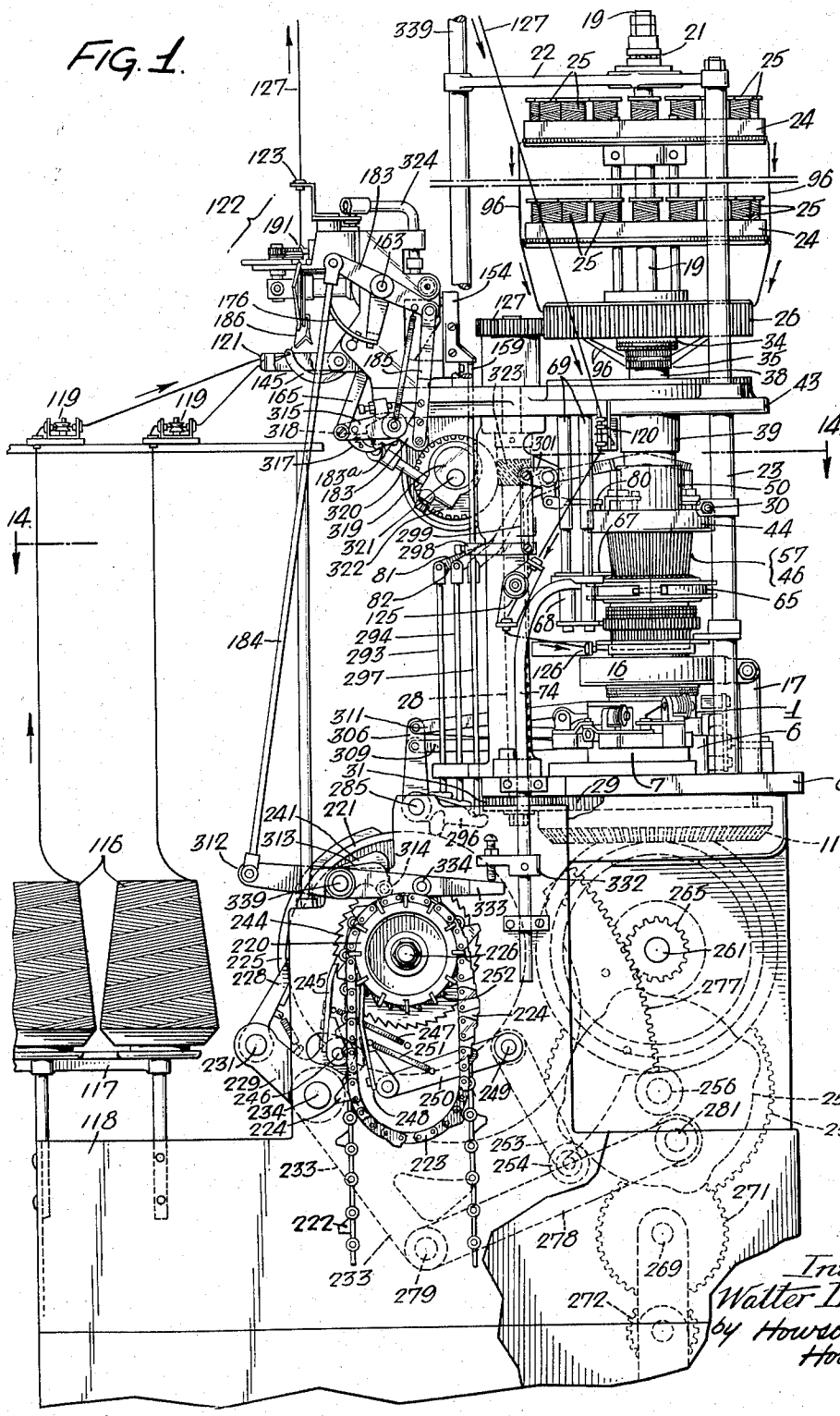
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CIRCULAR KNITTING MACHINE

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FIG. 1.



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FIG. 2.

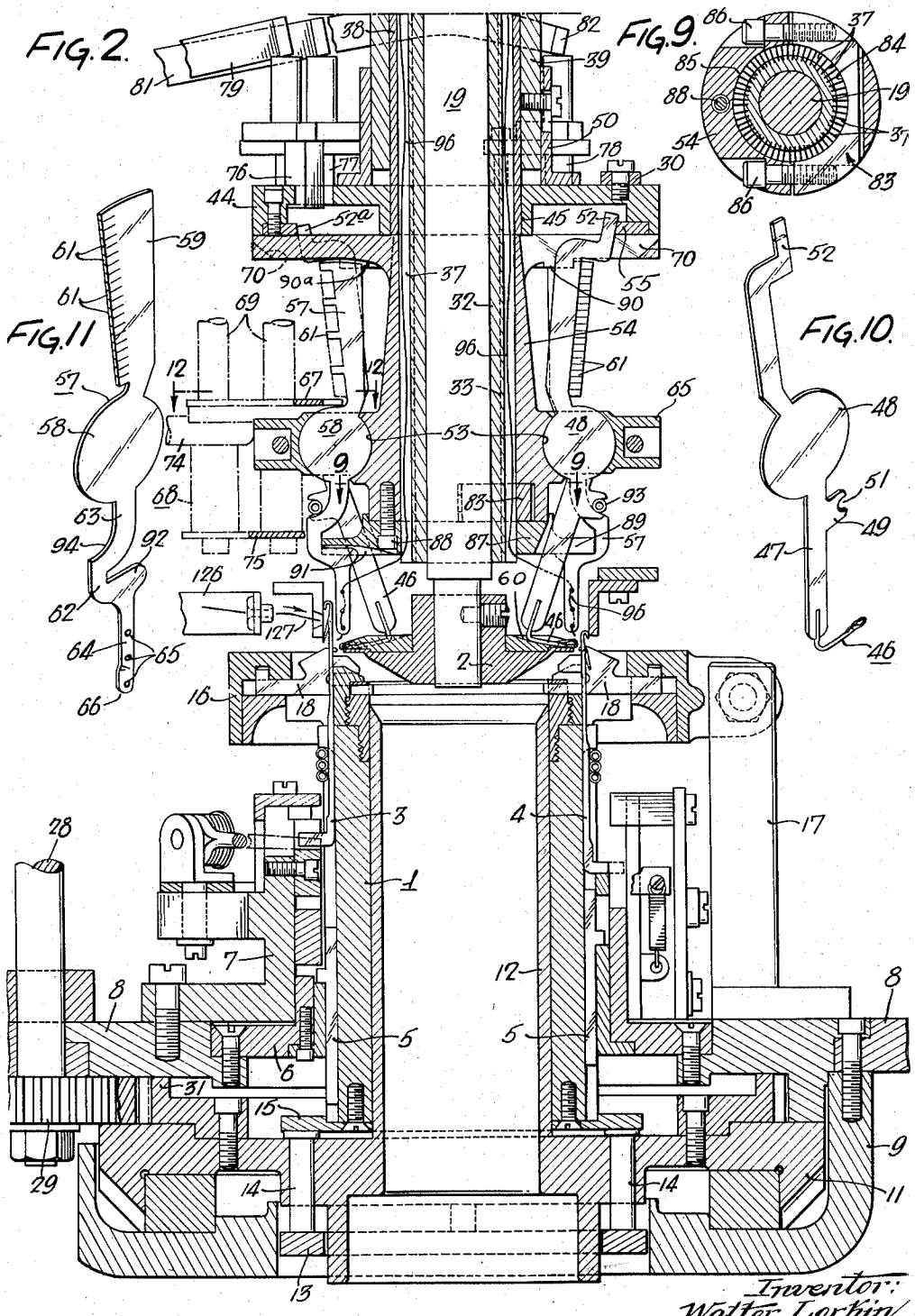


FIG. 9.

FIG. 11

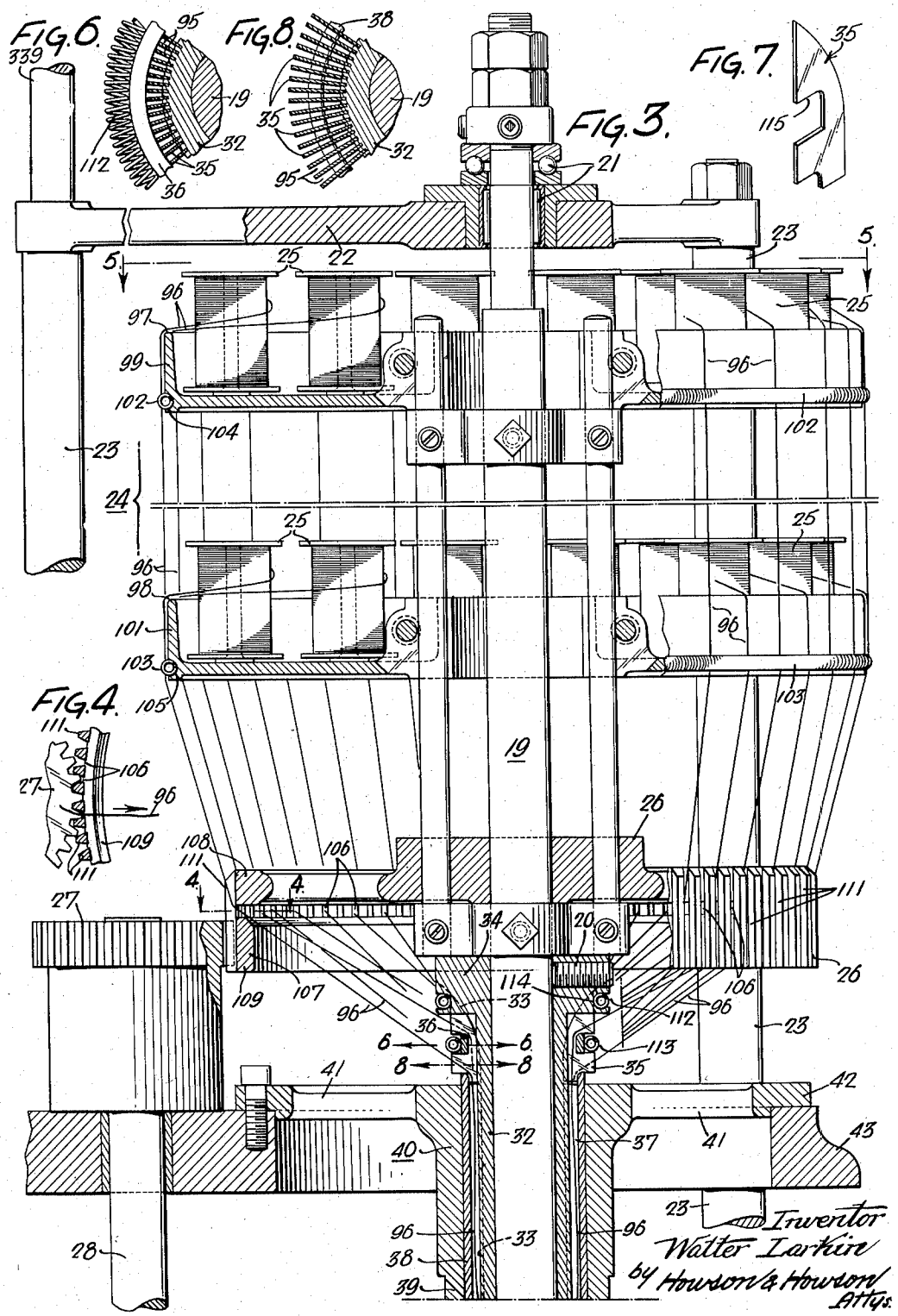
FIG. 10.

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FIG. 5.

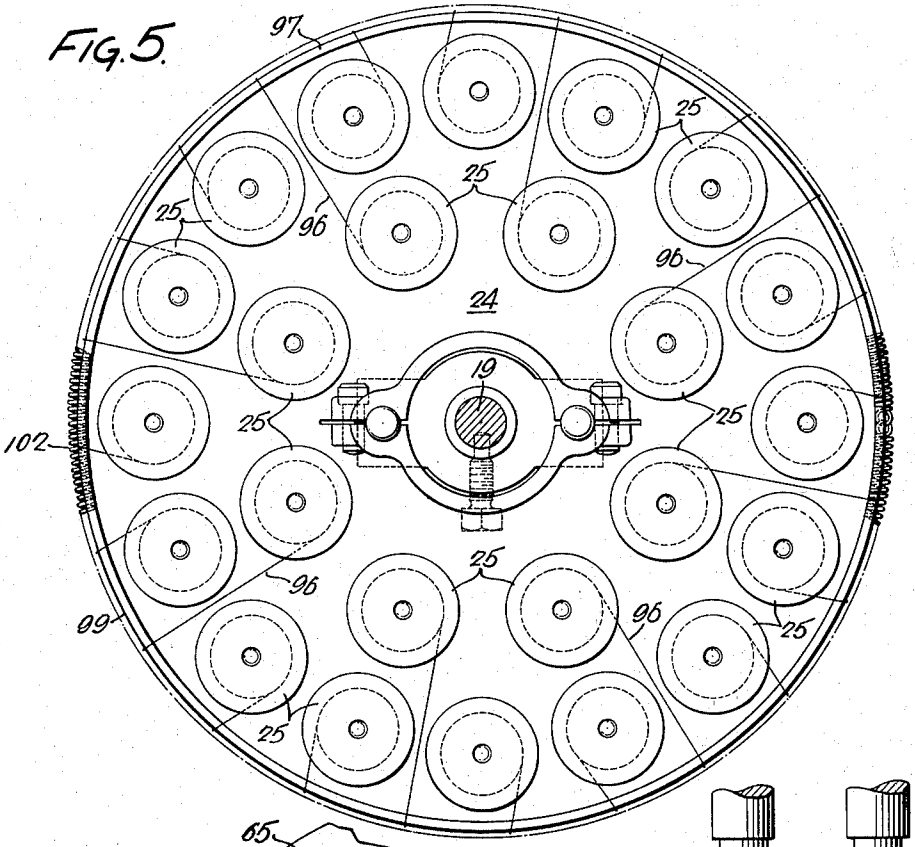


FIG. 12

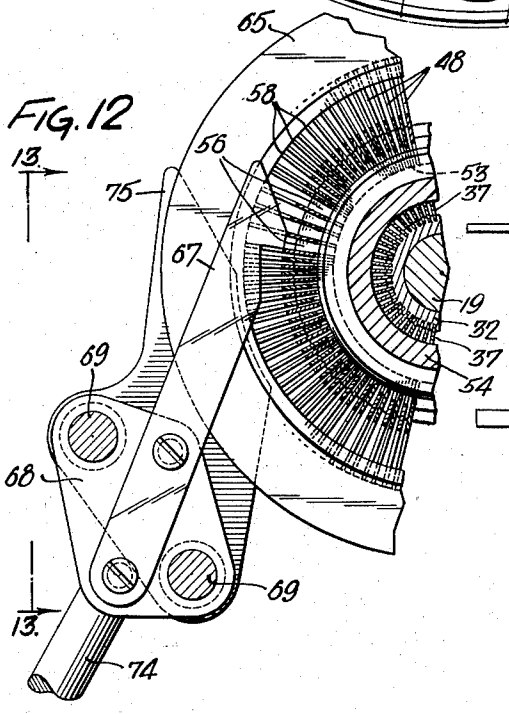
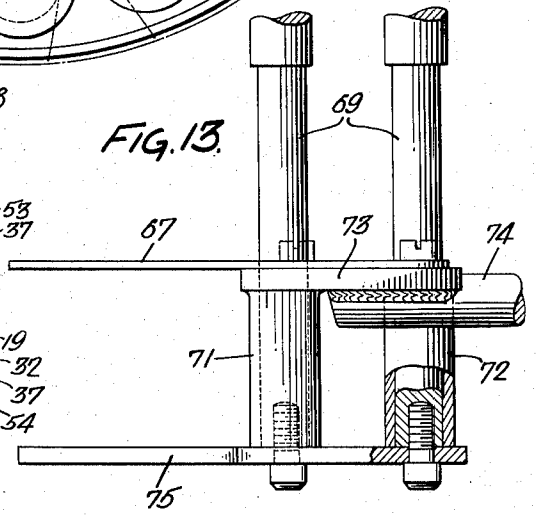


FIG. 13.



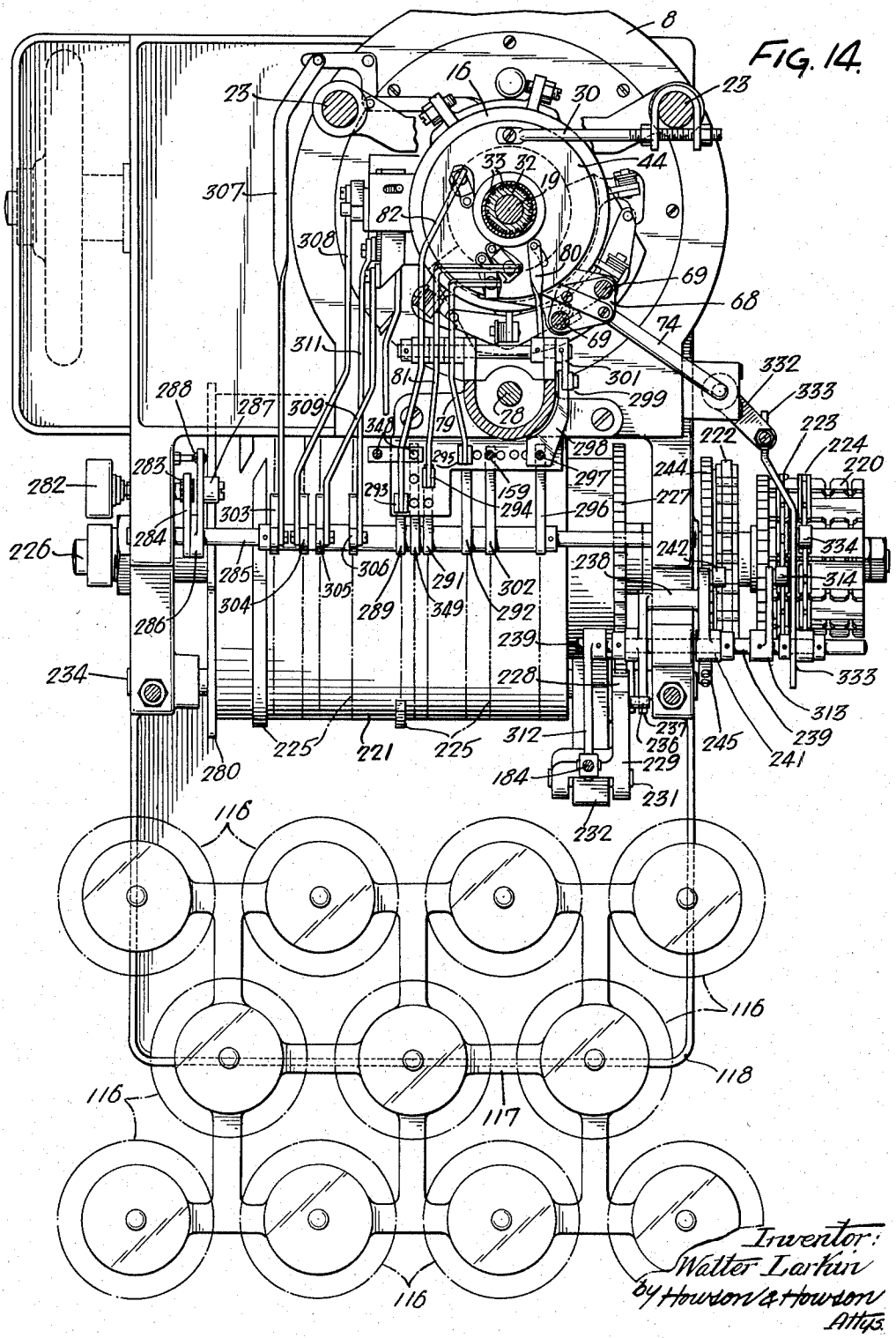
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FIG. 14.



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FIG. 15.

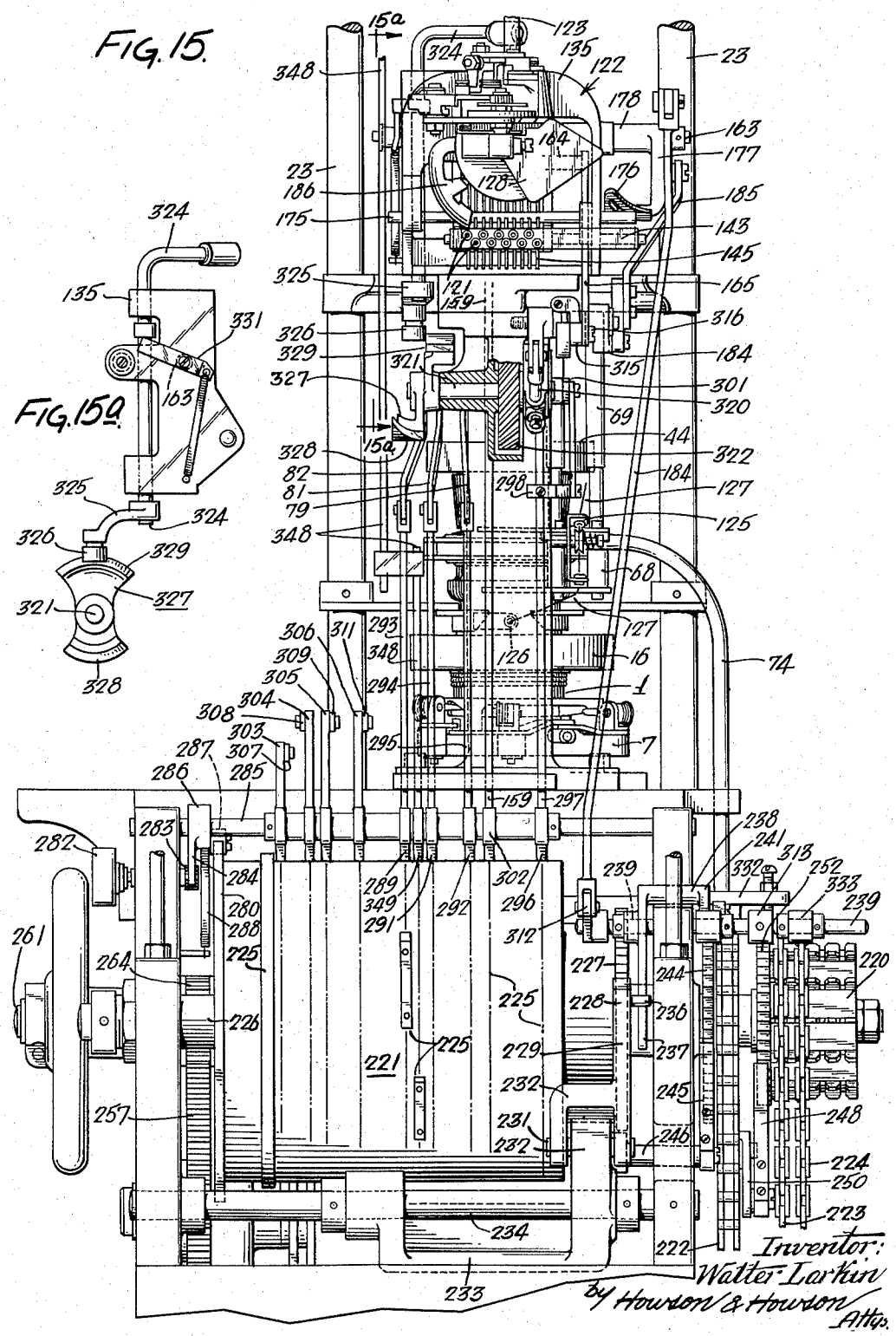


FIG. 15a.

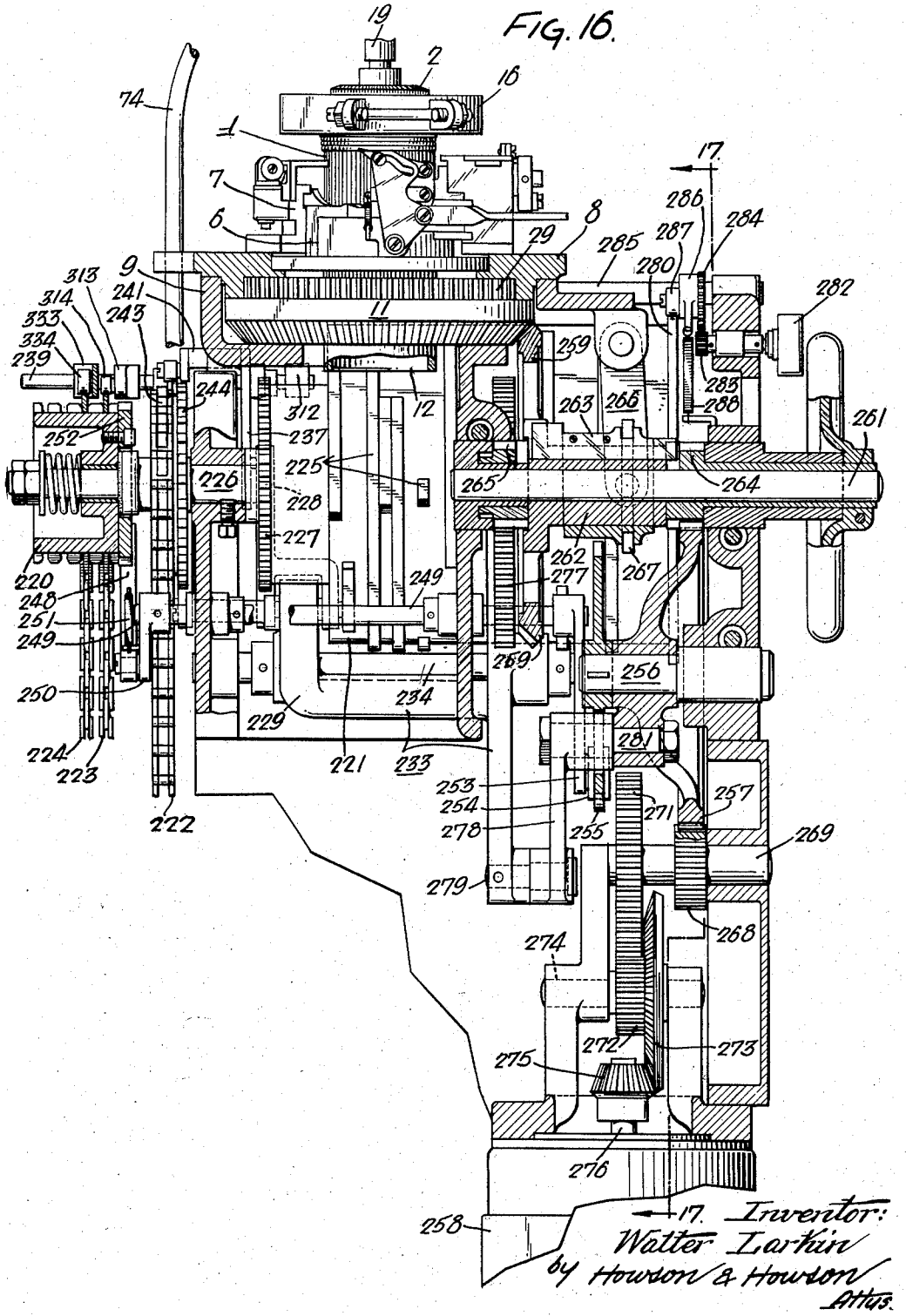
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CIRCULAR KNITTING MACHINE

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FIG. 16.

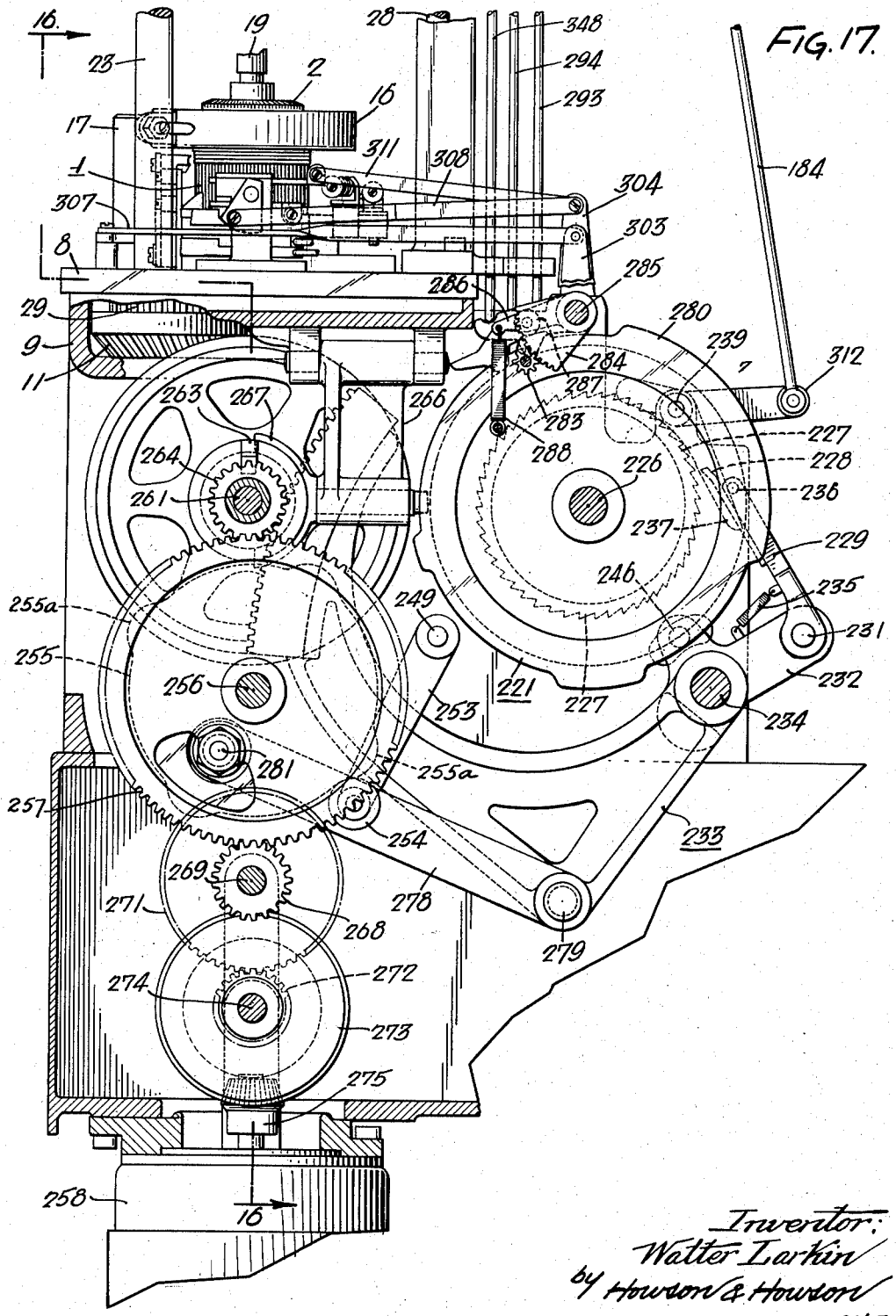


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FIG. 17.



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FIG. 19.

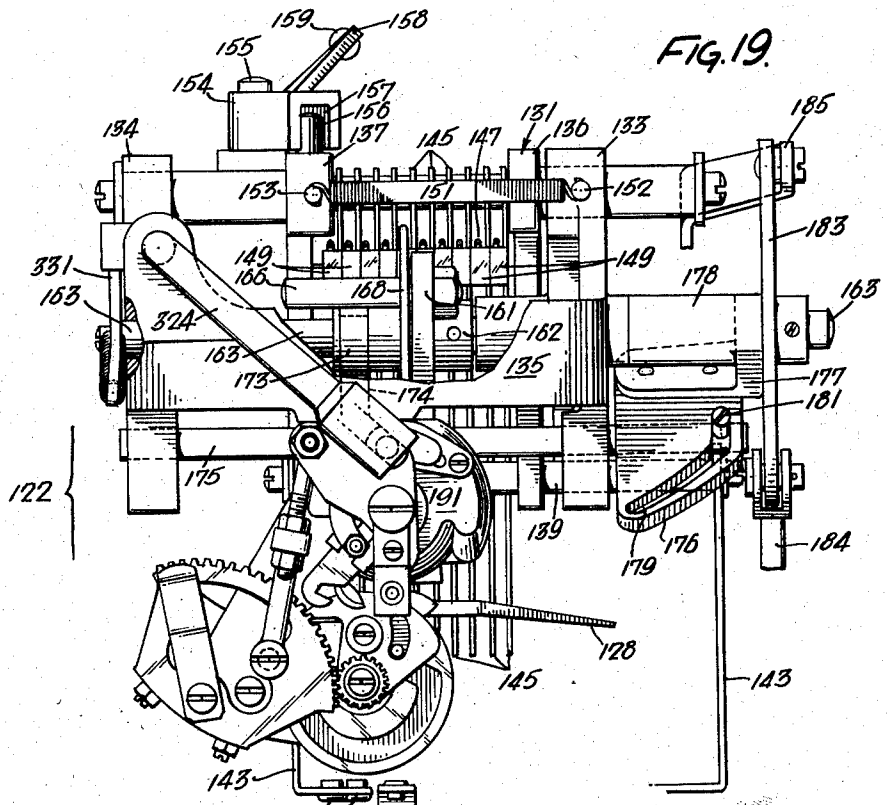
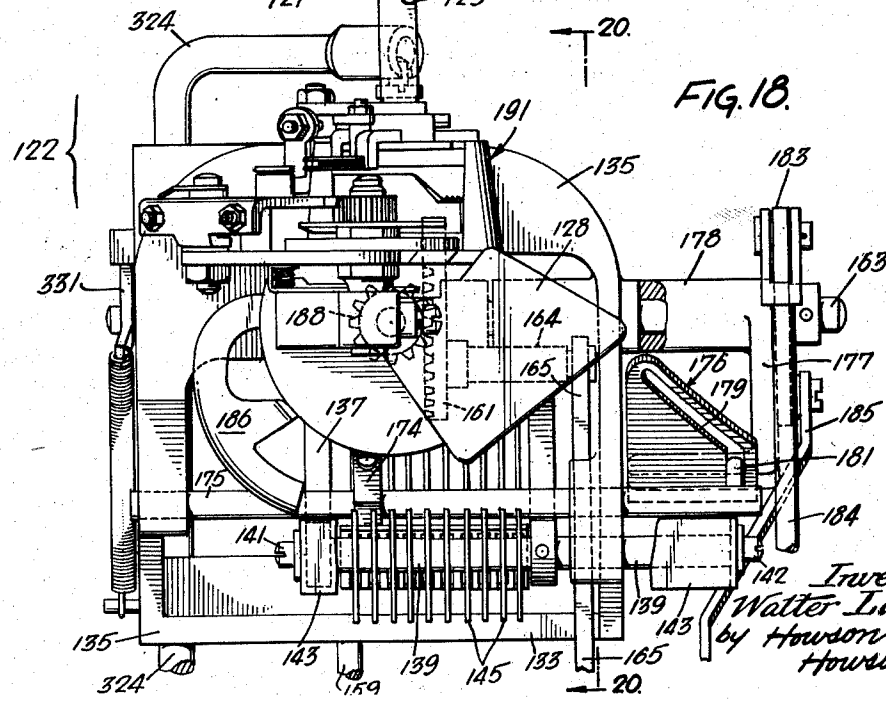


FIG. 18.



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FIG. 20.

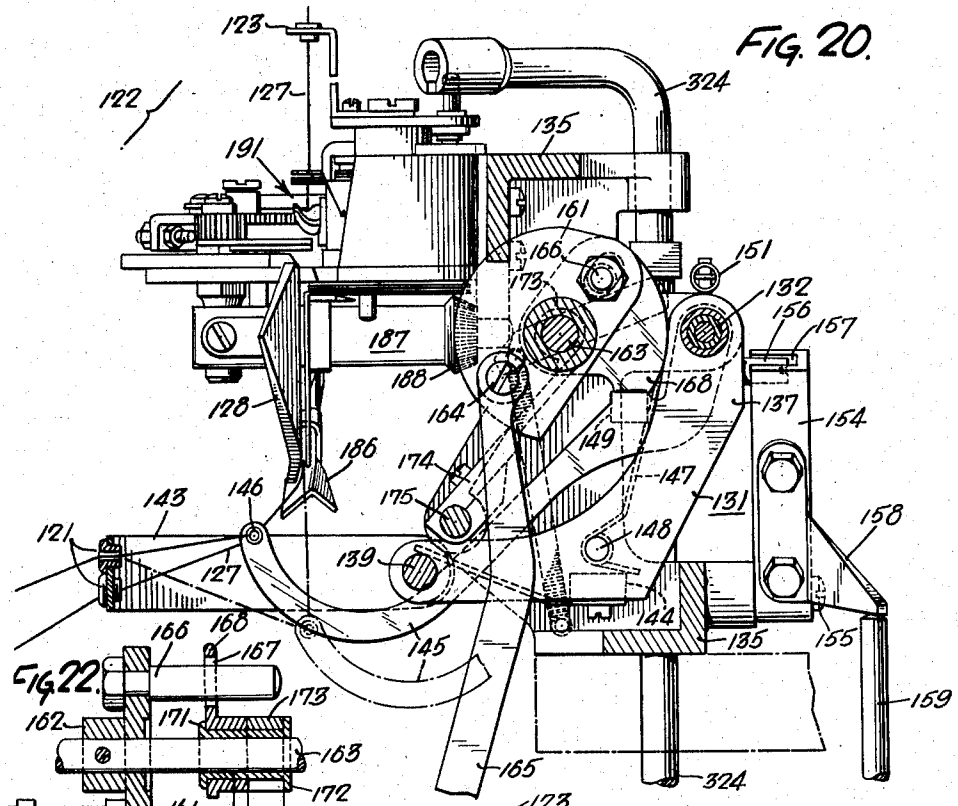


FIG. 22.

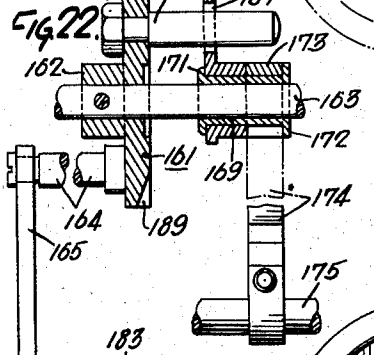


FIG. 21.

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FIG. 23.

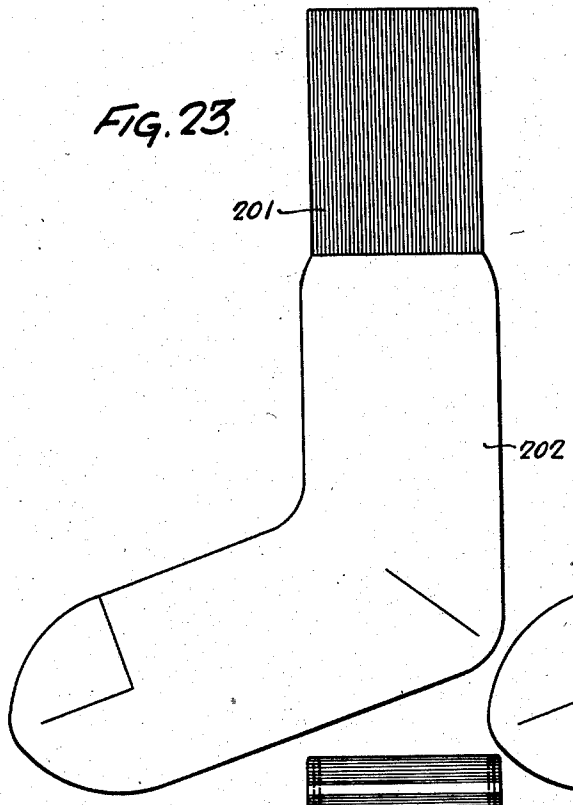


FIG. 24.

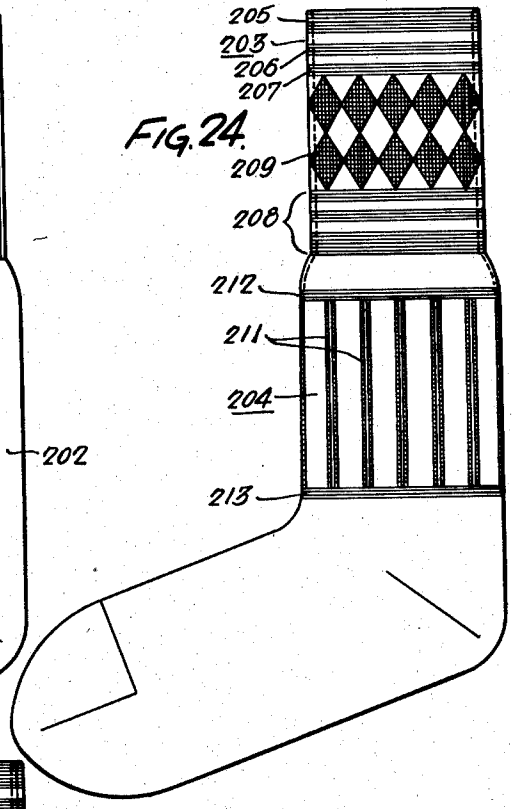
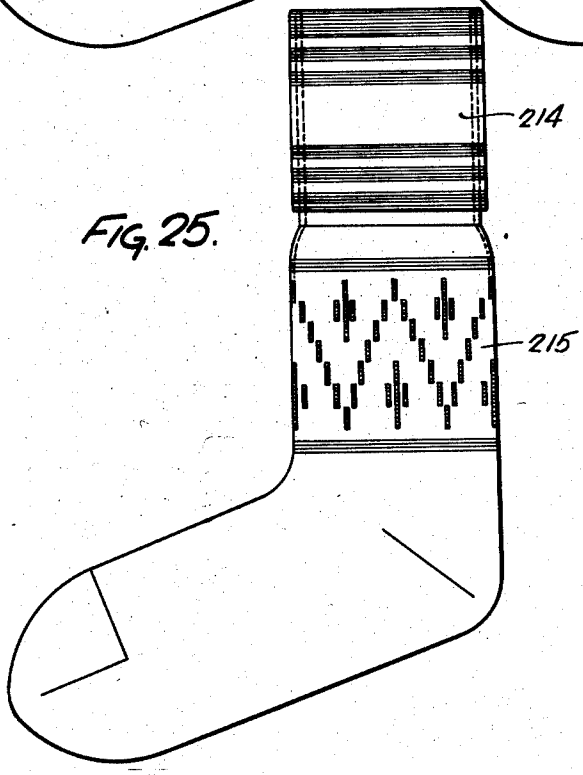


FIG. 25.



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FIG. 26.

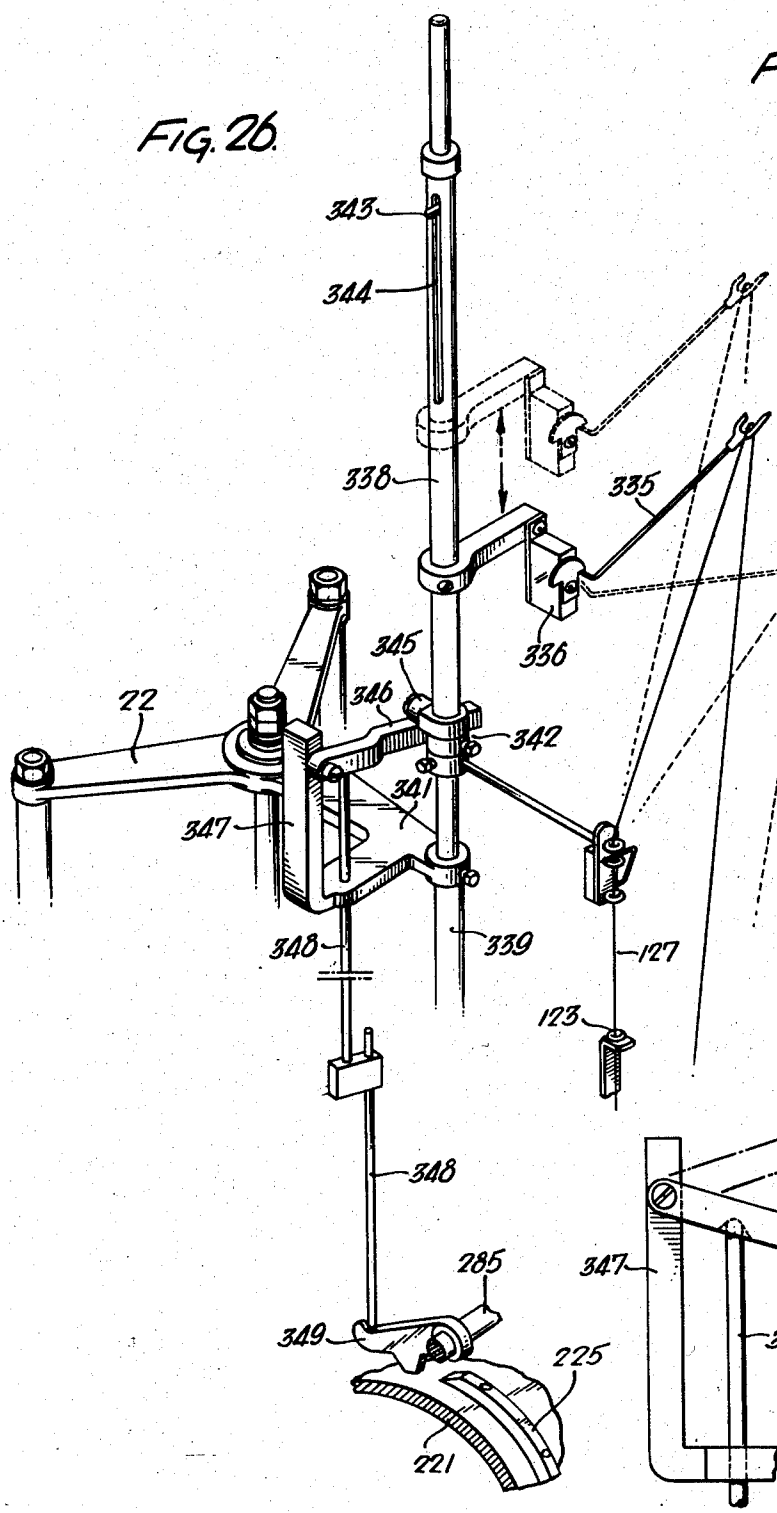
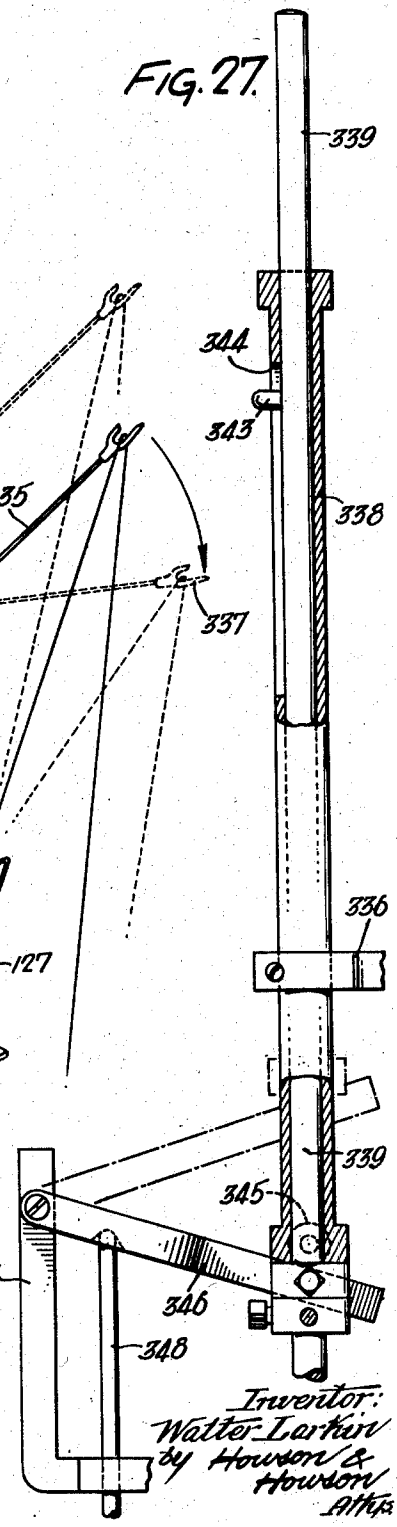


FIG. 27.



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United States Patent Office 2,873,592 Patented Feb. 17, 1959

2,873,592

CIRCULAR KNITTING MACHINE

Walter Larkin, Norristown, Pa., assignor to Fidelity Machine Company, Inc., Philadelphia, Pa., a corporation of Pennsylvania

Application July 23, 1954, Serial No. 445,295

11 Claims. (Cl. 66—15)

A primary object of the invention is to provide a circular knitting machine, of the class designed for production, selectively, of ribbed and plain knit fabrics, having incorporated in the mechanism thereof selective yarn-change and plating devices affording wide latitude in the selection of color combination and plain or figured design in either or both of the said fabrics.

More specifically, an object of the invention is to provide a knitting machine of the type adapted for knitting seamless hosiery as a continuous strip of tubular stocking units or blanks each including a welt or top of ribbed fabric, and a leg section, heel pocket, foot section and toe pocket, all of plain knit fabric, said machine comprising the aforesaid yarn-change and plating devices together with selective control mechanisms for actuating said devices individually or jointly so as to produce a wide variety of multi-color designs in either or both of the said ribbed and plain knit sections.

Another object is to provide a machine of the stated type having provision within the aforesaid wide range of multi-color design for substitution of the different weight yarns required respectively in the rib and plain knit fabrics.

Still another object is to provide novel means for compensating the irregularities which otherwise would result from the use of the differing weights of yarn, and more particularly to insure a consistent and uniform location of the junctures of the yarns differing as to weight or color at the back center of the stocking.

A further object of the invention is to provide a novel stocking and stocking blank in the form of a continuous knitted strip comprising alternate sections of rib and plain knit fabric each having ornamental designs where and as desired.

The invention resides also in certain novel mechanical and structural features which contribute to the design of a machine of the aforesaid characteristics.

In the attached drawings:

Fig. 1 is an elevational view of a knitting machine made in accordance with the invention;

Figs. 2 and 3 are enlarged vertical sectional views in a common plane of the lower and upper parts respectively of the knitting head of the machine;

Fig. 4 is a sectional view on the line 4—4, Fig. 3;

Fig. 5 is a sectional view on the line 5—5, Fig. 3;

Fig. 6 is a sectional view on the line 6—6, Fig. 3;

Fig. 7 is a view in perspective of an element of the thread guide means shown in Fig. 3;

Fig. 8 is a sectional view on the line 8—8, Fig. 3;

Fig. 9 is a sectional view on the line 9—9, Fig. 2;

Fig. 10 is a view in perspective of one of the dial needles in its associated jack;

Fig. 11 is a view in perspective of one of the plating yarn wrapping fingers;

Fig. 12 is a fragmentary sectional view on the line 12—12, Fig. 2, showing the plating finger actuating cam;

Fig. 13 is a side elevational and partial sectional view

of the plating finger cam assembly from the line 13—13, Fig. 12;

Fig. 14 is an enlarged sectional view on the line 14—14, Fig. 1;

Fig. 15 is an enlarged fragmentary elevational view of the machine from the left hand side of Fig. 1;

Fig. 15*a* is a fragmentary elevational view from the line 15*a*—15*a*, Fig. 15;

Fig. 16 is a sectional view on the line 16—16, Fig. 17;

Fig. 17 is a sectional view on the line 17—17, Fig. 16;

Fig. 18 is a front elevational view of the yarn selector and change mechanism;

Fig. 19 is a top plan view of the mechanism;

Fig. 20 is a sectional view on the line 20—20, Fig. 18;

Fig. 21 is a rear elevational view of the mechanism;

Fig. 22 is a fragmentary sectional view on the line 22—22, Fig. 20;

Fig. 23 is a side view of a conventional ornamental sock having a stand-up ribbed top and plain knit leg and foot;

Fig. 24 is a similar view of a sock having ornamented stand-up ribbed top and plain knit leg portions as made on my improved machine;

Fig. 25 is a like view of a sock having a turned top of ribbed fabric and a plain knit leg portion both ornamented by the mechanism forming the subject of the present invention;

Fig. 26 is a fragmentary view in perspective showing a detail of the yarn control mechanism, and

Fig. 27 is an enlarged elevational view of the upper portion of the mechanism shown in Fig. 26.

In the drawings, the reference numeral 1 indicates the cylinder and the numeral 2 the dial of the knitting machine. The cylinder needles, two of which are indicated at 3 and 4 respectively, and the jacks 5 are supported in the cylinder 1 in conventional manner and are operated by the usual cams mounted in a cam ring 6 and associated cam block 7. The cam 6 and block 7 are mounted in the present instance upon the bed 8 of the machine, and depending from the bed 8 is a bracket 9 on which is journalled a cylinder-operating gear 11. The gear has an axial upwardly extending sleeve 12 to which the cylinder 1 is attached, by means in the present instance of splines (not shown), and on which the cylinder is axially adjustable through the medium of a ring 13 having pins 14 which project upwardly through apertures of the hub portion of the gear 11 and which provide a seat for the flange 15 at the lower end of the cylinder.

A relatively fixed cam ring 16 is supported at the upper end of the cylinder 1 through the medium in part of a post 17 which extends upwardly from the bed 8, and slidably mounted in this ring are sinkers 18 which rotate with the cylinder 1 and operate in conventional manner with the needles 3.

The dial 2 is carried on the lower end of a shaft 19, the upper end of which (see Fig. 3) is supported by a bearing 21 in a spider 22 on the upper end of posts 23 which extend upwardly from the bed of the machine. On the upper end of the shaft 19 below the spider 22 is a multi-tiered rack structure 24 which carries the yarn spools 25, and below the rack and attached both to the latter and to the shaft 19 is a gear 26 which is operatively connected through a pinion 27, shaft 28, and a pinion 29 at the lower end of said shaft, with a spur gear 31 attached to the cylinder gear 11. The shaft 19 together with the rack 24 is thus rotated in synchronism with the cylinder 1.

Secured to the shaft 19 by set screw 20 immediately below the gear 26 is a sleeve 32. As shown in Fig. 2, this sleeve extends downwardly to a point above the dial 2. The sleeve 32 has a series of longitudinal slots in its outer peripheral surface, said series embracing the

entire circumference of the sleeve. The slots are indicated by the broken lines 33 in Fig. 3 and are shown also in Fig. 14, and as shown in Fig. 3 the slots extend at the top into the terminal portion 34 of the sleeve which terminal portion is of greater diameter than the other parts of the sleeve. The upper end of the slots 33 including the portions thereof which occupy the terminal portion 34 receive blades 35 of the form shown in Fig. 7 and these blades are held in place by a split ring 36. From the lower end of the blades 35 the slots 33 are occupied by elongated blades 37, these blades extending to the lower end of the sleeve 32 as shown in Fig. 2. The blades 35 and 37 form slots at the outer periphery of the sleeve 32 and the function of these slots will be described below.

A sleeve 38 is press fitted to the outer edges of the blades 37 and is journaled for rotation in the depending portion 39 of a member 40, said member having radial arms 41 at its upper end which terminate at their outer ends in a ring 42 which seats upon and is secured to the frame member 43. The blades 35 seat upon the upper edge of the sleeve 38 and are supported by the latter. The depending portion 39 of the member 40 terminates at its lower end above the upper surface of a cam ring 44, see Fig. 2, and the lower end of the sleeve 38 extends into the central bore 45 of this ring and centers the latter with respect to the shaft 19. The ring 44 carries the cams which control the operations of the dial needles, as hereinafter explained, and is kept from rotating by an arm 30, see Figs. 14, which is secured to the ring and to one of the posts 23. As shown in Fig. 2, the depending sleeve portion 39 of the member 40 has at its lower end a vertically adjustable collar 50 which normally engages the upper surface of the ring 44 and constitutes a hold-down for the latter.

The dial needles 46, see Fig. 10, are supported individually at the lower ends of flat shanks 47. Each of these shanks has a circular disc-like mid-section 48 and below this section a boss 49 having a recess 51 in its outer end. The upper end of the shank has an off-set butt 52 and in one-half or 180° of the dial needle assembly the butts 52 are of greater length or height than the butts 52*a* in the other 180°. The circular portions 48 of the shanks 47 are mounted in a circumferential recess 53, see Figs. 2 and 12, in a sleeve 54 clamped to the outer edges of the blades 37, as hereinafter described, and the butts 52 and 52*a* are confined by a flange 55 in the cam ring 44, as shown in Fig. 2.

Also mounted in the recess 53 of the sleeve 54 in alternate arrangement with the portions 48 of the needle shanks is a circumferential series of plating fingers 57, one of which is illustrated in Fig. 11. As therein shown, each of the fingers comprises a circular disc-like mid-section 58 corresponding to the mid-section 48 of the shanks of the dial needles 46; an upwardly extending arm 59 having at its forward edge a longitudinal series of transversely projecting butts 61 which may be individually and selectively removed as hereinafter set forth; a downwardly projecting arm 62 the upper portion 63 of which is curved outwardly, for a purpose hereinafter described, and the lower portion 64 of which contains a series of yarn receiving apertures 65. The lower terminal end 66 of the arm 62 which contains the lowermost of the yarn receiving apertures 65 is turned angularly from the plane of the finger as a whole about the longitudinal axis of the arm, and this terminal end is functionally related to the cylinder needles, also as hereinafter described. The physical and functional relation of the dial needles 46 to the cylinder needles 3 is the conventional one as disclosed for example in U. S. Patent 834,763. As shown in Fig. 2, the lower ends of the plating fingers normally occupy a position within the line of the cylinder needles 3 and below the upper ends of these needles when the latter are in the elevated positions, and this position is established by means set forth below. In accordance with the usual practice, there are twice as many cylinder needles than dial needles so that only half of or every other, cylinder needle paritcipates in the rib-knitting operation with the dial needles. The plating fingers, alternating with the dial needles as described, are in alignment respectively with the cylinder needles which participate in the rib-knitting operation.

The circular mid-portions 48 and 58, respectively, of the dial needle shanks and the plating fingers are confined to the recess 53 in the sleeve 54 by means of a split retaining ring 65, as shown in Figs. 1, 2, and 12, this ring embracing the said mid-sections and having a curved inner surface conforming to the curvature of said sections and complementing the arcuate surface of the recess 53. The upper ends of the dial needle shanks are guided in radial slots 70, see Fig. 2, in the upper flanged portion of the member 54; and the upper ends of the fingers 57 are similarly guided in radial slots 90*a* in depending bosses 90 at the under side of the said flange between the adjoining slots 70.

As previously set forth, the dial needles 46 which occupy the usual slots 60 in the upper face of the dial 2 operate conventionally with respect to the cylinder needles 3, the advance and retractive movements of the needles 46 being effected by oscillation of the shanks 47 about the circular mid-portions 48. The plating fingers, in the performance of their particular function, are also oscillated about the circular mid-sections 58 of the fingers, this oscillation being effected by an actuating cam 67, shown in Figs. 2, 12, and 13, which may be moved selectively into the path of any of the horizontally aligned series of the butts 61. To this end, the cam 67 is mounted upon a carriage 68 which is slidably supported on vertical rods 69, 69 depending from the fixed frame of the machine, in the present instance from the frame member 43 as shown in Fig. 1. The carriage 68 consists of two sleeves 71 and 72, see Fig. 13, which respectively slidably embrace the rods 69, 69 and which are connected by a cross member 73 to which the cam 67 is attached. When the cam 67 is in operative position with respect to the plating fingers, all of the fingers which then have butts 61 in alignment with the cam will be oscillated from the normal retracted positions shown in Fig. 2 to an advanced position wherein the lower ends of the fingers will be projected outwardly past the respective aligned cylinder needles, the angularly offset extremity 66 of the fingers thus oscillated acting as cams against the needles to deflect the fingers, which are flexible, to one side of the latter on the outward movement and to the other side of the respective needles in the return movement so that the yarn carried by the fingers as previously described will be wrapped around the needles. As the needles move downwardly, the plating yarn will be drawn into the fabric. The mode of operation of this type of plating finger is well known in the art and is fully described in my prior U. S. Patent No. 1,841,249.

The carriage 68 is elevated and lowered through the medium of an actuating rod 74, as hereinafter more fully described, in order to bring it into the path of any desired circumferential series of the butts 61 of the fingers. In order to provide for this movement of the cam 67 longitudinally of the fingers, a contiguous number of the fingers, four in the present instance, as shown at 56 in Fig. 12, are left out, thereby providing a path for movement of the cam without interference with the butts of any of the fingers. After actuation by the cam 67, the fingers are immediately and positively returned to their original and normal positions by a cam 75 attached to the lower ends of the rods 69, as shown in Fig. 13, this return movement of the finger completing the yarn wrapping operation previously described.

The dial needles 46 are actuated by cams in the ring 44. These include cams 76, 77, and 78, which are normally supported by springs (not shown) in elevated positions in which they lie out of the path of the needle butts

52 and may be depressed selectively through the medium of levers 79, 81, and 82 and by mechanism hereinafter described into positions in the path of the movement of the butts 52 and 52*a* so as to actuate the associated fingers. The dial needle actuating cams also include a fourth cam (not shown) which is mounted for pivotal movement in a horizontal plane into selected alternative positions, this cam being actuated through the medium of an arm 80, see Figs. 1 and 14, by mechanism also described below. The manner in which the several cams operate upon the butts 52 and 52*a* to actuate the needles is essentially the same as that described in U. S. Patent 834,763 and forms no part of the present invention apart from the fact that the adjustability of the cams provides for putting them into and out of operation selectively in accordance with the type of knitted fabric, ribbed or plain, required.

The device by means of which the sleeve member 54 is clamped to the blades 37 is illustrated in Figs. 2 and 9. The member 54 is counter-recessed at the lower end and at one side of a diametrical line for reception of a clamping block 83 which is segmental in form and has an inner semi-circular surface 84 which complements the confronting portion of the bore 85 of the sleve member to substantially embrace the annular series of blades 37. The block 83 is secured to the member 54 by screws 86, 86 by means of which also the block 83 may be drawn tightly against the outer edges of the blades 37 to clamp the annular series of blades securely between the block 83 and the confronting portion of the bore 85 of the said member. A flange 87 is secured by means of a screw 88 to the underside of the member 54, the flange being slotted as indicated at 89 to receive and guide the lower portions of the flat shanks of the dial needles 46, as shown in Fig. 2. Between the slots 89, the flange 87 is recessed from the underside, as shown at 91 in Fig. 2, for reception of the straight edge portion 92 of the fingers 57, the outer peripheral edge of the flange 87 constituting a stop to limit the retractive movements of the fingers and to establish the fingers in their normal positions as shown in Fig. 2, and the slots themselves acting as guides for the lower portions of the fingers while leaving the lower ends of the fingers free to flex laterally in accordance with their function.

As also shown in Fig. 2, the recesses 51 in the bosses 49 of the shanks of the dial needles receive an annular coiled spring 93 which exerts resilient pressure tending to retain the needle shanks and needles in retracted positions as shown; and the springs 93 also engage the curved edges 94 of the fingers 57 and tend to retain the fingers in the retracted positions. The spring 93 does not interfere with the actuations of the dial needles and the plating fingers by their respective actuating cams.

As previously set forth, the blades 35 and 37 mounted in the slots 33 of the sleeve 32 themselves form slots at the outer periphery of the sleeve which extend the full length of the latter with exception of the upper area of the terminal portion 34. These slots, which are designated by the reference numeral 95, are utilized as passages to conduct the yarn 96 from the spools 25 to the plating fingers 57. In the present instance each yarn end i. e. the strand of yarn drawn from each individual spool occupies its own individual one of the passages 95. From the lower ends of the passages the yarn ends pass between the adjoining shanks of the dial needles 46 to the yarn apertures 65 of the fingers 57, as best shown in Fig. 2, the yarn then passing successively through the three apertures from the upper to the lower as shown. From the respective spools 25 the yarn is guided over the upper rounded edges 97 and 98 of peripheral flanges 99 and 101 of the rack 24 and downwardly through the convolutions of a pair of coiled springs 102 and 103 which embrace the lower ends of and are seated in peripheral grooves 104 and 105 respectively in the said flanges. The yarn ends pass downwardly through guide openings 106 in the gear 26 which openings extend in continuous series around the circumference of the latter.

Figs. 3 and 4 of the drawings illustrate the structure of the gear member 26 which provides the guide openings 106. The rim portion 107 of the gear is divided in effect into two axially spaced circumferential portions, 108 and 109 respectively, which are connected solely by the teeth 111 of the gear, so that between the ad joining pairs of teeth and between the sections 108 and 109 of the rim a circumferential series of openings is formed, these openings being those designated by the reference numeral 106 and described above. It will be noted by reference to Fig. 3 that the portions of the teeth 111 which are engaged by the teeth of the pinion 27 lie entirely below the openings 106 so that the pinion teeth do not interfere with or in any way affect the yarn passing through the said openings.

From the openings 106, the yarn passes to the upper ends of the slots 95 between the blades 35. Some of the yarn ends pass behind the ring 36 and between coil and spring 112 and 113, the spring 112 seating in a circumferential recess 114 in the peripheral surface of the upper terminal portion 34 of the sleeve 32 and confining the upper ends of the blades 35, and the spring 113 seating upon the outer peripheral surface of and confining the retaining ring 36 and being itself confined by the sides of the recesses 115 in the blades 35 provided for reception of said ring. Other of the yarn ends passes into the slots 95 below the ring 36 and the spring 113. This is clearly shown in Fig. 3.

Yarn for production of the base fabric, plain or ribbed as the case may be, is brought to the needles 3, and 46 as the case may be, from spools or cones 116, see Figs. 1 and 14, which are supported on a relatively fixed bracket or rack designated generally by the reference numeral 117 and carried by an extension 118 of the fixed frame of the machine. From the cones 116, the yarn ends pass upwardly through suitable tensioning devices 119 and individual guides 121 to a yarn selector and change mechanism mounted at the top of the machine and indicated generally by the reference numeral 122. This mechanism receives and retains the yarn ends from each of the individual spools 116 and passes a selected one yarn to the needles. The mechanism operates when actuated to sever the latter yarn and to connect to the portion thereof which extends to the needles a selected one of the other ends of yarn passing from the spools 116. From the yarn changing unit the selected yarn end passes upwardly through guides 123 and 124 (see Figs. 1, 15 and 26) to a guide finger 335 and thence downwardly through guides 120, 125 and 126 to the knitting needles. In the present instance, guides 120 and 124 are components of a conventional stop motion system for the detection of slack or broken running yarn. The tension finger 335 is also included in this system, but, under certain conditions, through associated mechanism, functions to vary the length of yarn between the yarn selector and the needles for a purpose hereinafter disclosed. In the several figures, the yarn end is indicated by the reference numeral 127.

The yarn changer mechanism is illustrated in Figs. 18 to 22 inclusive. It operates on the principle fully disclosed in my prior United States Patent Nos. 1,624,792 and 1,841,249, and has been specifically described in my co-pending application Serial No. 412,511 filed February 25, 1954. For the purpose of the present application, the description given below will suffice.

The yarn changer comprises a carriage 131, the upper end of which is attached to a shaft 132 which is mounted for longitudinal sliding movement in guides 133 and 134 in the frame 135 of the mechanism. The carriage 131 comprises two side members 136 and 137 which are joined together by a transverse member 138. The side members 136 and 137 are substantially L-shaped as shown in Fig. 20, and the lower ends of these arms ex-

tend forwardly and carry a transverse rod 139 at their forward ends. The one end of the rod projects beyond the side member 136, as shown in Fig. 18, and this end of the rod is slidably supported in the lower end of the frame member 133. Secured to the ends of the rod 139 by screws 141 and 142 is the forwardly projecting bracket 143 which carries the yarn guides 121 so that the yarn guides move with the frame 131. The lower forwardly extending arms of the side members 136 and 137 are connected by means of a transverse bar 144.

Pivotally supported on the shaft 132 between the side members 136 and 137 and held in fixed relatively spaced relation between these side members is a series of yarn guide fingers 145. These fingers are shaped as best illustrated in Fig. 20, and as therein shown they extend downwardly from the shaft 132 and under the rod 139, the forward ends curving upwardly beyond that rod and each having a yarn guide eyelet 146 in its extremity. Each of the fingers is normally resiliently supported in a relatively elevated position, as shown in full lines in Fig. 20, by a spring 147, these springs being supported on a rod 148 extending transversely between the side members 136 and 137 and having their lower ends in pressure engagement with the transverse bar 144. The upper ends of the springs bear respectively against transversely projecting lugs or pads 149 at the upper edges and towards the upper ends of the respective fingers, these pads being in side by side relation as shown in Fig. 19. The fingers may be individually depressed to a position illustrated in broken lines in Fig. 20 against the pressure of the springs 147. It will be noted that in the present instance the fingers 145 are ten in number and that there is a corresponding number of the guide eyelets 21 in the bracket 143.

The finger-supporting carriage 131 is mounted for transverse movement in the fixed frame 135 of the yarn change unit, to an extent permitted by the side members 133 and 134 of the latter frame. A spring 151 is secured at one end to the frame side member 133, as indicated at 152, and is secured at its opposite end 153 to the side member 137 of the carriage 131. This spring thereby exerts resilient pressure tending to hold the frame 131 with the fingers in a position at the right hand side of the fixed frame 133 as illustrated in the several figures. The carriage 131 is adapted to be moved to the opposite side of the frame 135, wherein it lies in proximity to the fixed frame side member 134, by means of a lever 154, see particularly Figs. 19, 20, and 21. This lever is pivotally attached at 155 to the fixed frame 135 and is operatively connected to the carriage 131 at its upper end through the medium of a rearwardly projecting pin 156 on the member 137 which projects into a longitudinal slot 157 in the upper end of the said lever. The lever 154 has secured thereto a laterally projecting arm 158 the underside of which is engaged by the upper end of a rod 159 and through the medium of this rod the lever 154 is moved to the right as viewed in Fig. 21 to thereby move the carriage 131 to the right, as viewed in the same figure, into a position in proximity to the fixed frame member 134. As previously set forth this movement is in opposition to the pull of the spring 151, and when the rod 159 is subsequently depressed the spring will draw the carriage 131 to its original position as shown in the several figures of the drawings.

In conjunction with the structure described above, means is provided for selectively depressing the fingers 145. In the present instance this device comprises a segmental member 161 which is attached through the medium of a hub 162, see Fig. 22, to a shaft 163, this shaft being journalled for oscillation in the fixed side frame members 133 and 134. The member 161 has a transversely projecting pin 164 connected at its outer end to the upper end of an actuating arm 165; and the member 161 also carries at its opposite side a transverse pin 166. The pin 166 passes through a slot 167 in a cam 168, this cam being journalled for oscillation around the axis of the shaft 163 on a sleeve 169 which slidably embraces the said shaft. One end of the sleeve 169 is riveted over at 171 against the outer side of the cam 168, and the other end of the sleeve is flanged as indicated at 172 so as to confine to the sleeve 169 the upper looped end 173 of an arm 174 which is secured to and extends upwardly from a rod 175 slidably mounted in the fixed side frame members 133 and 134. With this arrangement axial movement of the rod 175 will result in a corresponding movement of the sleeve 169 and of the cam 168 longitudinally of the rock shaft 163. In this movement an operative connection is maintained between the member 161 and the cam 168 by means of the pin 166, so that in any position of the cam 168 the rocking movement of the shaft 163 will be transmitted to the cam.

Longitudinal traverse movements of the rod 175 are effected through the medium of a cam 176 which is supported on the lower end of an arm 177 depending from a sleeve 178 journalled on the shaft 163. The cam 176 has a cam slot 179 which receives a pin 181 projecting from an end of the rod 175. One end of the slot 179 i. e. that end which is occupied by the pin 181 when the rod 175 is in the position shown in Figs. 18 and 19, extends at right angles to the axis of the rod 175, whereas the remainder and main portion of the slot extends at an angle to said axis so that when the sleeve 178 is turned counter-clockwise, as viewed in Figs. 18 and 19, the cam 176 will function to shift the rod 175 to the left from the position in which it is shown in those figures. By reason of the aforedescribed connection of the shaft 175 with the cam 168 this movement of the rod will have the effect of moving the said cam in the same direction. In the present instance oscillation of the sleeve 178 is effected through the medium of a lever arm 183 which extends transversely from both sides of the sleeve. One end of this arm is pivotally attached to a rod 184 and the opposite end is similarly attached to a rod 185.

By means hereinafter described, the cam 176 is actuated so as to bring the cam 168 selectively into positions accurately aligned with the pads 149 of the respective yarn guide fingers 145. In the present instance and with reference to Fig. 19 the cam 168 is shown in an extreme right hand position where it is aligned with the yarn guide finger which occupies the fifth position from the left end of the series as viewed from the front or top of the mechanism. From this position the cam may be traversed by action of the cam 176 to the left, so as to bring it into alignment with any of the other yarn guide fingers of the set of five to the left of center. In other words, the traverse of the cam 168 is limited in the present instance to a range embracing five only of the yarn guide fingers. In order that the cam 168 may be brought into alignment with the five yarn guide fingers to the right of the center of the series of ten mounted in the carriage 131, it is necessary that the carriage 131 be traversed to the left, as viewed in Fig. 19, to a position at the opposite side of the fixed frame or in proximity to the fixed frame side member 134. In this alternative position the five yarn guide fingers at the right of the series will occupy a position within the range of movement of the cam 168 as actuated by the cam 176 so that the latter cam may function as hereinafter described to bring the cam 168 into accurate alignment with any selected one of the yarn guide fingers of this series.

When the cam 168 has been brought into alignment with a selected finger, oscillation of the cam through the medium of the member 161, the pin 166, and the actuating rod 165, will depress the finger from the normal elevated position to the depressed position indicated in broken lines in Fig. 20. When the fingers are in the elevated position the yarn ends passing through the eyelets 146 are held out of the path of an oscillatory yarn pick-up member designated by the reference numeral 186.

When any one of the yarn ends is depressed however by the aforedescribed depression of the associated yarn guide finger **145**, the yarn end is moved into a position in the path of the pick-up member **186**, as best illustrated in Fig. 20. The yarn pick-up finger **186** is carried by a shaft **187** which, as shown in Fig. 20, has a bevel pinion **188** at its inner end, said pinion meshing with a segmental bevel gear **189** formed at the edge of the member **161**. Angular movement of the latter member about the axis of shaft **163** is accompanied by a corresponding movement of the pick-up finger **186**. Normally this finger occupies a relatively elevated position as illustrated in Figs. 18 and 20, and when oscillated as described the finger will move downwardly to pick up on the outer end thereof the yarn which, by actuation of the member **161**, has been moved into the path of the finger. The finger will at the same time pick up the yarn which at the moment is passing to the knitting head, this by reason of the fact that that yarn, designated **127** in Fig. 20, extends from the associated eyelet **121** under the lower edge of and upwardly behind a fixed shield **128**. The pick-up finger carries the two yarns upwardly to a knotter designated generally by the reference numeral **191**, said knotter joining a part of the yarn change mechanism and functioning to sever the running yarn **127** and to knot the end portion of that yarn which extends to the needles to the newly introduced yarn so that the latter is fed to the needles and in effect replaces the yarn **127**. In this manner, the yarns from the cones **116** may be substituted one for another in the knitting operation. The yarn ends passing from the cones to and through the eyelets **121** and **146**, when not in use are retained by a common clamping device (not shown) in position for subsequent transfer operations of the character described. The mechanism of the knotter, the yarn severing and yarn clamping devices is fully disclosed in my prior patents mentioned above and in my U. S. Patent 1,841,249 and forms no part of the present invention. The novel features of the yarn changer and their mode of operation will be readily understood by those familiar with the art by reference to the foregoing detailed description of the finger traverse and actuating devices.

It will be noted that the yarn change mechanism provides for inter-change of ten different yarns or ten yarns differing as to color or in other respect. It is proposed in accordance with the invention that one-half of the series of yarn fingers, namely the five fingers adjoining one end of the series, shall carry a different weight yarn than the five fingers at the other end of the series. Thus, with the yarn finger carriage at one end of its traverse a yarn of one weight will be guided to the needles, and with the carriage at the other end of its traverse a yarn of a different weight will pass to the needles. In each case the color or other properties of the yarn may be varied within the range of the five fingers of the sub-series which at the moment occupies an operative position with respect to i. e. within the range of movement of, the cam **168**. In particular the device provides for the use of yarns of different weights in the rib knit upper portion of the stocking and in the plain knit lower leg and foot portions of the stocking respectively, and also provides for the use selectively in each of these portions of the stocking of five different colors or characters of yarn.

In the aforedescribed needle actuating device it was shown that by use of the adjustable cams controlling the operations of the dial needles, that the machine may be operated both with and without the dial needles to produce ribbed and plain fabrics as desired. In this respect the machine operates in accordance with the principle set forth in the aforesaid U. S. Patent 834,763. The yarn selector mechanism described above is individually operative in both the rib and plain knitting operations to change the yarn, within the aforesaid selective ranges of five control fingers respectively, for the production of stripes or bands extending around the circumference of the stocking and of desired color contrasting with the background color and with each other; and the plating fingers **57** may also be operated to afford in either type of fabric vertical stripes or markings of the contrasting color or colors afforded by the multiple spools in the rack **24**. By use of the yarn selector and plating mechanisms jointly or in predetermined sequence, a wide variety of ornamental design may be obtained in both the upper ribbed and lower plain knit portions of the stocking. With this wide range of color and design the machine provides also for use in the upper ribbed portion of the stocking of the relatively heavy yarn conventionally employed in this part, and for use in the lower leg portion of yarn of lesser weight. The heavier yarn may also be introduced into the heel and toe portions, or these portions may be reinforced by introduction of yarn from the plating sources.

The wide range of possible design is illustrated in Figs. 23, 24 and 25. Fig. 23 shows a conventional child's sock with stand-up top. The top portion **201** is of the conventional rib fabric and is composed of yarn somewhat heavier than the yarn employed in the lower portion **202** and foot portions of the stocking which are of plain knit fabric. Fig. 24 shows a similar type of stocking wherein both the upper ribbed portion **203** and the lower leg portion **204** are ornamented by introduction of colored yarn in specific patterns. The extreme upper portion of the ribbed welt shows three horizontal striped portions **205**, **206** and **207** of color different from the base yarn. A similar arrangement of colored stripes is shown in the lower end portion of the ribbed welt designated by the reference numeral **208**. These horizontal stripes in the ribbed welt are produced entirely by manipulation of the yarns passing to the needles from the cones **116** through the medium of the yarn selector mechanism described above. The intermediate portion **209** of the ribbed welt is produced on the other hand solely by means of the plating devices, the plating fingers **57** being manipulated through the medium of the adjustable cam **67** to introduce the plating yarns at the required points in successive courses so as to form the diamond design in the desired color or combination of colors. The plain knit portion of the stocking in the leg area is characterized by a series of vertical stripes **211** in relatively spaced relation which vertical stripes terminating at top and bottom in horizontal stripes **212** and **213** respectively. In this case, the horizontal stripes **212** and **213** are produced by means of the yarn selector mechanism and the vertical stripes **211** by the plating devices.

The stocking illustrated in Fig. 25 is of the so-called turned-down type wherein the ribbed upper portion **214** of the stocking is made of such length that it may be turned over on itself to provide a turned-down or double cuff. Obviously the horizontal bands or stripes appearing in the ribbed cuff are produced by operation of the yarn selector mechanism. The leg portion **215** of the stocking which is of plain knit fabric shows a design resulting from a sequential operation of the yarn selector mechanism and the plating devices. The formation of this design will be readily understood from the foregoing descriptions of the stocking in Fig. 24.

The operations of the machine are controlled by a pattern drum **221**, a measuring chain **222**, a yarn selector chain **223**, and a plating chain **224**. The drum **221** carries cams, designated collectively by the reference numeral **225**, and is mounted for rotation on a shaft **226** mounted in the fixed frame of the machine. The drum has a ratchet wheel **227** at one end which is engageable by a pawl **228** to advance the drum step by step.

The pawl **228** is carried by an arm **229** pivotally mounted at **231** on an arm **232** of a continuously rocking lever **233** of bell crank form which is journaled on a shaft **234** supported in the frame of the machine, see Fig. 15,

A spring 235, Fig. 17, tends to retain the pawl in engagement with the ratchet wheel 227. The pawl arm 229, Figs. 14 and 15, has a transverse pin 236 which engages one arm 237 of a lever 238 journaled on a shaft 239 rotatably mounted in the frame. Another arm 241 of this lever carries a roller 242 which is engaged with the measuring chain 222 so that the high links of that chain may operate to retract the arm 237 and permit the pawl 228 to engage the ratchet wheel 227 under action of the spring 235. When the pawl is thus engaged, the pattern drum will be advanced in angular increments.

The chain 222 is carried on a sprocket 243 which is journaled for rotation on the shaft 226, and attached to the sprocket is a ratchet wheel 244. The ratchet wheel, and the sprocket, are advanced step by step by a pawl 245 pivotally mounted on a pin 246 projecting transversely from the lever 233. A spring 247, see Fig. 1, retains the pawl in engagement with the ratchet wheel.

The sprocket 220 is mounted for rotation on the shaft 226 and is given a step by step rotation by a pawl 248 which is pivotally attached to the outer end of an arm 250 on a rock shaft 249 journaled in the frame of the machine and is held by a spring 251 in engagement with a ratchet wheel 252 secured to the sprocket, see Fig. 16. The shaft 249 is operatively connected through an arm 253 at its opposite end and a roller 254 with a cam 255, this cam being mounted on a continuously rotating stub shaft 256. The cam has flour uniformly spaced elevations 255*a* each of which actuates the pawl 248 to advance the ratchet wheel to a predetermined extent and with it the sprocket 225 together with the chains 223 and 224 carried by the sprocket.

The stub shaft 256 carries a gear 257 which constitutes an element of a gear train connecting the cylinder gear 11 with a motor 258. The train includes a bevel gear 259 journaled on a shaft 261 mounted in the frame and meshing with the gear 11. The hub 262 of the gear 259 carries a clutch 263 which is axially adjustable to connect the gear selectively with pinions 264 and 265, said clutch being adjustable through a lever 266 and yoke 267 and being actuated by cams on the drum 221 as indicated in Fig. 17. When the gear 259 is connected to the pinion 264, the needle cylinder is rotated continuously; and when connected to the pinion 265 the needle cylinder is given the oscillatory motion required for formation of the heel and toe portions of the stocking.

As shown in Fig. 16, the pinion 264 meshes with the gear 257, and the aforesaid gear train includes also a pinion 268 on a shaft 269, a gear 271 on this same shaft, a pinion 272 and bevel gear 273 on a jack shaft 274, and a bevel pinion 275 on the motor shaft 276 which meshes with the gear 273.

The pinion 265 is engaged by a segmental gear 277 on the rock lever 233, previously described, and this lever is actuated by way of an arm 278 which is pivotally connected at 279 to the lever and at 281 to the cam, see Figs. 1 and 17. The segmental gear 277 is thus also connected through elements of the aforesaid gear train to the motor 258.

The function and mode of operation of the cam drum 221 is essentially the same as described in my United States Patent 2,422,568. Speed regulation of the knitting operations is obtained in the present instance by electronic means under control of a potentiometer 282 which is actuated by a ring cam 280 on one end of the drum 221. The potentiometer is connected with the cam through a pinion 283, a gear segment 284 journaled for oscillation on a shaft 285 fixed in the frame, a lever 286 connected with the segment, and a cam follower roller 287 on the lever. A spring 288 holds the roller against the cam.

The drum 221 through its several cams 225 controls the operations of the cylinder and dial needles. The shaft 285 provides a pivotal support for a number of lifter arms 289, 291, 292 which are rocked in vertical planes by suitably placed cams on the drum and which actuate rods 293, 294 and 295 connected respectively with the cam actuating levers 82, 81 and 79 respectively. A fourth lifter arm 296 is operatively connected through a rod 297, an arm 298 secured to the rod (see Fig. 1), a connecting rod 299, and a bell crank lever 301 with the cam-actuaing arm 80 previously referred to, and the lifter arm 296 is also operatively associated with one of the drum cams for actuation in timed relation with the other dial needle cams and with the other operating parts of the machine.

Also pivotally mounted on the shaft 285 is a lifter arm 302 which is operatively associated with a suitable cam on the drum and with the rod 159 which actuates the lever 154 of the yarn selector unit previously described.

The cylinder cams are actuated from the drum 221 by cams on the latter associated respectively with bell crank levers 303, 304, 305 and 306, and rods 307, 308, 309 and 311 connected respectively to the levers and extending to the cam ring 6 and block 7 in which the cams are mounted as previously set forth.

As previously described, axial adjustment of the yarn selector cam 168 are effected through the medium of the cam 176 and lever arm 183. The latter is connected through the rod 184 with an arm 312, see Fig. 15, on the end of the shaft 239. The shaft is rocked and its angular position is determined by the action on an arm 313 of the cam links of the yarn selector chain 223, see Fig. 14, said arm being secured to the shaft and having a follower roller 314 at its outer end in engagement with the chain.

The rod 165 which actuates the member 161 to, in turn, actuate the cam 168, is attached at its lower end, see Fig. 1, to an arm 315 pivotally mounted on a pin 316. The arm 315 carries a pawl 317 which is operatively associated with a continuously oscillating element 318, said element receiving its oscillation through a rod 320 from an eccentric 319 on a shaft 321, see Figs. 1 and 15, continuously rotated through a gear 322 and a pinion 323 on the shaft 28. The rod 185 attached to the lever arm 183 has attached to its lower end a pawl guard 183*a* which normally, when the lever arm is as shown in Fig. 1, will deflect the pawl from the element 318 so as to prevent oscillation or displacement by the latter of the arm 315. When the lever arm 183 is actuated as described above by the yarn selector chain 223, the resulting elevation of the rod 185 withdraws the pawl guard and permits the pawl to engage the element 318, which then rocks the arm 315 and causes the rod 165 to turn the member 162 and to thereby actuate the yarn finger depressing cam 168. This device for actuating the member 162 is disclosed in detail in my United States Patent 1,624,792.

The yarn knotting and clipping elements of the yarn selector unit 122 are actuated by a rock shaft 324 in accordance with the mechanism and principles set forth in my prior United States patents aforesaid. In the present instance the shaft has an arm 325 at its lower end which carries a roller 326 arranged for engagement with a cam 327 on the end of the shaft 321. The cam, see Figs. 15 and 15*a*, has an element 328 which when engaged with the roller 326 acts to rock the shaft 324 to actuate the yarn-clipping and -knotting devices; and the cam has a second element 329 which functions to return the shaft to the original position after actuation by the element 328. Normally, the shaft 324 is held by a latch lever 331 on the end of shaft 163 in an elevated position in which, as shown in Figs. 15 and 15*a*, the roller 326 lies out of the path of the continuously rotating cam element 328. When the latch element 331 is depressed, which occurs when the shaft 163 is turned to actuate the yarn finger depressing cam 168, the shaft 324 drops

downwardly to bring the roller into the path of cam element 328 which then rocks the shaft 324 to actuate the yarn clipping and knotting devices of the selector unit. Such rocking of the shaft also shifts the roller into the path of cam element 329 which acts immediately to return the shaft to the original position and simultaneously the shaft is elevated by the latch 331. In this position also the roller is brushed by the high portion of the cam element 329 at each revolution, as shown in Fig. 15.

The actuating rod 74 for the plating finger cam 67 is actuated from the chain 224. As shown in Figs. 1 and 14, the rod 74 carries an arm 332 which seats on the end of a lifter arm 333 pivotally mounted on the shaft 239 and having a roller 334 engaged with the chain 224. The position of the cam 67 with respect to the butts 61 of the fingers 57 is thus determined by the cam links of the chain 224. As previously noted, the butts 61 are removable selectively to afford the desired plated pattern.

As noted above, the machine provides for feeding to the needles a different weight of yarn for the rib and plain knit fabrics respectively, and in each case for interchanging the yarn with a number of yarns of different color but of same weight so as to form horizontal stripes of different or contrasting color. In such interchanges, it is desirable that the knot between the different color yarns fall as nearly as possible at the back center of the stocking and in alignment with each other. There is a difference, however, in the lengths of yarn required for knitting a single course of a given number of stitches in plain and rib knit fabrics respectively, so that unless compensation is provided, the knots in the ribbed fabric will not be aligned with the knots in the plain fabric. This variable is complicated by the fact that in the present instance different weights of yarn are used in the two fabrics.

In Figs. 26 and 27, I have illustrated a device for compensating the aforesaid variation so as to bring the knots in the two fabrics into approximate alignment at the back center of the stocking. The device consists of a guide finger 335 over which the running yarn passes in its travel from the yarn selector unit to the needles. The finger 335 is connected in the present instance to a detector or stop motion device 336 so that excessive tension on the yarn will draw the finger down to the position shown in dotted lines at 337 and thereby operate the stop motion. This freedom of movement of the finger and its lost motion between the normal elevated position and position 337 also compensates for the momentary interruption in the feed of the yarn which occurs when the selector unit operates to change from one foundation yarn to another. The device 336 is mounted on a sleeve 338 which is slidably supported on a vertical rod 339 secured in one of the arms 341 of the spider 22. The downward movement of the sleeve 338 is limited by a collar 342 secured to the rod 339; and the sleeve is prevented from turning on the rod by a pin 343 on the latter which extends through a longitudinal slot 344 in the sleeve.

The sleeve carries a roller 345 at its lower end which is engaged by a lever 346 pivotally secured to an upstanding bracket arm 347 on the spider arm 341. The underside of this lever is engaged by the upper end of a rod 348 the lower end of which seats on a lift finger 349 pivotally attached to the shaft 285 and operatively associated with a properly located cam on the drum 221. When the lever 346 is elevated by action of the cam drum, the sleeve 338 is elevated and with it the finger 335, is indicated in broken lines in Fig. 26, thereby increasing the length of the yarn between the selector or knotter and the needles. In the present instance, this elevation will occur simultaneously with the change over from plain knitting to rib knitting but after the change of yarn at the selector. The knot formed in said change will then fall as normally in the proper position in the web and since elevation of the sleeve will have provided the additional length of yarn between the selector and the needles required in the knitting of the individual course of rib fabric, any subsequent knot at the juncture of two different yarns will also fall at the desired back center of the stocking. The finger will remain elevated during knitting of the ribbed fabric and all knots between the different colored yarns used in this fabric will lie at the desired position at the back of the stocking.

When the change is made from rib to plain knitting, the sleeve 338 and finger 335 will assume the depressed positions shown in the drawings, which will reduce the length of yarn between the knot where it is formed and the needles. Again the knotting of the different foundation yarn for the plain knit fabric will precede the depression of the sleeve so that the knot will fall at the desired position. The finger will remain depressed during knitting of the plain fabric, however, and the knots subsequently made in changes of color will fall where desired. It is evident that the amount of compensation may be accurately regulated by adjusting the height of the cam actuating the lifter 349.

The operation of the machine in the knitting of a continuous strip of stocking blanks will be readily understood by those familiar with the art or by reference to the prior United States patents mentioned above. The essential operations are conventional in this phase of the knitting operation. The devices for selectively changing the foundation yarn, and the introduction selectively of plating yarns of differing colors, are also known in the art, as herein indicated. The manner in which these mechanisms have been combined so as to make possible their use in the knitting of both portions of the individual blank to afford in each as desired a wide variety of ornamental pattern differing both as to configuration and color combination, and the means for changing the physical properties of the foundation yarn without imposition of limits as to pattern or color is novel and constitutes a primary feature of the applicant's invention as defined in the appended claims.

I claim:

1. In a circular knitting machine having a rotary needle cylinder and a rotary needle dial, needles in said cylinder and dial, and relatively fixed cylinder needle and dial needle actuating cams, mechanism for rotating the cylinder, a dial-supporting shaft extending upwardly from the dial, a spool rack mounted on the upper end of the shaft, a plurality of spools on the rack, yarn wrap fingers operatively associated with the cylinder needles, means for mounting said fingers in annular series on the said shaft above the dial, relatively fixed and axially adjustable cam means for actuating said fingers, transmission means for operatively connecting the cylinder rotating mechanism with the shaft at a point between the spools and the said fingers, and yarn guide means rotatable with the shaft for conducting the yarn from the respective spools to the individual fingers.

2. A circular knitting machine according to claim 1 wherein the yarn guide elements include channels extending longitudinally of the shaft and radially within the annular series of fingers.

3. A knitting machine according to claim 2 wherein the said transmission means includes a gear element connected to the shaft below the said rack and having a rim and teeth extending downwardly below said rim, and a pinion connected to the cylinder rotating mechanism and engaging the lower end portions of the teeth in an area below and spaced from the said rim so as to leave unobstructed openings between the adjoining teeth of the gear element, said openings constituting elements of the said yarn-guide means.

4. In a circular knitting machine, a needle cylinder and needles guided therein, a depending shaft above and in

axial alignment with the cylinder, a needle dial attached to the lower end of the shaft at the upper end of the cylinder and needles guided in said dial, mechanism for synchronously rotating the cylinder and shaft, yarn wrap fingers mounted in circumferential series on the shaft for rotation with the latter and operatively associated with the cylinder needles, sleeve means secured to the shaft and comprising yarn guide channels extending to said fingers, and a yarn spool rack supported on said shaft at the upper end of the said sleeve means.

5. A knitting machine according to claim 4 including a cam ring embracing the shaft at a point intermediate the upper and lower ends of the channels, cams mounted in the ring in operative association with the dial needles, cam means for actuation of the yarn wrap fingers also located in the area between the upper and lower ends of the channels, and mechanism for adjusting said cam means axially of the shaft.

6. A knitting machine according to claim 4 wherein the said sleeve means comprises an inner longitudinally slotted sleeve, blades fitted in the slots and projecting beyond the outer surface of the sleeve, and outer sleeve means embracing and confining the blades and forming with the latter and said inner sleeve the yarn guide channels.

7. A knitting machine according to claim 6 including a collar clamped around the lower ends of the blades and constituting an element of the sleeve means, means in said collar for pivotally supporting the dial needles and said fingers in midportions thereof, a relatively fixed cam ring supported at the upper end of the collar, cam mounted in the ring for engagement with the upper end portions of the dial needles to oscillate the latter, finger oscillating cam means engageable with the upper end portions of the fingers, and means for adjusting the cam means axially of the shaft.

8. In a circular knitting machine having a rotary needle cylinder and a rotary needle dial, needles in said cylinder, a depending shaft supporting the dial at the upper end of the cylinder, a needle in said dial for each alternate cylinder needle, each said dial needle having a shank at its inner end extending upwardly along said shaft and comprising an intermediate fulcrum portion, a yarn wrap finger cooperatively disposed with respect to each of said alternate cylinder needles and each comprising a shank extending upwardly along the said shaft, said shanks being substantially in parallel alignment and interspersed with the shanks of the dial needles, each of the finger shanks comprising an intermediate fulcrum portion, circumferential means on the shaft providing a pivotal support for the fulcrum portions of the shanks both of the dial needles and the fingers, radial guide means for said shanks, cam means for actuating the cylinder needles, and other cam means operatively associated with the shanks for actuating the dial needles and the fingers.

9. A circular knitting machine according to claim 8 wherein the cam means for actuating the dial needles comprises a cam ring at the upper ends of the needle shanks, the said means for actuating the fingers comprises a cam adjustable in axial direction with respect to the said shaft in the space between the said cam ring and the said pivotal support means for the shanks and externally of the shank circle, and means for feeding yarn to the fingers from the inside of said circle and between the shanks of the dial needles.

10. In a circular knitting machine having a rotary needle cylinder and a rotary needle dial, needles carried by the cylinder and relatively fixed cams for actuating said needles, a dial shaft extending upwardly from the dial, an annular series of flat shanks pivotally mounted on the shaft for oscillation in planes radial to the shaft axis and extending downwardly from said pivot toward the cylinder needles, a dial needle on the lower end of each alternate shank and a guide slot for each said needle in the dial, a yarn wrap finger at the lower ends of the other shanks operatively positioned with respect to the cylinder needles, a relatively fixed cam ring at the upper ends of the shanks and cam means in said ring in operative association with the needle shanks, and actuating cam means for the fingers engageable with the finger shanks in the area between the cam ring and the said pivot and externally of the shank circle, and means including guides on the shaft for feeding yarn to the fingers from inside of said circle.

11. A circular knitting machine according to claim 10 wherein the dial needles and fingers are arranged for cooperation with the same alternate cylinder needles.

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