarn fingers 250, 251, 252, 253 and 254 respectively. The lugs along the line 481 as shown in Figure 17 actuate the lever 432 shown in Figure 2 of the drawings to control the pick arm 430; the lugs along the line 482 operate the lever 444 to raise the web take-up support and work tube 440, and thus throw the clutch of the take-up out of action; the lugs 483 and 488 actuate the two levers 284 and 285 for controlling the cam arms 280 and 281 which actuate the dial needle pro-

jecting fingers 130. The lugs 485 and 486 actuate the levers 277 and 278 which control the levers 272 and 273; the latter actuating on the upper and lower butts respectively of the dial projecting fingers 130.

The lever 385 rides on the line of lugs 487 in order to operate the binder and cutter mechanism. The line of lugs 488 actuate the lever 352 that operates the yarn guide lever 350. The line of lugs 489 operates the lever 295 which holds the sinker cap stationary when the sinker cams are thrown out of action as above mentioned. The line of lugs 490 actuate the lever 324 shown in Figure 3 for the purpose of raising and lowering the mechanism which operates the yarn tensioner 310 for yarn 304.

With reference to Figure 12 showing the pattern chain G, as above mentioned this chain contains a link for each course of the stocking to be knitted. On this view has been diagrammatically indicated the relation of the lug arrangement for the knitting of the different parts of the stocking.

Referring to the string of stockings N illustrated in Figure 18 of the drawings, the same designates at least one stocking and portions of other stockings connected at the ends thereof. The stocking is knitted commencing with the rib top and then working through the leg and foot Each stocking includes a welt 500; a rib top 501; an advance top 502 which is knitted with the same yarn as the rib top 501; a leg 503; high splice heel section 504; heel pocket 505; a foot which includes an instep 506 and a splice yarn reinforced sole 507; a ring toe 508; toe pocket 509; loopers rounds 510; binding yarn section 511; run back section 512; and a section 513 knitted on the alternate cylinder needles which are to be used during rib knitting, just prior to reception of the yarn by the dial needles, and after yarn has been dropped from inactive cylinder needles.

Respecting the pawl advancement of the drums F′ and F″, which are both mounted on the same shaft, and the advancement of the pattern chain driving sprocket 90, as before mentioned the ratchet 85 has thirty-six teeth on it and is keyed to the main drum shaft 75. The ratchet wheel 91 of the pattern chain sprocket 90 has seventy-two teeth around it. The lever 195 which moves the pawls 200 and 201 in ratchet wheel advancing relation is kicked by means of eight lugs positioned in equi-distant relation about the gear 185. Four of these lugs 204 are set in advance of the other alternating four 203, so that the lugs 204 will throw the lever 195 farther than the lugs 203. The gear 185 is driven at one-fourth the speed of the cylinder, that is, makes one turn to four turns of the cylinder.

The rollers 204 kick the pawl advancing lever 195 for the length of one tooth of the chain ratchet 91, that is, for one seventy-second of a revolution. They operate the pawl 200 continuously, advancing the ratchet 91 one tooth length each time that the lever 195 is kicked thereby. This for the reason that there are just as many links on the pattern chain G as there are courses in the stocking, so that the chain G must be kicked ahead one link for each revolution of the cylinder. The arm 223 which is operated off of the pattern chain lug operated lever 218 normally holds the pawl 201 out of operation on the ratchet wheel 85, and when a lug in the pattern chain lifts the lever 217 it moves the said lever 223 and permits the pawl 201 to act on the teeth of the ratchet wheel 85. This advances the pattern drum at the time that a lug 203 and 204 hits the pawl advancing lever 195.

As before mentioned another pawl 207 is provided. It operates on the ratchet wheel 85 in order to move the pattern drum so that the clutch 169 may be shifted in order to go into and out of reciprocating knitting, that is, at the beginning and end of knitting of each of the heel and toe pockets. The pawl 207 is normally held inactive by the detent arm 224 which is rigid on the lever 218. When a lug on the pattern chain hits the lever 218 it raises it and throws the detent arm 224 out of the path of the pawl 207 and it can function in order to advance the pattern drum. The lever arm 205 on which the pawl 207 is mounted, as before mentioned, is operated off of the foot 211 of the segment gear, at each rotation of the gear 185, that is, at every fourth complete turn of the cylinder. This is due to the pitman connection 186, as is quite apparent.

Referring to the cycle of operation for knitting a complete stocking, starting with the finish of the loopers round 510, shown in Figure 18, just before the binding yarn is fed to the cylinder needles, it should be noted that stitch cams 110 and the cam 111 are in position to operate on the butts of the needles, since they are stationary cams and preferably in position at all times. So far as their action on the needles is concerned in order to knit fabric they are conventional and need not be further described. Cam 414 is also in position for lowering needles. It went into position after knitting of the toe in order to lower the needles used in knitting the toe pocket.

The needle position at this time corresponds to the showing in Figure 9, although the position of the feed yarns is different, since the toe of the stocking is knitted out of the yarn 304. The binding yarn 305 is thrown into action for four courses through control of the finger 253 off the pattern mechanism above described, as can readily be seen from the pattern lug arrangement in Figure 17; the finger 253 being operated off of the lever 261. In connection with operation of the feed fingers 250 to 254 inclusive it should be noted that lugs on the pattern drum along the lines indicated by numerals 476 to 480 of the drawings will throw the feed fingers out of action and it is when the bell crank levers operating directly on the pattern drum F′ drop into depressions between the lugs on the pattern drum that the feed fingers are thrown into action for feeding yarn to the needles. Thus, the binding yarn feed finger 305 is operated by the lug and depression arrangement along the line 479 shown on the drum F′ in Figure 17 of the drawings, it is at the point designated by numeral 500 that the binding yarn commences its feed to the cylinder needles for binding in the toe courses as indicated at 511 in Figure 18 of the drawings. After the binding yarn has fed for four courses in order to prevent run back into the toe section of the stocking just knitted, when yarn is dropped from certain needles as will be subsequently described, the cam 414 is retracted. This cam is actuated through the means above described along the lug line 470 of the drum F″ as shown in Figure 17 of the drawings.

We are now about to knit the run back section 512 shown in Figure 18 of the drawings and the pattern drum rotates in the direction shown in Figure 17 of the drawings. The operating levers which operate on the drum are now in position on the lugs shown at the extreme right hand

portion of the drums of Figure 17. Each lug operation on the lever which controls the various parts will not be described, since the relation will be apparent from the above description in connection with the drawings. The cams 425 and 411 are moved in one half-way to take the long butt jacks and long butt needles respectively. The cam 512a which is stationary assists the cam 411 in lowering the needles which are in position to be operated on by the cam 411, and cam 426a assists the cam 425 in elevating the jacks. Cams 413 and 414 go into operation at the same time, one half-way. Cam 413 raises the needles to shed the stitches off the latches of the cylinder needles, and cam 414 lowers them to regular position. Cams 411, 413, 414 and 425 go in the whole way to take the long butt needles. The cams 413 and 414 operate this way on every needle cylinder. The cams 425 and 426a operate on only those jacks 232 and 233 having butts at the lower level in order to raise the alternate needles of the cylinder which are active during rib knitting to points above the cam 411. The cam 411 at this time lowers the needles which are inactive during rib knitting; dropping the stitches therefrom and allowing the stitches to run back to the binding yarn which was knitted in at the section 511 in the stocking. It is to be understood that cams 411 and 512a completely bury the needles which are inactive during rib knitting. The position of such alternating buried needles is shown on the right hand portion of Figure 10 of the drawings. The run back section 512 of the stocking is approximately thirty courses in length, although this may vary as desired. It is of a length sufficient to permit an even tension of the yarn to be maintained on the cylinder, due to the tension of the fabric hung on the needles produced by the take-up mechanism when it is desired to start the knitting of the welt.

After the knitting of the run back section 512, cams 411, 413, and 414 are retracted, and cam 425 is retracted half-way and then all of the way. The section 513 is then completed on the alternate needles which are active during rib knitting for about fifteen courses, more or less. During the knitting of this section 513 cam 273 which actuates the dial needle projecting fingers 130 having the lower butts 130e is thrown in the whole way, followed by cam 272. This brings all of the dial needles out into position so that the brush 264 will open the dial needle latches preparatory to knitting rib top. Of course projection of the dial needles by these cams 272 and 273 acting on the fingers 130 is assisted by the cam 145, shown in Figure 7 of the drawings. While we are still knitting the last part of the section 513, cam 273 is retracted and cam 280 which operates on the upper butts of the advancing fingers 130 is thrown into action.

Throwing of the cam 280 into action projects half of dial needles which are to take yarn 304; the finger for which is in feeding position. This yarn 304 is fed to both cylinder and dial needles for the knitting of rib. Cam 272 then comes out or is retracted, and cam 281 goes into position to project the rest of the dial needles to take yarn 304. In this manner rib knitting is effected for one course. Then cam 280 is retracted followed by cam 281. In this position the dial needles do not take the yarn 304. I now knit two courses on alternate cylinder needles. They are those cylinder needles which have been raised as above mentioned and are active during rib kniting. Stitches on the previous course are of course held on the dial needles. After two courses of knitting on only alternate needles the cam 280 is thrown into action followed by cam 281. This completes the welt 500. As above described the cams 280 and 281 in cooperation with the cam 150 will throw the dial needles into position for taking the yarn 304. At this point in the knitting the sinker cams 61 and 62 are thrown out of action. Briefly this is accomplished by holding the sinker cam ring 54 stationary through engagement of the lever 293, shown in Figure 3 of the drawings, with the ring, and the sinker cam retracting ring 65 is then rotated through its control off the pattern drum. The slots 65b provided on this sinker retracting ring 65 operating on the pins 67 will throw the sinker cams 61 and 62 out of action, to the dotted line position shown in Figure 16. We are now knitting the rib top.

During knitting of the rib top three courses are knitted at the start of the rib top 501 and a lug 515, in the pattern chain G, designated in Figure 12 of the drawings, enables the pawl 201 to be controlled through the advancing means above mentioned to advance the pattern drum so that a pin 435 on the brake drum portion shown in Figure 3 moves the conventional belt shipping mechanism 516 and throws the belt onto the idling pulley 176 of the machine. This stops the machine. Of course this feature may be eliminated but it is a safeguard against the continuance of defective work. The operator may merely trip the detent 517 and the rib top will be completed throughout its length.

At the completion of the rib top, and just before going onto the leg 503 it will of course be necessary to transfer stitches from the dial needles to the cylinder needles which are inactive during rib knitting. This is effected by throwing cam 273 into position to operate the lower butt dial projecting fingers 130 of the mechanism above described; the cam 426 going in one half-way to operate on the long butt jacks having butts at the upper level. Cam 272 then is thrown into position to operate on the upper butted dial needle projecting fingers 130 and cam 426 is pushed in the whole way to operate also on the short butt jacks having butts at the upper level. Cams 272 and 273 push out the dial needles in cooperation with the cam 145 to a transfer position. The cam 426 is assisted by a stationary cam 518 shown in Figures 9 and 10 of the drawings, elevating those needles which were inactive during rib knitting into a transfer position to receive stitches from the dial needles. It should be noted that the transfer commences at the center of the short butt needle section, as can be seen from Figure 10 of the drawings.

At the time that the cam 426 is thrown into action cam 281 which projected the dial needles opposite the fingers having butts 130e at the low level is thrown out of action, and then cam 280 is also thrown out of action, since there is no further necessity for projecting the dial needles for receiving knitting yarn. All of the transfer from dial needles to cylinder needles takes place during one revolution of the cylinder, and at the completion cam 273 is retracted, followed by cam 272, and cam 426 is retracted half-way and then whole-way. It should be noted that at the time that the cam 426 was thrown into action singer cams 61 and 62 were also thrown into action through the lever control above described. We are now knitting the advance top 502 of the leg of the stocking. This continues for four courses

on all of the cylinder needles, using the rib top yarn 304. However, the fingers 250 and 254 are now thrown into feed position with respect to the cylinder needles, and the finger 252 is retracted. The plating and lining yarns are now being fed to the cylinder for knitting the leg, and at about this time the lever 293 which held the sinker cap against movement is thrown out of action in order to position the sinker cam cap for movement during reciprocatory knitting of the heel and toe.

The leg is knitted for the desired number of courses, according to the size of the stocking, and the splice yarn finger 251 is thrown into action at the start of knitting the high heel splice 506, shown in Figure 18 of the drawings. As this splice finger 251 is thrown into action the splice yarn guide 340 above described is thrown into action to the dotted position shown in Figure 15 of the drawings in order to guide the splice yarn under the dial. This high splice section continues for about fifty courses until we reach the heel pocket.

The pawl 207 through the mechanism above described operates the ratchet wheel when the lug 520 of the pattern chain G, shown in Figure 12 of the drawings, engages the lever 218 and throws the arm 224 to an inactive position. The pivoted lever 461 shifts the clutch 169 as a pin 463, above described, and shown in Figure 3 of the drawings, rides on the pattern drum F'' along the path 460. This pin is guided through the channel 526 into the channel 526[a] of the pattern drum, throwing the clutch 169 into engagement with the gear 175. Through section 165[b] rotation of the gear 185 will now oscillate or reciprocate the knitting machine cylinder due to the connection of the clutch 169 with the gear 175 and the pitman and segmental gear 187 meshed with gear 175 as will be apparent to those skilled in the art.

Immediately prior to reciprocation of the cylinder the fingers 252 of yarn 304 was thrown into action to feed yarn to the cylinder needles, and the fingers 250, 251 and 254 are now thrown out of action. At this time the splice yarn guide 340 is also thrown out of action. At this time the cam 410 goes into position half-way to engage the long butt cylinder needles and comes right out and is retracted immediately after the long butt cylinder needles have been elevated. The narrowing picks 400 and 400[a] are then released for automatic picking. This continues for the desired number of courses, one half-way through the heel pocket and the widening pick 430 goes into action. The heel pocket is completed throughout the desired number of courses and just before completion of the heel pocket the clutch shift lever 461 is swung by tripping of the pin 463 at the end thereof into the channel 527 on the pattern drum F''. This shifts the clutch and positions the machine for full rotary knitting. The cam 414 is thrown into position to lower the long butt cylinder needles which were used for knitting the heel pocket. We now go back to the use of the yarns 302, 303, and 306, and the yarn 304 is taken out of feeding relation to the needles. The yarn splice guide 340 is of course again thrown into position and we are now knitting the foot with the instep knitted out of the yarns 302 and 306 and the insole has the additional splice yarn 303 knitted therewith. The foot is knitted in this manner until we reach the ring toe.

At the ring toe 508 the yarn feed fingers 250, 251 and 254 are retracted and the yarn feed finger 252 is thrown into action. The splicing yarn guide 340 is retracted and cam 414 is also retracted. We now knit the required number of courses for the ring toe, and we are ready to knit the toe pocket.

The toe is of course knitted during reciprocation of the machine and to effect reciprocation the pawl 207 advances the pattern drum at the point where the clutch arm pin 463 rides into the pattern drum channel 528, shown in Figure 17 of the drawings. This shifts the clutch into reciprocating position. This advancement of the drum off of the pawl 207 is enabled because the lever 218 rides onto the lug 530 of the pattern chain G, as shown in Figure 12, throwing the pawl restraining arm 224 out of restraining position. The cam 410 is now thrown into position to elevate the long butt needles. The narrowing picks and then the widening picks go into operation as above described, in somewhat conventional manner, in order to complete the knitting of the heel pocket. The clutch lever pin 463 is then shifted along the pattern drum channel 529 to shift the clutch so that the cylinder goes into full rotary knitting. Advancement of the pattern drum by the pawl 207 to accomplish this shift of the clutch is permitted by reason of the fact that the lever 218 rides onto a lug 531 on the pattern chain, thus throwing the restraining arm 224 out of restraining position.

Cam 414 is then thrown into position to lower the long butt cylinder needles on which the toe pocket was knitted. Pick 400 is thrown to inoperative position.

We now knit the loopers round 510 for the desired number of courses using the yarn 304 and the cycle of operation is completed.

It should be noted that the combined length of the lug arrangement on the chain G along the lines 215 and 216, as shown in Figure 12 of the drawings, covers thirty-six links, equivalent to the number on the pattern drum advancing ratchet wheel. It is solely through these lugs that the pawls 201 and 207 are enabled to advance the ratchet wheel 85 and the drum. The pattern drum of course completes one revolution for each complete stocking knitted.

It is to be noted that there are a considerable number of blank dot and dash lines on the pattern drum. Reference was heretofore made to the construction by which the cylinder can be raised and lowered. Lugs may be provided on the pattern drum to raise the cylinder in order to control the tension of the stocking. Thus the line 550 may have a lug arrangement to raise the cylinder for control of the stocking when knitting the heel and toe; 551 may have a lug arrangement to raise the cylinder for control during the knitting of the foot, and the line 552 may have lugs to raise the cylinder for control when knitting the top. The tension is of course increased when the cylinder is elevated and it is necessary to vary this tension for the purpose of compensating for different weights of the yarn.

From the foregoing description of this invention it will be apparent that an improved machine has been provided which is relatively simple in nature, and which is so compact that all of the parts are very durably mounted and in readily accessible locations. One of the problems confronting the industry prior to this invention in providing a stitch transfer machine has been to so synchronize the cylinder and dial action that the stitch transfer could be effectively completed without liability of mishap. The direct dial drive off of the main drive shaft of

the drive mechanism for the present machine by means of herring-bone gears presents a decided improvement over anything heretofore provided.

It is entirely within the contemplation of this invention to utilize the selector dial needle projecting fingers 130 for the purpose of selectively projecting the dial needles in order to receive patterning yarns for the knitting of "fancies."

Various changes in the shape, size, and arrangement of parts of the improved knitting machine and the improved article or articles which may be knitted thereon, as well as changes in the steps of the method to knit the article may be made to the forms of invention herein shown and described, without departing from the spirit thereof or the scope of the claims.

I claim:

1. The method of automatically knitting a string of connected seamless stockings which consists of knitting a welt, knitting a rib top, knitting a leg, foot, and heel and toe pockets, introducing a splice yarn to the sole and high heel during the knitting of the leg and foot, knitting a loopers round, introducing a binding yarn at the end of the loopers round, knitting a run-back section, and then continuing the operation of knitting a welt on stocking next to be knitted.

2. The method of knitting a string of seamless stockings which consists in knitting on the dial and cylinder needles of a knitting machine a rib top, transferring stitches from dial needles to cylinder needles, continuing the knitting on the cylinder needles to produce the start of the leg of the stocking, feeding another yarn or yarns to the cylinder needles and dropping the yarn used during the knitting of the rib top and continuing the knitting of the leg and foot of the stocking out of said other yarn or yarns, feeding to a portion of the cylinder needles a splice yarn to knit a high splice heel and double sole, knitting the heel pocket and toe construction of the stocking with the yarn used in knitting the rib top, feeding a binding yarn at the end of the toe of the stocking, continuing the knitting on the cylinder needles and after a predetermined number of courses dropping stitches from certain of the cylinder needles to permit the fabric to run back to said binding yarn, knitting a welt on the next succeeding stocking on both the cylinder and dial needles, and continuing the knitting of the next succeeding stocking in the cycle of steps above described.

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