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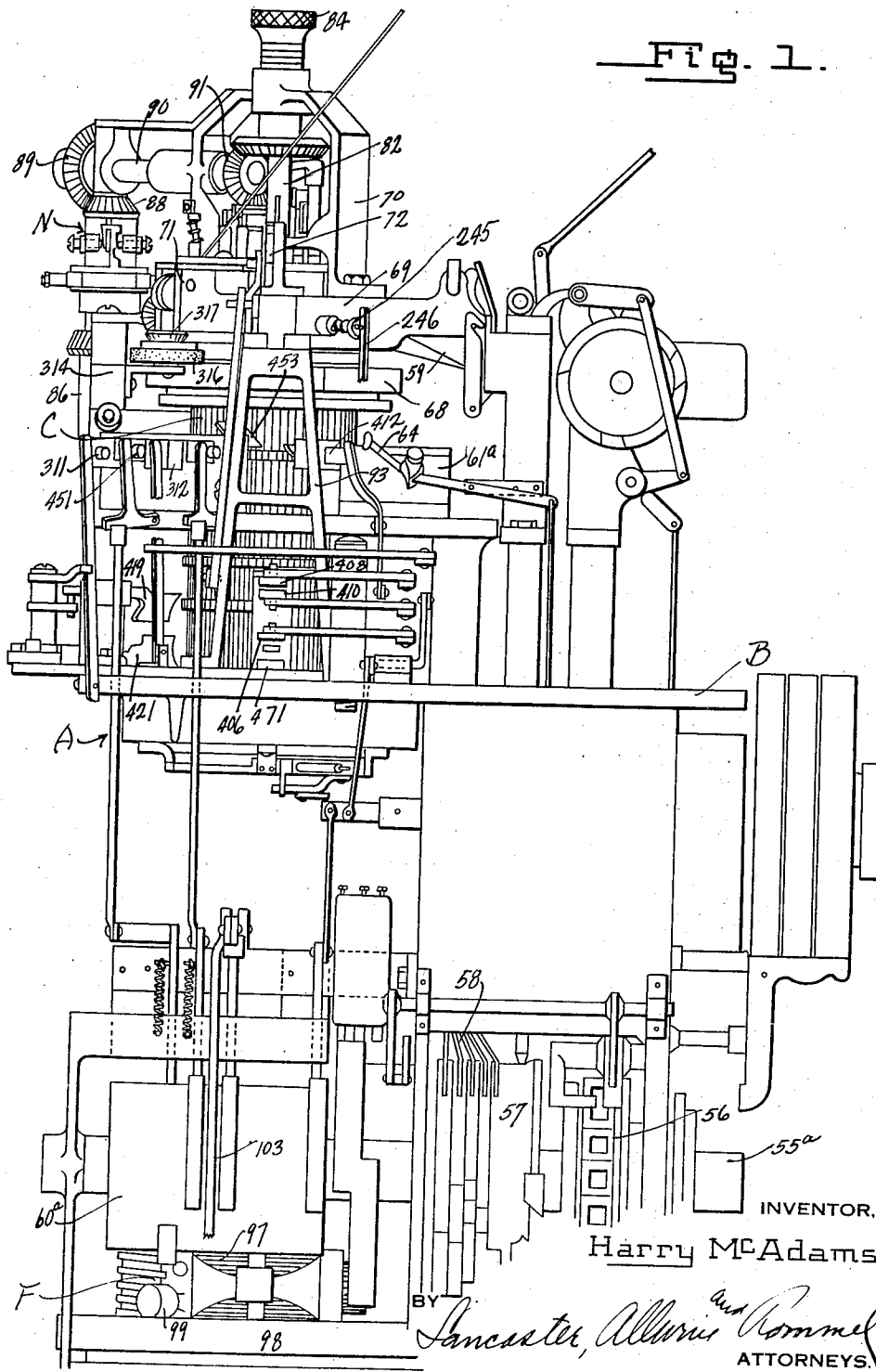
H. McADAMS

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KNITTING MACHINE

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Fig. 2.

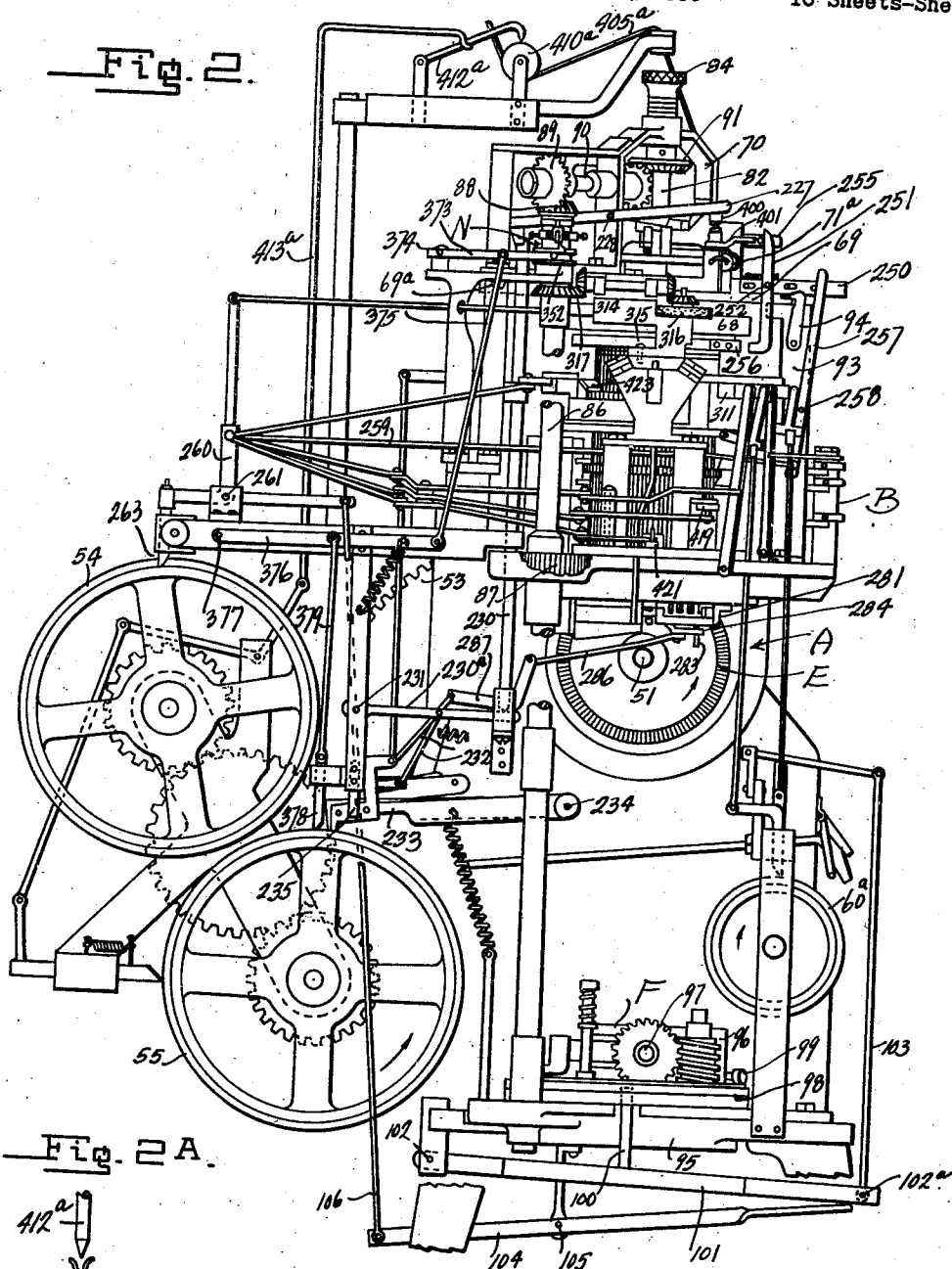
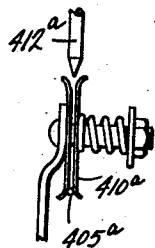


Fig. 2A.



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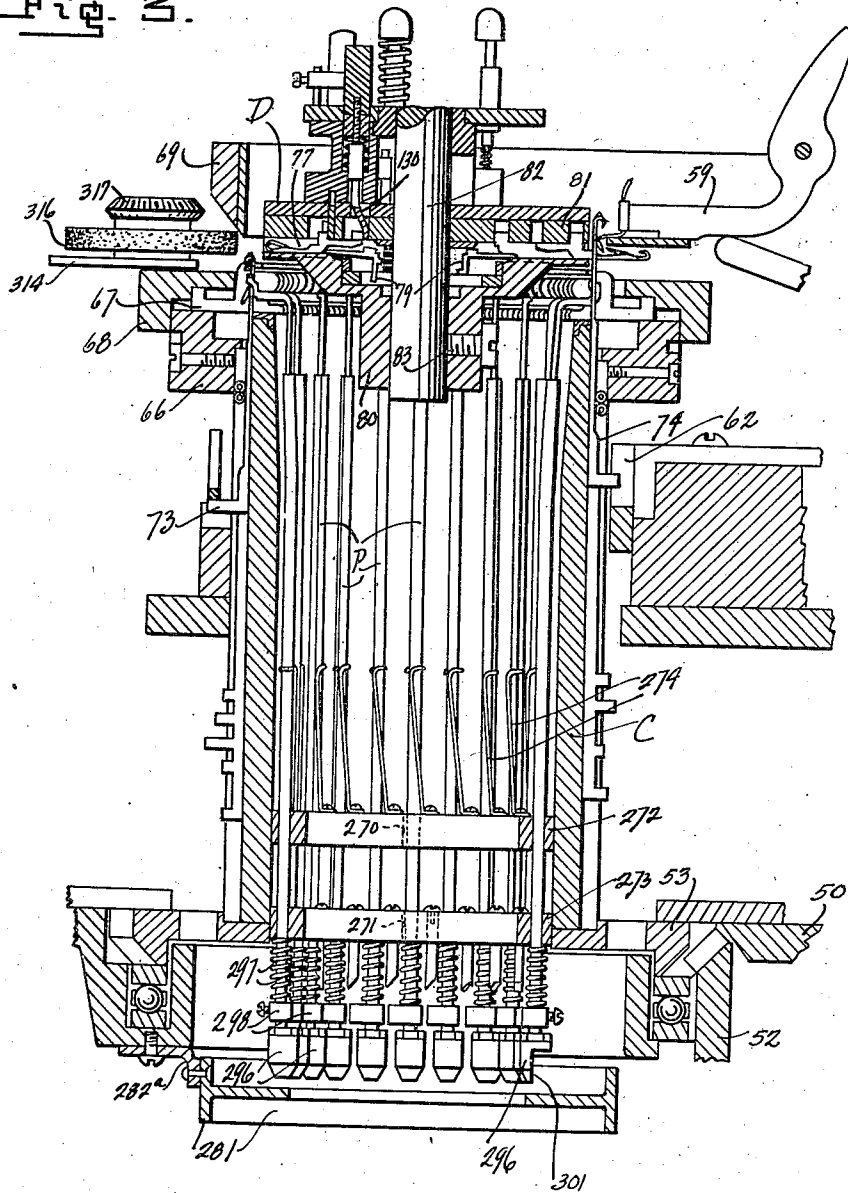
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Fig. 3.



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Fig. 5.

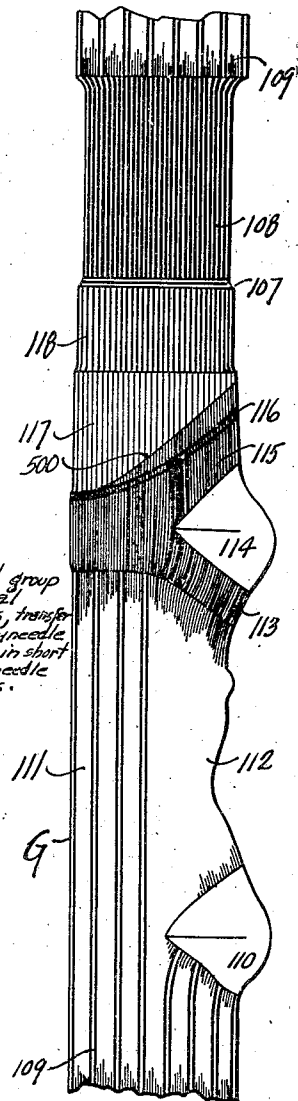


Fig. 4.

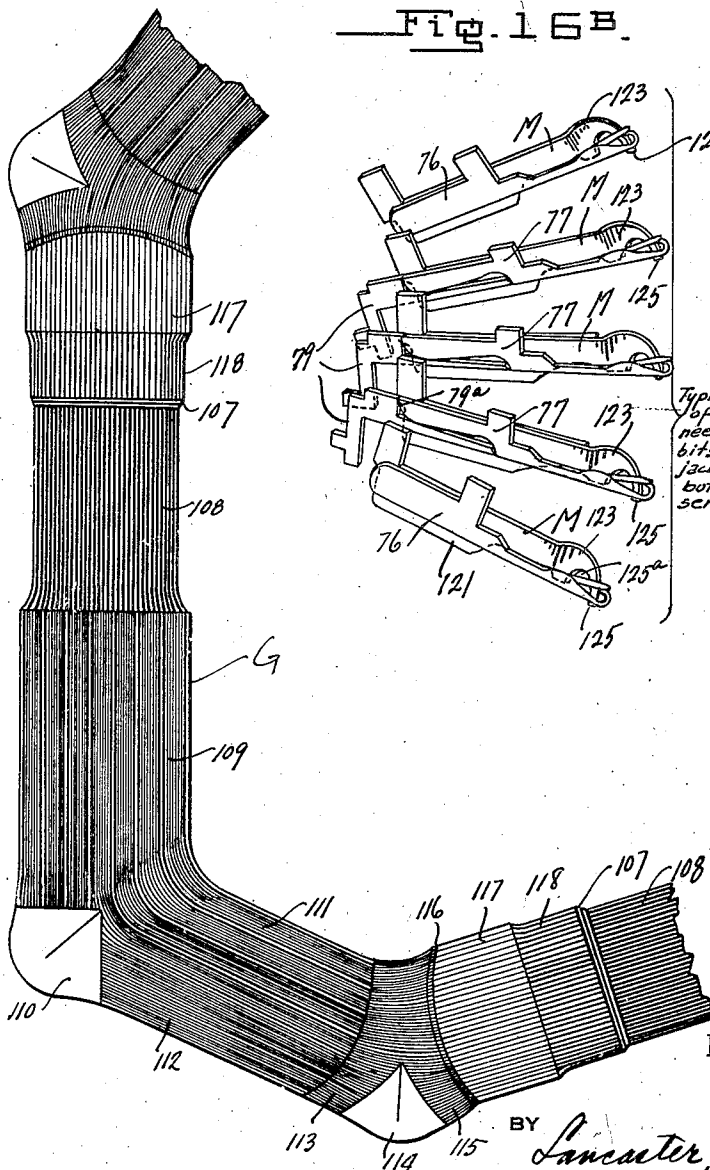
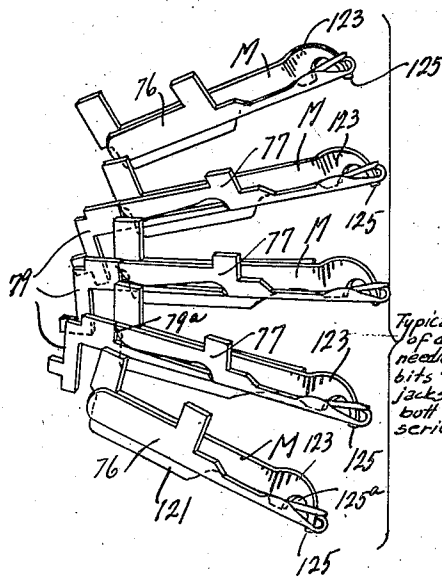


Fig. 16B.



Typical group
of dial
needles, transfer
bits and needle
jacks in short
butt needle
series.

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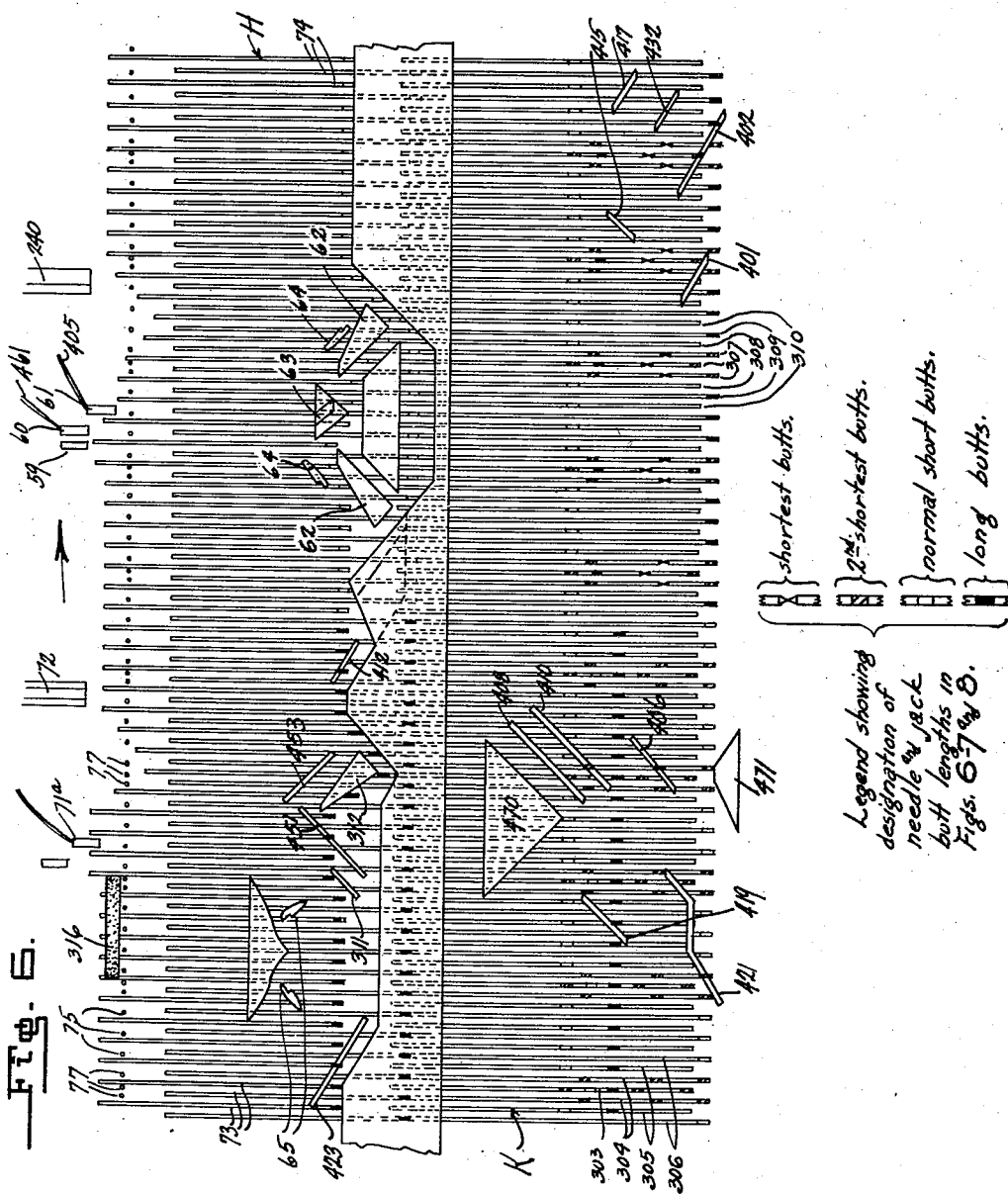
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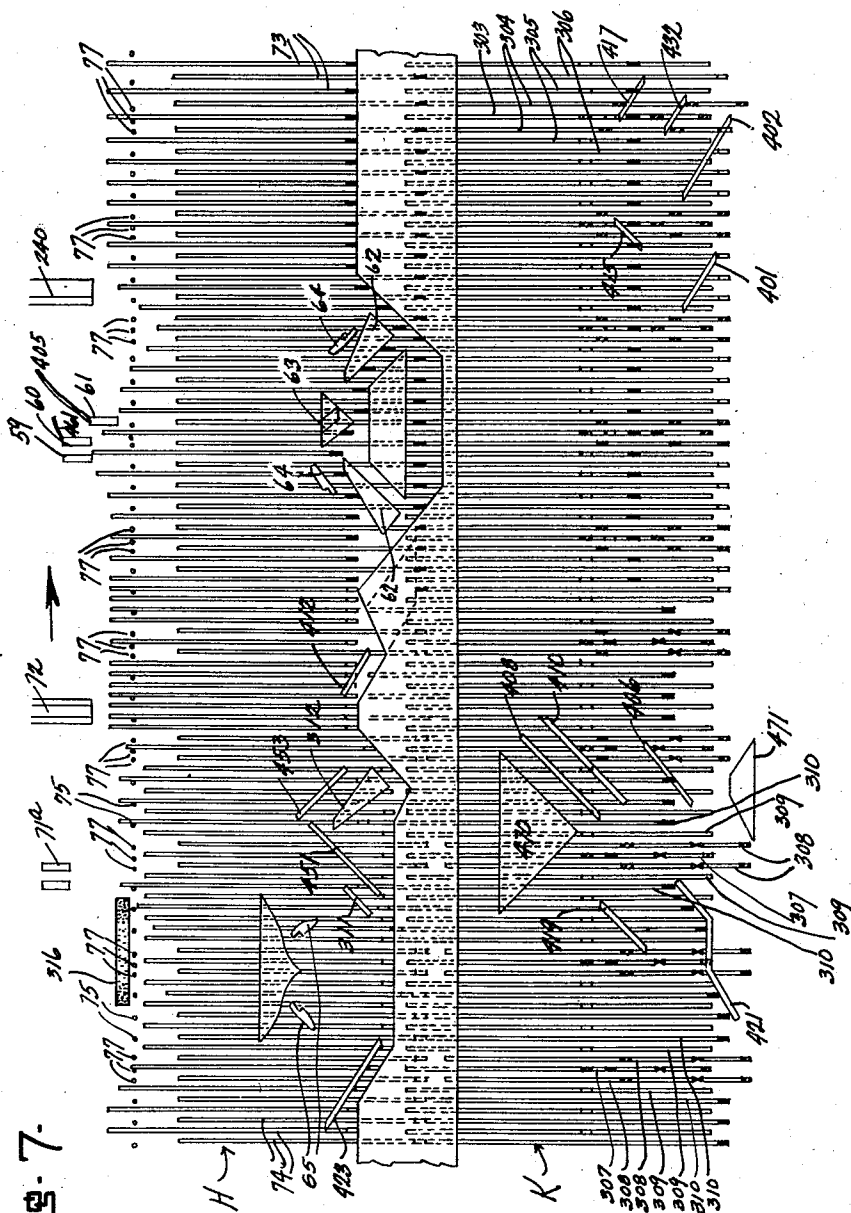


Fig. 7.

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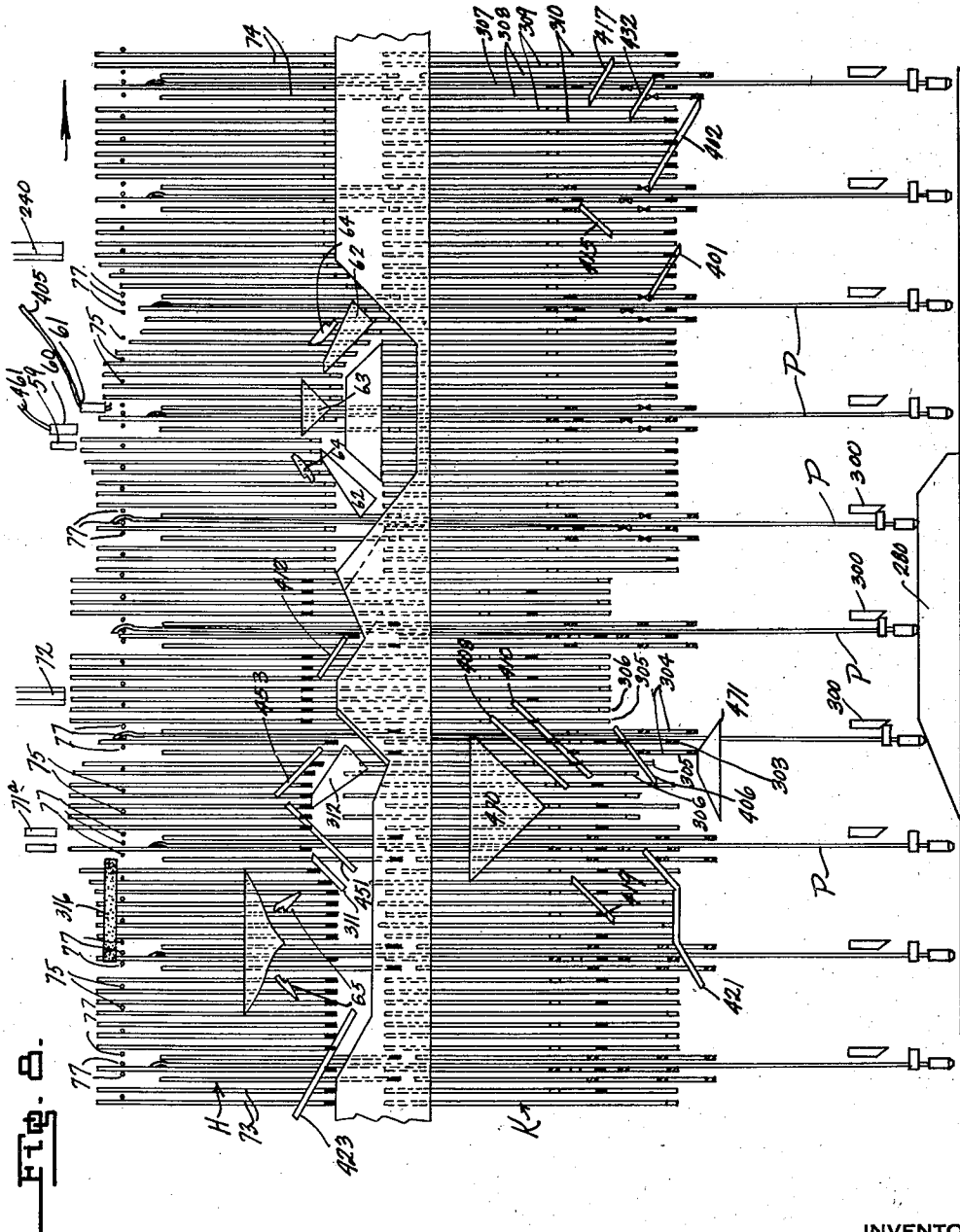
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Fig. 9.

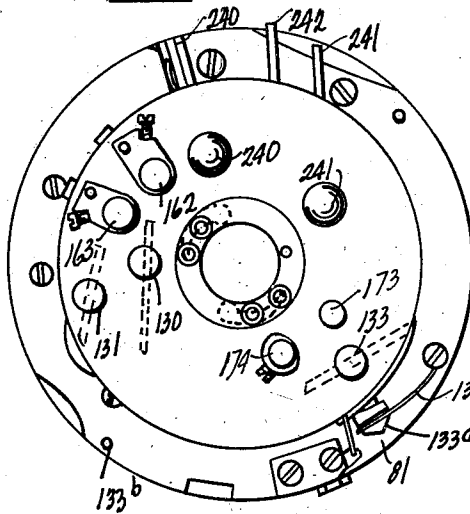


Fig. 11.

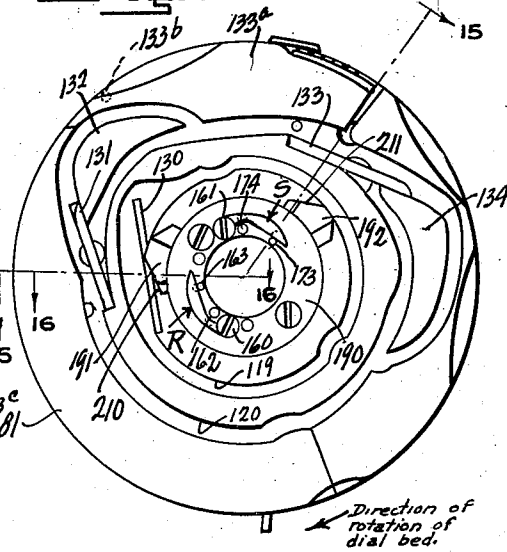


Fig. 10.

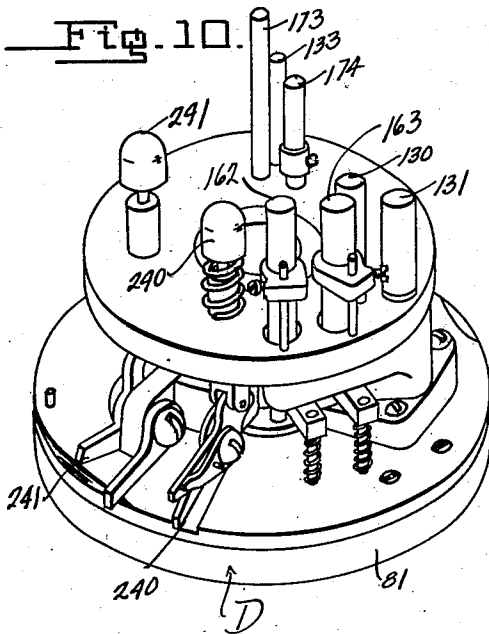
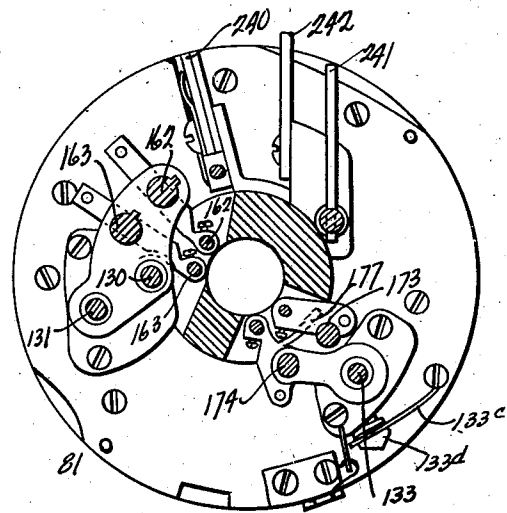


Fig. 12.



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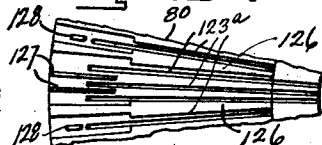
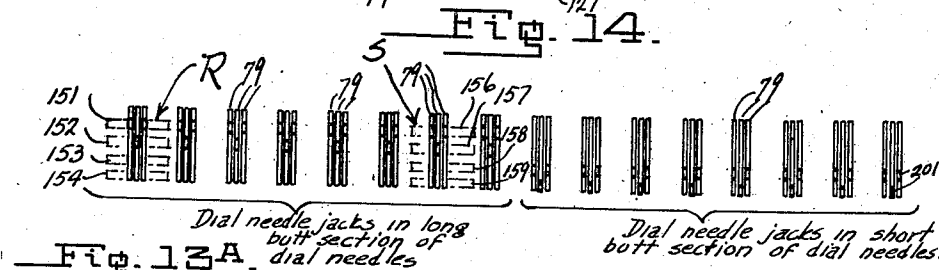
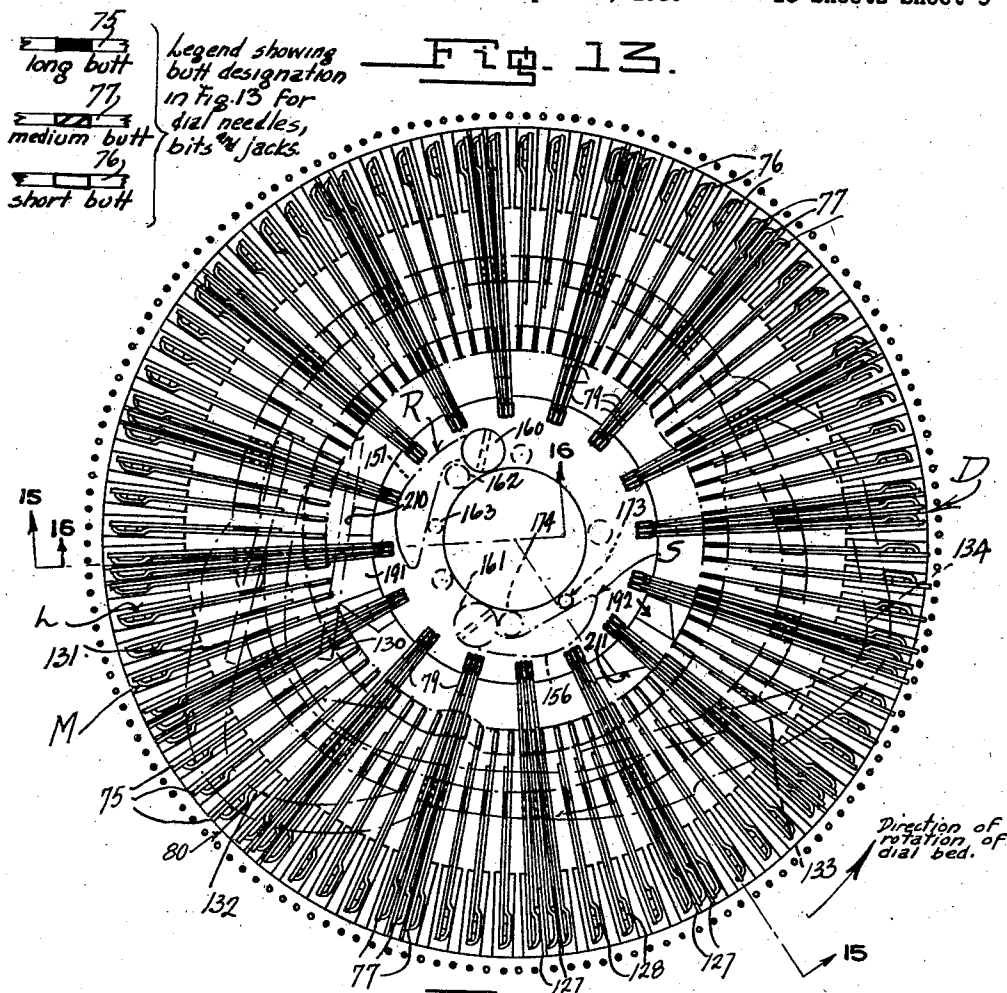
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KNITTING MACHINE

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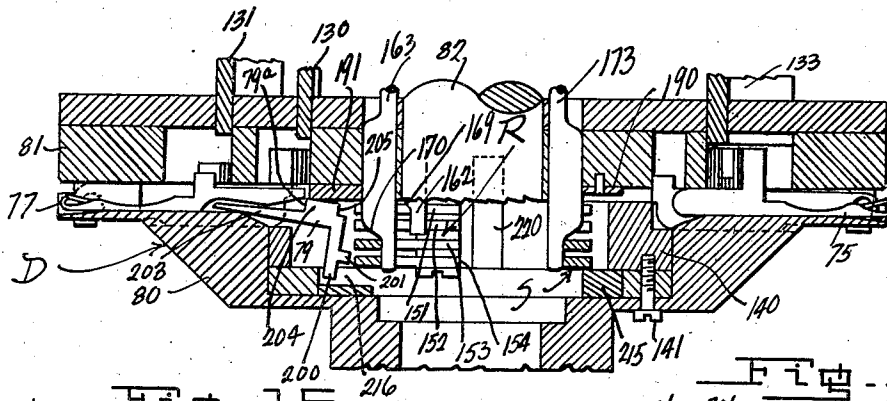
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Fig. 15.



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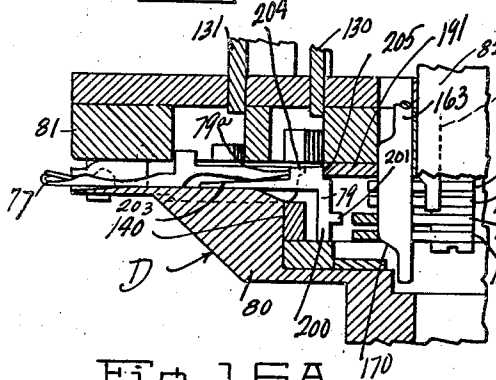
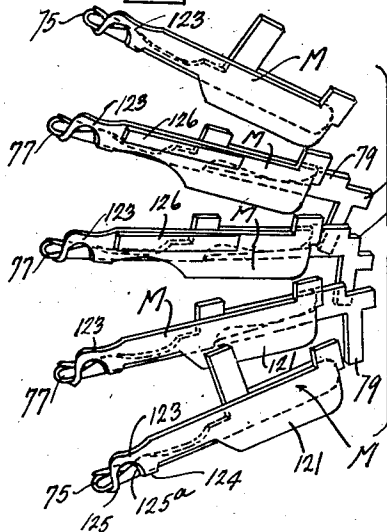
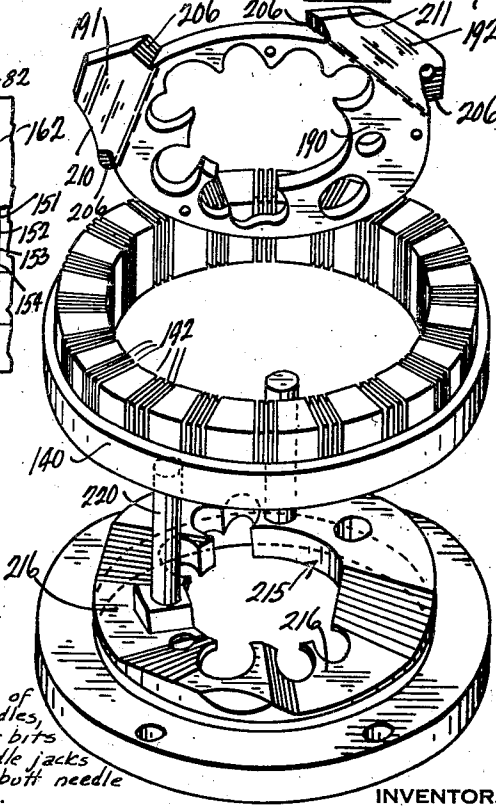


Fig. 16A.



Typical group of Dial needles, transfer bits and needle jacks in long butt needle series.

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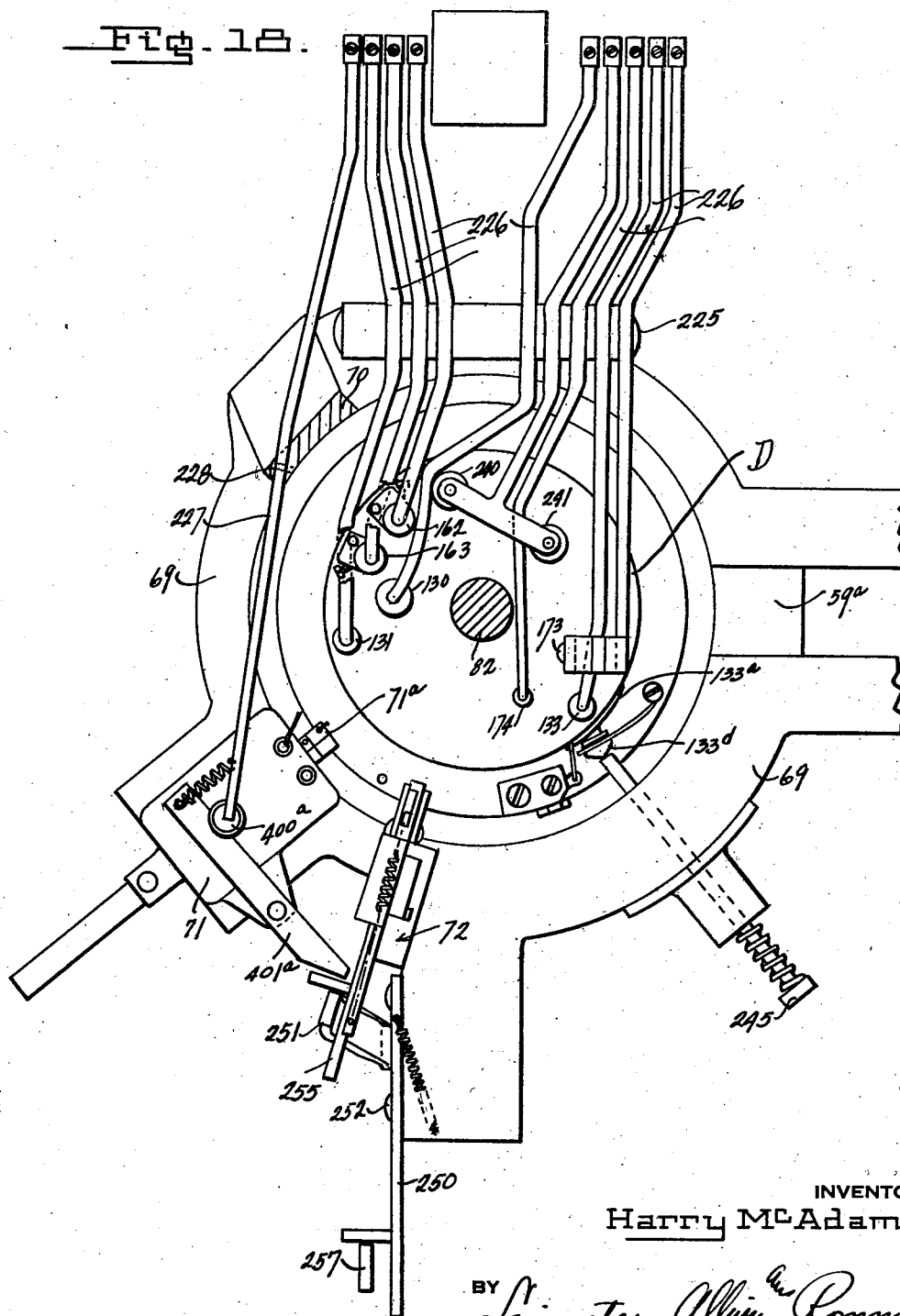
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Fig. 19.

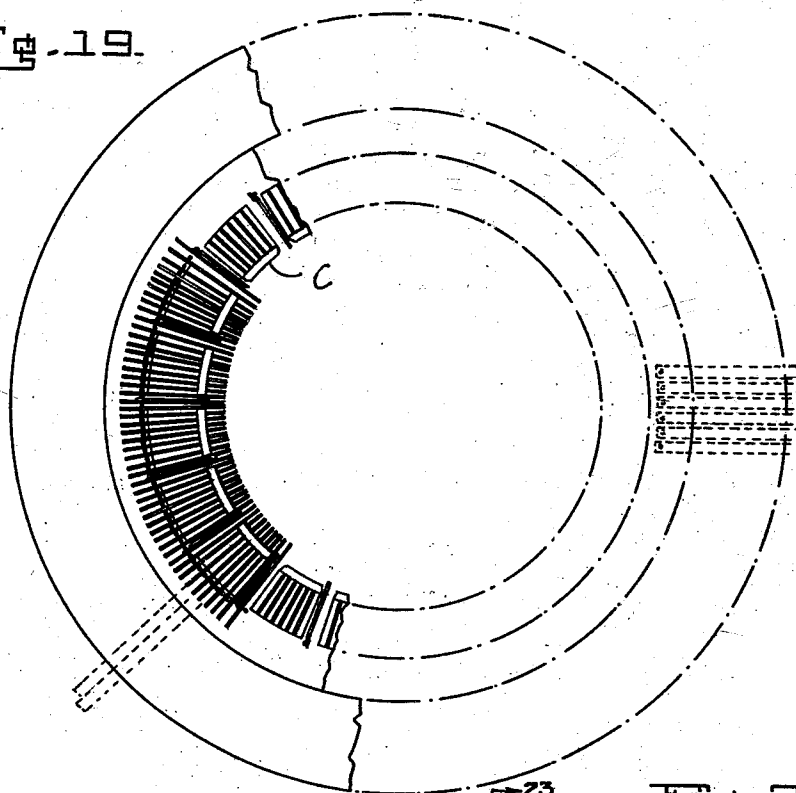


Fig. 21.

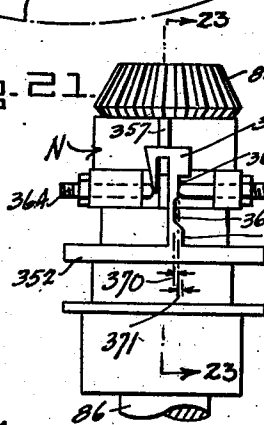


Fig. 22.

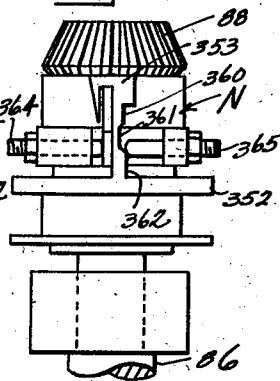
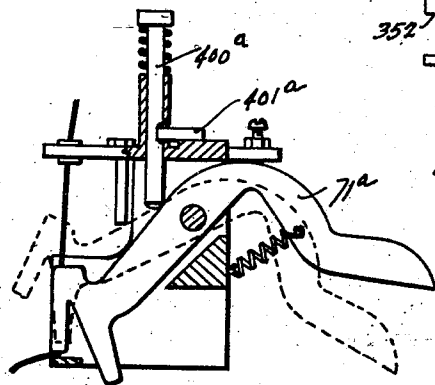


Fig. 20.



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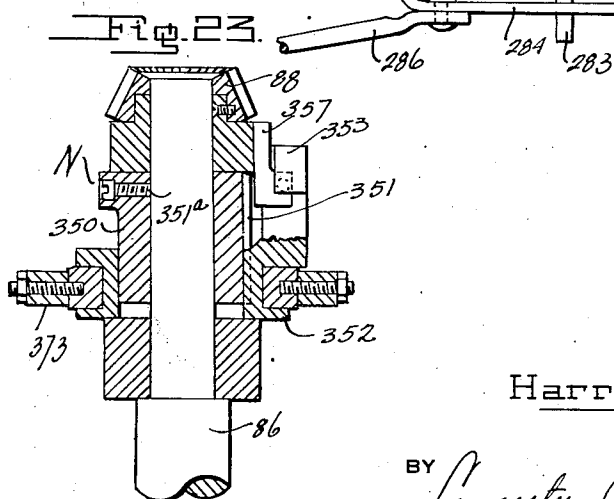
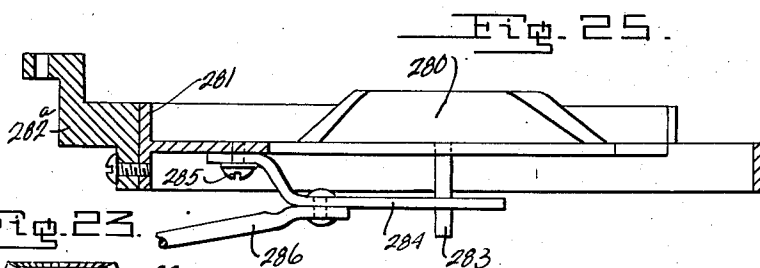
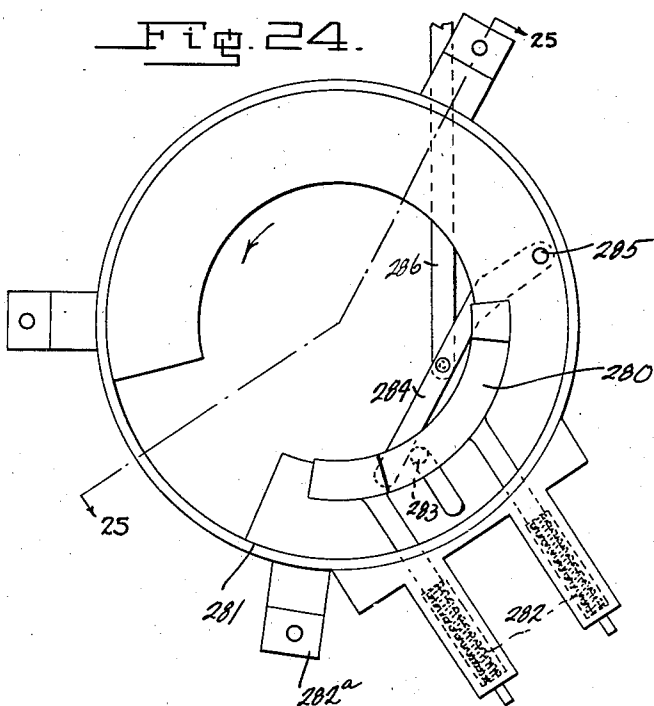
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KNITTING MACHINE

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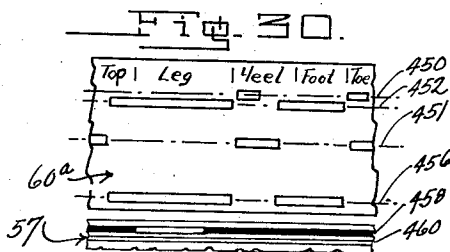
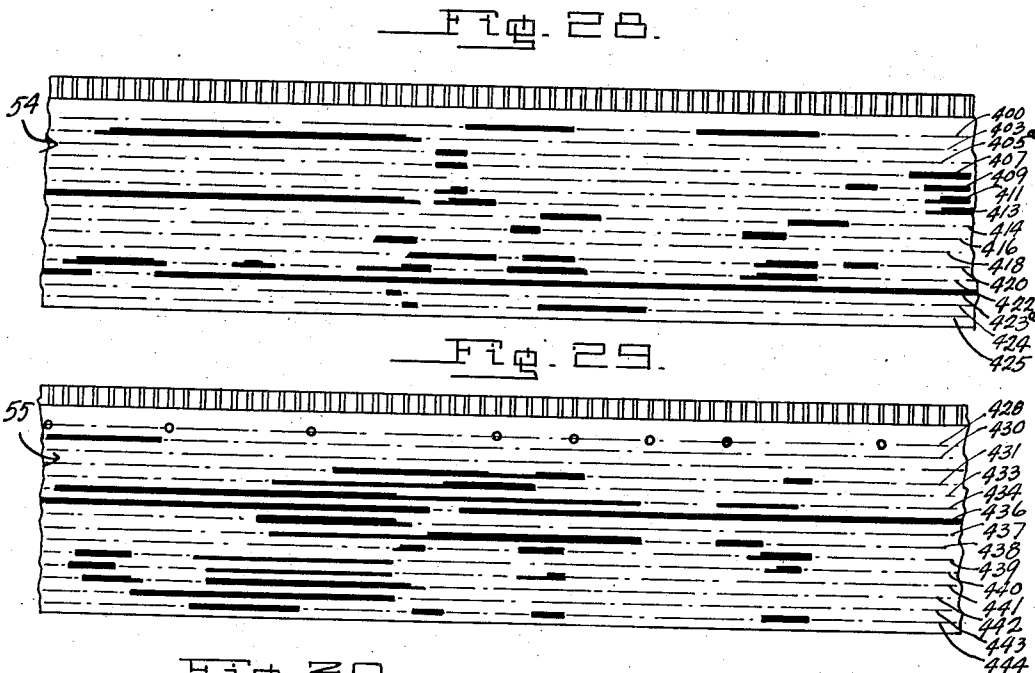
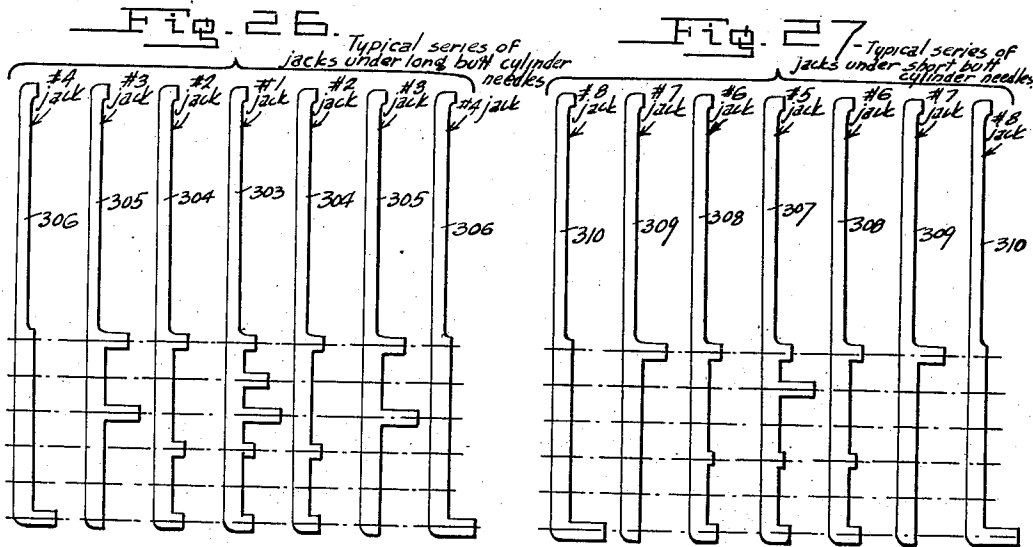
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KNITTING MACHINE

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KNITTING MACHINE

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Fig. 31.

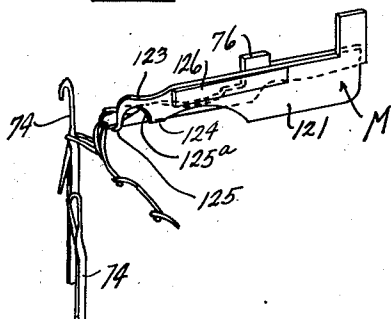


Fig. 34.

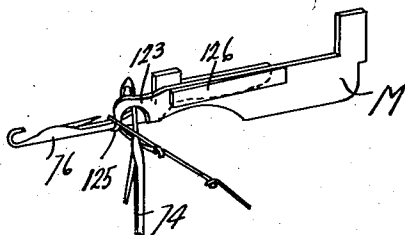


Fig. 32.

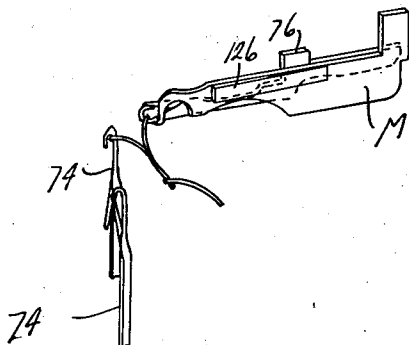


Fig. 35.

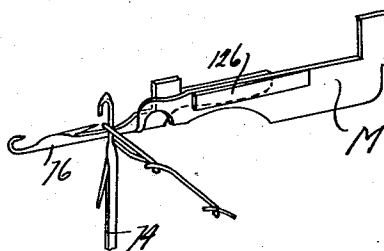


Fig. 33.

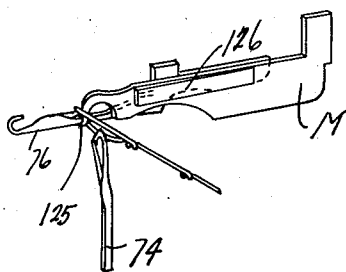


Fig. 36.

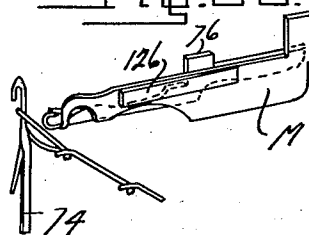
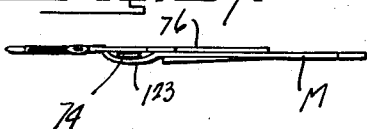


Fig. 37.



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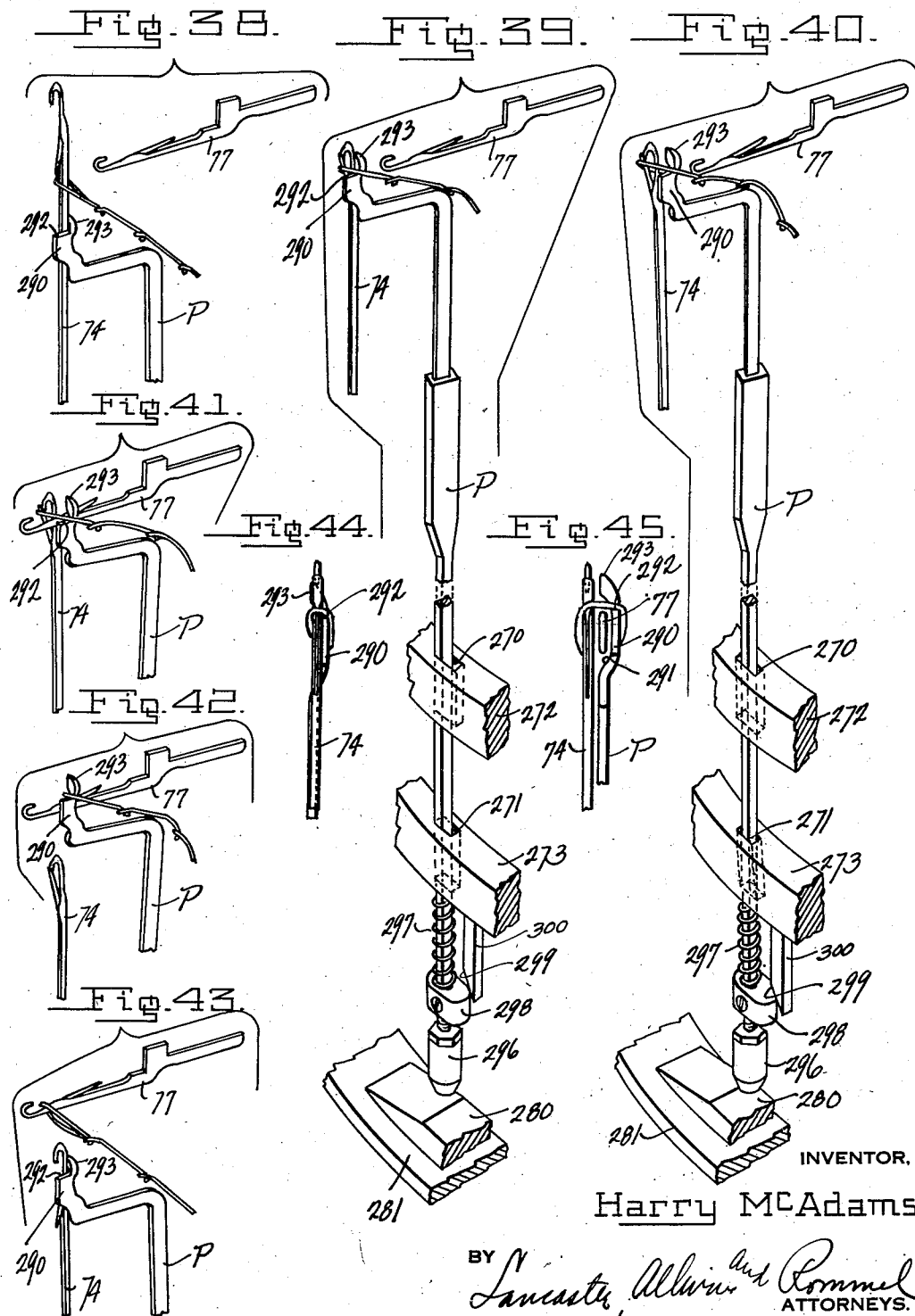
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H. McADAMS
KNITTING MACHINE

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UNITED STATES PATENT OFFICE

2,181,679

KNITTING MACHINE

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Application September 19, 1936, Serial No. 101,659

15 Claims. (Cl. 66—24)

This invention relates to improvements in knitting machines adapted for the knitting of continuous strings of stockings or other tubular work wherein the character of knitting is changed at different sections throughout the stocking or other article being knitted.

The primary object of the invention is the provision of an improved knitting machine whereon seamless knitted fabric, such as stockings, may be continuously knitted in an efficient and economical manner, and which machine incorporates the automatic transferring of stitch loops of the fabric between the various sets of needles of the machine for the purpose of varying the character of knitting throughout the article.

A further object of this invention is the provision of an improved knitting machine of the general type set forth in my application Serial No. 755,621, now Patent No. 2,164,337, but embodying improvements thereover.

A further object of the invention is the provision of an improved method for the knitting of continuous strings of stockings or like tubular articles.

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 2* is a fragmentary view of a yarn tensioning release mechanism.

Figure 3 is a vertical sectional view taken through the cylinder and dial of the improved knitting machine, showing associated details thereof.

Figure 4 is a fragmentary side elevation of a string of stockings such as may be produced upon the improved machine; the same showing a complete stocking with integrally connected and knitted portions of other stocking blanks at the ends thereof.

Figure 5 is a fragmentary side elevation of a string of the stockings, showing how they are tensioned upon the knitting machine during the knitting process.

Figure 6 is a developed plan view showing the cooperative needle action upon the improved knitting machine and the association of cam details as positioned for double feed knitting. This

particular view shows cooperative needle action for the knitting of one and one rib.

Figure 7 is a developed plane view showing the cylinder needle and jack arrangement during the transfer of stitch loops from the dial needles to the cylinder needles.

Figure 8 is a developed plane view showing the cooperative positioning of the cylinder needles, jacks, dial needles and transfer members for the transferring of stitch loops from certain cylinder needles to complementary dial needles.

Figure 9 is a plan view of an improved dial cap of the knitting machine, showing the associated cam control plungers and other parts.

Figure 10 is a perspective view of the improved dial cap.

Figure 11 is a bottom plan view showing the cam groove arrangement of the dial cap and the association of selector cam details for the control of dial needles and transfer bits associated therewith.

Figure 12 is a cross sectional view taken transversely through the dial cap just above the grooved dial cap plate and looking downwardly.

Figure 13 is an enlarged plan view of the slotted dial bed showing therein the associated relation of dial needles, transfer bits and improved dial needle jacks; the parts being arranged for the knitting of the selvage and plain knitting.

Figure 13* is a fragmentary plan view of a typical portion of the slotted needle bed of the dial showing the dial needle, jack and transfer bit guiding ribs, projections and slots.

Figure 14 is a diagrammatic representation of the butt arrangement upon the improved dial needle jacks, relative to two groups of dial needle selector cams which may be selectively operated to independently actuate desired dial needles.

Figure 15 is a vertical sectional view taken through the improved dial, showing the relation therein of dial needles, transfer bits and needle actuated jacks in relation to groups of selector cams.

Figure 16 is a view showing the manner in which certain dial needles are jack actuated by cams into yarn receiving and latch shedding position.

Figure 16* is a perspective view showing a typical group of dial needles and complementary transfer bits; the view incorporating certain needle jacks which are used in predetermined groups of the dial needles throughout the needle set, and which are used during the knitting of English rib sections in the stocking; this view

showing the arrangement in the long butt needle series.

Figure 16^b is a similar perspective view of dial needles, transfer bits and needle jacks in the short butt needle series.

Figure 17 is a perspective view of certain parts of the dial adapted more particularly to cooperate in camming and guiding the dial needle jacks.

Figure 18 is a fragmentary plan view taken through the upper portion of the knitting machine, above the dial cap, and more particularly showing the lever arrangement for actuating the cam and other details of the dial; the view also showing the auxiliary yarn feed and binder and cutter therefor.

Figure 19 is a fragmentary view of the sinker ring, showing a sinker arrangement of the improved machine in relation to cylinder needles and transfer members for the shifting of cylinder needles stitch onto dial needles.

Figure 20 is a fragmentary sectional view showing the locking mechanism for the auxiliary feed finger.

Figures 21 and 22 show an improved cam arrangement for the shifting of the dial bed in varying degree, for the purpose of changing the relation of the dial needles with respect to the cylinder needles as is necessary during the transfer of stitches between the needle sets.

Figure 23 is a vertical sectional view taken through the dial bed shifting means, substantially on the line 23—23 of Figure 21.

Figure 24 is a detailed view of the cam arrangement for actuating the cylinder transfer bits or members.

Figure 25 is a transverse sectional view taken through the cam of Figure 24, substantially on the line 25—25 of Figure 24.

Figure 26 shows in side elevation a typical series of jacks used under the long butt cylinder needles.

Figure 27 shows in side elevation a typical series of jacks as used under the short butt cylinder needles.

Figures 28 and 29 are respectively developed views of the upper and lower pattern drums of the machine, showing more particularly the cam or lug arrangement thereon for the actuation of various details of the machine.

Figure 30 is a fragmentary developed view of certain pattern drums used on the machine.

Figures 31 to 36 inclusive show the progressive positions of cylinder and dial needles and a dial transfer bit for the transferring of a dial needle stitch to a cylinder needle.

Figure 37 is a plan view showing the relation of dial and cylinder needles, and a transfer bit.

Figures 38 to 43 inclusive show the progressive position of a cylinder needle, a dial needle, and a cylinder needle stitch transfer member for the transferring of a stitch loop from a cylinder needle to a dial needle.

Figures 44 and 45 are respectively front elevations showing the relationship of a cylinder needle, dial needle, and transfer member; Figure 44 showing the transfer member in normal relation with respect to the cylinder needle, and Figure 45 showing it spread for opening the stitch loop and permitting the dial needle to enter the stitch loop more efficiently.

In the drawings, wherein for the purpose of illustration is shown but a preferred embodiment of the improved knitting machine, the letter A may generally designate the machine. It in-

cludes a frame B; cylinder C; dial D; dial and cylinder driving mechanism E, and a take-up F for tensioning and holding taut the string of stockings or fabric G produced upon the machine.

Generally the machine frame B includes a supporting bed 50 whereon the cylinder C is rotatably mounted. The operating parts of the machine, that is, so far as the drive of the cylinder and dial are concerned; the reciprocation thereof; the control of the stitch cams at the main knitting wave; the operation of narrowing and widening picks; the control of the yarn feeds at the main stitch cams, and many other features conventional to the Banner type of knitting machine are substantially identical to that disclosed in United States Patent No. 933,443, and such conventional operating, patterning, and control parts have not been detailed herewith, since they are conventionally understood in the art. Thus, the cylinder C is driven off of a main shaft 51 shown in Figure 2 of the drawings, whereon are positioned the usual gears and clutching mechanism to enable full rotary drive of the cylinder and dial, the inoperative positioning thereof, or the reciprocatory action of the same such as is necessary during knitting of the toe and heel pockets of a stocking. All of this mechanism is amply disclosed in the above identified Hemphill Patent No. 933,443. This gearing includes a gear 52 meshing with the gear 53 keyed to the cylinder, in the relation shown in Figure 3 of the drawings. The conventional "104" gear is shown at 53 in Figure 2 of the drawings, whereon may be positioned suitable lugs or mechanism for intermittently advancing the pattern control drums 54 and 55, hereinafter known as the upper and lower control drums. The arrangement for the intermittent control and operation is substantially identical with that described in my United States Patent No. 1,995,995, and need not herein be described in detail. As shown in Figure 1 of the drawings the machine also includes the usual pattern shaft 55^a on which speed and yarn changing cams, etc., are secured or mounted. It is of the type which makes one complete revolution during the production of each stocking or piece of knitted work, in accordance with the teaching in the above identified United States Patent No. 933,443. It has geared thereto an endless pattern chain 56 of conventional nature. The main yarn selecting and changing device has a drum 57 keyed to the cam shaft 55^a, provided with suitable cam lugs. Means 58 in the nature of wires, levers, etc. are provided for operating the yarn feed fingers 59, 60, and 61, at the main feed of the machine, all of which yarn finger operation and devices for control thereof is described in detail in said United States Patent No. 933,443. This cam shaft also has attached thereto a small pattern drum 60^a whereon are positioned certain of the part controlling cams of the present invention, as will be subsequently described.

The machine includes the conventional main cam block 61^a, shown in Figures 1, 6, 7 and 8 of the drawings, which has the usual raise and draw cams 62; the central cam 63 and the narrowing picks 64, all of which are operated in the usual manner, such as set forth in Patent No. 933,443 and need not herein be further detailed. There are also provided widening picks 65 also operated as described in said Patent No. 933,443. The usual Banner type mechanism for controlling the picks and needles and reciprocating the cylinder for the knitting of the toe and heel pockets, or other parts of the stocking are substantially iden-

tical with the mechanism described in Patent No. 933,443.

The cylinder C has the usual needle and jack slots. At its upper end it has the usual sinker bed ring 66 whereon the sinkers 67 are mounted for radial sliding in the usual web holding manner. They are of course controlled by cam means on the sinker cap 68, in conventional manner.

The dial and latch needles are of the independent type. The latch ring 69 is pivotally supported in the usual manner at 69^a. It has framework 70 mounted thereon for rotatably supporting the dial mechanism. In addition the latch ring supports the auxiliary yarn feed mechanism 71; the auxiliary yarn feed binder and cutter mechanism 72 and the leverage mechanism for operating the various cams on the dial (see Figure 18).

The needles of the cylinder and dial are of the pivoted latch type. The cylinder needle set designated at H in the drawings is divisible into long butt needles 73 and short butt needles 74. A set K of jacks cooperates with the cylinder needles for enabling the needles of the machine to knit rib, plain, variable rib and plain work, and for continuously knitting stockings and transferring stitch loops from dial needles to cylinder needles, and vice versa.

As shown in Figure 13 of the drawings the dial has associated therewith a set L of dial needles which consists of long butt needles 75, short butt needles 76, and needles 77 having butts of intermediate length. The medium butt needles 77 are scattered in groups throughout both the long and short butt series and they have associated therewith jacks 79 at the rear ends thereof, which are cam operated in a unique manner to provide for independent selection of the said medium length butt dial needles. Of course this principle of independent control of jacks need not be limited to the medium length needles, or to only a predetermined number of the needles, since the use of the improved selector means is generally adapted to all of the needles of the dial, however arranged.

Associated with the set L of the dial needles is a set of dial needle bits M. These bits or implements cooperate with the dial needles in properly positioning the stitch loops on the dial needles for transfer to predetermined cylinder needles. These features have generally been described in my above identified co-pending application Serial No. 755,621.

There are also provided in the cylinder set of needles cooperating transfer bits or implements P which enable the stitch loops of fabric hung on cylinder needles to be properly transferred to predetermined dial needles.

The dial D includes the radial slotted and rotatable needle supporting bed 80, best shown in detail in Figures 13, 13^a and 16 of the drawings, and the stationary cam plate 81 which is associated therewith. The dial mechanism is supported by the frame 70 on the latch ring 69. The frame 70 rotatably supports the vertical dial bed drive shaft 82 and of course the dial bed is keyed to this shaft 82 as shown at 83 in Figure 3 of the drawings. The shaft 82 is axially disposed with respect to the cylinder C and has a vertical adjustment through the supporting nut 84 mounted above the frame 70. The mechanism for driving the dial bed is substantially identical with that described in my co-pending application Serial No. 755,621 and consists of a shaft 86 geared at 87 to the cylinder gear 53. The shaft 86 at its upper end is provided with a dial bed

angular shift mechanism N, shown in detail in Figures 21, 22 and 23 of the drawings, which in turn supports a bevel gear 88 meshing with a bevel gear 89. The latter is on a horizontal shaft 90 supported by the frame 70 and is geared at 91 with the shaft 82, as shown in Figure 2 of the drawings. The dial shift mechanism N will be subsequently described in connection with the specific purpose which it serves. It is to be noted that the gear 89 lifts off of the gear 88 when the latch ring 69 is moved backward upon its pivot 69^a. The latch ring is supported at the front of the machine upon a frame bracket 93, shown in Figures 1 and 2 of the drawings and to which the latch ring may be latched at 94, as shown in Figure 2.

The take-up mechanism F is generally the same as shown in my United States Patent No. 1,991,563, and further detailed and described in my co-pending application Serial No. 755,621. In fact the nature of the take-up of the present invention is identical with the take-up described in my said application Serial No. 755,621, except as herein specifically modified. It includes a supporting frame 95 detachably mounted upon the lower end of the machine frame B. It has a revoluble frame 96 provided with rollers 97 between which the stocking or other article being knitted is clamped in order to provide tension thereon. The rollers 97 are driven in the same manner as set forth in my Patent No. 1,991,563. A clutch is included in the driving mechanism which is thrown out when the pull upon the fabric being knitted is such as to raise the frame 96, or when said frame 96 is mechanically raised by means to be subsequently described.

The means for driving the frame 96 of the take-up mechanism consists of an extension to the shaft 86. It has suitable gearing at its lower end meshing with the gearing of the take-up mechanism.

The take-up mechanism F furthermore includes a circular track 98, which has been described in my co-pending application Serial No. 755,621, and which is not shown to any great extent in the present application, but which is vertically movable with respect to the frame 95. The revolving frame 96 has rollers 99 which rest upon the circular track 98 and ride thereabout. During various operations, such as when knitting the heel and toe, and in some cases where plain knitting is resorted to, it is necessary to throw the take-up mechanism out of action so that it will not pull upon the fabric. Means to throw the take-up out of operation consists of supporting pins or posts 100 fixed at their upper ends in the track 98. These pins are reciprocal through suitable openings in the frame 95 and are moved by means of a lever 101 pivoted at 102 on the frame of the machine. The free moving end of the lever 101 is connected at 102^a with an operating leverage 103 which is actuated off of lugs upon the small pattern control drum 60^a, for the purpose of lifting the ring track 98 and throwing the clutch out of action to prevent the take-up rollers from tensioning the fabric during the knitting of the heel and toe, that is, when the cylinder is reciprocating. There is also provided means for throwing the take-up mechanism out of action during the transfer of stitches between the needles of the two sets. This means consists of a lever 104 pivoted at 105 on the machine frame. It engages at one end against the movable end of the throw-out lever 101, and at its opposite end has a connecting leverage 106 ex-

tending to and operating off of certain lugs on the upper pattern drum 54.

The string of stockings shown in Figures 4 and 5 is continuously produced upon the machine without the necessity of the operator stopping the machine to transfer rib tops to the machine. In the present machine the stockings are preferably knitted commencing with the welt top, but of course the features of the invention are adaptable to a machine which commences the knitting of the stocking at the toe. In the example shown the stocking string includes a welt 107, preferably a French welt; a one and one rib top 108; a leg 109 which may be either plain knitted or combination of plain and rib knitting. Thus, it is possible upon the machine to knit the leg of one and one rib; two and one rib; or any other desired rib arrangement conventionally known as English rib. In the example shown the stocking is preferably known as seven and three rib, but of course the machine is adaptable for any wale rib and plain proportioning. The stocking furthermore includes a heel pocket 110; instep 111 preferably knitted the same as the leg 109; sole 112; ring toe 113; toe pocket 114; loopers round 115, and a selvage 116. Sections 117 and 118 respectively designating ravel and slack portions are knitted between the toe of one stocking and the top of the next stocking. These sections provide a marker between the stockings due to the slackness. Partial unraveling in the section 117, as shown in Figure 5 enables the pull of the take-up mechanism upon the stocking just knitted to preserve an even circumferential tension upon the needles of the machine so that a tightly knitted and elastic welt and rib top may be provided in the next stocking.

Referring to the means for transferring the stitch loops from dial needles to cylinder needles, as is necessary when either altering the style of rib knitting or going from rib knitting to plain knitting, Figures 13 to 17 inclusive and 31 to 37 inclusive designate the mechanism and steps in the method of effecting such transfer.

In the dial there is provided a transfer bit or implement for each dial needle, although the arrangement is purely optional. As is shown in Figure 11 a dial cap is provided with grooves and cams for actuating both the dial needles and transfer implements. The inner groove 119 in the dial cap receives the butts of the transfer implements and determines the path of travel of said implements, and the outer groove 120 receives the dial needle butts and determines the path of travel of said dial needles. The bits M are of special construction. Each of them includes a body portion 121 relatively deeper than the body portion of the cooperating dial needle, as is indicated in various figures of the drawings, so that the lower marginal portion of said body portion of the bits may ride in slots 123^a provided individually therefor in the dial bed, as shown in Figure 13^a. This stabilizes and determines the path of movement of the dial bits. It is only the rear lower portions of the bits which ride in these slots; leaving the fore ends of the bits free to flex laterally and enable the dial needles and their bits to retract with respect to the complementary cylinder needles which are elevated to receive the stitches to be transferred from the dial needles to the cylinder needles, as is indicated in Figures 31 to 36 inclusive. The bits M at their fore ends are laterally curved or offset at 123 to provide an opening facing the complementary

dial needle and through which the complementary stitch receive cylinder needle slips, as indicated in Figures 31 and 36 inclusive. These offset portions 123 are reduced in height by recessing the lower portions thereof, where the cylinder needle enters the opening, as shown at 125^a in the drawings, so as to cooperate with the cylinder needle in permitting proper play of the parts and to efficiently transfer the stitch. The portion 124 of the transfer bit just rearwardly of this offset eye 123 has the lower edge thereof on the same level as the lower edge of the dial needle, or substantially at that level. The extreme fore end of each bit is provided with a lip 125 which extends beneath the lower edge of the dial needle and upon which the latter rests; the dial bottom being cut away to enable the said lip to fit in such position. This lip enters the stitch to be transferred from the dial needle to the cylinder needle in order to properly receive and hold said stitch.

In a normal rib knitting machine whereon it is intended to produce in automatic fashion a one and one rib top and a plain knitted leg, there would usually be employed one half as many dial needles as cylinder needles and in an alternating relation therewith, as can readily be understood by one skilled in the art. However, with the present machine it is intended to produce an English rib effect with a considerable number of adjacent wale lines in the leg of the stocking knitted of plain knitting upon the cylinder and intermediate these groups producing rib knitting upon two or more adjacent wale lines.

In order to knit an English rib it is therefore necessary in the dial to closely position those dial needles and the respective cooperating transfer bits which are used during such knitting. To that end medium butt dial needles and the complementary transfer bits M associated therewith are provided in groups which are disposed in a single radial groove or recess in the dial bed, and these groups comprise any desired number of dial needles, to suit the style of English rib to be knitted in the leg of the stocking. In the present instance seven and three rib is to be knitted in the leg, and therefore each of such groups comprises three medium butt dial needles 77 and three transfer bits M, all of which are placed in the same dial bed groove. The transfer bits have their individual slots 123^a to maintain the position thereof, and these groups of medium length butt dial needles are separated from the adjacent long and short butt dial needles and their transfer bits by radial walls 126, as shown in Figure 13^a. In each radial groove wherein three medium butt dial needles are disposed with their transfer butts there are provided radial lugs 127 near the fore end of the dial bed, to separate the three dial needles and their transfer bits from each other.

For the purpose of stabilizing the relation of the transfer bits M and the dial needles, lugs 128 are provided in alignment with the bodies of the transfer bits M which are disposed in the individual dial needle slots in the bed, as shown in Figure 13^a, and which lugs 128 fit in the offset eyes of the transfer bits M.

As before mentioned all of the needle butts travel in the dial cap groove 120, and the transfer implement butts travel in the groove 119. As shown in Figure 16^a and Figures 31 to 36 inclusive certain filler pieces 129 are soldered

to the side walls of certain of the transfer bits **M** in the groups which operate in the wide dial bed slots or grooves to prevent lateral play of the parts.

5 Jacks **79** cooperate with the three dial needles in each of the wide grooves of the dial bed for the purpose of selectively feeding their respective dial needles into position for stitch transfer relative to the cylinder needles. This means
10 of feeding the dial needles individually and selectively is not to be limited to the purpose set forth in this invention, since the jacks are entirely capable of being used for any purpose where it is desired to selectively feed the dial
15 needles in radial projection or retraction.

A plunger cam **130** is mounted on the dial cap for operation across the transfer butt groove **119**, for the purpose of engaging the butts of the transfer bits **M** and projecting them radially
20 outward into transfer position. This cam is shown in Figures 11 and 13 of the drawings. A second cam **131** is plunger operated across the groove **120** for the purpose of engaging the butts of the dial needles and projecting the dial needles
25 into position against the projecting cam **132**, either for stitch transfer or in order to take yarn at the auxiliary feed upon the machine. Another plunger cam **133** operates across the groove **120** at the main feed of the machine for
30 projecting the butts of the dial needles against a cam **134** in order to also project the dial needles into yarn receiving relation at the main feed of the double feed machine.

It will be noted from Figure 13 of the drawings and elsewhere that the transfer bits **M** are divided into a long butt series and a short butt series, and likewise the dial needles are divided
35 mainly into a long butt series and a short butt series, except that in both the short and long butt series of the dial needles there are additionally provided the above described groups of medium length butt dial needles which are intended to be used during the knitting of English
40 rib effects. The comparative butt lengths are shown adjacent to Figure 13, and in Figures 16^a and 16^b of the drawings. As more particularly shown in Figure 15 of the drawings the dial bed
45 **80** is provided with a radially slotted jack supporting ring **140**, keyed therewith as at **141**. This ring **140** has radial slots **142**, best shown in Figure 17 of the drawings, which receive and support the jacks **79** for radial movement. The
50 jacks **79** operate at the rear ends of each of the medium length butt dial needles **77** in the groups of three which are intended to interchange stitches with the cylinder needles. These jacks are longitudinally slidable and also vertically
55 rockable for a purpose to be subsequently described. They are provided, as shown in Figure 15, with shoulders **79^a** which operate against the rear or tail ends of the dial needles **77** so as to enable said dial needles **77** to be projected.

The jacks **79** have the butts thereof located at four different levels, although this arrangement is purely optional, since any desired
60 arrangement of butts may be provided.

As shown in Figure 16^a of the drawings, the jack **79** in a typical long butt dial needle series are provided with butts at the two upper levels,
65 and as shown in Figure 16^b of the drawings each typical group of short butt dial needles have jacks with butts at the two lower levels. The middle jack of each group of three used for stitch inter-transfer has the butt thereof at a lower
70 level than the other jacks of that group, in or-
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der to permit the dial needle cooperating therewith to be selectively divided from the adjacent dial needles, although this arrangement is purely optional.

In order that the dial needle jacks **79** may be properly actuated for the purpose of feed and transfer of yarn and stitches to the respective
5 dial needles with which they cooperate, there are provided upon the dial two sets of swinging cams **R** and **S**, shown in Figures 11, 13, and 14 of the
10 drawings. In each of these sets there are four of the cams. They may be independently controlled. In the set **R** there are four jack actuating swinging cams **151**, **152**, **153**, and **154**, and in the set **S** there are four cams **156**, **157**, **158**, and
15 **159**. Spring actuated cam-like plungers are provided for urging the swing cams radially outward. The sets of cams **R** and **S** are respectively pivoted at **160** and **161**. Spring actuated
20 plungers **162** and **163** are provided for actuating the cams of the set **R**. Referring to Figure 15 of the drawings the cams of the set **R** are shown in relation to the actuating plungers **162** and **163**. These plungers **162** and **163** are actuated by certain
25 leverage mechanism shown in Figure 18 and elsewhere in the drawings, and in turn these levers are actuated off a pattern mechanism to be subsequently described. The cam **162** has a cam slope **169** thereon so positioned as to only
30 actuate the upper two cams **151** and **152** of the set **R**, and the plunger **163** has a cam slope **170** thereon so related that when depressed it will only actuate the two lower cams **153** and **154** of the set **R**. Plungers **173** and **174** are also provided for actuating the cams of the set **S**. The
35 plunger cams **173** and **174** are so actuated that when the cam **173** is pressed to its lowest point, due to the fact that a bracket arm **177** is added to the cam **174**, the latter will also be depressed, although these cams **173** and **174** may be actuated
40 independently (see Figure 12). The cam **174** has its cam slope (not shown) so situated that it will only actuate the upper two cams **156** and **157** of the set **S**, and the cam **173** is intended to actuate the cams **158** and **159**, as shown in Figure 15 of the drawings. All of the plunger
45 cams **162** and **163**, **173** and **174** are spring actuated and normally retracted with respect to their various swinging cams of the sets **R** and **S**, as shown in Figure 15 of the drawings.

It is the purpose of the swinging cams of the sets **R** and **S**, through the jacks **79**, to so selectively actuate the needles **77** of the groups of three that the said needles may be fed into actuating relation with the cams **132** and **134**, for
50 projection purposes. This is accomplished in the following manner:

There is a cam ring **190**, shown in Figure 17 and elsewhere in the drawings, which is screwed to the under-central part of the dial cap. It has
55 jack actuating cams **191** and **192** positioned thereon, respectively opposite the cams **132** and **134**, and the purpose of which is to urge the jacks **79** and the respective needles thereof so that the latter may respectively engage the cams
60 **132** and **134** and be fed outwardly.

The jacks **79** are shaped as shown in Figures 15 and 16 of the drawings, each including a depending shank **200** on which a butt **201** is positioned at one of the levels of the cams **151**—**154** **70** and **156**—**159**. The jack furthermore includes a supporting shank **203** which rests in one of the slots **142** of the jack supporting ring **140**.

The under-side of the dial cap, as before mentioned, is provided with cams **191** and **192**, the
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opposite ends of these cams are sloped in a beveled manner at 208 so that a raised portion 204 on the jacks 79, which provides the shoulder 79^a above described, may ride during the circular travel of the jacks. These cams 191 and 192 are provided with sloping edges 210 and 211 respectively, which are adapted to engage shoulders 205 (see Figure 16) of the raised portion 204 of the jacks in order to feed said jacks 79 radially outward to a position where the needles 77 projected thereby may butt engage the cams 132 and 134 for further projection. It is thus understood that upon depression of the proper plunger 162, 163, 173, or 174, that a swinging cam 151—154, 156—159 will be actuated to move the jacks 79 with a butt positioned at the level of that particular swinging cam, so that the shoulder 205 may engage against the sloping edge 210 or 211 and thus assist in the initial projection of the dial needle 77. Normally the raised portions 204 of the jacks ride beneath the cams 191 and 192. The inoperative position of the jack is shown in Figure 15, and the operative position is shown in Figure 16. In order that the jacks 25 may be elevated after they are once depressed, as shown in Figure 15, a jack raising ring 216, shown in Figures 15 and 17 of the drawings, is provided, having depressions 216 therein permitting the jacks 79 to be depressed at locations beneath the cams 191 and 192 above described; the bevel on the ring 216 facing the depressions 216 elevating the jacks 79 after they have passed said cams 191 and 192, so that the jack is in position for proper actuation. The ring 216 is stationary, the same as the dial cap, and it is held stationary by means of a shank 220, shown in Figures 15 and 17, which is rigid on the ring 216 and engages in a socket in the dial cap, as shown in Figure 15.

The assembly of the dial bed 80 and the jack supporting ring 140 has been above described. It will be noted from Figure 15 that the latter overhangs a portion of the stationary ring 216 (see Figure 15) thus holding the ring 216 in position upon the dial bed 80, but permitting relative rotation between the same and the dial bed. The shank 220 detachably rests in its socket in the dial cap, so that the latter may be removed.

Referring to the manner of operating the various cams, plungers, etc. upon the dial and upon the latch ring, a shaft 225, shown in Figure 18 pivotally supports a series of levers 226. These levers actuate the various cam and part actuating plungers upon the dial cap, as is clearly shown in Figures 9 and 18. In addition there is also provided a lever 227, pivoted at 228 upon the latch ring, as shown in Figure 18, which is provided to throw into and hold in action the auxiliary feed finger 71^a, which is shown in Figure 20 of the drawings. All of these levers 226 and 227 extend to substantially the same points rearwardly of the axis of the cylinder of the machine where they are actuated by individual vertical reciprocating rods 230, shown best in Figure 2 of the drawings. These rods are in turn actuated by levers 230^a pivoted at 231 on the frame of the machine. Connecting rods 232 connect the levers 230^a with individual levers 233, which are pivoted at 234 on the machine, and actuated off of lugs on the lower pattern drum 55. Spaced depending shanks 235 on the machine guide the free ends of the levers 233. It is readily seen that a lug upon the drum 55 will actuate the levers 233 through the rod connection 232 the member 230 will be lifted in order to actu-

ate the various levers 226 or 227, as the case may be.

At the main feed location upon the machine, which is designated by fingers 59 in Figure 3 of the drawings, and also at the location 59^a on the latch ring shown in Figure 18, there is provided a binder and cutter mechanism. It is mounted upon the dial cap substantially the same as shown in my co-pending application, Serial No. 755,621 and includes a spring actuated cutter 240; a spring actuated binder 241 and a drag binder 242. The actual binding and cutting parts of these mechanisms are plunger actuated and as above described are operated by means of the levers 226.

The stitch regulating cam 133^a is pivoted on the dial cap at 133^b. It is normally spring urged to an outward position by means of a spring 133^c, shown in Figure 12 of the drawings, and engages a head portion 133^d of the cam 133^a, which is located on the top of the dial cap. This head 133^d as shown in Figure 18 of the drawings, is actuated by means of a plunger 245. The latter, as shown in Figure 1 of the drawings, is actuated by a lever 246, shown in Figure 1 of the drawings, and controlled off a pattern drum of the machine.

The binder and cutter at the auxiliary feed of the machine is shown in Figures 1, 2 and 18 of the drawings. It is controlled off of the pattern drum 54. As shown in Figure 2 the mechanism includes a spring urged slide bar 250 having a pin and slot mounting upon the latch ring frame. It supports an operating lever 251 pivoted at 252, and at its upper end operates against the cutter and binder bar 255. At its lower end the lever 251 is returned and actuated off of a cam 256 mounted upon the sinker ring of the cylinder, as described in my co-pending application Serial No. 755,621. A lever 257 pivoted at 258 operates against the pin on the slide bar 250. The lever 257 is controlled by linkage 259 (see Figure 2) off of one of a series of bell crank levers 260. The latter are actuated off of the drum 54, and intended to actuate a large number of cams and other parts of the knitting machine, as will be apparent from the drawings and the succeeding description. These bell crank levers 260 are pivoted at 261 upon the frame of the machine and their upper ends have various levers connecting them with the cams and parts of the machine to be operated. The opposite ends of said bell crank levers are actuated by means of reciprocating plungers 263 in the machine, which are lug actuated off the pattern drum 54.

It is to be noted that the slide bar 250 and the pivot shaft 252 are both mounted upon the latch ring.

The stitch transfer implements for transferring stitches from cylinder needles to dial needles are reciprocally mounted upon the inside of the cylinder C in a manner similar to that described in my above identified co-pending application Serial No. 755,621, although provision is made for tipping them and actuating them different from the corresponding transfer members of my said co-pending application. As shown in the drawings these transfer members P are closely arranged around the inner peripheral wall of the cylinder and they are slidably mounted for vertical and lateral tilting in suitable openings 270 and 271 in collars or supporting rings 272 and 273 fixed on the inside of the cylinder. A spring 274 is provided for each stitch transfer member P normally urging them at their upper ends to-

ward the respective cylinder needles with which they are associated. Normally their upper ends cooperate along the respective cylinder needles 74, as described in my co-pending application Serial No. 755,621, except as hereinafter qualified, for the purpose of lifting the stitches off of the cylinder needles in order that the dial needles may receive said stitches. The means for elevating and spreading the stitches consists of a movable arc cam 280, shown in Figures 24, 39 and 40 of the drawings, for radial movement upon a supporting ring 281 mounted detachably immediately below the cylinder bed of the machine, upon suitable brackets 282^a, as shown in Figure 3 of the drawings. In my above identified co-pending application there was a dual cam arrangement to effect stitch movement and spreading of the transfer members P, but in the present arrangement only one cam 280 is provided. Normally it is out of the path of travel of the transfer members P, but is movable radial outward to be positioned in their path, so that the transfer members P may be raised and laterally tilted to move and spread the stitch for dial needle reception. As shown in Figure 24 of the drawings the cam 280 has springs 282 normally urging the same inward, and it is provided with a depending pin 283 rigid therewith. This pin is actuated by means of a lever 284 pivoted at 285 upon the supporting ring 281 of the machine. The lever 284 is actuated by means of a lever 286. The lever 286, as shown in Figure 2 of the drawings, is actuated by a bell crank lever 287 pivoted upon the frame of the machine and connected by one of the rods 232 with one of the levers 233, actuated off the pattern drum 55.

Referring to the means for lifting and spreading the stitch by the transfer implements P, the latter is of the general construction detailed in my above mentioned co-pending application, except that in the present invention the transfer implement is provided with a stitch lifting head which moves away from the respective cylinder needle with which it cooperates in the direction of rotation of the cylinder, in order to spread the stitch and while the stitch is still hung partially on the cylinder needle. To that end the transfer implement P is offset at its upper end, at 290, as shown in Figure 45 of the drawings, to provide a dial needle entering groove 291 which lies in the plane of the body of the implement P. The cylinder needle 74 lies normally in the vertical plane of the groove or opening 291, as shown in Figure 44, so that the flange forming the offset 290 lies alongside of and in contact with the side of the cylinder needle. This head end of the implement is provided with a stitch engaging shoulder 292 having a lip 293 extending thereabove normally lying in the line of the needle and back of the needle for the purpose of entering the stitch so that as the implement P is lifted the stitch will come to rest upon the shoulder 292 with the lip 293 lying within the stitch, as is shown in Figure 44.

The lower end of each implement P is provided with a foot 296 which rides normally spaced above the cam supporting ring 281, but which is adapted to engage the cam 280 in order to lift the implement P for stitch entering and spreading purposes. This foot 296 is convergently beveled at its lower end and rides upwardly on the sloping end of the cam 280 and then along the cam and then down the rear sloping end. A spring 297 normally urges the foot 296 to its downmost position, shown in Figure 3 of the drawings. A radial

extension 298 is provided upon the implement P above the foot 296 adapted to engage a sloping cam face 299 of a cam 300 which is carried by the ring 273. Each implement P has one of the cams 300 and the purpose of it is to laterally tip the implement P away from the respective needle with which it cooperates in the direction of rotation of the cylinder in order to spread the stitch. This is accomplished by the radial extension 298 engaging the sloping shoulder 299, causing the implement P to fulcrum in the opening 271 of the supporting ring 273 and tilting it in the direction shown in Figure 40 for spreading the stitch as shown in Figure 45, so that the proper dial needle 77 may enter the stitch.

Inasmuch as the cam 280 is normally held out of position with respect to the implement P, and is movable radially into position for elevating the implement P, it is preferred to cut away portions of five or six of the feet 296 of the implements P, as shown at 301 in Figure 3 of the drawings, in order to enable the transfer cam to slip into position just ahead of the short butt section of cylinder needles.

The sequence of steps in transferring a stitch of the fabric knitted from a cylinder needle 74 to a dial needle 77 is shown in Figures 38 to 45 of the drawings. The normal position is shown in Figure 38 and the implement P is shown elevating into the stitch loop in Figure 39. In Figure 40 the implement P has spread the stitch due to the fact that the extension 290 has contacted the cam 300. In the next step, as shown in Figure 41 the dial needle 77 has entered the stitch. The cylinder needle 74 is then retracted, as shown in Figure 42, and then the transfer implement P is retracted as shown in Figure 43. The front elevation of the cylinder needle and the respective transfer implement P in the operation of entering and spreading the stitch are shown in Figures 44 and 45.

It should be noted from Figures 40 and 41 of the drawings that the stitch loop of the fabric which is to be transferred from the cylinder needle 74 to the dial needle 77 is hung on the upper end of the cylinder needle with the latch closed and ready to shift the stitch at a time that the bit end of the implement P is spreading the stitch in order to facilitate entry of the dial needles 77.

Referring to the cylinder needle and jack set up, the latter entirely depends upon the type of knitting which is to be done on the improved machine. The developed showing of the needle and jack set up is illustrated in Figures 6, 7 and 8 for the knitting of one and one rib in the upper section of the stocking, and a leg and instep of seven and three rib.

As shown in Figures 26 and 27 of the drawings there are six butt levels for the cylinder needle jacks. The latter are conventional in that the butts may be broken off to suit any desired length or level requirement. There are four lengths of butts used in the present set-up. The long butts are designated in full black in Figures 6, 7 and 8; the conventional normal short butts are shown in blank; the second short butts are shown with cross-hatching in the blank spaces, and the shortest butts are designated with an "X" at the butt location.

During one and one rib knitting, preferably in the top of the stocking, I employ alternate cylinder needles and all of the dial needles except in the groups of three dial needles 77 the center

dial needle 77 of each of said groups is not used during one and one rib knitting.

When transferring from one and one rib knitting in the top of the stocking to seven and three rib knitting in the leg of the stocking, as the invention is herein disclosed, it will become necessary to intertransfer stitches from certain dial needles to certain cylinder needles and from certain cylinder needles to certain dial needles. During normal one and one rib knitting alternate cylinder needles are active and the remainder of the cylinder needles are inactive. The dial needles 75 are all active during one and one rib knitting and the outside dial needles 77 of each group of three dial needles 77 are also active. When going into the knitting of seven and three rib it will be necessary to transfer the stitches from all of the dial needles 75 to the previously inactive cylinder needles. It also becomes necessary to transfer the stitch from the respective cylinder needle active during one and one rib knitting which is opposite the center dial needle 77 of each group of three dial needles 77 to that center dial needle 77.

In a typical jack set-up shown in Figures 26 and 27, the butt arrangements are different for the jacks under the long and short butt cylinder needles. Thus the center jack in each series of jacks under the long butt cylinder needles known as the #1 jack is designated by the numeral 303; the #2 jacks at each side thereof are designated by numerals 304; the next adjacent #3 jacks are designated by numerals 305; and the outside #4 jacks are designated by numerals 306. In a typical series of jacks under the short butt cylinder needles the center #5 jack is designated by numeral 307; the #6 jacks at each side thereof are designated at 308; the next adjacent #7 jacks are designated at 309, and the outside #8 jacks are designated at 310. These jacks have six butt levels which may be broken off at any desired level and at any desired length. In the present set-up, in contradistinction to the set-up shown in my co-pending application Serial No. 755,621, there are four butt lengths for cooperative cam actuation. The long butts are designated in full black; the normal short butts in blank; the second shortest butts are cross-sectioned, and the shortest butts are designated by an "X" in Figures 6, 7 and 8 of the drawings. In these figures it will also be noted that the jacks between adjacent typical groups of jacks under the short butt cylinder needles alternate with jacks 309 and 310, and under the long butt cylinder needles the jacks between adjacent typical groups of jacks alternate with jacks 305 and 306.

In the particular machine herein described, at the main feed the finger 61 may feed a body yarn to the needles, and other fingers 59 and 60 may feed such yarns as striping yarns, plating yarns, heel and toe yarns, reinforcing yarns, etc. Since the improved machine may be used in different attachments such as plating attachments, yarn wrapping attachments, etc.

At the auxiliary feed the yarn feed finger 71^a above described may be provided, as well as other feed fingers if desired for feeding of various yarns to the needles.

At the auxiliary feed of the machine a latch shedding cam 311 may be provided for cooperation with a knitting cam 312.

A power driven brush assemblage similar to that described in my above identified co-pending application Serial No. 755,621, is also provided for throwing open the latches of the dial needles as they are projected at the auxiliary feed of the

knitting machine, particularly during transfer operation. This brush (shown in Figure 2) may be thrown into or out of action with respect to the dial needles. It comprises a supporting frame 314, pivotally mounted at 315, having a brush 316 driven by an arrangement of bevel gearing 317 off of the shaft 86 above mentioned. A detailed operation of this power driven brush has been set forth in my above mentioned co-pending application.

Means is provided for shifting the dial of the machine in order to change the relation of dial needles to cylinder needles at the times of varying the character of knitting. This is accomplished in the following manner:

As shown in Figure 23 of the drawings the shaft 86 is provided with a sleeve 350 keyed thereto at 351^a. Splined upon the sleeve 350 at 351 is a vertically movable peripherally grooved member 352 having an upstanding cam extension 353 the nature and purpose of which will be subsequently described. The shaft 86 furthermore has a gear 88 rotatably mounted thereon and only keyed for rotation with the shaft 86 by a portion 357 which cooperates with the cam extension 353 in order to vary the angular relation of the gear 88 with respect to the shaft 86. As shown in Figures 1 and 2 of the drawings the gear 88 is meshed with the dial driving gear 89.

The cam extension 353 has three cam positions upon it, designated at 360, 361, and 362 in the drawings, as shown in Figures 21 and 22. The sleeve 350 is provided with adjustable cam cooperating pins or members 364 and 365 at opposite sides of the the cam extension 353. The degree of angular shift is shown at 370 and 371 in Figure 21 of the drawings. With the pin 365 in contact with the surface 360, as shown in Figure 21 of the drawings, there will be permitted an angular shift of the gear 88 in two directions relative to the shaft 86 from this position. The cam extension 353 is raised and lowered by means of a yoke 373 which extends into the peripheral groove of the collar 352, as shown in Figure 23. As shown in Figure 2 the yoke 373 is pivoted at 374 on the frame of the machine and intermediate its ends it is pivotally attached to a connecting rod 375 which in turn is pivoted at one end to a lever 376. The latter is pivoted at 377 on the frame of the machine and is connected by rod 379 to a pattern controlled plunger 378 operating off of the drum 55.

Referring now to the relation of cylinder and dial needles, and the reasons for shifting the dial needle position with respect to cylinder needle position, during knitting of the one and one rib top 108 of the stocking the cam extension 353 is in the position shown in Figure 21 of the drawings, with the contact pin 365 engaging the surface 360 of this cam. In this position the relation of the cylinder and dial needles is that shown in Figure 6 of the drawings, with the center dial needle 77 of each group of three dial needles 77 lying slightly to the left of the complementary cylinder needle 73. During knitting of the regular rib top the cylinder needles are centered in the center of the bit eye with respect to the dial needles, since the load of the yarn and needles working in the dial will create a drag and thus center the dial needles in this way. This position is maintained until the change from rib top knitting to leg knitting of the stocking G. The change is made after the transfer of stitches from dial needles to cylinder needles has taken place, but before the change of stitches from the cylin-

der needles to dial needles has taken place. Thus, as shown in Figure 7 the position during change of stitches from dial needles to cylinder needles is the same as during rib knitting, but when it is desired to transfer the stitch from the cylinder needle to the center dial needle of each group of three dial needles 77, in order to go into knitting of seven and three rib in the leg portion of the stocking, it becomes necessary to shift the dial to the right. This is accomplished by elevating the cam 353 to the position shown in Figure 22 of the drawings, which shifts the entire dial to the right and positions the center dial needle 77 of each group of three dial needles 77 to the right of its complementary cylinder needle, and in position to permit the transfer members P to lift the stitches from the cylinder needles so that the center dial needle 77 which is to receive the stitch may readily slip into the eye of the transfer member P, as is shown in Figure 8. At the time that the cam 280 which elevates the stitch transfer members P in the cylinder goes out of action the cam 353 is automatically shifted to the position shown in Figure 21 and remains in that position until transfer of stitches at the heel of the stocking becomes necessary. During heel transfer when the center dial jack 79 in the short butt section of dial needles is actuated upon by the swinging cam 154 the dial is shifted to the left by the pin 365 operating in the cam position 361. When the plunger cam 154 goes out of action, the cam 353 again shifts to the position shown in Figure 21, with the pin 365 in engagement at the surface 360 and this position is maintained until the start of the toe transfer. At the time of toe transfer the dial remains in the position shown in Figure 21 until the swinging cam 152 on the dial moves down to operate the butt of the center jack 79 at the #2 level, and at which time the dial is shifted to the position 361 and immediately thereafter moves back to the position 360 when the cam 152 goes out of action. Thus it can be seen that during transfer from the top to the leg the dial is shifted once to the right in order to position the normally inactive center dial needle to the right side of the previously active cylinder needle, in order to provide proper stitch transfer. Again at the heel and toe when transferring from the three dial needles to the complementary cylinder needles in order to perfect plain knitting in the heel and toe the dial shifts to the left because the dial not having a heavy load at this time runs ahead and it is necessary to shift the dial counter to normal rotation in order to bring the dial needle into proper position for transfer. The position of the dial and cylinder needles shown in Figure 13 is that used when knitting the selvage of the ring toe. In this position the cylinder needles are just slightly ahead of the complementary dial needles, due to the fact that there is no load on the dial and the gears will enable the dial to assume that position.

The auxiliary feed finger 71^a is spring actuated to normally be thrown out of position. The lever 227 pushes upon a spring actuated plunger 400^a in order to depress the lever feed finger 71^a into feed position, and as shown in Figures 18 and 20 a spring actuated lock lever 401^a is provided which slips into a notch in the plunger 400^a to hold the same locked in position and the feed finger 71^a in feed position against its normal spring action. This lever 401^a is thrown out of action against its normal spring tendency by the

lever 251 when the latter throws the binder and cutter mechanism 72 into action.

The various cylinder needle and cylinder jack actuating cams, to be subsequently mentioned during a description of the cycle of operation are lever operated, as shown in Figures 1 and 2 of the drawings, off of various lever arrangements controlled by the bell crank levers 260, which are actuated off of the pattern drum 54.

At the main feed, the yarn 405 feeds off of the finger 61. It is necessary to vary the tension of this yarn in order that extra tension may be placed on it during knitting of rib top. This is to insure the making of a good elastic rib top. The variation in tension is accomplished as follows:—In addition to the normal tension (conventional tensioning devices not shown) there is provided an additional device 410^a shown in Figure 2^a of the drawings, comprising spring pressed plates between which the yarn 405^a passes, as is usual with tensioning devices. A pointed lever 412^a is provided to separate the plates, as when knitting of this yarn into the leg of the stocking. As shown in Figure 2 of the drawings this lever 412^a is in turn actuated upon by a leverage mechanism 413^a which is controlled off of the pattern drum 55, so that the above mentioned varied tension on the yarn may be effected.

Referring to the developed pattern drum layout shown in Figures 28, 29 and 30, Figure 28 shows the lug lay-out for the upper pattern drum 54. The dot and dash line 400 designates the lug lay-out for operating the cylinder needle jack cams 401 and 402 shown best in Figures 6, 7 and 8 of the drawings, both of which are operated off of the same leverage mechanism (not shown) controlled off of one of the plunger operated bell crank levers 260 (see Figure 2). The lugs along line 403 actuate the auxiliary feed knitting cam 312; the lugs along the pattern drum cam 405^a actuate the cylinder jack cam 406, shown in Figures 6, 7 and 8 of the drawings; the lugs along the path 407 actuate the cylinder jack cam 408; the lugs along the path 409 actuate the cylinder jack cam 410; the lugs along line 411 actuate the cylinder needle retracting cam 412; the lugs along line 413 actuate the auxiliary feed needle elevating cam 311; the lugs along line 414 actuate the cylinder needle jack cam 415; the lugs along line 416 actuate the cylinder needle jack cam 417; the lugs along line 418 actuate the cylinder needle jack cam 419; the lugs along line 420 actuate the cylinder needle jack cam 421; the lugs along line 422 actuate the cylinder needle lowering cam 423; the lugs along path 423^a actuate the power operated brush 316; the lugs along line 424 operate the binder mechanism 72 at the auxiliary feed, and also release the yarn finger 71^a; the lugs along path 425 operate the web take-up mechanism F, that is, as above described lifts and lowers the same into and out of clutching action through the leverage mechanism 106 above described.

Referring to the lug lay-out on the lower pattern drum 55, as shown in Figure 29, the pins along the line 428 operate the trip for the detent mechanism of the machine, in accordance with the pattern control for the upper and lower drums, such as has been more specifically detailed in my United States Patent No. 1,995,995. On this lower drum 55 the lugs along line 430 operate the yarn tensioning mechanism 410^a as above described, through the leverage control 413^a, as shown in Figure 2. The lugs along line 441 actuate the jack cam 422; the lugs on line

433 actuate the plunger cam 173 for regulating the dial needle jack cams, as above described; the lugs along line 434 actuate a leverage mechanism 435 (shown only partially in Figure 2 of the drawings) in order to shift the sinker cap so as to loosen the stitches during knitting of certain parts of the stocking, such as the rib and leg. The lugs along line 436 are used to actuate the cam 280 for moving the transfer implements P into stitch transfer relation on the cylinder needles with respect to the dial needles; the lugs along line 437 operate dial cam 133; the line of lugs 438 actuate the plunger cam 174 for moving the dial needle jack cams into position as above described; the line of lugs 439 actuate the plunger cam 130 for controlling the projection of the dial needle transfer bit; the line of lugs 440 and 441 respectively actuate the plunger cams 162 and 163 for swinging the cams R which move the dial jacks into position; the line of lugs 442 actuate the dial needle projecting cam 131; the line of lugs 443 actuates the auxiliary yarn feed finger 71^a, and the line of lugs 444 operates one of the plunger cams 378 and through the linkage 375—376—379 operates the cam 353 for shifting the dial as above described.

In Figure 30 is diagrammatically shown the pattern lug lay-out on drum 60^a. The position of it during the knitting of the top, leg, heel, foot and toe is shown in the drawings. The line of lugs 450 actuates the needle raising cam 451; the line of lugs 452 actuates the needle lowering cam 453; the line of lugs 454 actuates the take-up mechanism F through the leverage 103 above described; the line of lugs 456 actuates the usual gap closing mechanism at the main feed location on the latch ring (not shown). On drum 57 the line of lugs 458 actuates the leverage mechanism 58 for feeding the binding yarn 461 on finger 60, to the cylinder needles at the position 116 in the knitting of the stocking G; and the line of lugs 460 controls through leverage 58 the heel, toe and body yarn feed finger 61.

Various stationary leveling cams are provided, such as 470 and 471.

Referring now to the cycle of operation, salvage 118 of the stocking is knitted upon alternate cylinder needles using only the main feed yarn 61, for approximately eleven courses. At this time cam 423 is moved into operation to lower the active needles on which this section 118 is knitted, in order that the dial needles may be brought out into position so that the brush 316 can throw their latches open. Plunger cam 131 is now lowered to bring the long and medium butt dial needles into projected relation so that the said brush 316 may open the latches. At this time the plunger cams 162 and 163 are depressed in order to open the swinging dial jack cams 151, 152, 153 and 154 (see Figure 14). This brings the medium butt dial needles which are controlled through the jack arrangement above described, into projection so that the latch brush may open them. Thereafter the latch butt 316 is thrown out of operation through the means above described. Cams 311 and 312 are now moved into knitting position getting ready for two feed knitting, that is, knitting at the auxiliary feed as well as the main feed. Dial jack operating plunger cams 162 and 163 are withdrawn and also dial needle cam 131, and at this time the brush 316 is thrown out of action.

At the time that the cams 311 and 312 are thrown into action the auxiliary feed finger 71^a is moved down to active position. The needle

lowering cam 423 is then retracted and this permits the alternate cylinder needles to take the auxiliary yarn at feed finger 71^a for double feed plain knitting in order to finish the section 102 of the stocking, through about nine courses.

I now come to the start of the French welt. Plunger 162 is moved into position half-way by the means above described to operate the cam 151, and at the same time the cam plunger 163 moves half-way down in order to operate the cam 153. The plunger cam 131 is then depressed in order to throw the long and medium butt dial needles against the needle projecting cam 132 and thus move them into yarn feeding position. The machine makes one revolution with the dial needles in the position for taking yarn at the auxiliary feed on both cylinder and dial needles and upon the cylinder needles only at the main feed. The cam 423, shown in Figures 6, 7 and 8 is then thrown into operation half-way in order to lower the long butt cylinder needles, and then it goes in the whole way to lower the short butt cylinder needles. This puts the cylinder needles in position to miss the auxiliary feed yarn at the yarn finger 71^a. However, the feed yarn finger 71^a at this time does feed yarn onto the dial needles in order to knit the inside web of the welt 107 for several courses. The outside web of the welt is knitted at the main feed 61 onto the alternate cylinder needles for several courses. In order to join the webs the cam 423 is retracted one half-way and then the whole way and allows the alternate cylinder needles to take the yarn at the auxiliary feed and to knit the joining course of the French welt. I am now knitting the rib top at the auxiliary feed. At the main yarn feed I throw in the plunger cam 133, one half-way, and then the entire way in order to first throw the long and then the medium butt dial needles onto the dial needle projecting cam 134. At the same time the yarn tensioner 410^a is permitted to place additional tension on the yarn fed at the main feed, so as to render the rib top more elastic. At the same time the plunger cams 173 and 174 are thrown in one half-way in order to cam out the pivoted selector cams 156 and 158 and medium butt dial needles whose jacks 79 have butts at the levels of said cams 156 and 158 are projected by the means above described onto the cam 134. In this manner all of the dial needles except the center dial needles 77 of each series of three dial needles 77 are now operating off of cam 134 and take the main yarn feed at 61 to knit two feed rib. This continues for the entire rib top section 108 shown in Figure 4. It should be noted that during knitting of the rib section the alternate cylinder needles are buried and inactive.

I now come to English seven and three rib knitting. Preparatory to stitch transfer for the knitting of seven and three English rib, the cam 423 is thrown into position one half-way, in order to lower the long butt cylinder needles, which were active during rib knitting preparatory to transfer from dial needles 75 to the respective cylinder needles. The transfer position from dial needles to cylinder needles is shown in Figure 7 of the drawings. Cam 419 is thrown into position at this time, engaging the long butts of the jacks 303 and 305 in the long butt series of needles in order to elevate them for receiving the yarn at the auxiliary feed 71, since the move of lowering the needles by cam 423 is merely preparatory. The cam 432, shown in Figure 6 is now thrown in the entire way in order to lower the series of jacks 304 and 308 so they will ride under the cam 421. The cam 423 then moves in the entire way

to take the short butt cylinder needles down to a transfer position and cam 419 is retracted so as not to raise the long butt cylinder needles any longer for knitting of the auxiliary yarn. Plunger 163 is then retracted, and this retracts the cam 153 preparatory to stopping dial needle knitting. The plunger cam 130 that operates the dial transfer bits M is then moved into position one half-way to move the long butt bits thereof, which lie in the short butt dial needle section, to a transfer position. At the same time cams 311 and 312 at the auxiliary feed are retracted one half-way to miss the short butt cylinder needles. Then cam 421 is moved into position one half-way and then the entire way, bringing the alternate cylinder needles which were inactive during the knitting of the rib top up to a position for transfer with respect to the dial needles. Cam 130 then moves in the entire way to bring the short butt transfer bits which cooperate with the dial needles 76 into a projected position. Cams 311 and 419 come out the entire way to miss the long butt cylinder needles. The yarn feed finger 71^a is then raised out of action and the binder and cutter mechanism 72 serves to bind and cut the yarn at the auxiliary feed finger 71^a. The entire transfer operation from dial needles to cylinder needles is accomplished in one course and the transfer from cylinder needles to dial needles is accomplished in one course. The entire inter-transfer operation between these needles takes place over two and one-half courses. This is, there is one-half of a course which is inactive so far as actual transfer is concerned. I am now transferring stitches from the short butt dial needles to the long butt cylinder needles, that is, the dial needles 76 are transferring in the short butt section and then the long butt dial needles 76 are transferred. Cam 133 moves out one half-way and then the entire way to release the long and medium butt dial needles from taking main yarn at the main yarn feed and at the same time the tension is released at 410^a by the means above described. All of the dial needles 76 have now transferred their stitches to the previously inactive cooperative and complementary alternate cylinder needles, except the two end dial needles 77 of each series of three dial needles 77. The plunger cams 130 and 131 now are retracted one half-way and then the entire way. When transferring from dial needles to cylinder needles we continue knitting rib at the main feed upon the two end dial needles 77 of each of these series of three.

We are now ready to transfer from the cylinder needles, with which the implements P cooperate, in order to lift the stitches therefrom to the center dial needles 77 in each group of three dial needles 77. At the start the cylinder cam 423 is retracted the entire way. The cams 406 and 408 move in the entire way. Cam 412 moves in one half-way. The cams 406 and 408 elevate all of the cylinder needles which are not to be buried to a level above cam 412. The transfer implement cam 280 then is moved into position to raise the transfer implements P. Cam 311 then goes into action to elevate the needles and move the stitches under the cylinder needle latches, as shown in the position represented in Figure 38 of the drawings. Plunger cams 173 and 174 are then depressed the entire way from their one half-way position in order to operate the swinging cams 157 and 159 in order to bring the dial needles which cooperate with those jacks 79 having butts at the level of cams 157 and 159 into position between the previously elevated cylinder

transfer implements P and the cylinder needles with which they cooperate. The cylinder needles and their implements have been spread due to movement of the transfer implements upon the cams 300, as above mentioned. The center dial needles 77 thus enter the stitches on those cylinder needles from which the stitches are to be transferred. The cam 412 then moves in the entire way in order to lower all but the cylinder needles which have transferred their stitches. Thereafter cams 412, 408, 406 and 280 are retracted and a half cylinder turn later the cams 421 and 311 are retracted. The cam 432 then moves out just sufficient to miss the jacks 307 and 308, but is still in position to engage the jacks 303 and 304, preparatory to transferring at the heel. This cam 432 stays in during the knitting of the entire leg, in this position. Cams 401 and 402 go into action preparatory to transferring at the heel, in order to lower all the long and medium butt jacks so cam 421 will not engage them at the heel transfer. Knitting is continued thus throughout the leg to the heel of the stocking.

Transferring at the heel is accomplished in the short butt section of the needles. It is necessary at this point to transfer the stitches from the dial needles in the short butt needle sector to the complementary cylinder needles. Cam 423 moves in the entire way. Cams 415 and 417 move in the entire way to position the jacks for heel transfer. The cam 417 operates on the second butt line of jacks 307 so the bottom butt thereon will miss the cam 421. The cam 421 moves in the entire way. Cam 173 is retracted the entire way and cam 163 moves in one half-way in order to project the swinging cam 153 so as to hit the jacks 79 which operate the two dial needles 77 at the outside of each group of three dial needles 77, in the short butt dial section. Plunger cam 130 is now projected one half-way, in order to bring out all of the long butt dial needle transfer bits preparatory to transfer. Jack cam 421 now brings the cylinder needles which are above the jacks 308, in the short butt cylinder needle section into the stitches of the projected dial bits and needles. Cam 417 is then retracted and cam 415 comes out half-way to miss the butts on center jack 303. Plunger cam 163 is then projected the whole way in order to operate on the swinging cam 154 for projecting the center dial needles in each group of three dial needles 77 in the short butt dial needle section, into a transfer position. The three cylinder needles now receive the stitches from these groups of three dial needles 77, in the short butt dial needle section. Plunger cam 163 now goes out of action as does also cam 130. Cam 421 is retracted. The heel transfer has now been completed and I am ready to knit the heel.

Cams 423, 415, 432, 401 and 402 now come out of action. Cam 174 is retracted. Cam 451 is now thrown into action in order to raise the long butt cylinder needles for heel pocket knitting. I now use four courses of plain knitting before reciprocating. Reciprocating for knitting the heel pocket is accomplished at the main feed.

Going into knitting of the instep and sole of the stocking plunger cam 174 operates the swinging cams 156 and 157 in order to project the dial needles 77, that is, each group of three dial needles in the long butt dial needle section. Cams 401 and 402 are thrown into action on the cylinder needle jacks to place them in position for

transfer at the ring toe. I now knit the instep and sole.

In order to knit the ring toe it is necessary to transfer the three dial needles 77 in the long butt needle section to their complementary cylinder needles, that is, at the end of the instep. This is accomplished by throwing cam 423 into operation and also cam 417. The duty of cam 417 is to move jacks 303 into position so as not to engage the cam 421. The plunger cam 162 is now moved into position one half-way to operate the swinging cam 151 in order to project, through the jacks 79, the two end dial needles 77 in each group of three dial needles 77 in the long butt dial needle section to transfer position. Cam 130 is now thrown into operation half-way to bring the long butt dial needle transfer bits out. Cam 421 moves in and brings the jacks 304 which lie in the long butt cylinder needle section up so that the cylinder needles thereabove may enter the stitches of the dial needles which have thus been projected. Plunger cam 174 which operates the swinging cams 156 and 157 is retracted. Cam 417 is retracted. Cam 415 moves in to raise the central jacks 303 above the cam 432. Plunger 162 now moves in the entire way to operate the swinging cam 152 in order to bring the center dial needle 77 in each group of three dial needles 77 in the long butt dial needle sector to a transfer position. Transfer now takes place. Plunger cams 130 and 162 are then brought out of action, as are also cams 423 and 421. Cams 415, 401 and 402 are now dropped out of action. Cam 410 is moved in the entire way and stays in for several courses and then comes out. This brings the jacks back to normal position. I now knit the ring toe 113 for about twenty courses.

Cam 451 is now thrown in to raise the long butt needles, and the machine is oscillated to knit the toe pocket 114 in the usual manner. At the end of the toe pocket the cam 453 goes in to pull the long butt cylinder needles down to place the machine in condition for circular knitting, for the loopers round, which takes place through sixteen courses at 115. The yarn finger 60 at the main yarn feed now drops into position to knit a binding yarn 461 for four courses and thereafter it comes out. I now knit eighteen courses of plain single feed full circular knitting on every cylinder needle. Thereafter cams 410 and 408 go in followed by cams 311 and 412. This cam action buries the alternate cylinder needles and the yarn stitches are run back from the needles which are thus buried. This enables an evening of tension to take place on the stitches hung on the cylinder needles. This position of the fabric is shown in Figure 5 where the stitches under action of the tensioning device have run back to line 500. Cams 410, 408 and 412 now come out of action and the selvage 118 is now knitted on alternate cylinder needles. The machine then proceeds in the above described manner to again knit the French welt and continue the automatic knitting of stockings in stringwork.

Attention is called to the pointed tip on the head of the needle. Ordinary knitting needles are rounded, as shown for the dial needles in Figures 31 to 36 inclusive, but as also shown in those views the cylinder needle is distinctly pointed at the tip to facilitate stitch entry.

The bars 127 separating the three needles 77 in each group of the dial are extremely important since they support the needle in proper position and prevent the fabric from pushing the

needles 77 together. That is, the tightness of the stitch would ordinarily pull the two outside needles 77 of each group towards the center dial needle. These bars prevent this and do away with other means for making the stitch longer. The portion of the yarn between adjacent stitches on the dial needles 77 are now stretched around the front edge of these bars 127 and not straight across. This is important.

The loosely knitted section 117 serves as a severing marker between adjacent stockings.

Various changes in the shape, size, and arrangement of parts may be made to the form of invention herein shown and described, without departing from the spirit of the invention or the scope of the claims.

I claim:

1. In a knitting machine the combination of two sets of needles, means operating on said sets of needles for knitting rib work, means for inter-transfer of stitches from one set of needles to the other and vice versa, for varying the character of rib knitting, means for knitting fabric on either set of needles independent of the other, and means for automatically laterally shifting the relation of one set of needles with respect to the complementary needles of the other set in order that inter-transfer of the stitches may be effected.

2. In a knitting machine a cylinder, a set of cylinder needles, a dial, a set of dial needles, means for feeding fabric to said two sets of needles, means for maintaining the two sets of needles in such relation that the dial needles are slightly offset with respect to the complementary needles of the cylinder set, and means for shifting the dial relative to the cylinder from that position both in the direction of rotation and counter to the direction of rotation of said dial and cylinder to vary the angular spacing of complementary needles of said two sets.

3. In a knitting machine the combination of a cylinder, a dial, a set of cylinder needles, a set of dial needles, means for knitting one and one rib fabric upon said sets of needles, means for automatic inter-transfer of stitches from one set of needles to the other set of needles and vice versa in the same general course location whereby to knit English rib fabric upon said sets of needles with the active dial needles in groups of three or more immediately adjacent dial needles.

4. In a knitting machine, two sets of needles, independent carriers therefor, means for knitting fabric upon said two sets of needles, means for inter-change of stitches from one set of needles to the other and vice versa to vary the character of knitting, means during knitting of the fabric to normally maintain a tension upon said fabric as it is held upon the needles of said carriers, and means during the different operations of stitch transfer from needles of one set to the other and vice versa for automatically releasing the tension on the fabric.

5. In a knitting machine the combination of a set of dial needles, a set of cylinder needles, transfer implements cooperatively related with the cylinder needles to lift the stitches therefrom for transfer to the complementary dial needles, said transfer implements being located at the advancing side of the respective cylinder needles, and means for moving said implement at the stitch holding ends thereof away from the respective cylinder needles in the direction of rotation of the cylinder whereby to spread the

stitch and permit entry of the respective dial needles.

6. In a knitting machine the combination of a dial, a set of dial needles, a cylinder, a set of cylinder needles, stitch transfer implements individually associated with predetermined cylinder needles, means for moving said transfer implements along the cylinder needles to move the stitches thereon into transfer relation with the dial needles, and additional means for laterally distending the stitches after they have reached the transfer position in order to permit the dial needles to readily enter the same.

7. In a knitting machine the combination of a rotary carrier, a set of needles therefor, a second rotary carrier, a set of needles therefor, said carriers being associated together with their needles for the production of ribbed knitted fabric, transfer members individually associated with predetermined cylinder needles, means for moving said transfer members along their associated cylinder needles for moving the stitches on said cylinder needles into transfer relation with predetermined dial needles, said transfer members and their associated cylinder needles being shaped to permit a dial needle to enter between the said transfer member and its cylinder needle during a stitch transfer relation while the stitches are hung on both the cylinder needle and the transfer implement, and means for moving said dial needle to take the stitch to be transferred.

8. In a knitting machine the combination of a cylinder, a set of cylinder needles, a dial, a set of dial needles, means for independently moving the needles of both the cylinder and the dial, means for selectively elevating the cylinder needles to shed stitches thereof below the latches at the time of desired transfer of said stitches to dial needles, stitch transfer implements associated with the cylinder needles for bringing and holding the stitches on the cylinder needles to transfer relation with the dial needles, means for laterally moving the transfer implements while the stitches are hung in latch shedding relation on the cylinder needles for distending the stitches, and means for selectively projecting the desired dial needles into the stitches to effect a stitch transfer thereto.

9. In a knitting machine a cylinder, a set of cylinder needles, a dial, a set of dial needles, individual jacks for the dial needles having portions engaging the needles for projecting them and additional portions extending transverse to the line of the jacks and having butts thereon at different predetermined levels, selector cams within the dial at different levels for acting on said jack butts, and means for actuating said cams to selective operative relation with said butts.

10. In a knitting machine the combination of a cylinder, a set of needles therefor, a dial, a set of needles therefor, jacks individually associated with the dial needles, means for rotating the cylinder and dial, a stationary dial cap, said dial needle jacks having butts thereon at different levels, and movable cams carried by said dial cap for actuating against the butts of the jacks at the desired levels in order to project the dial needles.

11. In a rotary knitting machine the combination of a rotary cylinder, a rotary dial, a set of independent needles for the cylinder, a set of independent needles for the dial, and means for selectively inter-transferring cylinder needle stitches to dial needles, and dial needle stitches to cylinder needles all at the same general knitted zone in the fabric whereby to produce English rib knitted effects with the rib groups comprising at least three adjacent wales.

12. In a rib knitting machine the combination of a cylinder, a set of cylinder needles therefor, a dial, a set of dial needles therefor, means for feeding yarn and manipulating said dial and cylinder needles to knit on the dial needles and alternate cylinder needles a one and one rib fabric, means for transferring predetermined stitches from predetermined dial needles to predetermined previously inactive cylinder needles, means for then shogging the position of the dial and cylinder needles in order to bring predetermined cylinder needles whose stitches still remain thereon into transfer relation with predetermined dial needles, means for then effecting the transfer of the said stitches to said predetermined dial needles, and means for then continuing the knitting of fabric.

13. In a knitting machine the combination of a cylinder, a dial, a set of cylinder needles, a set of dial needles, the cylinder needles being symmetrically arranged with respect to the dial needles and numbering substantially twice as many as the dial needles except in predetermined groupings of the dial needles where additional dial needles are provided, means for feed of yarns to said dial and cylinder needles for the production of one and one rib with alternate cylinder needles inactive and all of the dial needles active except at the predetermined special groups of dial needles where certain dial needles are inactive, and means for inter-transfer of stitches from the dial needles to previously inactive cylinder needles and from certain cylinder needles to the said inactive dial needles of said groups to produce English rib knitting with the yarn fed to all of the cylinder needles except those complementary arranged to the special groups of dial needles where the yarn is only fed to said special groups of dial needles.

14. In a knitting machine the combination of a cylinder, a set of needles therefor, a dial, a set of needles for the dial, jacks individual to the dial needles having butts at relatively different and predetermined levels, cam means for moving the dial needles into yarn receiving position, and selector cam means operable upon said jack butts to selectively project the dial needles into operative relation with the first recited cam means.

15. In a knitting machine, the combination of a cylinder, a set of needles therefor, a dial, a set of needles radially slidable in the dial for knitting cooperation with the cylinder needles, individual jacks in the dial for the dial needles having butts at relatively different and predetermined levels, and selector cam means operative upon said jack butts for selectively projecting the dial needles.

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