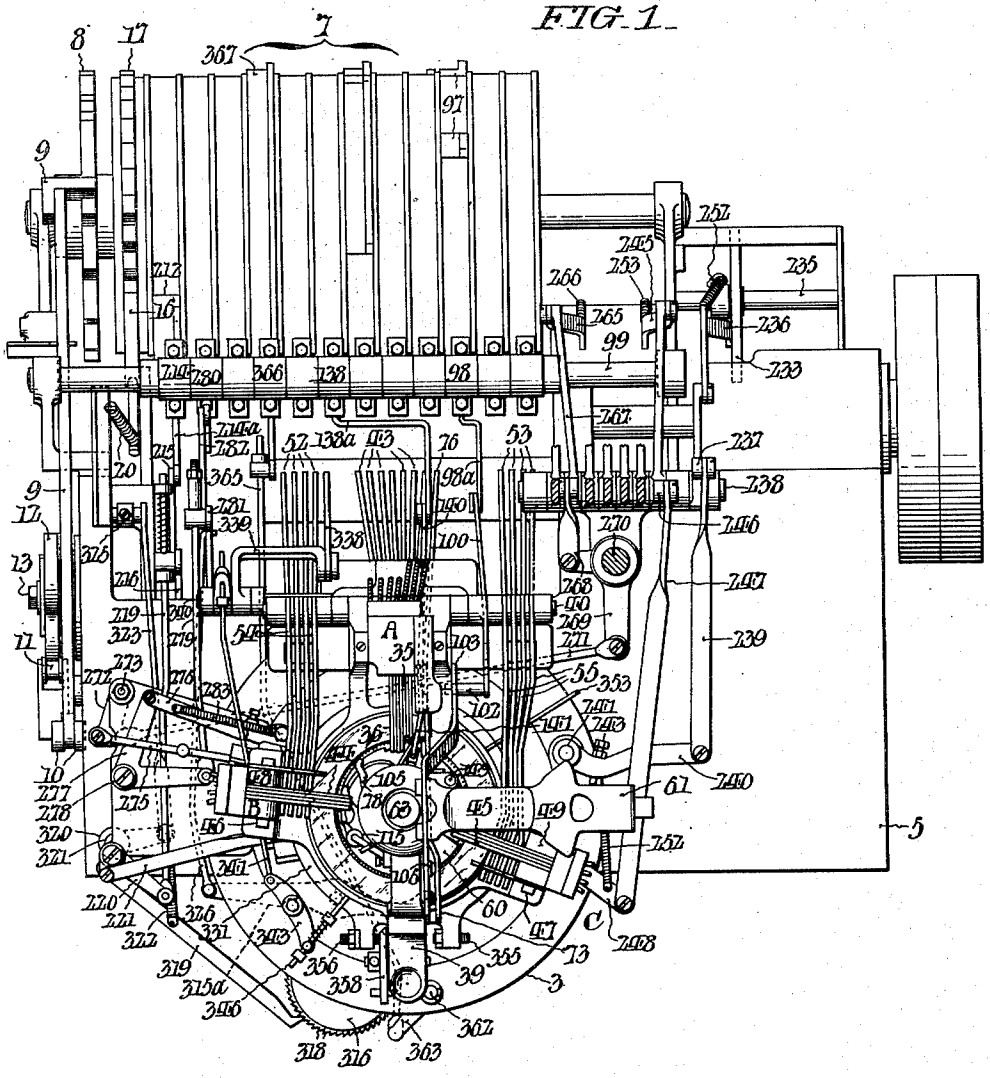
Oct. 10, 1950 E. F. MILLER 2,525,704

KNITTING MACHINE AND METHOD

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FIG. 1.



WITNESSES

Thomas W. Kerr, Jr.

Hubert Fuhr

INVENTOR:

Eugene F. Miller,

BY Paul & Paul

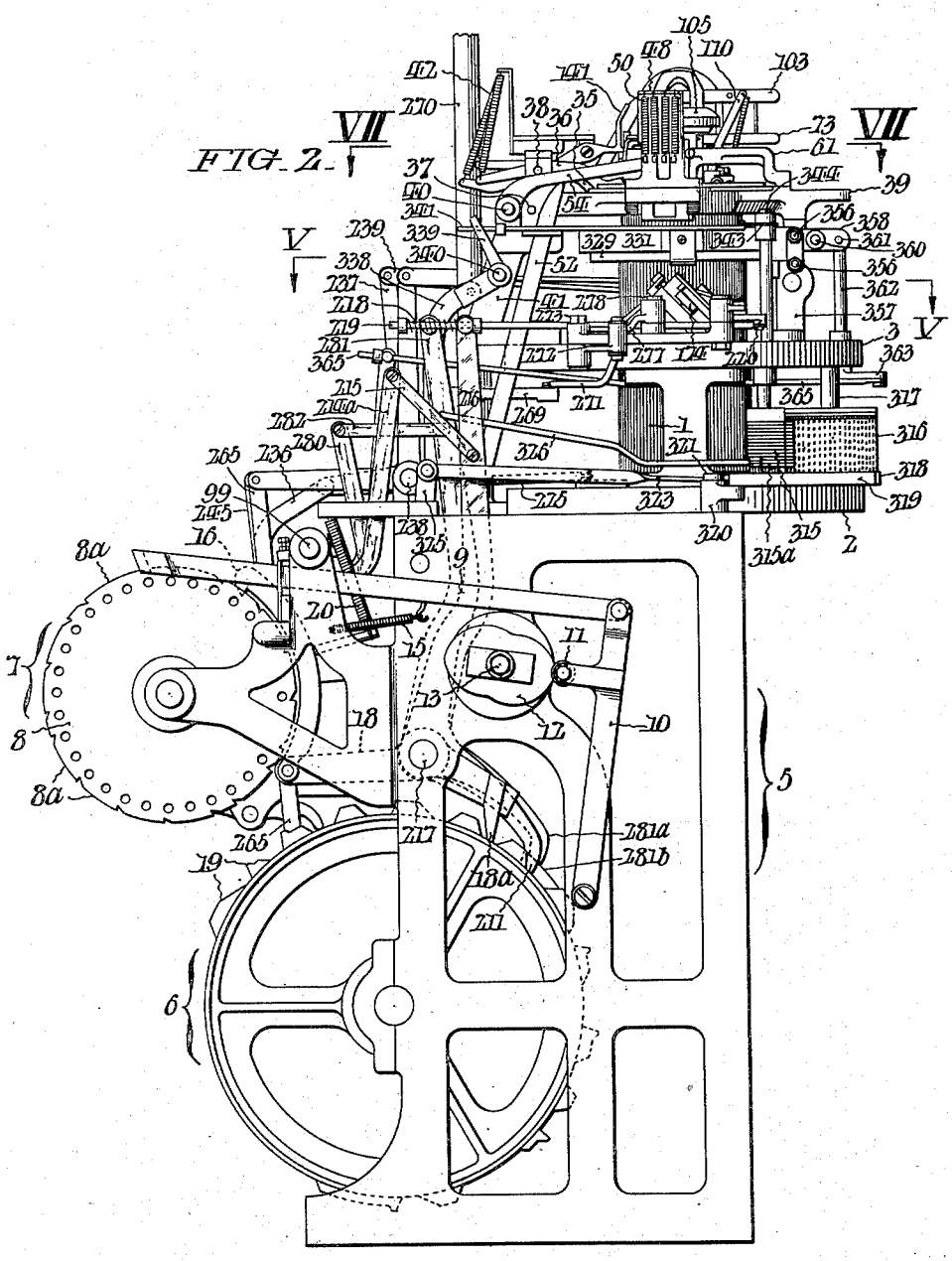
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Oct. 10, 1950 E. F. MILLER 2,525,704

KNITTING MACHINE AND METHOD

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FIG. 2.



WITNESSES

Thomas W. Kerr, Jr.

Herbert Fuchs

INVENTOR:

Eugene F. Miller,

BY Paul & Paul

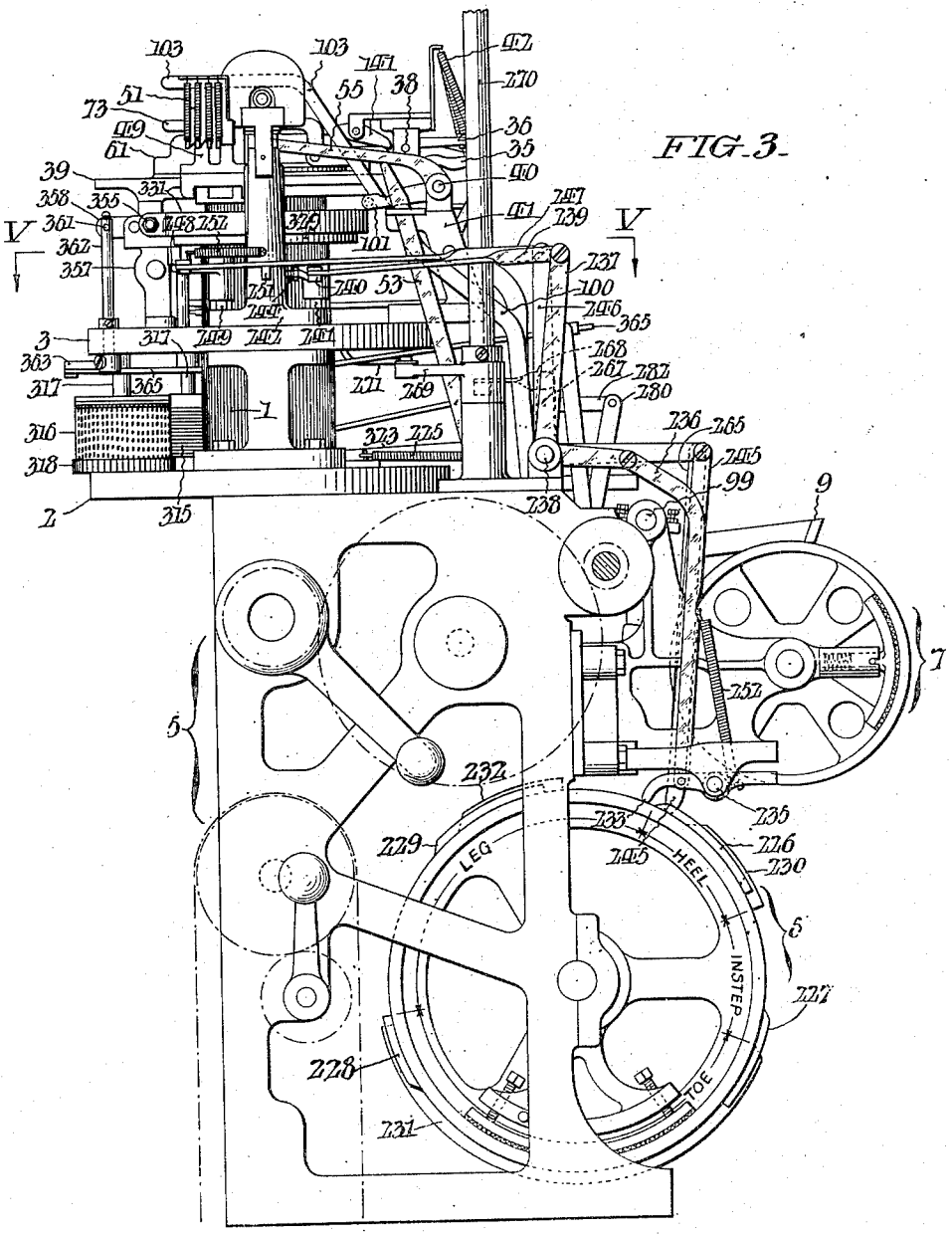
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Oct. 10, 1950 E. F. MILLER 2,525,704

KNITTING MACHINE AND METHOD

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FIG. 3.



WITNESSES

Thomas W. Kerr, Jr.

Hubert Fuchs

BY

INVENTOR:

Eugene F. Miller,

Paul & Paul

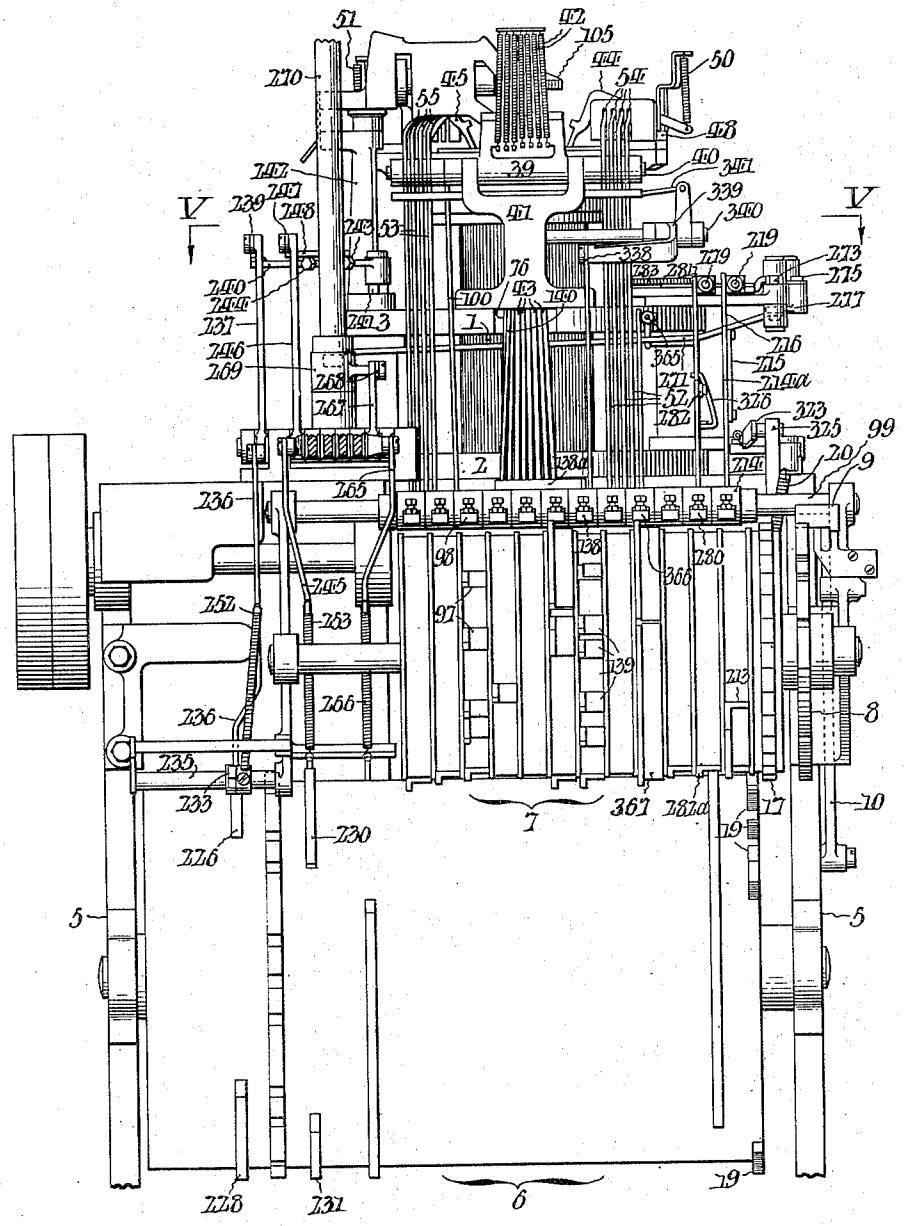
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Oct. 10, 1950 E. F. MILLER 2,525,704

KNITTING MACHINE AND METHOD

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FIG. 4.



WITNESSES

Thomas W. Kerr, Jr.

Hubert Fuchs

INVENTOR:

Eugene F. Miller,

BY Paul & Paul

ATTORNEYS.

Oct. 10, 1950 E. F. MILLER 2,525,704

KNITTING MACHINE AND METHOD

Filed Jan. 16, 1946 26 Sheets-Sheet 5

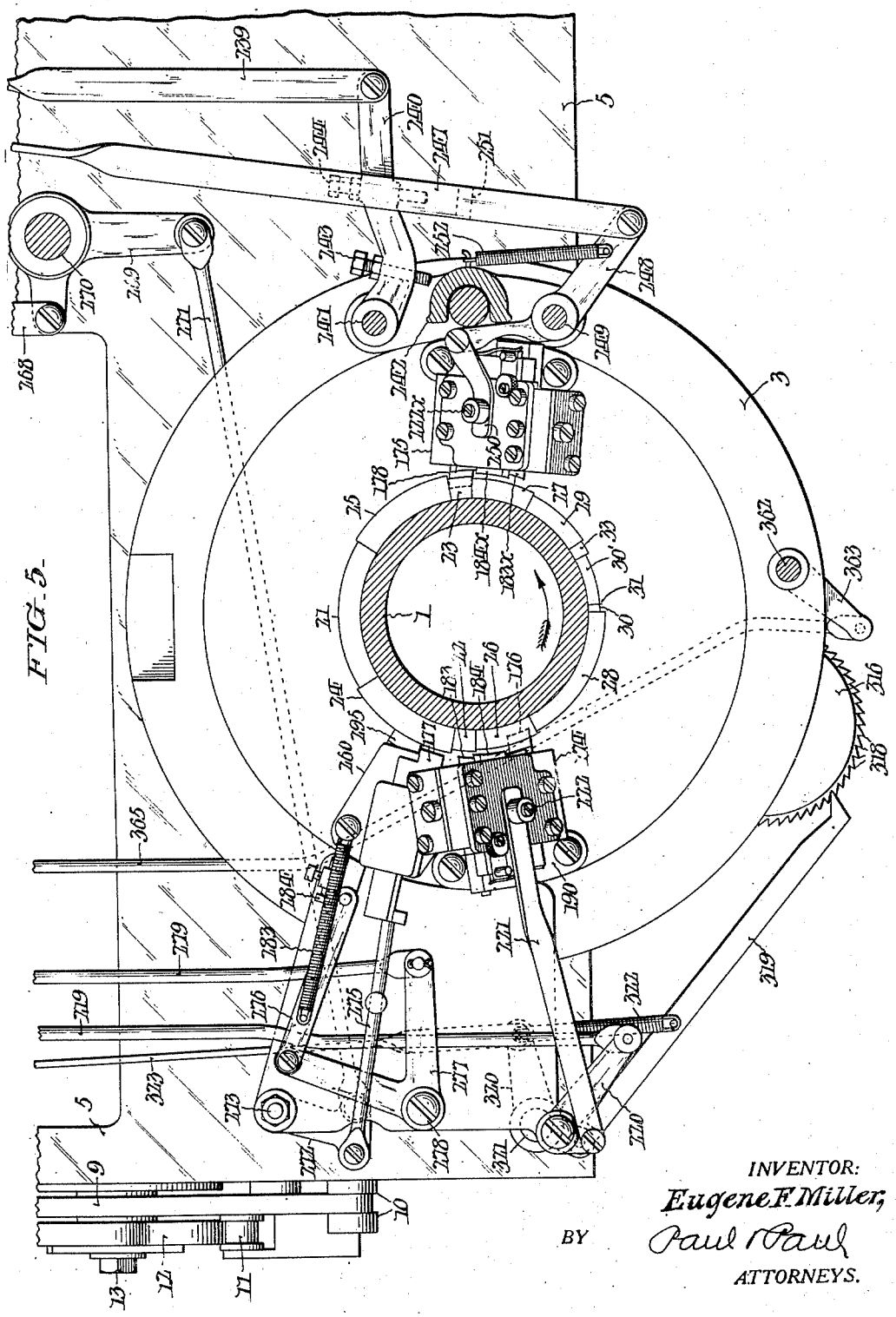


FIG. 5.

INVENTOR:
Eugene F. Miller,
BY Paul & Paul
ATTORNEYS.

Oct. 10, 1950 E. F. MILLER 2,525,704

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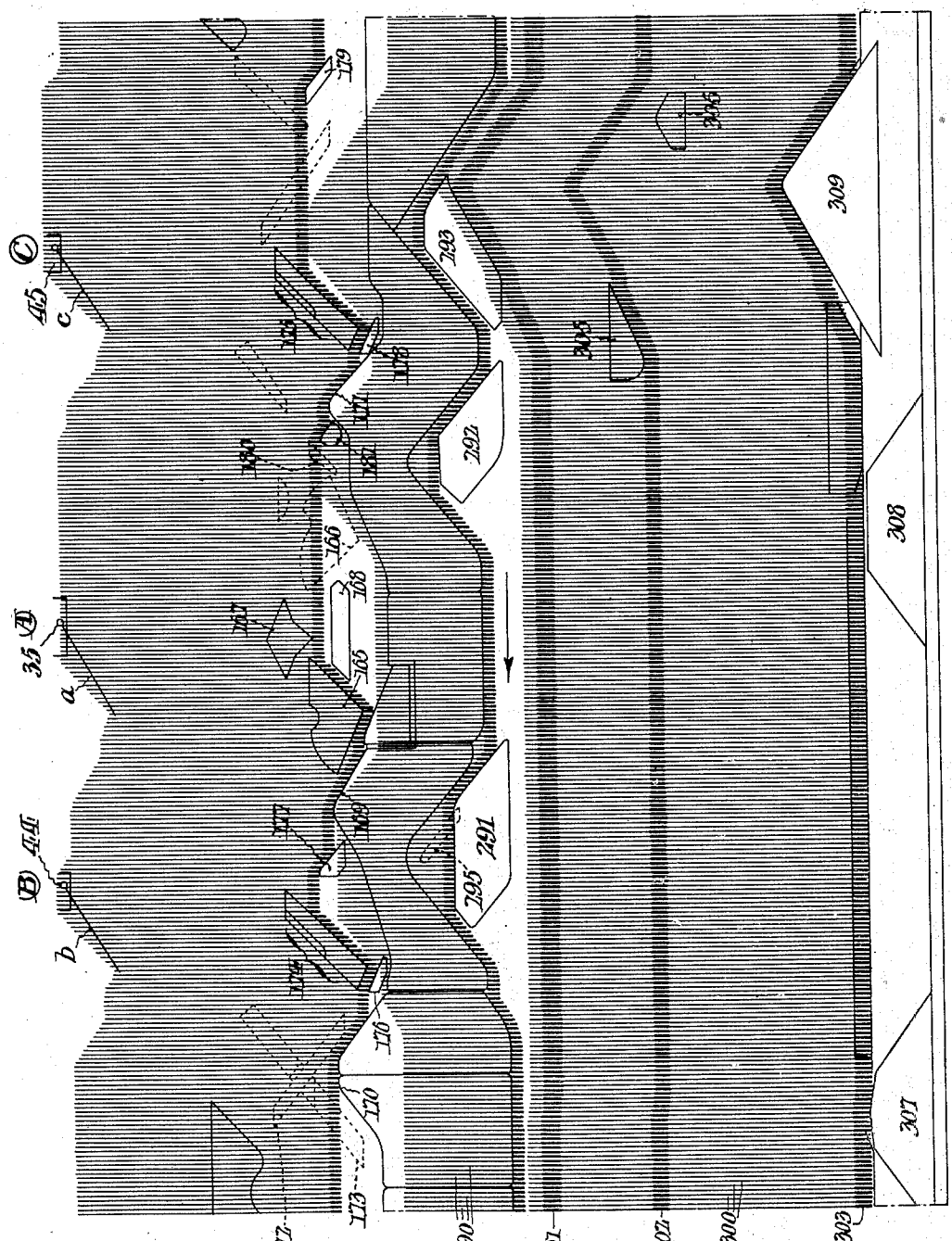


FIG. 6.

WITNESSES:
Thomas W. Kerr, Jr.
Hubert Fickes

INVENTOR:
Eugene F. Miller,
BY Paul & Paul
ATTORNEYS.

Oct. 10, 1950 E. F. MILLER 2,525,704

KNITTING MACHINE AND METHOD

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FIG. 7.

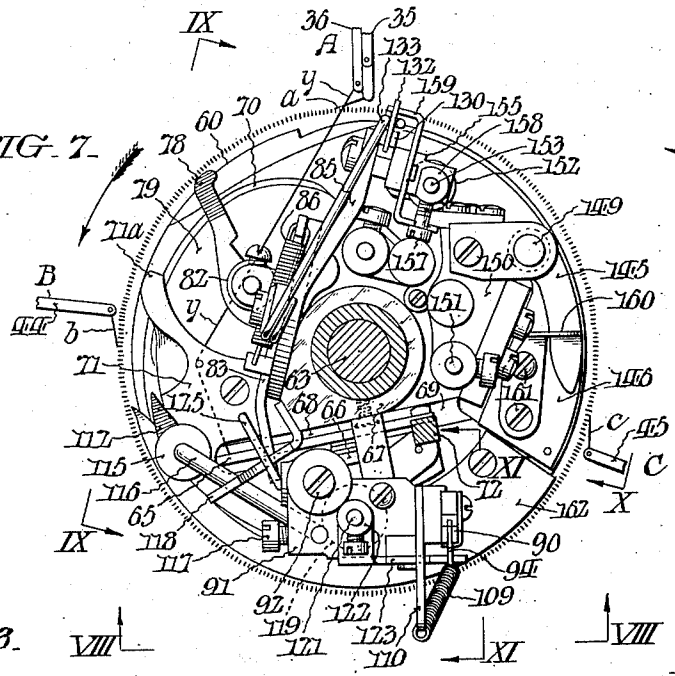


FIG. 13.

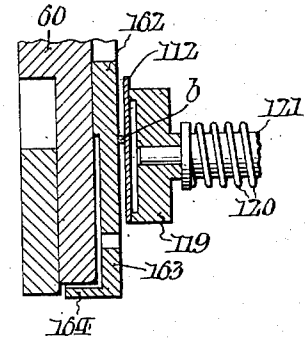


FIG. 8.

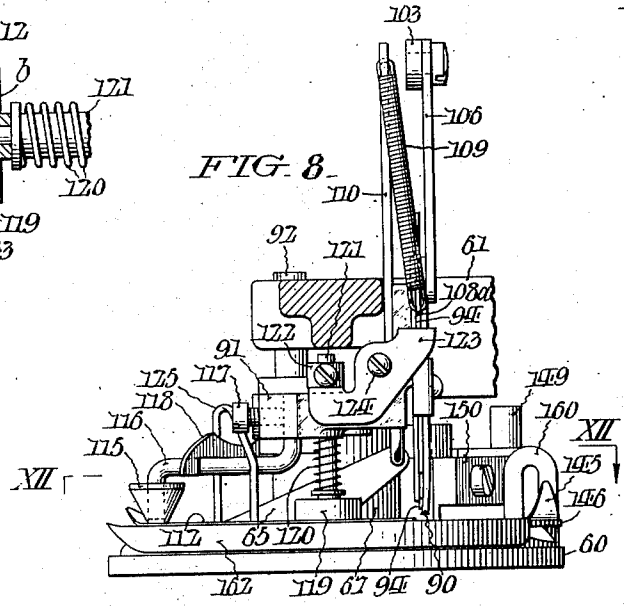


FIG. 14.

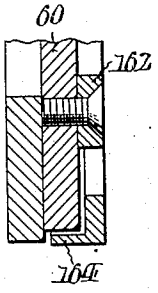
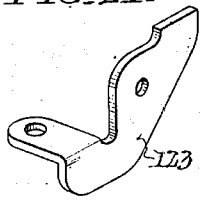


FIG. 24.



WITNESSES

Thomas W. Kerr, Jr.

Hubert Fuchs

INVENTOR:

Eugene F. Miller,

BY Paul & Paul

ATTORNEYS.

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FIG. 9.

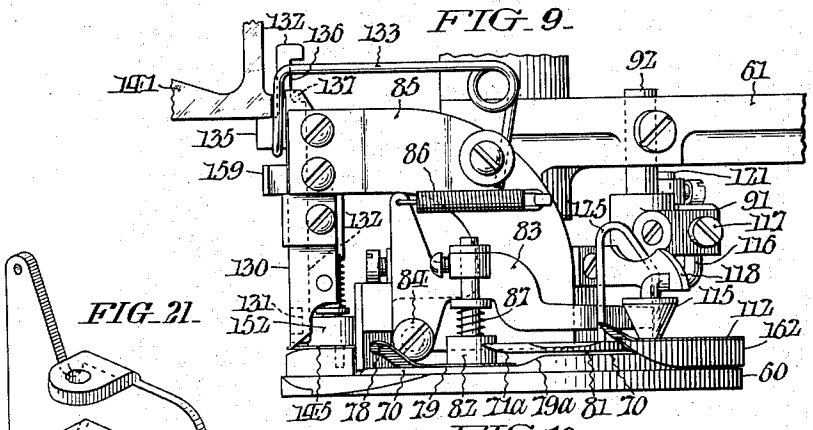


FIG. 21.

FIG. 22.

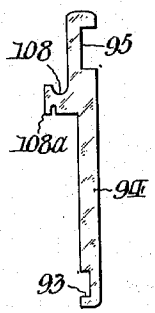


FIG. 10.

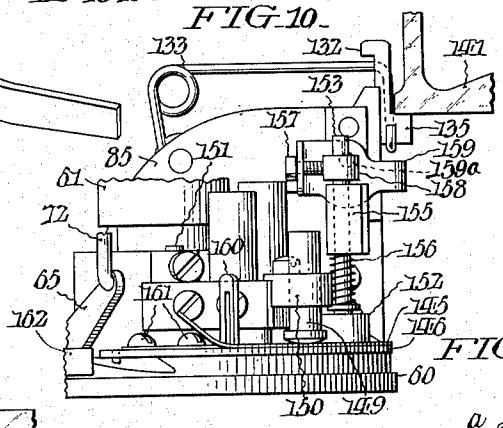


FIG. 23.

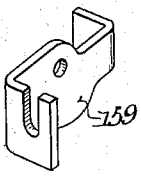


FIG. 12.

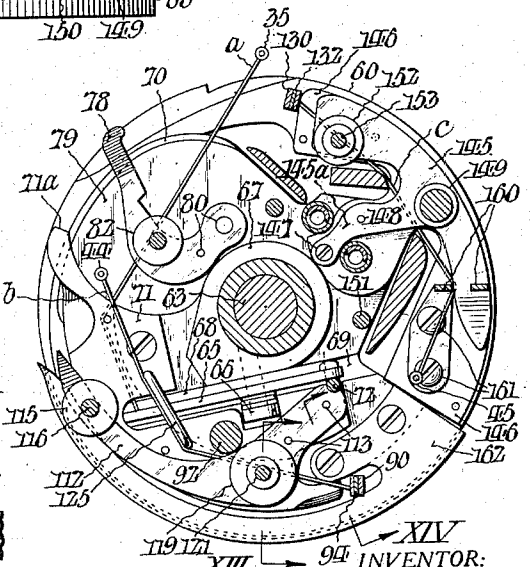
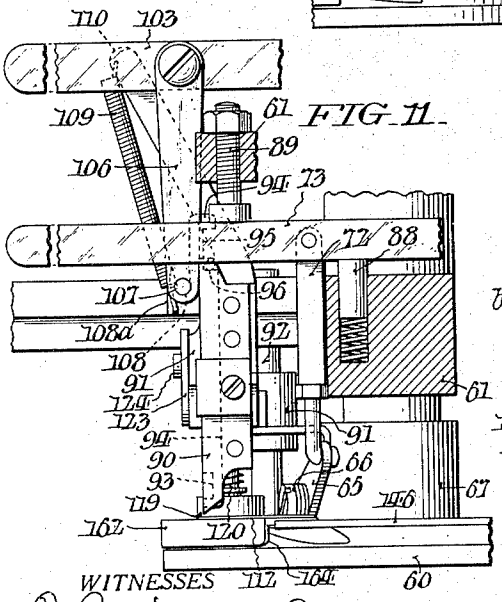


FIG. 11.



WITNESSES

Thomas O. Kerr, Jr.

Hubert Fuchs

INVENTOR:

Eugene F. Miller,

BY Paul & Paul

ATTORNEYS.

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KNITTING MACHINE AND METHOD

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FIG. 15.

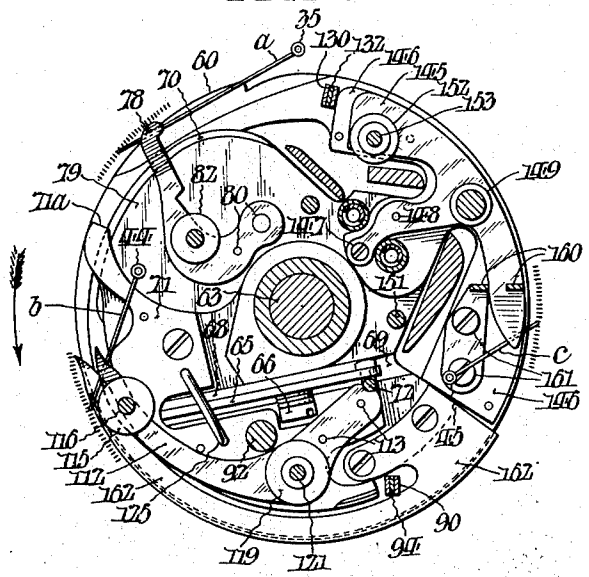


FIG. 16.

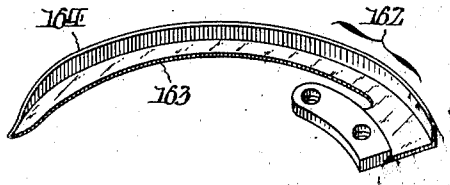


FIG. 17.

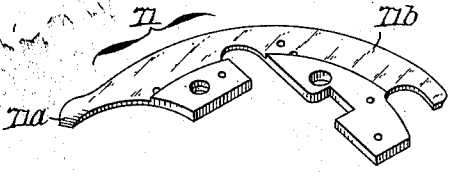


FIG. 18.

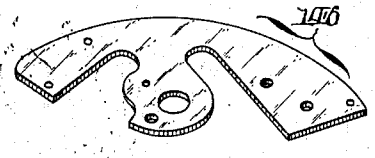


FIG. 19.

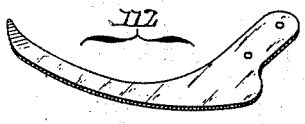
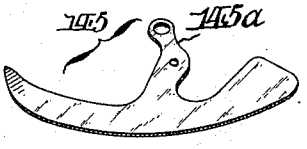


FIG. 20.



WITNESSES

Thomas W. Kerr, Jr.

Hubert Fuchs

INVENTOR:

Eugene F. Miller,

BY Paul & Paul

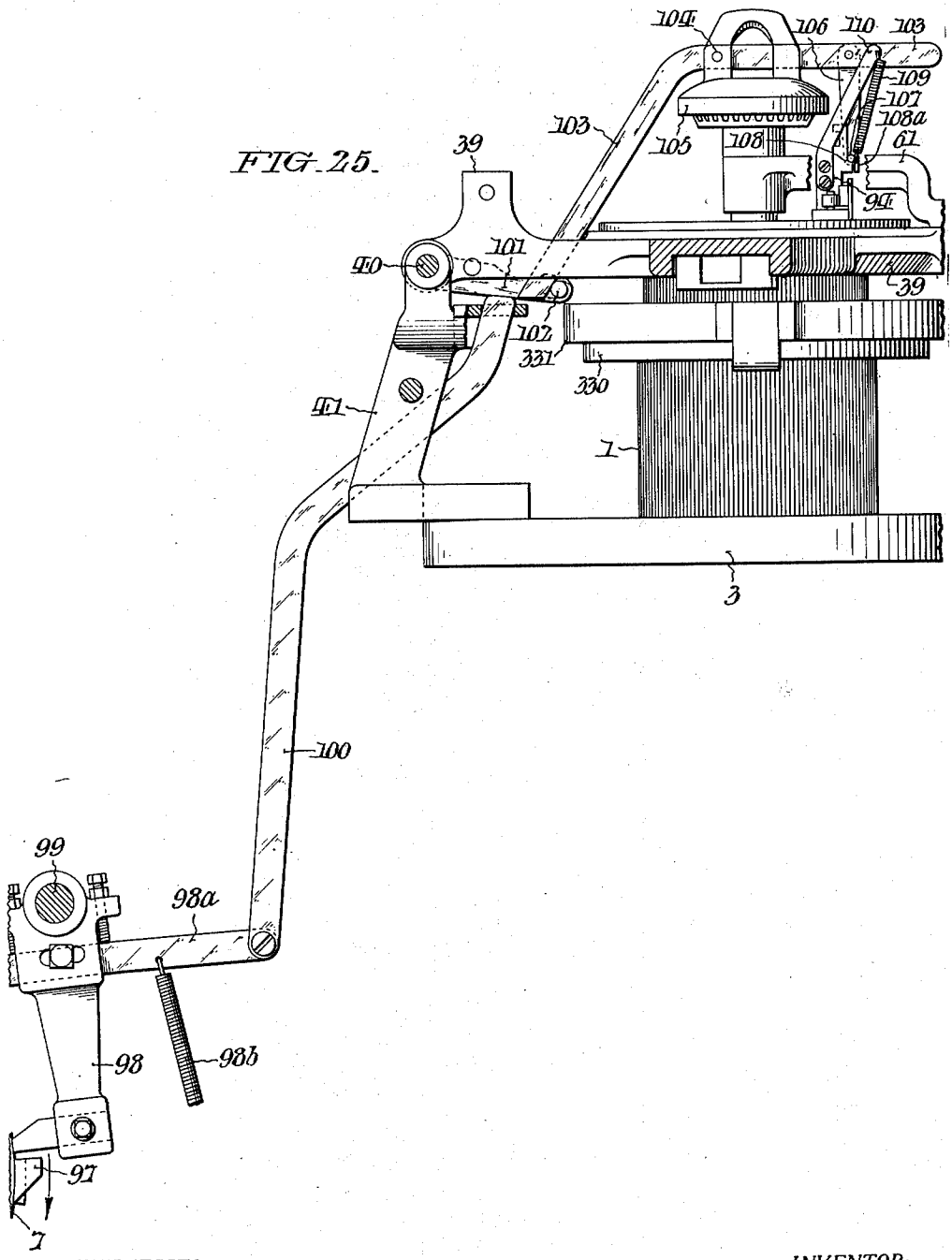
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FIG. 25.



WITNESSES

Thomas W. Kerr, Jr.

Hubert Fuchs

INVENTOR:

Eugene F. Miller,

BY Paul & Paul

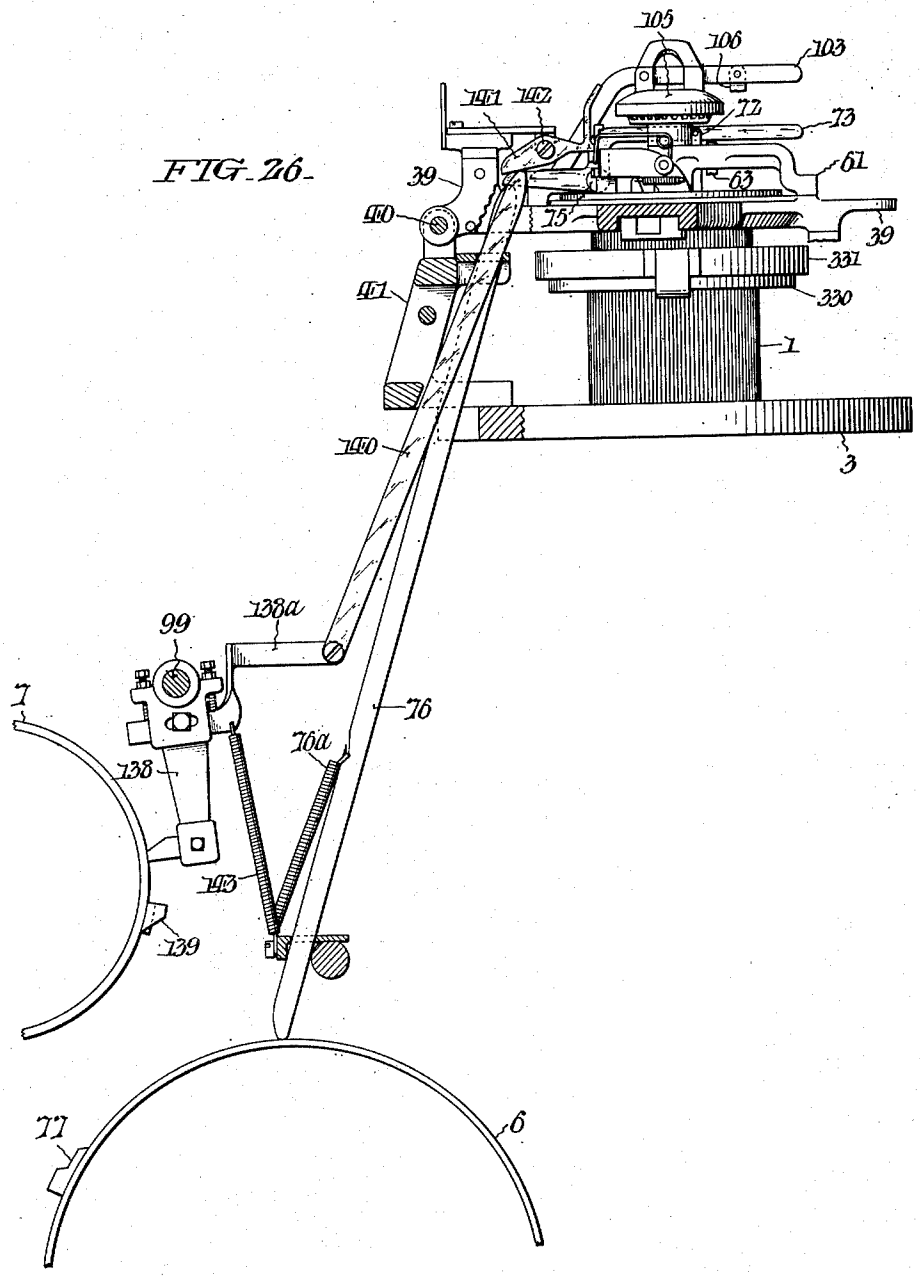
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FIG. 26.



WITNESSES

Thomas W. Kerr, Jr.

Hubert Fuchs

BY

INVENTOR:

Eugene F. Miller,

Paul & Paul

ATTORNEYS.

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FIG. 27.

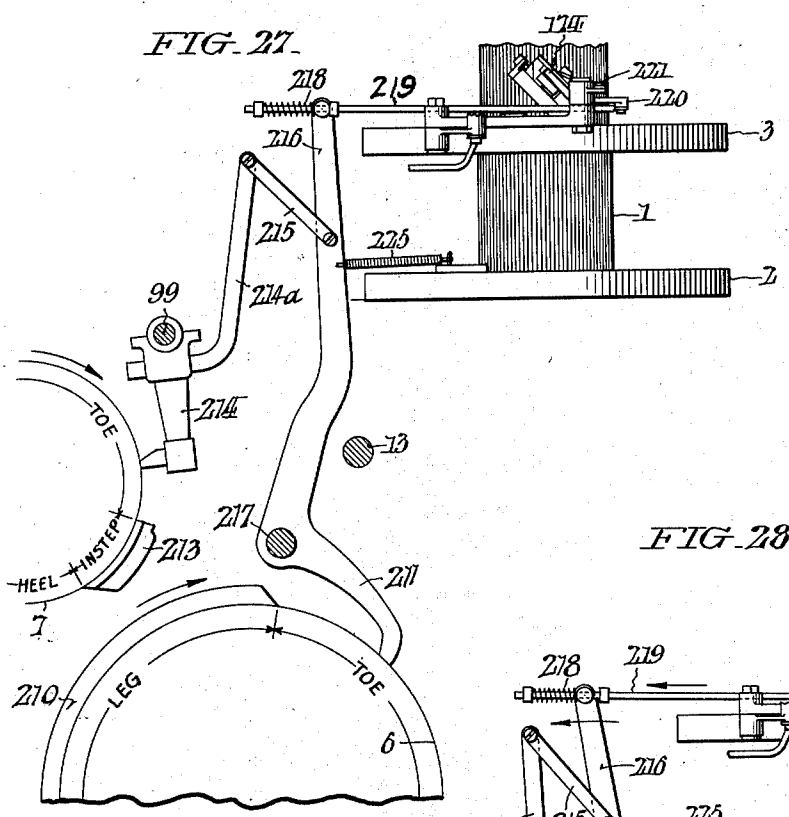
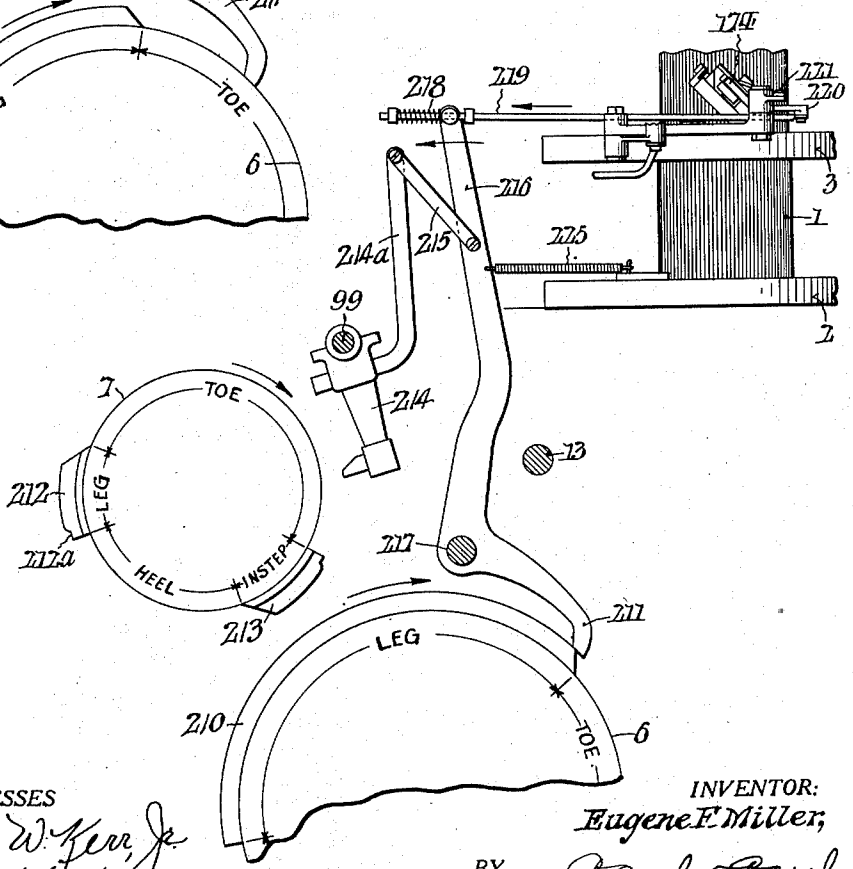


FIG. 28.



WITNESSES

Thomas W. Kerr, Jr.

Hubert Tucker

INVENTOR:

Eugene F. Miller,

BY Paul & Paul

ATTORNEYS.

Oct. 10, 1950 E. F. MILLER 2,525,704

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FIG. 29.

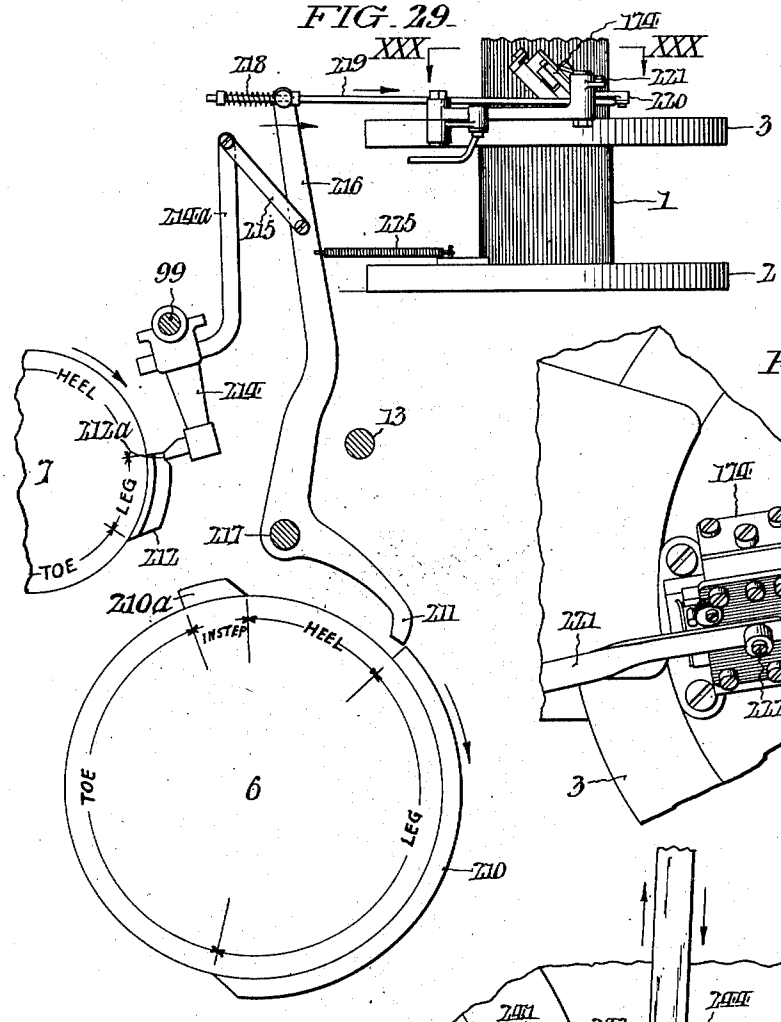
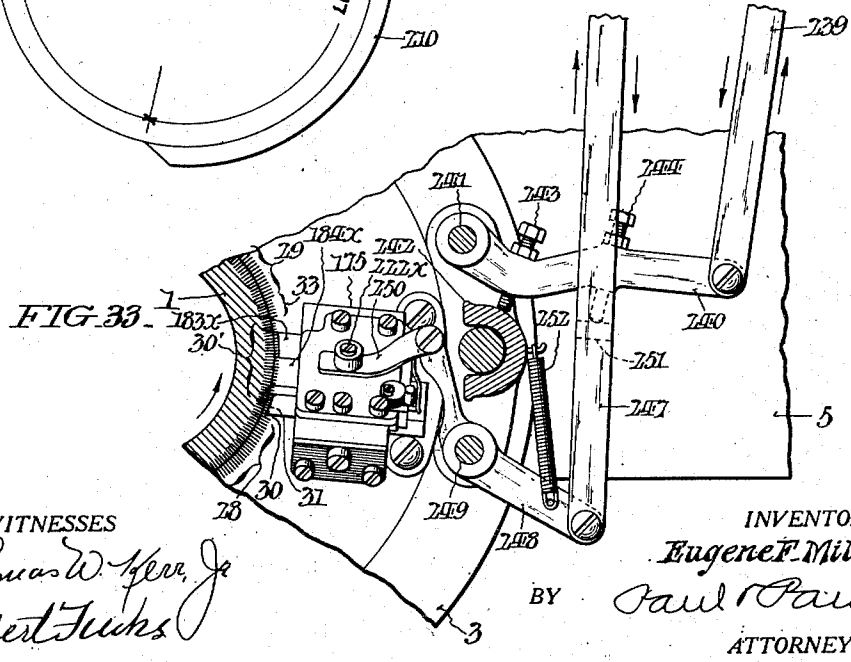


FIG. 30.

FIG. 33.



WITNESSES

Thomas W. Kerr, Jr.

Hubert Fuchs

INVENTOR:

Eugene F. Miller,

BY Paul & Paul

ATTORNEYS.

Oct. 10, 1950 E. F. MILLER 2,525,704

KNITTING MACHINE AND METHOD

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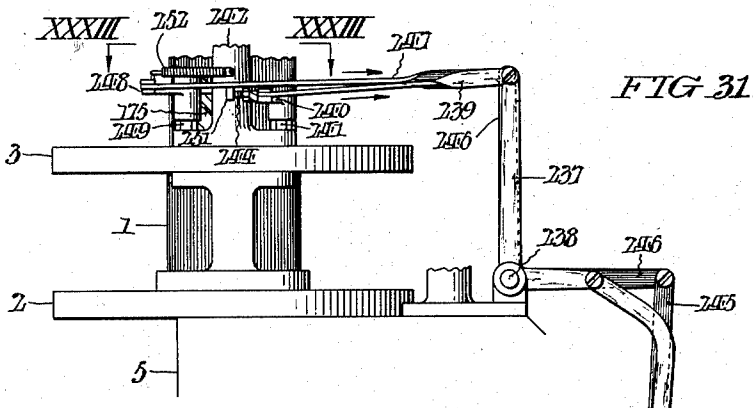


FIG. 31.

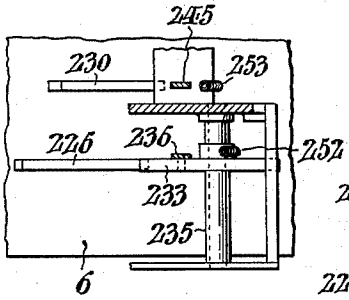
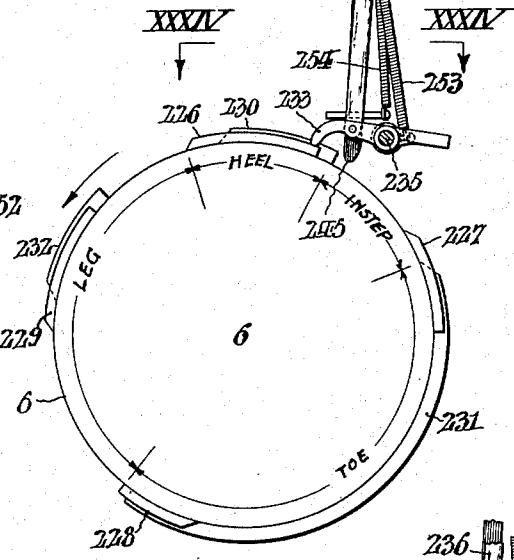


FIG. 34.



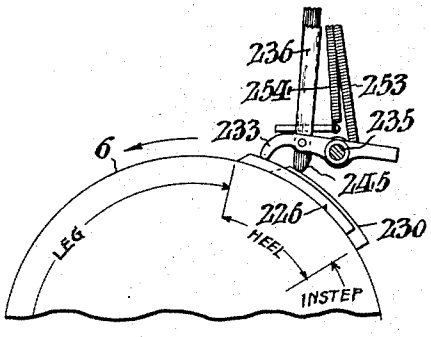


FIG. 32.

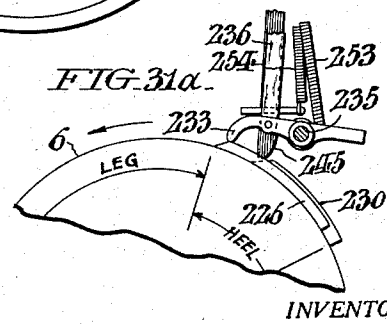


FIG. 31a.

INVENTOR:
Eugene F. Miller,
BY Paul Paul
ATTORNEYS.

Oct. 10, 1950 E. F. MILLER 2,525,704

KNITTING MACHINE AND METHOD

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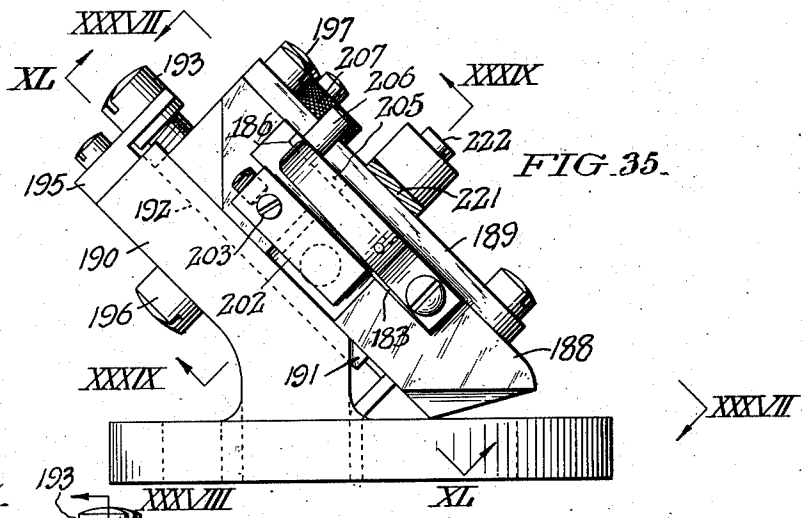


FIG. 35.

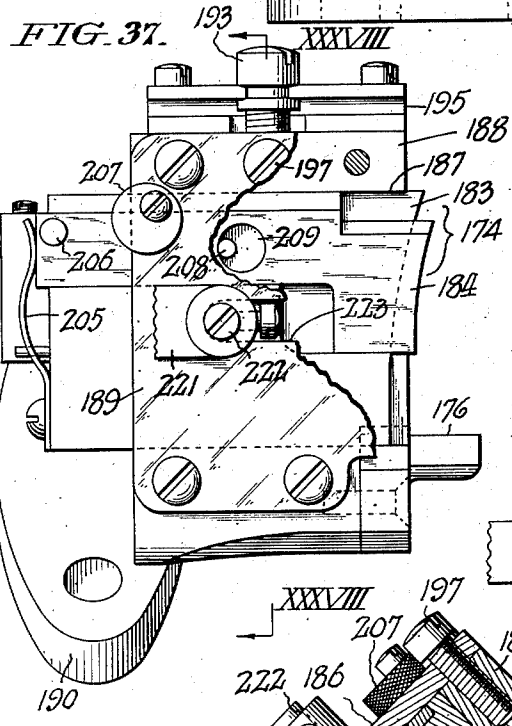


FIG. 37.

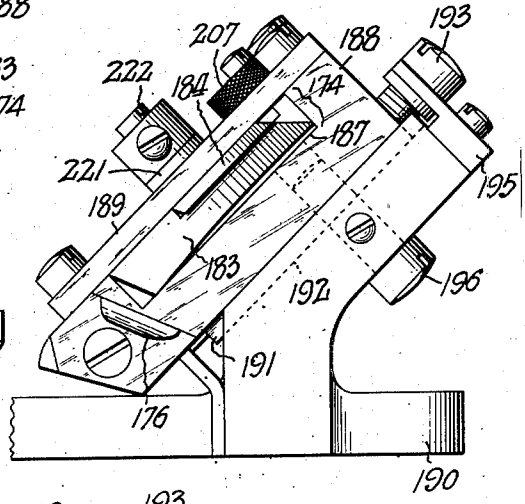


FIG. 36.

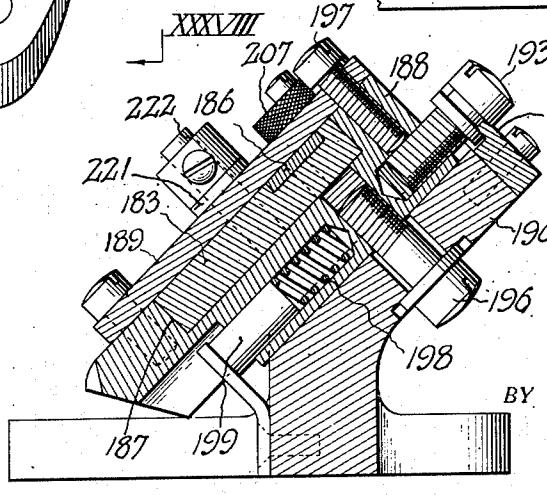


FIG. 38.

INVENTOR:
Eugene F. Miller,
BY
Paul & Paul
ATTORNEYS.

Oct. 10, 1950 E. F. MILLER 2,525,704

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FIG. 39.

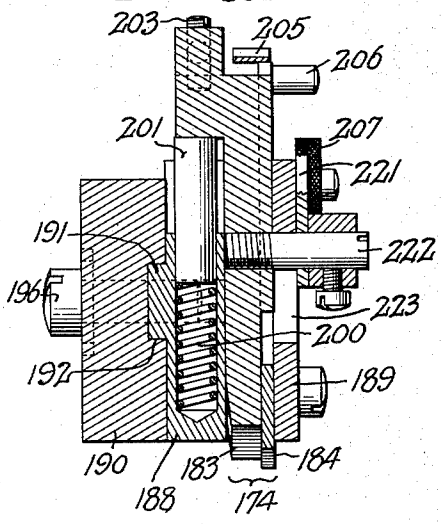


FIG. 40.

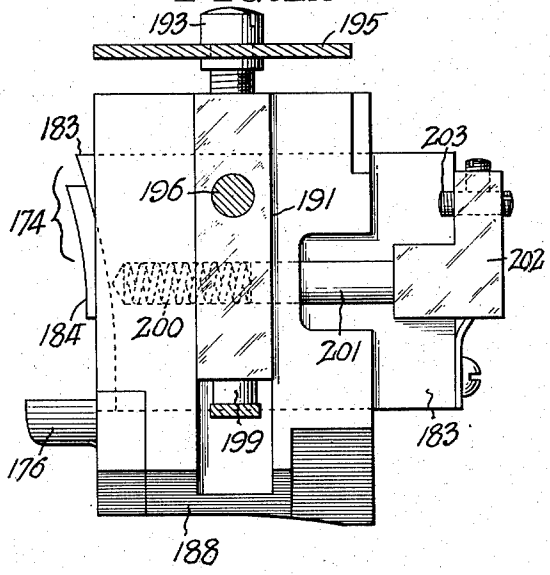


FIG. 41.

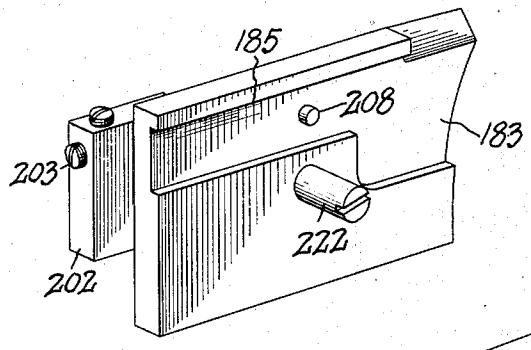


FIG. 42.

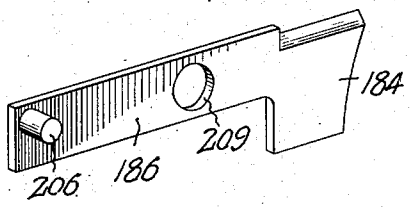
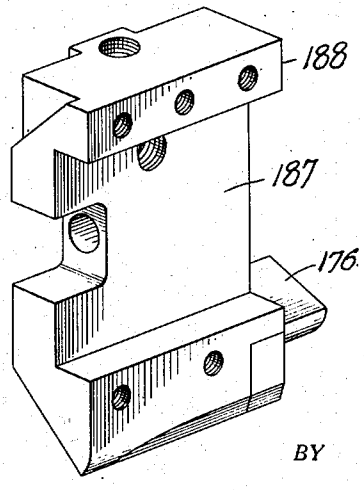


FIG. 43.



WITNESSES

Thomas W. Kerr, Jr.

Hubert Fuchs

BY

INVENTOR:

Eugene F. Miller,

Paul & Paul

ATTORNEYS.

Oct. 10, 1950 E. F. MILLER 2,525,704

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FIG. 44.

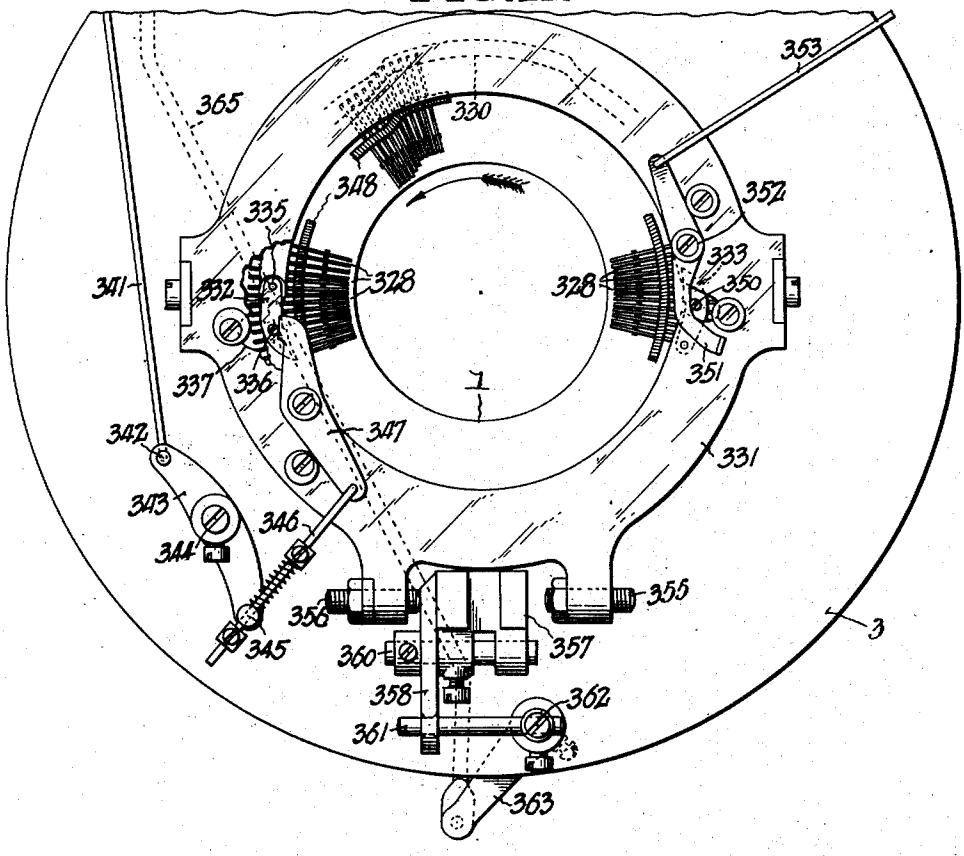
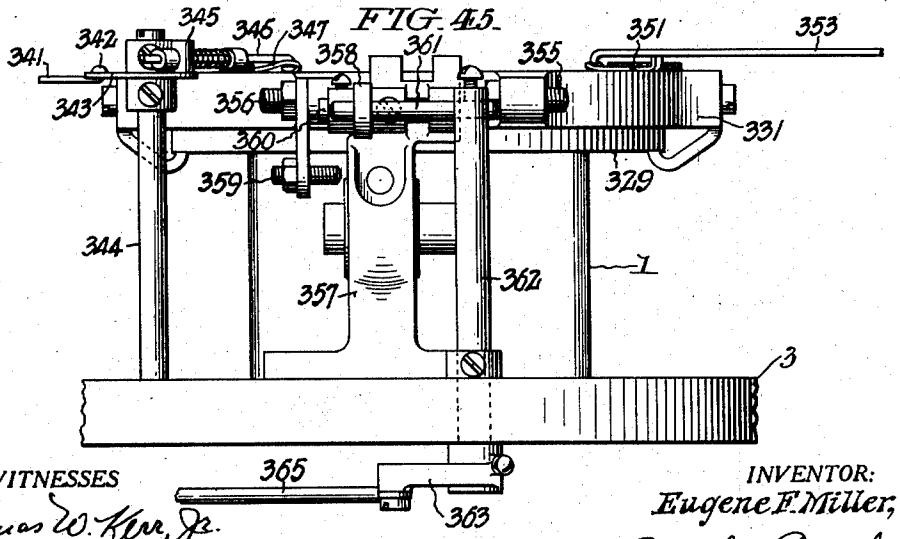


FIG. 45.



WITNESSES

Thomas O. Kerr, Jr.

Hubert Fuchs

INVENTOR:

Eugene F. Miller,

BY Paul & Paul

ATTORNEYS.

Oct. 10, 1950 E. F. MILLER 2,525,704

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FIG. 46.

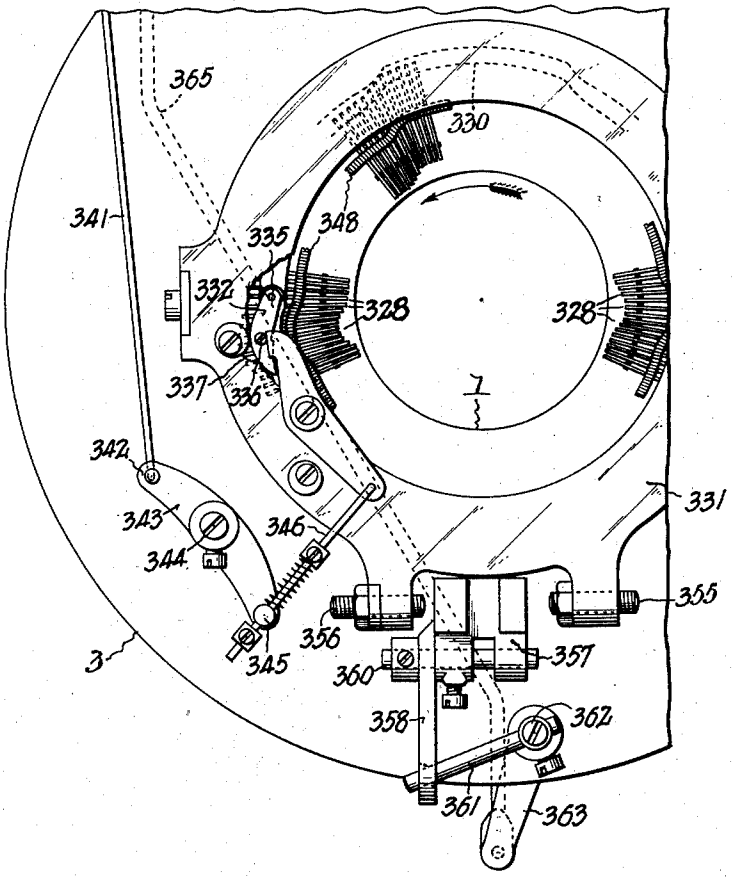
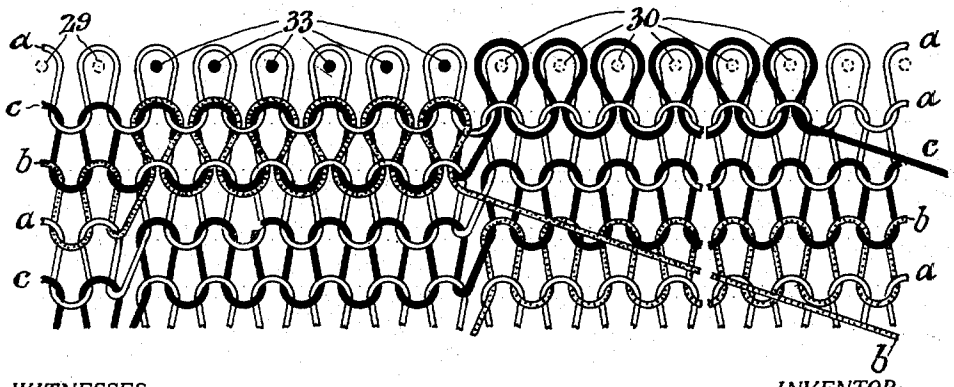


FIG. 70.



WITNESSES

William W. Kerr, Jr.

Hubert Fuchs

INVENTOR:

Eugene F. Miller,

BY Paul & Paul

ATTORNEYS.

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FIG. 47

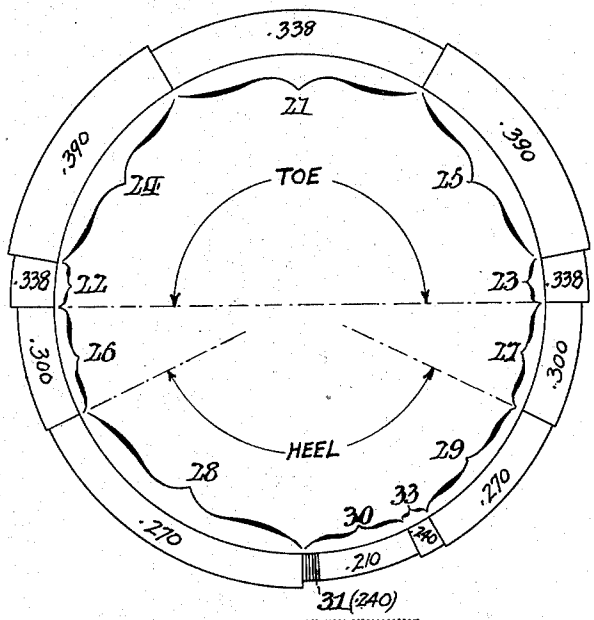
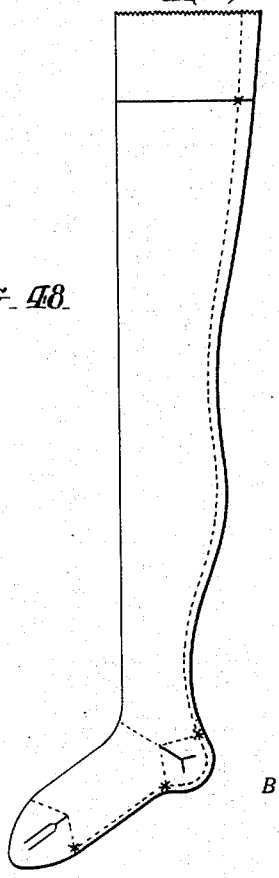


FIG. 48



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FIG. 49.

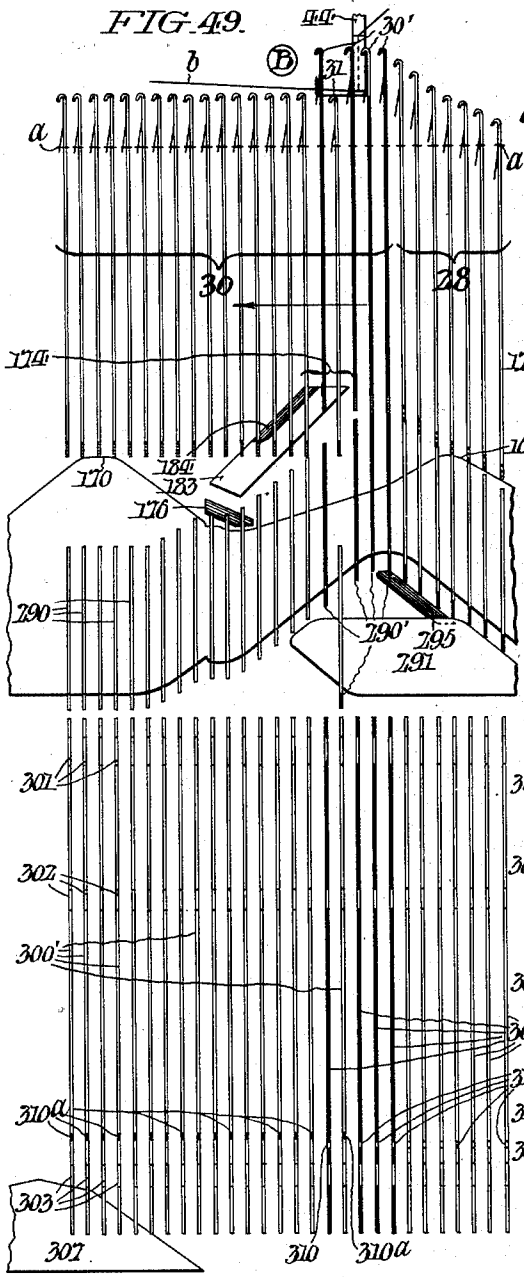
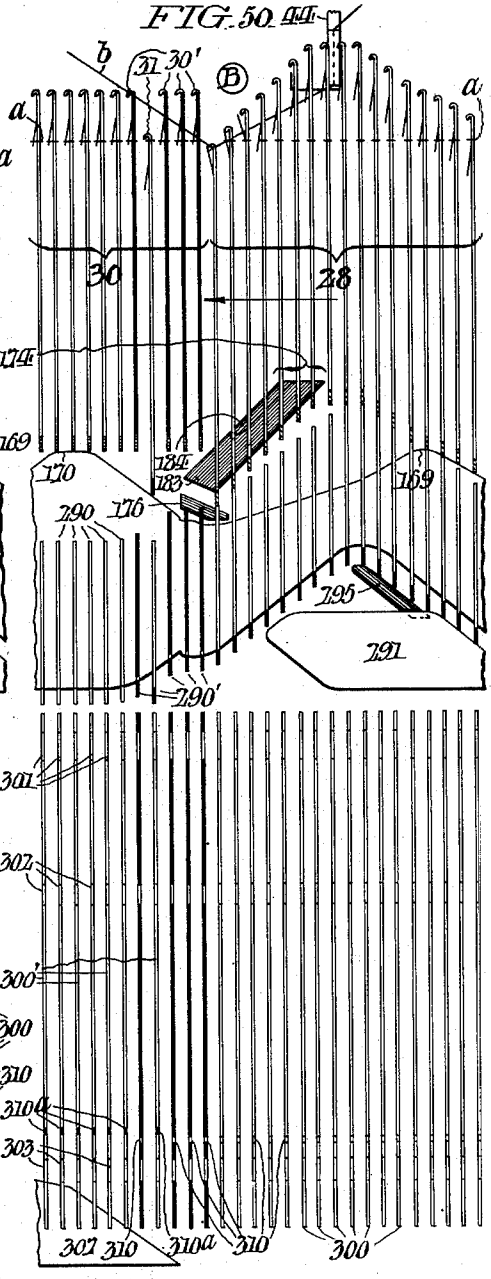


FIG. 50.



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FIG. 51.

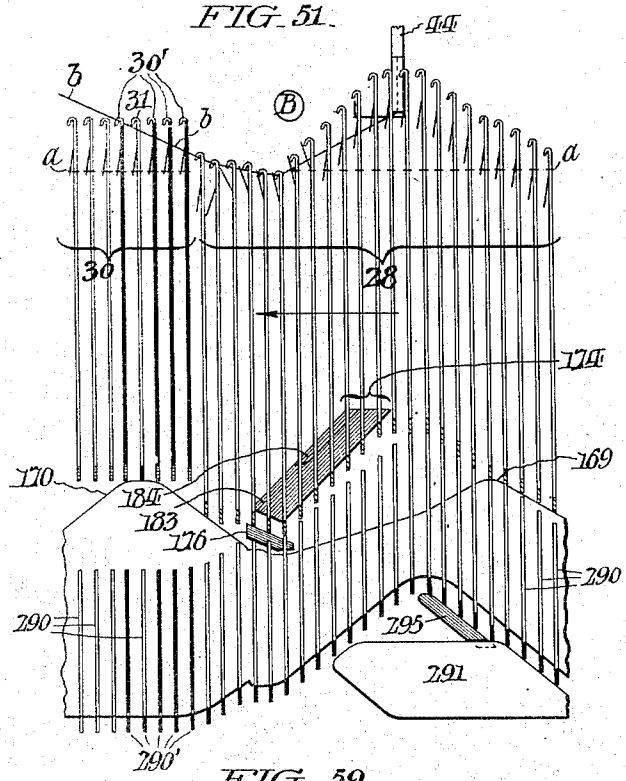


FIG. 59.

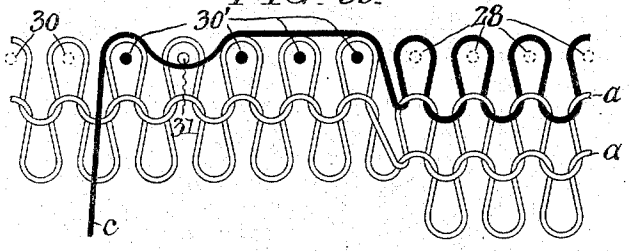
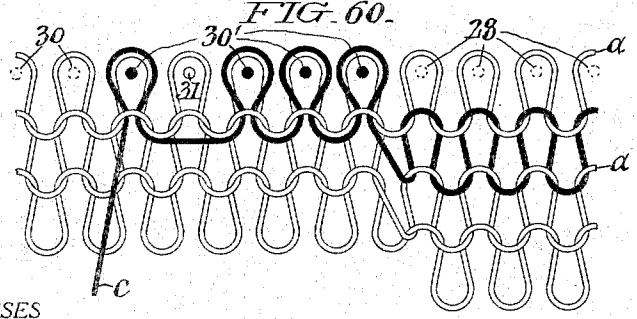


FIG. 60.



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FIG. 52.

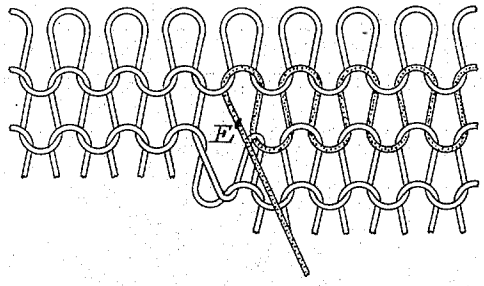


FIG. 53.

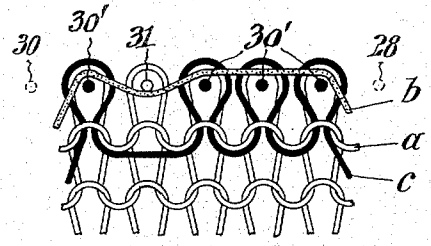
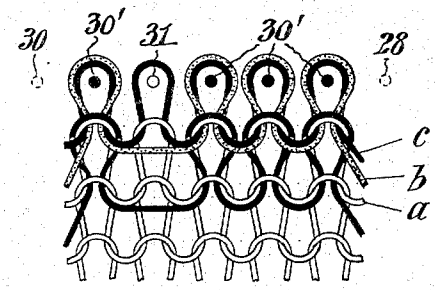


FIG. 54.



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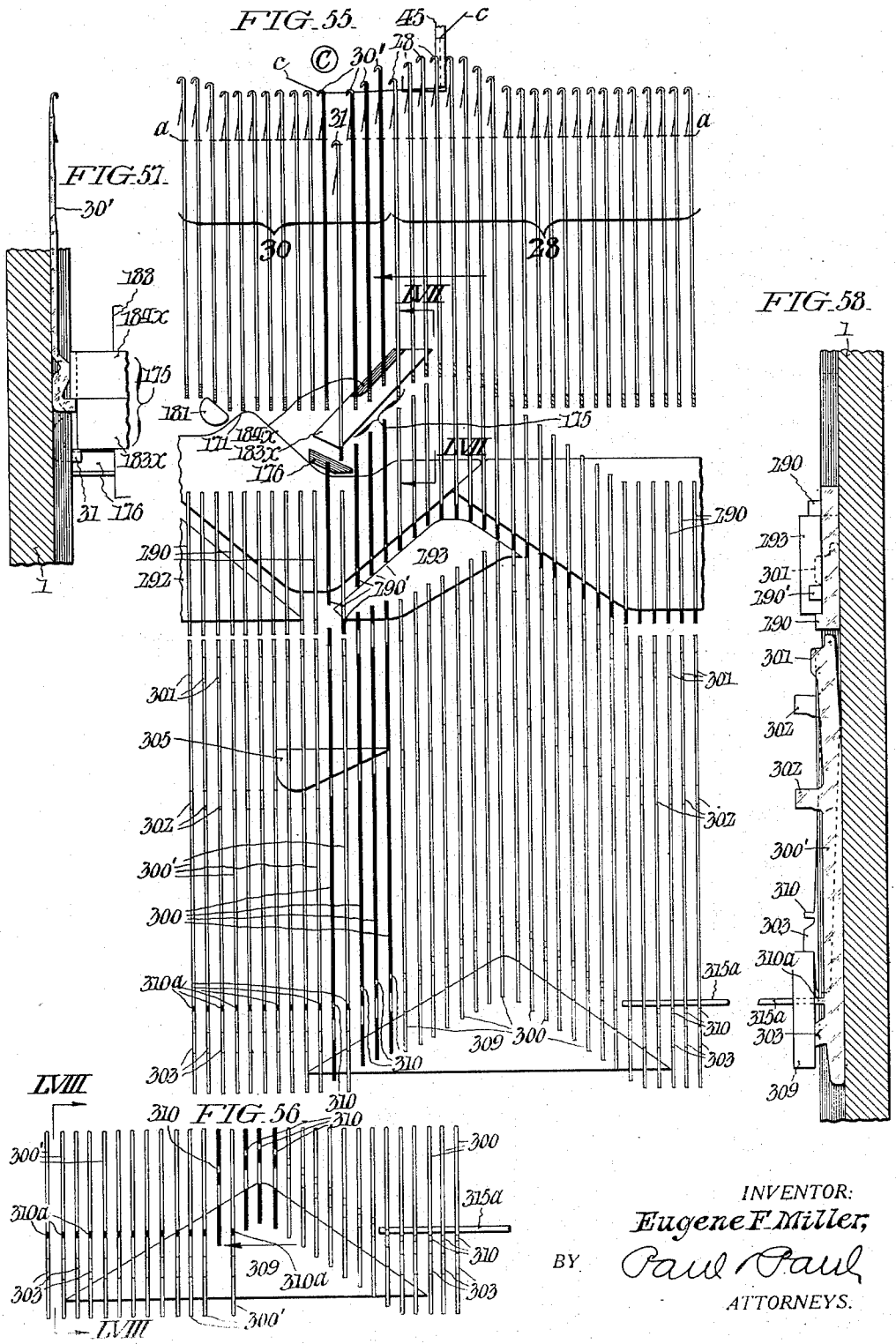
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FIG. 62.

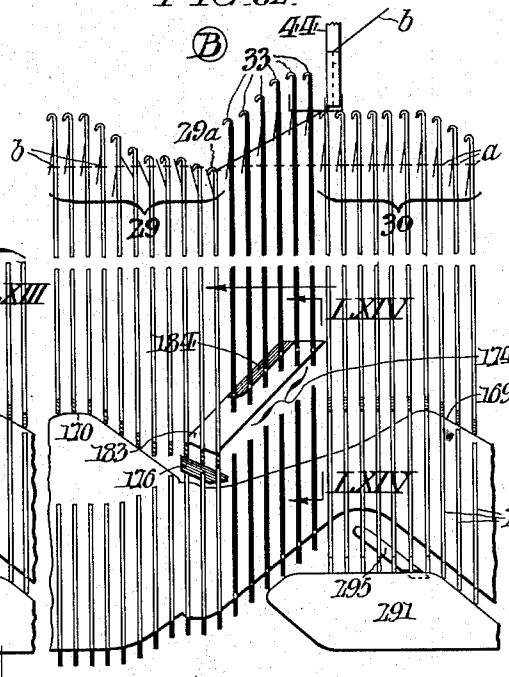


FIG. 61.

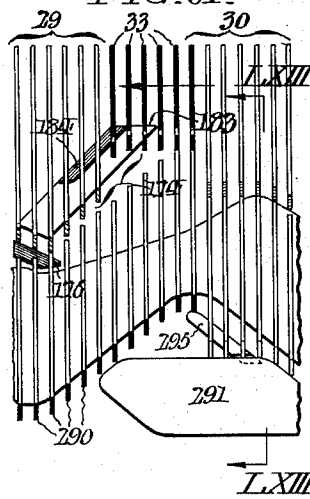


FIG. 64.

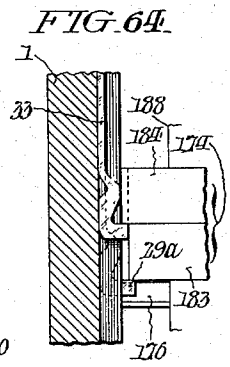


FIG. 63.

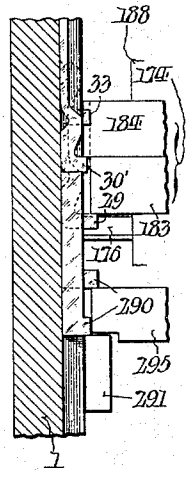


FIG. 65.

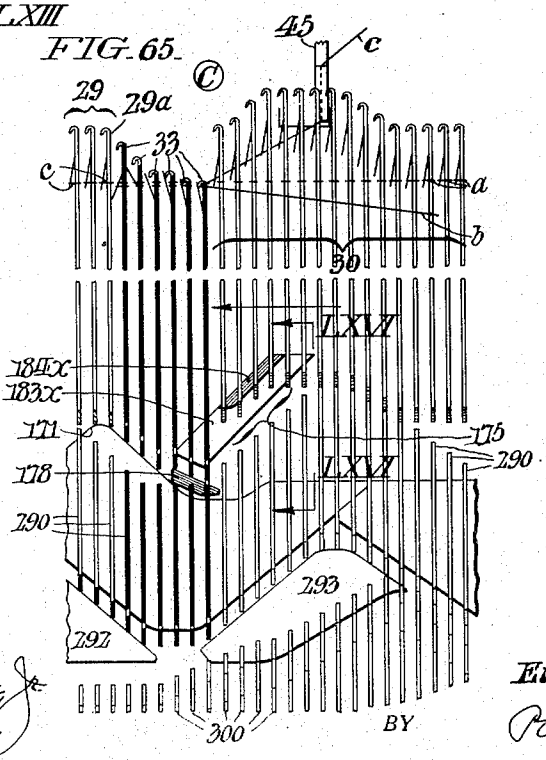
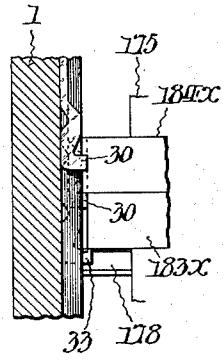


FIG. 66.



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KNITTING MACHINE AND METHOD

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FIG. 67.

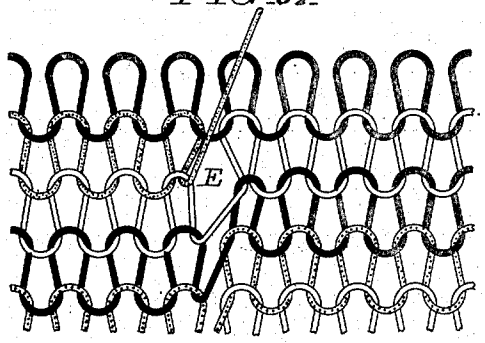


FIG. 68.

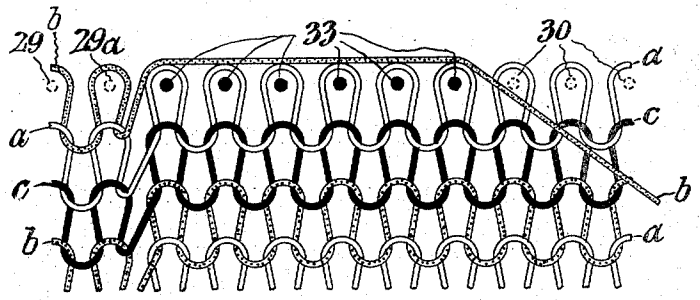
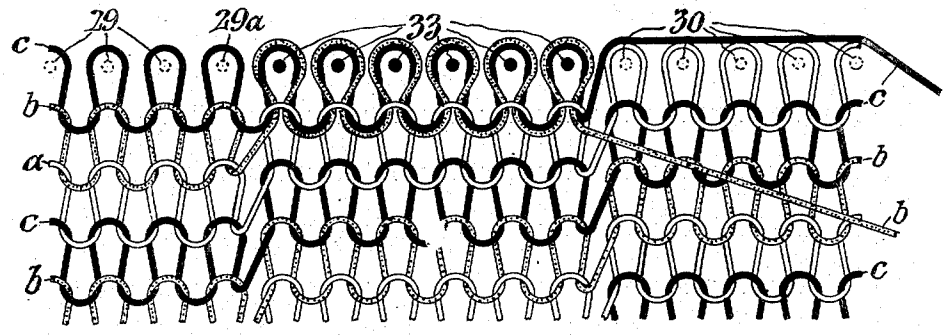


FIG. 69.



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FIG. 71.

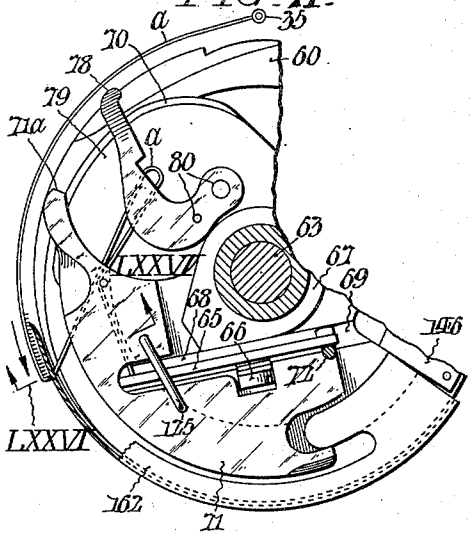


FIG. 72.

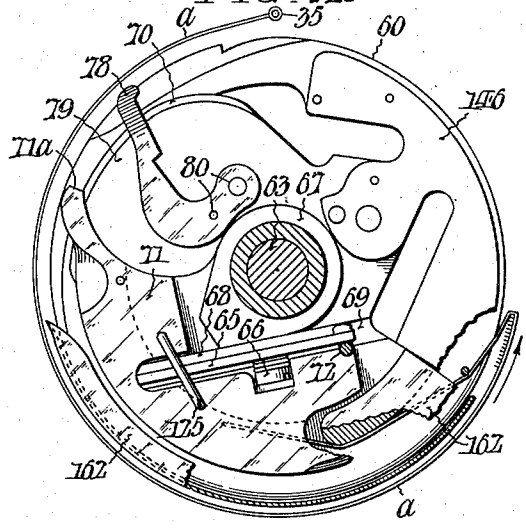


FIG. 73.

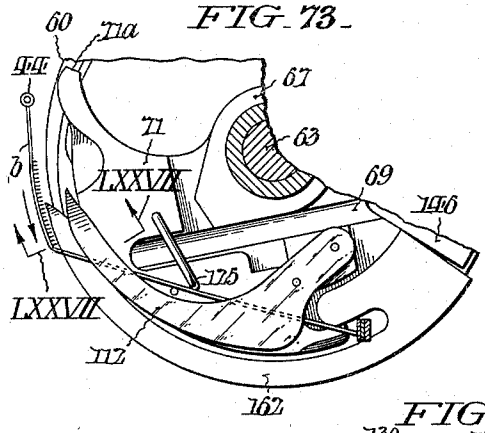


FIG. 74.

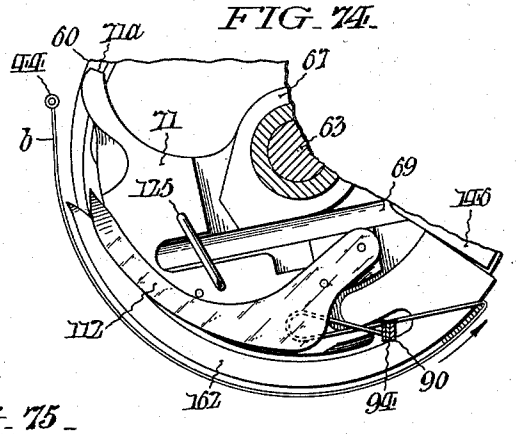


FIG. 75.

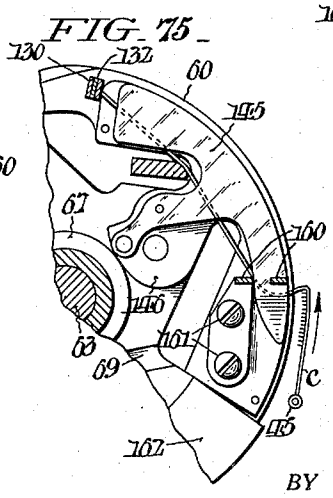


FIG. 76.

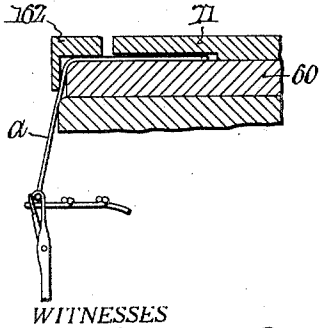
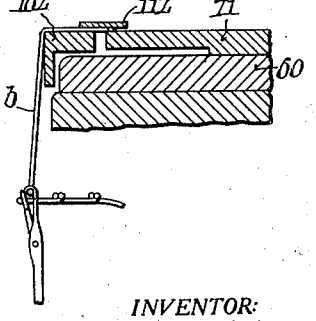


FIG. 77.



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Patented Oct. 10, 1950 2,525,704

UNITED STATES PATENT OFFICE

2,525,704

KNITTING MACHINE AND METHOD

Eugene F. Miller, Winston-Salem, N. C., assignor to Hanes Hosiery Mills Co., Winston-Salem, N. C., a corporation of North Carolina

Application January 16, 1946, Serial No. 641,504

15 Claims. (Cl. 66—42)

1

This invention relates to multiple feed knitting machines. More especially it has reference to multiple feed circular knitting machines of the type disclosed in U. S. Patent 2,146,647, granted to Albert E. Page on February 7, 1939, and having a main feed and two (left and right) auxiliary feeds for feeding three body yarns designed for the production of seamless stockings with integrally formed welt tops, Y-sutured heel pockets, split-sutured toe pockets, and reinforced foot areas outlined to simulate a "cradle" effect, wherein the leg and instep portions are knitted from three body yarns, for example of silk, nylon or rayon respectively, fed by main and left and right auxiliary feeds at spaced points circumferentially of the needle cylinder, while the heel and toe pockets are knitted from a yarn or yarns different from those employed in the knitting of said leg and instep portions, for example of cotton, fed at the main feeding station.

In producing seamless stockings on a machine of the kind referred to, openings (eyelets) are formed in the fabric when the additional or auxiliary body yarns are introduced upon the completion of the welts and the commencement of the legs, and upon completion of the heels and starting of the insteps, and also upon withdrawal of the additional or auxiliary body yarns in going into the insteps and into the toes. These eyelets are objectionable in that they detract from the appearance of the stockings and render them unsalable. The machine of the Page patent supra is so organized that the eyelets are caused to occur centrally of the back of the stocking, and the patentee depends upon a mock seam for concealing them, the formation of such seams requiring either special mechanism for the purpose in the machine, or resort to a separate subsequent seaming operation.

My invention is directed in the main toward overcoming the above drawbacks, that is to say, to obviate the necessity for reliance upon mock seams, tucked loops or any other types of special loops to conceal the eyelets in stockings throughout of plain fabric with ordinary or regular loops produced in multiple feed circular knitting machines, and to make it possible to definitely control the insertion and withdrawal of the individual body yarns and so insure production of perfect fabric at all times.

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These objectives are realized in practice as hereinafter more fully disclosed, through provision of improved means and method for controlling certain selected needles in such a way that, upon introduction and withdrawal of the auxiliary body yarns, the leading and trailing ends of these yarns are knitted into the fabric across the regions where the eyelets would ordinarily occur; and through the further provision of individual severing and clamping devices for said auxiliary body yarns, together with means for maintaining them definitely separated at a different level from that of the main body yarns en route to and from the respective severing and clamping devices.

Other objects and attendant advantages will appear from the following detailed description of the attached drawings, wherein—

Fig. 1 shows the top plan of a circular multiple feed stocking knitting machine conveniently embodying my invention.

Fig. 2 shows the machine in side elevation as viewed from the left of Fig. 1.

Fig. 3 shows a machine in side elevation as viewed from the right of Fig. 1.

Fig. 4 shows the rear elevation of the machine.

Fig. 5 is a fragmentary view in horizontal section drawn to a larger scale and taken as indicated by the angled arrows V—V in Figs. 2, 3 and 4.

Fig. 6 shows a linear development of the needles, the knitting cams, the associated slide jacks, and the cams for actuating said jacks.

Fig. 7 is a horizontal sectional view taken as indicated by the angled arrows VII—VII in Fig. 2 showing the feeds for the several yarns employed in the knitting, together with the severing and clamping devices for said yarns.

Fig. 8 is a fragmentary view partly in elevation and partly in section looking as indicated by the angled arrows VIII—VIII in Fig. 7.

Figs. 9, 10 and 11 are similar views taken as indicated respectively by the angled arrows IX—IX, X—X, and XI—XI in Fig. 7.

Fig. 12 is a plan sectional view taken as indicated by the angled arrows XII—XII in Fig. 8 with the body yarn feeds in active position.

Figs. 13 and 14 are fragmentary detail sectional views taken as indicated respectively by the an-

gled arrows XIII—XIII and XIV—XIV in Fig. 12.

Fig. 15 is a view like Fig. 12 with the body yarn feeds retracted, showing how said yarns are drawn into their respective clamps.

Figs. 16–24 are individual detail views of various component parts of the yarn severing and clamping means.

Fig. 25 is a view partly in side elevation and partly in vertical section showing the control mechanism for the severing and clamping means for one of the auxiliary body yarns.

Fig. 26 is a view similar to Fig. 25 showing the control mechanism for the severing and clamping means for the other auxiliary body yarn.

Figs. 27, 28 and 29 are views like Figs. 25 and 26 showing the means through which the left auxiliary stitch cam is controlled.

Fig. 30 is a fragmentary view in horizontal section taken as indicated by the angled arrows XXX—XXX in Fig. 29.

Fig. 31 is a view like Fig. 29 showing the means through which the right auxiliary stitch cam is controlled.

Figs. 31*a* and 32 are fragmentary views corresponding to Fig. 31 with certain parts differently positioned.

Figs. 33 and 34 are fragmentary horizontal sectional views taken as indicated respectively by the angled arrows XXXIII—XXXIII and XXXIV—XXXIV in Fig. 31.

Fig. 35 is a larger scale view showing in elevation the outer side of one of the auxiliary stitch cams, together with the mounting therefor, and the parts directly associated with it.

Fig. 36 shows in elevation the inner side of the organization illustrated in Fig. 35.

Fig. 37 shows the organization of Fig. 35 in top plan, i. e., looking as indicated by the arrows XXXVII—XXXVII in the latter illustration, with portions broken away to expose underlying parts.

Fig. 38 is a section taken as indicated by the angled arrows XXXVIII—XXXVIII in Fig. 37.

Figs. 39 and 40 are sectional views taken as respectively indicated by the angled arrows XXXIX—XXXIX and XL—XL in Fig. 35.

Figs. 41 and 42 are perspective views of the component parts of the auxiliary stitch cam shown in Figs. 35–40.

Fig. 43 is a perspective view of an adjustable part of the mounting for the auxiliary stitch cam of Figs. 35–40.

Fig. 44 is a fragmentary view in top plan showing the means provided for controlling the auxiliary sinker-actuating cams, with said cams in retracted position.

Fig. 45 is a view in elevation, looking toward the bottom of Fig. 44.

Fig. 46 is a view corresponding to Fig. 44 with the auxiliary sinker cams in operative position.

Fig. 47 is a diagrammatic view showing the arrangement of the needles in the needle cylinder of the machine.

Fig. 48 shows the type of stocking produced by the machine.

Figs. 49, 50 and 51 are detail views in development like Fig. 6 showing successive steps incident to the introduction of the left auxiliary body yarns.

Fig. 52 shows a fragment of the knitted fabric with an eyelet such as would ordinarily be formed upon introduction of an auxiliary body yarn.

Fig. 53 is a view like Fig. 52 showing how the left auxiliary body yarn is fed to a small group of selected needles in preparation for eyelet closure.

Fig. 54 is a view in turn like 53 showing how the newly introduced auxiliary body yarn is subsequently knitted by the selected needles.

Figs. 55 and 56 are views like Figs. 49–51 showing how the right auxiliary body yarn is fed to the above mentioned selected group of needles in preparation for eyelet closure.

Figs. 57 and 58 are fragmentary detail sectional views taken as indicated respectively by the angled arrows LVII—LVII and LVIII—LVIII in Figs. 55 and 56.

Figs. 59 and 60 are diagrammatic views like Figs. 53 and 54 showing the fabric at the regions of feeding and interknitting of the right auxiliary body yarn to the selected group of needles.

Figs. 61 and 62 are linear developments similar to Fig. 6 showing how the left auxiliary yarn is fed to another group of selected needles rearward, in preparation for eyelet closure incident to withdrawal of said yarn.

Figs. 63 and 64 are fragmentary detail sections taken as respectively indicated by the angled arrows LXIII—LXIII and LXIV—LXIV in Figs. 61 and 62.

Fig. 65 is a view like Fig. 62 showing how the right auxiliary body yarn is fed to the second mentioned group of selected needles in preparation for eyelet closure incident to withdrawal of said yarn.

Fig. 66 is a fragmentary sectional view taken as indicated by the angled arrows LXVI—LXVI in Fig. 65.

Fig. 67 shows a fragment of the knitted fabric with an eyelet such as would be ordinarily formed upon withdrawal of an auxiliary body yarn.

Figs. 68–70 are views like Figs. 53 and 54 showing the fabric at the regions where the two auxiliary body yarns are fed to said second mentioned group of selected needles.

Figs. 71–75 are views like Fig. 7 showing how the main and auxiliary body yarns are pulled out of their respective clamps incident to their introduction into the knitting; and,

Figs. 76 and 77 are fragmentary views in section taken as indicated respectively by the angled arrows LXXVI—LXXVI and LXXVII—LXXVII in Figs. 71 and 73.

With reference first more particularly to Figs. 1–3 of these illustrations, the knitting machine chosen for convenience of exemplifying my invention has a needle cylinder 1 which is rotatably mounted in a stationary bed 2, and which extends up through another stationary bed 3 at a higher level, said beds being rigidly supported by the framework generally designated 5. The means for rotating and oscillating the needle cylinder as required in the production of seamless hosiery, may be of well known construction and need not therefore be described.

In accordance with my invention, the control and timing of the various instrumentalities of the machine is divided between the usual timing drum 6 and a special supplemental timing drum 7, these drums being variantly and intermittently shifted, each through a complete rotation during each stocking knitting cycle. As shown, the supplemental timing drum 7 is provided at one end with ratchet teeth 8 arranged to be picked by a pawl 9 which is pivotally connected to a rocker arm 10 actuated through cooperation of a roller 11 thereon with a double lobe edge cam 12 at one end of a rotary shaft 13 of the machine, said roller being held to the cam by a spring 15 in

tension between the pawl and an anchorage on the frame 5. Amongst the ratchet teeth 8 on the drum 7 are several blank spots 8a (Fig. 2) whereon the pawl 9 can ride idly back and forth. At certain times in each knitting cycle, the drum 7 is given rotative shifts sufficient to move the blank spots 8a beyond the pawl 9 when picking is to be resumed, by a second pawl 16 which acts on another series of ratchet teeth 17 (Fig. 4) on said drum. As shown, the pawl 16 is pivotally connected to one end of a lever 18 medially fulcrumed on the frame 5 and having at its other end a finger 18a in the path of a series of cam rises 19 on the main drum 6. The spring indicated at 20 yieldingly maintains the pawl 16 in operative engagement with the ratchet wheel 17.

Slidable in the individual grooves of the cylinder are needles which, in practice, may total four hundred in number, and which, see Fig. 47, are arranged according to butt lengths in thousandths of an inch in generally the same manner as in the Page patent, as is necessary for the production of stockings of the kind illustrated in Fig. 48 characterized as hereinbefore pointed out. The needle arrangement in the upper half of the circle in Fig. 47 is symmetric, there being a central series 21 of sixty-eight .338 butt needles, two end series 22, 23 each of eleven .338 butt needles, and two intermediate series 24, 25 each comprising fifty-five .390 butt needles. In the lower half of the circle are two end series 26, 27 each of twenty-eight .300 butt needles, and immediately adjacent these end series are series 28, 29 respectively comprising seventy-one and thirty-eight .270 butt needles. Intermediate the two series 28, 29 of .270 needles there is a series 30 of .210 butt needles, and a group 33 of six .240 butt needles. Interposed in the series 30 of .210 butt needles is a single .240 butt needle 31, there being twenty-five .210 butt needles in advance of said single needle in the direction of cylinder rotation, and three .210 butt needles behind it. The three .210 butt needles designated 30' in Figs. 49–54, the single .240 butt needle 31, and one needle 30' forward of said single needle I employ as a special group to effect eye closure incident to introduction of auxiliary body yarns *b* and *c* into the knitting. The group 33 (Figs. 62 and 65) of six .240 butt needles on the other hand, I employ in accordance with my invention to knit in the trailing ends of the auxiliary body yarns *b*, *c* to close the eyelets incident to the withdrawal of said yarns. For the purpose of more ready distinction, the needles 30' are indicated in solid black in diagrammatic Figs. 49–54 and the needles 33 likewise in solid black in Figs. 62 and 65. It is to be understood that in fashioning of heel and toe pockets of the stocking by the usual oscillatory knitting, all of the needles in the upper half of the circle in Fig. 47 are used in the knitting of the toe pockets, and that all except the two end groups 26, 27 of .300 butt needles in the lower half of the circle are used in knitting the heel pockets.

Yarn feeds

Of the main yarn feeds located at a station A, I have illustrated two which are indicated at 35 and 36, the first to feed a main body yarn *a*, i. e. one of the multiple yarns during knitting of the legs and insteps of the stockings, and the second for feeding a heel and toe yarn *y*. The feeds 35 and 36 have the usual form of fingers, being respectively swingable up and down about fulcrum pins 37 and 38 (Fig. 2) extending transversely of upstanding ears on the shank of the usual needle latch guard ring 39 which is hingedly connected at 40 to the top of a bracket 41 on the bed plate 3. The main yarn feeds 35 and 36 are individually subject to springs 42 and controlled through thrust rods 43 from the main timing drum 6 as ordinarily.

In addition to the main feeds 35 and 36 just referred to, the machine is provided with groups of left and right auxiliary feeds 44, 45 at stations B and C which are circumferentially spaced from each other and from the main feeding station A and designated to feed auxiliary body yarns *b* and *c* respectively. The auxiliary feeds 44, 45 are likewise in the form of fingers pivoted for up and down swinging movement on horizontal pins 46 and 47 fixed in upstanding projections 48 and 49 on the latch guard ring 39, and are intended to be individually used with the main yarn finger 35 in the knitting of the stocking legs and insteps as shown in Fig. 7. The auxiliary feeds 44, 45 are likewise subject to individual springs 50, 51, and actuated through individual thrust rods 52, 53 (Figs. 1–4) respectively in the paths of suitably spaced cam rises on the main timing drum 6, which rods act upon the rear ends of horizontal levers 54, 55 medially fulcrumed on the extended ends of the pivot pin 40 with their opposite ends underreaching said feeds.

Yarn severing and clamping mechanism

The severing and clamping instrumentalities (Figs. 7–24 and 71–76) of this mechanism are mounted on a fixed disk 60 which carries the actuating cams for the usual transfer bits (not shown) ordinarily employed in forming the setting up course and in closing the stocking welts, and which is supported adjacent the top of the needle cylinder 1 by an overhanging bracket arm 61 (Figs. 1–3) secured to the latch guard ring 39 of the machine. The transfer bits are slidable as ordinarily in a radially grooved dial (not shown) affixed to a vertical shaft 63 immediately below the disk 60 in coaxial relation to the needle cylinder 1 and rotated in unison with the latter by well known driving connections.

The severing means for the main and heel-toe yarns *a* and *y* includes a horizontally-arranged cutter blade 65 which is pivoted for up and down movement about a stud 66 screwed into the flat frontal side of the hub boss 67 of the disk 60, said blade having a sharpened bottom edge which shears against a ledger blade 68 affixed to one edge of a slot 69 in said disk, see Figs. 7, 11 and 12. Secured to the top surface 70 of the disk 60 is an undercut segmental plate element 71 (separately illustrated in Fig. 17) formed with an arcuate finger 71a which extends to the edge of said disk 60. The end of the finger 71a is tapered and upwardly rounded at the bottom, see Figs. 9 and 17. Through a short drop link 72, the blade 65 is connected to one extremity of an angular lever 73 (Figs. 11 and 26), fulcrumed for up and down movement about a fixed screw stud 75 (Fig. 26) on the latch guard ring 39, the opposite extremity of said lever being engaged from beneath by a vertical thrust rod 76, which, at its lower end, bears on the top of the main timing drum 6 in the path of stepped actuating cam rises 77 thereon, and which is held to said drum by a spring 76a. The clamp means for the main yarns includes a tongue 78 fashioned from thin sheet metal laid on top of a depressed surface 79 of the disk 60 which surface merges with the top surface 70 of said disk through the ogee rise

at 79a in Fig. 9, said tongue being positioned by dowels 80 and turned up at its end to facilitate entry of the main yarns *a* and *y* beneath it incident to withdrawal of the corresponding feeds 35 and 36 from action. In this connection it will be noted that the greater portion 71b of the undercut plate element 71 overhangs the top surface of the disk edge with incidental formation there of a horizontal groove 81 for a purpose later on explained. Resting on the tongue 78 (Figs. 7 and 9) is the head of a vertical axis plunger 82 whereof the stem passes through laterally-projecting guide ears on a lever 83 (Figs. 9 and 21) pivotally supported at 84 by a gooseneck bracket 85 with its end bearing on the movable main yarn cutter blade 65, being so held by a relatively strong spring 86. A very light coil spring 87 in compression between the lower ear of the lever 83 and the plunger head 82 normally acts to keep the clamp tongue 78 under pressure for capacity to yieldingly retain the yarns inserted beneath it. As a consequence of this construction and arrangement, the lever 83 is caused to rise with the cutter blade 65 upon actuation of the latter, with resultant easement of the spring 87 and attendant release of the pressure upon the clamp tongue 78 to facilitate withdrawal of the yarns *a* or *y* as the corresponding feed fingers 35 and 36 are moved to inactive position. Normally the cutter blade 65 is maintained in closed position through upward pressure upon the lever 73 of a spring-pressed plunger 88 (Fig. 11) which is guided for axial movement in a socket hole in the top of the bracket arm 61, the upward movement of said lever being limited by an adjustable stop 89 in the bracket arm 61.

The severing means for the auxiliary yarn *b* includes a vertically-arranged stationary blade 90 (Figs. 7, 8, 11 and 12) supported by a block 91 in turn sustained by a fixed upright stud 92, said blade having an inclined cutting edge at its lower end to shear against the sharpened bottom of a lateral notch 93 in the front edge of a vertically movable blade 94 (Fig. 22) which latter is disposed alongside of and in contact with the back of said stationary blade, and which is suitably guided at the outer end of said block. The movable blade 94 is limited in its upward movement through engagement of the bottom of a lateral notch 95 in the inner edge thereof adjacent the top with a stop stud 96 (Fig. 11) on the stationary blade 90. The blade 94 is controlled from the supplemental timing drum 7 wherefore the said drum is provided, see Fig. 25, with circumferentially spaced cam rises 97 to coact with a finger 98 pivoted on a fixed rod 99 and held in engagement with said drum by a spring 98b, the lateral projection 98a of said finger being pivotally connected to the bottom end of another thrust rod 100 whereof the upper end contacts a lever 101 from beneath. This lever 101 is pivoted on the hinge pin 40 of the latch guard ring 39, and at its outer end is provided with a stud 102 which in turn underreaches the downwardly inclined extremity of an angular lever 103 medially fulcrumed at 104 on a fixed gear cover 105 carried by the bracket 61. To the other extremity of the lever 103 is pivoted a drop link 106 with a stud 107 at its lower end engaging a notch 108 in the top of a lateral lug projection 108a adjacent the upper end of the movable cutter blade 94. A spring 109 (Figs. 11 and 25) in tension between a fixed anchorage 110 and the blade 94 is relied upon to yieldingly hold the latter raised with the lever 103 in contacting the pin 102 on the arm 101. The clamping means for the auxiliary yarn *b* includes an arcuate tongue 112 (Figs. 7, 8, 12 and 19) of thin spring metal like that of clamp tongue 78, arranged along the edge of the disk 60 and positioned by dowel-pins 113 on the top surface of the plate 71. Pressing on the clamp tongue 112 adjacent its upwardly rounded pointed end, is a frusto conical weight element 115 which is free to move axially of the pendent end of an angular guide member 116 of stout wire secured by a set screw 117 to the block 91 and braced by a small bracket piece 118 extending outward from the hub of the disk 60. As a further means for yieldingly holding down the clamp tongue 112, there is provided a vertical axis plunger head 119 (Figs. 8 and 13) which bears on said tongue adjacent its root end, said head being subject to a compression spring 120, and its stem 121 being guided for up and down movement in the block 91. To the upper end of the plunger stem 121 is secured a collar 122 which is underreached by one end of a small lever 123 medially fulcrumed at 124 on the block 91 and having its other end underreaching the lug adjacent the movable cutter blade 94. Thus each time that the blade 94 is actuated, the pressure of the spring 120 on the plunger head 119 is relieved to facilitate entry of the auxiliary yarn *b* under, or its removal from beneath, the clamp tongue 112. For the purpose of keeping the auxiliary yarn *b* away from the main yarn cutting blade 65 as it is passed beneath the clamp tongue 112 upon retraction of its feed finger 44, there is provided an upstanding wire guard 125 (Figs. 7–9 and 12) which is bridged over said blade and which has its ends anchored in the plate segment 71.

The severing means for the auxiliary yarn *c* fed at the station C is generally like that described for the yarn *b*. It comprises a vertically-arranged stationary cutter blade 130 which blade 130 is fixedly secured to the end of the gooseneck bracket 85 (Figs. 7 and 9). As shown, the lower end of the blade 130 is inclined and sharpened to shear with the bottom of a lateral notch 131 in the outer edge of a cooperating movable shear blade 132 adjacent the lower end of the latter which is confined to up and down sliding movement in contact with said stationary blade. The movable blade 132 is held normally in raised position as in Fig. 9 by a finger spring 133 whereof the outer end is hooked to underreach a lateral outer edge lug projection 135 adjacent the top of said blade. The upward movement of the blade 132 is limited through engagement of the bottom of a lateral notch 136 in its inner edge adjacent its top with a stop stud 137 on the stationary blade 130. The movable blade 132 is controlled from the supplemental timing drum 7 (see Fig. 26) through means including another finger 138 pivoted on the rod 99 with its end in the path of circumferentially spaced cam rises 139 on said drum, the lateral arm 138a of said finger being pivotally connected to the bottom end of another thrust bar 140. The upper end of the bar 140 engages beneath one extremity of an angular lever 141 which is medially pivoted on a fixed stud 142, with its other extremity bearing on the top of the lug 135 on the movable blade 132 as shown in Fig. 9. A tension spring 143 (Fig. 26) keeps the parts just described in the positions in which they are illustrated. The clamp means for the yarn *c* is in turn in the form of a tongue-like element 145 of thin sheet metal with a pointed upwardly curved end, and rests on still another segmental

plate 146 superposed upon and fixed to the top of the disk 60. As best shown in Fig. 12, the clamp tongue 145 has a lateral arm projection 145a and is positioned against displacement in concentric relation with the edge of the plate by dowel pins 147 and 148. It is also to be noted that the top surface of the segmental plate 146 on which the clamp tongue 145 rests is in the same plane as the top of the segmental plate 71 opposed by the clamp tongue 112 for the yarn b. Bearing on the clamp tongue 145 at a point about midway of its length is a vertical axis weight plunger 149 which is confined to axial sliding movement in a guide on a block 150 supported by a post 151 upstanding from the disk 60. As a further means for yieldingly holding down the clamp tongue 145 there is provided a plunger head 152 which bears on said tongue adjacent its rear end, the stem 153 (Fig. 10) of said plunger being confined to axial movement in a guide 155 fixedly secured to the gooseneck bracket 85. The plunger head 152 is yieldingly urged downward by a spring 156; and affixed to the upper end of the plunger stem 153 above the guide by a set screw 157 is a collar 158. A small lever 159 pivoted at 159a on the guide 155 has one of its ends notched, see Fig. 23, to engage the set screw 157 from beneath and its other end extending beneath the lateral lug projection 135 on the movable cutter blade 132. Accordingly, upon each actuation of the cutter blade 132, the pressure of the spring 156 upon the plunger head 152 is relieved to facilitate insertion or withdrawal of the yarn c from beneath the clamp tongue 145. The lift of the front end of the clamp tongue 145 is limited by an arched stop piece 160 (Figs. 7, 8, 10 and 12) secured by screws 161 to the segmental plate 146 and the disk 60.

Rising from the disk 60 (see Figs. 7, 8, 11–14 and 16) is a thread guard 162 with a curved rigid tongue portion 163 which lies alongside the plate 71 outwardly thereof. As shown, the tongue 163 has a pendent flange 164 which overhangs the circumferential edge of the disk 60.

Needle cams

The knitting cams of the machine (Fig. 6) includes the two usual main stitch cams 165, 166 of which the latter is retractable, top and bottom center cams 167, 168, elevating cams 169, 170 and 171, cams 172, 173, as well as improved auxiliary stitch cams 174 and 175 which are disposed to the left and to the right of said main stitch cams and suitably spaced relative to the latter circumferentially of the needle cylinder 1. Adjacent the left stitch cam 174 are a small fixed elevating cam 176 and a retractable clearing cam 177, and adjacent the right stitch cam 175 is a fixed elevating cam 178. There is also a clearing cam at 179; and between the main stitch cam 166 and the elevating cam 171 are a small supplemental cam 180 and a clearing cam 181. The machine is also provided with other cams which are shown, but which need not be particularly referred to herein. The usual elevating and depressing pickers required for heel and toe fashioning have been omitted from the drawings to avoid complicity of illustration.

In accordance with my invention the left auxiliary stitch cam 174 is split, i. e., composed of two sections 183 and 184 (Figs. 35–42) of which the lower or primary section 183 is recessed as at 185 (Fig. 41) in its top face to slidingly receive the tongue or shank extension 186 of the upper secondary section 184 (Fig. 42).

The primary section 183 is guided for in and out sliding movement radially of the needle cylinder 1 in the recess 187 of a block 188 (Figs. 35, 37 and 43) and retained with the section 184 by a removable cover plate 189 (Fig. 38). The block 188 is adjustable up or down in a fixed bracket 190 on the bed 3 (Figs. 27–29, 35–37), said block having a pendent rib 191 in engagement with a guide groove 192 in the sloping surface of said bracket. Up or down adjustments of the block 188 are effected by means of a regulating screw 193 which is rotative in but held against axial movement in a keeper piece 195 on the bracket 190 and which has its shank threadedly engaging into said block, the latter being fixable in adjusted positions by a headed clamp screw indicated at 196 in Fig. 38. A set screw 197 binding upon the regulating screw 193 insures against accidental displacement of the block 188 after the desired adjustment has been made. A compression spring 198 lodged in a hollow in the block 188 reacts with a plug 199 extending into the bottom of said groove and fixedly supported by the bracket 190, urges said block upward upon easement of the clamp screw 196 and so facilitates adjustment by means of the regulating screw 193. The primary section 183 of the auxiliary stitch cam 174 is yieldingly pressed outward away from the needle cylinder 1 by a spring 200 (Figs. 39 and 40) which is lodged in a cavity in the block and which abuts a plunger 201 bearing against a lug 202 on said section. The inward movement of a section 183 is however limited to prevent direct contact thereof with a needle cylinder by a stop screw 203 (Figs. 39, 40) adjustable in the lug of said section and adapted to contact the outer edge of the block 188. The secondary section 184 of cam 175 is on the other hand yieldingly urged inward toward the needle cylinder 1 independently of the primary section 183 by a leaf spring 205 secured to the outer edge of the segment, its inward movement being limited by engagement of a stud 206 on its shank or tongue 186 with an adjustable stop 207 on the retaining plate 189. The normal positional relation of the section 184 to the section 183 is determined by cooperation of a stop pin 208 (Fig. 37) on the latter with one side of a clearance opening 209 in the shank or tongue of the former. From Figs. 35, 36, 37 and 40 it will be observed that the supplemental raising cam 176 previously mentioned is fixedly secured to the block 188 and therefore adjustable up and down with the auxiliary stitch cam 174.

The construction of the right auxiliary stitch cam 175 is identical to that above described of the left auxiliary stitch cam 174, wherefore, in order to preclude the necessity for repetitive description, the corresponding component parts of said right hand cam are identified with the same reference numerals previously used except for the addition in each instance of the letter "x" for convenience of distinction.

For the description of the actuating means for the left auxiliary stitch cam 174 reference will now be had to Figs. 1, 5 and 27–30 . As shown, this means is jointly controlled from the main and supplemental timing drums 6 and 7 of which the former has two circumferential rises 210 and 210a adapted to act on a finger 211, and the latter has two circumferentially-spaced stepped rises 212 and 213 on which a finger 214 rests during the leg and instep phases respectively of the

knitting. The finger 214 is fulcrumed on the rod 99 hereinbefore referred to and has an upward extension 214a connected by a link 215 to a corresponding upwardly-reaching extremity 216 of the finger 211 which is fulcrumed to rock on another fixed horizontal shaft 217 at a lower level likewise extending between the machine frame brackets, see Fig. 2. At its upper end, the extremity 216 of the finger 211 has a spring-biased sliding pivotal connection 218 with one end of a link rod 219, the other end of which is pivotally connected to the long arm of a bell crank 220. The short arm of this bell crank is coupled, by another link 221, with a stud 222 projecting up from the section 183 of the auxiliary stitch cam 174 through a clearance opening 223 in the retaining plate of the bracket 190 (Figs. 37 and 39). A helical spring at 225 in Figs. 27–29 maintains the fingers 211 and 214 yieldingly in engagement with timing drums 6 and 7 respectively.

The right-hand auxiliary stitch cam 175 (Figs. 5, 31, 31a and 32) is controlled solely from the main timing drum 6, which, for that purpose, is provided with two contiguously-arranged groups of circumferential rises 226, 227, 228, 229 and 230, 231, 232 respectively. Cooperative with the cam rises 226–229 is a finger 233 which is pivoted on another horizontally disposed rod 235 fixed on the machine frame, and which through a bent upright link 236 is connected to a horizontal arm of a bell crank 237 fulcrumed on a fixed rod 238 at the top of the frame 5. The vertical arm of the bell crank 237 is in turn connected to one end of a horizontal link 239 whereof the other end is pivotally connected to a horizontal lever 240 (Fig. 5) fulcrumed at 241 on a post bracket 242, said lever carrying two set screws 243 and 244 of which the first is adapted to engage said post bracket. Arranged for cooperation with other rises 230–232 on timing drum 6 is another vertical thrust rod 245 which, at its upper end, is connected to the horizontal arm of another bell crank lever 246 mounted for independent movement alongside lever 237 and having its vertical extremity coupled by means of a horizontal link 247 with one arm of a bell crank 248 (Fig. 5) pivoted at 249 on the post bracket 242. As shown, the other arm of bell crank 248 is connected by a short link 250 to a stud 222x on the primary section 183x of the right auxiliary stitch cam 175. It is to be noted that the link 247 has a lug 251 adapted to be engaged by the screw 244 on arm 240. The spring at 252 in Fig. 5 urges the lever 247 counterclockwise; while the spring at 253 in Fig. 31 operates to yieldingly maintain the finger 233 in proper operative relation to the main timing drum 6, and a spring 254 draws downward upon the thrust rod 245.

As shown in Fig. 5, the auxiliary clearing cam 177 is mounted for sliding movement radially of the needle cylinder 1 in a bracket 260 secured to the bed 3 alongside the bracket 190 for the left auxiliary stitch cam 174 and is controlled from the main timing drum 6 through means including a vertical thrust rod 265 (Figs. 1 and 4) held to said drum by a spring 266. The upper end of the thrust rod 265 is connected to the horizontal arm of a bell crank 267 which is fulcrumed on the rod 238 and has its other extremity connected by a short horizontal link 268 to one arm of a bell crank 269 (Figs. 1 and 5) fulcrumed to swing horizontally about the post 270. The other arm of the bell crank 269 is in turn coupled by a long horizontal link rod 271 extending transversely of the machine, to an arm 272 pivoted at 273 on the plate 3, said arm being also connected by a shorter horizontal link 275 to the slide of the clearing cam 177. During the knitting of the leg and instep portions of the stocking, the cam 177 occupies its innermost or active position as in Fig. 6.

An auxiliary jack cam 295 (later on again referred to) is also supported in the bracket 260 with capacity for radial movement relative to the needle cylinder 1 and is controlled from the main timing drum 6 as well as from the supplemental timing drum 7. The intermediate connections comprise a horizontal link 276 (Figs. 4 and 5) which has one of its ends pivoted to the slide of the cam and its other end pivoted to one arm of a bell crank 277 which is fulcrumed at 278 on the plate 3. The other arm of the bell crank 277 is coupled by a long horizontal link rod 279 with the upright arm 281 (Figs. 1, 2 and 4) of a finger 281a whereof the end is in the path of cam rises 281b on the main timing drum 6, and said upright arm 281 connected through a link 282 with a finger 280 like the finger 214 arranged to be actuated by rises 282a (Fig. 4) on the supplemental timing drum 7. A spring 283 (Fig. 5), influential upon the link 276, tends to urge the cam 295 inward to its active position, such position being determined by engagement of a stop screw 284 on said link with the bracket 260.

Needle jacks

Located in the grooves of the cylinder 1 directly under the needles are the usual individually-associated short intermediate jacks 290 (Fig. 6). These jacks are actuated by cams 291, 292 and 293 located immediately below the knitting cams, and also by the retractable auxiliary cam 295 previously mentioned. The intermediate jacks 290' corresponding to the group 30' of .210 butt needles indicated in solid black in Figs. 49–51 and 55 have long butts. The intermediate jack associated with the special needle 31, those associated with the needles of the series 28, and those corresponding to the needles 33 also have long butts which are indicated in solid black. All the other intermediate jacks have shorter butts.

The machine is also equipped with a set of relatively long pattern jacks 300 one located in each needle groove below an intermediate jack 290, see Fig. 6. The pattern jacks 300 have large upper, intermediate and lower butts 301, 302, and 303 respectively so that they may at certain times be actuated by the cams 293, as well as by other cams 305, 306 and 307, 308, 309 which two latter groups are located below the intermediate jack actuating cams. At different levels the jacks 300 also have small butts such as the ones indicated at 310 in order that selection may be made between them by reader cam levers 315 controlled by a trick wheel 316 which is rotatable about a fixed upright stud 317 on the bed 2. This drum 316 is intermittently rotated through picking of ratchet teeth 318 at the bottom thereof by a pawl 319 which is connected to the short arm of a bell crank 320 fulcrumed at 321 on the machine frame and held to said teeth by a spring 322. A link 323 connects the longer extremity of the bell crank 320 with the upper end of a rocker arm 325. Amongst the reader cam fingers in the group 315 is one designated 315a in Fig. 1 which is not subject to the trick wheel 316, and which in accordance with my invention is operated through a link connection 326 (Fig. 2), from the arm 281 previously described. The pattern jacks 300' associated with the special needle 31 and

with all of the needles of the series **30** except the first and the last three of group **30'** have butts **310'** adapted to be acted upon by the reader cam finger **315***a*. When pushed inward by the finger **315***a* as in Fig. 58, the lower butts **303** of the jacks **300'** will be beyond the range of cam **309** and said jacks and the corresponding needles will therefore not be elevated by said cam..

Sinker motion

Cooperative with the needles in the knitting are the usual individually-associated sinkers **328** (Figs. 44 and 46) which are radially movable in a dial **329** (Fig. 45) at the top of the needle cylinder **1** and actuated at the main yarn feeding station A by a draw cam **330** on the usual superposed sinker cap ring **331**. At the stations B, C, the sinker cap ring **331** is provided with auxiliary left and right sinker actuating cams **332** and **333**. The cam **332** is pivoted at **335** and has a stud projection **336** which extends up through a slot **337** in the top of the cap ring **331**. The draw cam **332** is controlled from the main cam drum **6** through means including a thrust rod **338** (Figs. 1, 2 and 4) whereof the upper curved end is pivotally connected to the horizontal arm of a bell crank lever **339** fulcrumed on a stud **340** projecting laterally from the bracket which supports the latch guard ring **39** of the machine. The upright arm of the bell crank lever **339** has a sliding spring-biased connection with a link rod **341** which extends to and is pivotally connected at **342** to one arm of a lever **343** medially fulcrumed on a post **344** upstanding from the bed plate **3**. The other arm of the lever **343** in turn has a sliding spring-biased pivotal connection **345** with another but shorter horizontal link **346** whereof the other end is pivotally connected to one end of the lever **347** medially fulcrumed on the top of the sinker cap ring **331**, the other arm of the last mentioned lever reaching to the stud **336** on the auxiliary sinker draw cam **332**. As suitable cam rises (not shown) on the main drum **6** pass under the thrust rod **338**, the auxiliary sinker actuating cam **332** is moved from the normal position in which it is shown in Fig. 44 to the position of Fig. 46 to retract the sinkers **328** at the yarn feeding station B. The usual retaining spring belts **348** for the sinkers **328** is relied upon to maintain the auxiliary cam **332** yieldingly in its normal position. The auxiliary sinker actuating cam **333** at the right-hand yarn feeding station C is likewise provided with an upstanding stud projection **350** for actuation also from the main cam drum **6** through a lever **351** medially fulcrumed at **352** on the top of the sinker cap ring **331** and a link rod **353**. The other intervening parts may be like those described above in connection with the actuating means for the left auxiliary cam **333**, and for this reason have been omitted from the drawings.

During the heel and toe knitting, the sinker cap ring **331** is accorded the usual necessary amount of lost motion determined by alternate contact of adjustable set screws **355** and **356** thereon, respectively, with the stop post **357** and a beveled wedge slide **358**. In order to rotatably shift the sinker cap ring **331** to properly position the auxiliary sinker draw cams **332**, **333** to prevent rupturing of the auxiliary body yarns *b* and *c* at the times of their insertion, the beveled wedge slide **358** is withdrawn as shown in Fig. 46, thus allowing the screw **359** to contact the stop post **357** as the ring **331** moves in a counter-clockwise direction. Upon being moved inward, the slide **358** engages between set screw **356** on the cap ring **331** and the contiguous side of the stop post **357**, thereby giving said ring **331** a clockwise rotative shift to the desired extent. As shown, the slide **358** is longitudinally slotted through a portion of its length for guidance by a pin **360** transversely supported in ears on the stop post **357**, and is moreover apertured at its end for engagement by a finger **361** at the top of a vertical rock shaft **362** which passes down through the bed plate **3**. At the lower end of the shaft **362** is an arm **363** which through a horizontal link **365** is connected to a rocker arm **366** fulcrumed with several others on the horizontal rod **99** for actuation by rises **367** on the supplemental timing drum **7**, see Figs. 1 and 4.

Operation

Let it be assumed that the machine is in operation and knitting the leg portion of the stocking of Fig. 48, with the cylinder rotating in the direction of the arrow in Fig. 6, with the main feed **35** and the two auxiliary feeds **44** and **45** in action serving the respective body yarns *a*, *b* and *c* to all of the needles, and with the component sections **183**, **184** and **183***x*, **184***x* of the auxiliary stitch cams **174**, **175** occupying their innermost positions to actuate the needles for loop formation at the stations B and C contemporaneously with actuation of the needles by the main cam **165** at station A. It will be observed from Fig. 6 that during this phase of the knitting, as the needles approach the station A, they are first raised to the tuck level by the cam **171**, and immediately thereafter further elevated to the latch clearing level by the cam **181**, being later depressed to the stitch-forming level as they travel down the slope of the main stitch cam **165**. In approaching station B, after having been raised by the cam **169**, the needles are further elevated to the yarn taking level by the clearing cam **177**; and after taking the yarn *b*, the needles are depressed to the stitch-forming level by the left auxiliary stitch cam **174**. As the needles approach the station C, they are raised from the tuck level to the latch clearing level by the cam **179** in readiness to take the yarn *c*, whereafter they are depressed to the stitch-forming level by the right auxiliary stitch cam **175**. Throughout the knitting of the stocking leg, the sinker actuating cams **332**, **333** are of course kept in operative position to retract the sinkers **328** at the stations B and C.

During the knitting of the last course of the stocking leg and just before the machine goes into the heel knitting phase, the timing drums **6** and **7** are racked so that the rise **210** (Fig. 29) on the drum **6** is advanced from beneath the finger **211**, while the finger **214** rides off the high portion of the rise **212** on drum **7** and onto the lower step ledge **212***a* of said rise. At the same time, the jack cam **295** is moved part way to the position in which it is shown in Fig. 63 by passage of the rise **281***b* (Fig. 2) of the main timing drum **6** from beneath the finger **281***a*. Through the intermediate connections hereinbefore described, the primary section **183** of the left auxiliary stitch cam **174** is partially retracted to the position in which it is shown in Figs. 30 and 64. As a consequence, the group **33** of .240 butt needles is elevated through action of the cam **295** upon the long butt intermediate jacks **290** as in Fig. 61 in approaching station B. As the cylinder **1** con-

tinues in its rotation, the needles 33 are depressed by the section 184 of cam 174 as in Fig. 62 to the tuck level only after having taken the yarn *b* as in Fig. 68, the end needle 29*a* of the series 29 as considered with regard to the direction of cylinder rotation being the last to knit said yarn at the station B. The following series 30 of .210 butt needles are simply elevated to the tuck level as they approach the station B (without taking the yarn *b*) by the needle elevating cam 169, since the associated short butt intermediate jacks 290 are not acted upon by the jack cam 295 at this time due to the positioning of the latter as above explained.

Upon passage of the needles 33 beyond the section 184 of cam 174, it and the section 183 are both fully retracted as is also the jack cam 295 incident to another rotative shift of the drums 6 and 7, when the rise 212 (Fig. 29) is moved entirely from beneath the finger 214, and the rise 281 (Fig. 2) from beneath the finger 281*a*. By the same shift of the drum 7, the left auxiliary feed 44 is withdrawn, the timing being such that the yarn *b* is caught by the needles 33 and drawn up at the last needle of this group as considered with regard to the direction of cylinder rotation. Also during the last mentioned shift of the drum 6, the rise 226 is advanced beneath the finger 233 as in Fig. 31*a* with resultant impartation, through the link 236, the bell crank 237 and the link 239, of clockwise movement to the lever 240 from the position shown in Fig. 5 to the position shown in Fig. 33. In this movement of the lever 240, the screw 243 is brought into contact with the post 242 as shown in Fig. 33, and the screw 244 into contact with the lug 251 on the link 247. Clockwise movement is thereby imparted to the lever 248 in opposition to the spring 252 whereby the primary section 183*x* of cam 175 is partially withdrawn to the position in which it is shown in Fig. 33 when it will depress the needles 33 to the stitch drawing level but miss the needles of the group 30 by reason of the shorter butt lengths of these needles. The needles 30 will, however, be drawn down to the tuck level by the section 184*x* of cam 175 as shown in Fig. 65. Immediately after the last needle of the group 33 has formed its stitch, the auxiliary feed 45 is withdrawn so that the yarn *c* is caught in the hooks of a few of the leading needles of the series 30 as shown in Fig. 69. The yarn thus caught in this small group of the needles 30 will subsequently be knitted when said needles are actuated by the main stitch cam at the main feeding station A. Upon passage of the needles 33 beyond the cam 175 in Fig. 65, the drum 6 is again racked so that the cam 230 is now moved as shown in Fig. 32 beneath the thrust rod 245, this movement being translated through the bell crank lever 246 and the link 247, into further clockwise movement of the lever 248 in Fig. 33. As a result the lever 248 is moved from the position shown in Fig. 33 to that of Fig. 5 to fully retract the right auxiliary stitch cam 175. By another rack of the drums 6 and 7, the heel yarn feed 36 is substituted for the main body yarn feed 35 at the station A, and the sinker draw cams 332 and 333 caused to be moved to their inoperative positions in which they are shown in Fig. 44 upon actuation of the levers 347 and 351 which are controlled through the interposed connections hereinbefore described from the drum 6. The timing drums 6 and 7 will thereafter remain still with both auxiliary stitch cams 174 and 175 fully retracted, throughout the knitting of the heel pocket which will take place by oscillation of the needle cylinder 1 with concurrent narrowing and widening in the usual well known manner.

As the heel pocket is about completed, the timing drums 6 and 7 are given another rotary shift, during which the heel yarn feed 35 is withdrawn and the body yarn feed substituted at the station A, and another of the rises 367 on drum 7 (Figs. 1 and 4) advanced beneath the rocker arm 366 which through the link 365, arm 363, shaft 362 and finger 361 (Fig. 46) causes the wedge slide 358 to be retracted as in Fig. 46. By the latter action, the sinker cam ring 331 is slightly rotated counter-clockwise as far as permitted upon contact of the stop screw 359 (Fig. 45) with the picker post 357 to bring the auxiliary sinker actuating cams 332 and 333 into such position with respect to the auxiliary stitch cams 174 and 175 respectively as to insure against pinching of the auxiliary yarns *b* and *c* upon the introduction of the latter which soon follows. Also by the last rack of the drums 6 and 7, the sinker actuating cams 332 and 333 are restored to their operative positions as in Fig. 46, and the finger 281*a* (Fig. 2) is engaged by another rise 281*b* on the drum 6, whereby through the rod 279, the bell crank 277 and the link 276 (Fig. 5), the jack cam 295 is moved to active position. At the same time through the link 326 connected to the upward extremity 281 of the finger 281*a* (Fig. 2), the reader cam lever 315*a* is operated to tilt all the pattern jacks 309' having butts 310*a*, after the manner shown in Fig. 58 to prevent said jacks from being affected by the cam 309. The corresponding intermediate jacks associated with the needles of the series 30, except those associated with the first and the last needles of the group 30', will therefore not be raised by the pattern jacks 300' into the province of cam 293. Also during the last described shift of the timing drum 6, the rise 230 thereon is moved from beneath the thrust rod 245 to the position shown in Fig. 31 while the finger 233 remains on the rise 226. As a consequence, the two components of the right-hand auxiliary stitch cam 175 will again be placed in the positions in which they are shown in Fig. 33. Due to actuation of the pattern jacks as above explained, the needles 30 except for the first and last three needles of group 30' will not be raised into the province of cam 293 so that said needles 30 all pass the cam 175 at the tuck level without being influenced by it. The needle 31 by reason of its slightly longer butt will, however, be depressed by the section 183*x* of cam 175 to the stitch drawing level without taking the yarn *c* fed from the feed 45 which in the meantime has been inserted, while the leading and the last three needles of group 30', after having taken said yarn, will be depressed by the section 184*x* of said cam to the tuck level as shown in Fig. 55. After passing the cam 175, the needle 31 will be raised by the cam 171 and move to the front of the yarn *c* as in Fig. 59. In this way, the leading end of the reinstated yarn *c* will be bound and prevented from reeving out of the hooks of the needles 30' until it can be knitted into the fabric upon subsequent actuation of the latter needles by the stitch cam 165 at the station A. The needles of the series 28 raised through actuation of the jacks 309 by cam 309 and by reason of having longer butts will be depressed by the section 183*x* of cam 175 at station C and thus knit the newly introduced yarn *c*. Upon advance of the last needle of group 30'

beyond the cam 175, the primary section 183x of the latter will be moved to its full inward position and so remain during the ensuing knitting of the instep portion of the stocking. The advance end portion of the yarn c is thus incorporated into the fabric by the needles 30' immediately ahead of the leading needle of the series 28 (which leading needle would ordinarily be the first to receive said yarn at the station C) and thereby effects, as shown in Fig. 60, closure of the eyelet which would otherwise appear in the fabric.

As they approach the station B, the needles of the group 30', except for the interposed .240 butt needle 31, will be raised through action of the cam 295 upon the corresponding intermediate jacks 290, to take the yarn b as shown in Fig. 49 and in the continued rotation of the cylinder be depressed to the tuck level as when they ride down the incline of section 184 of stitch cam 174. The needle 31 by reason of its slightly longer butt will here again be depressed to the stitch drawing level as shown in Fig. 50 by the section 183 of the auxiliary stitch cam 174 and will therefore not take the yarn b at the station B. Here also the needles of the following series 28, by reason of having longer butts, will be depressed by the section 183 of cam 174 and thus knit in the newly introduced yarn b. Upon advance of the last needle of group 30' beyond the cam 174, the primary section 183 of the latter will be moved to its full inward position and so remain throughout the knitting of the stocking instep. The portion of the yarn caught by the needles of group 30' will subsequently be knit into the fabric when said needles are actuated at the station C by the stitch cam 175. After passing the cam 174 the interposed needle 31 will be raised by the cam 170 and to the front of the yarn b as shown in Figs. 51 and 53. Thus, the leading end of the reinstated yarn b will be bound in the same way as previously described in connection with the introduction of yarn c and prevented from reeving out of the hooks of the needles of group 30' until it can be knitted into the fabric as shown in Fig. 54 at the right auxiliary feeding station C.

The transition from the instep knitting phase to the toe knitting phase is identical with that above described of the transition from the leg knitting phase to the heel fashioning phase and need not therefore be separately described. Moreover in going from the welt knitting phase immediately after welt closure, the transition into the leg knitting phase is attended by changes in the arrangement of the machine generally like those above described in connection with the transition from the heel knitting phase to the instep knitting phase. Thus through my invention, it is possible to avoid open eyelets in the stockings at the cross-marked regions in Fig. 48 in the courses where these various transitions take place.

From Fig. 15 it will be noted that as the main body yarn a is withdrawn, by rotation of the needle cylinder 1 it is swept beneath the clamp tongue 78 and then under the finger 71a and the plate 71 in Fig. 12 en route to the cutter 65. The auxiliary body yarn b upon withdrawal of the feed 44, on the other hand, is swept by rotation of the cylinder over the plate 71 and the guard 162 beneath the clamp 112, and en route the cutter 90, is intercepted by the guard 125 as shown in Fig. 12. The auxiliary yarn c in turn, upon withdrawal of its feed 45, is swept beneath the clamp 145 as shown in Fig. 15, and, en route cutter 140, is kinked about the inner leg of the element 160 as shown in Fig. 12. Thus in their withdrawal, the yarns b and c are maintained in a different plane from that of the yarn a, as a consequence of which interference and entanglement of these yarns with each other is avoided during their withdrawal as well as during their insertion in the way about to be explained. In being pulled from beneath the clamp 78, upon insertion of its feed 35, the main yarn a is held down by the finger 71a and the plate 71 and passed beneath the flange of the guard finger 162 as shown in Fig. 71, and in its further travel is confined to the interval between the under cut portion of the plate 71 and the top surface of the disk 60, as shown in Figs. 72 and 76. Upon insertion of the feed 44, the auxiliary body yarn b passes over the top of the plate 71 and is dragged along beneath the clamp 112 as shown in Fig. 73. Continuing on, the yarn b passes over the guard finger 162 as shown in Figs. 73 and 77, above the level to which the main yarn a is confined. In the same general manner, the auxiliary yarn c is withdrawn from beneath its clamp 145 as shown in Fig. 75, being likewise prevented from interfering with the main yarn a by reason of the elevation of the plate 146 above the top surface of disk 60 over which said yarn a is drawn incident to its insertion. As previously explained, the springs acting upon the weight elements 82, 119 and 152 are eased at the times of withdrawal and insertion of the yarns a, b and c from and into their respective clamps Accordingly very light yarns can be used in the machine without danger of being ruptured by straining incident to feed manipulation.

Having thus described my invention, I claim:

1. In a circular knitting machine, a cylinder with needles; a main station with a main yarn feed and a main stitch cam for knitting the main yarn; a withdrawable auxiliary feed and an auxiliary knitting cam at a station spaced circumferentially of the cylinder from the main station; means for moving the auxiliary feed into operative position to initiate knitting of its yarn at a definite needle by the auxiliary cam at the auxiliary station; means for selecting a small group of selected needles in advance of said definite needle in the direction of cylinder rotation and for elevating them at said auxiliary station to take the auxiliary yarn at the time of its introduction; and means for controlling the auxiliary stitch cam to depress the selected needles to the tuck level only while depressing said definite needle and the needles following it to the stitch forming level.

2. In a circular knitting machine, a cylinder with needles; a main station with a main yarn feed and a main stitch cam for actuating the needles to knit the main yarn at said station; a withdrawable auxiliary feed and a retractable auxiliary stitch cam at an auxiliary station spaced circumferentially of the cylinder from the main station, said auxiliary stitch cam having a primary section for depressing needles to the stitch forming level and a separately movable secondary section for depressing needles to the tuck level only; means for moving the auxiliary feed into operative position to initiate knitting of its yarn at a definite needle by the auxiliary cam; means for selecting a few needles in advance of said definite needle in the direction of cylinder rotation and for elevating them at the auxiliary station to take the auxiliary yarn at the time of

its introduction; and means for controlling the auxiliary stitch cam to first insert its secondary section to effect depression of the selected advance needles to the tuck level and thereafter to insert its primary section to depress said definite needle and the needles following it to the stitch forming level.

3. In a circular knitting machine, a cylinder with needles including a small group having butts shorter than those of the remaining needles; a station with a main yarn feed and a main stitch cam for actuating the needles to knit the main yarn; a withdrawable auxiliary feed and a retractable auxiliary stitch cam at an auxiliary station spaced circumferentially of the cylinder from the main station, said auxiliary stitch cam having a primary section for depressing needles to the stitch forming level and a separately movable secondary section for depressing needles to the tuck level only; means for moving the auxiliary feed into operative position for initiation of the knitting of its yarn at the needle immediately following the group of short butt needles in the direction of cylinder rotation; means for elevating the short butt needles at the auxiliary station to take the auxiliary yarn at the time of its introduction; and means for controlling the auxiliary stitch cam to first insert its secondary section to effect depression of the short butt needles to the tuck level and immediately thereafter to insert its primary section for depression of the other needles to the stitch forming level.

4. In a circular knitting machine, a rotary cylinder with needles; a main station with a main yarn feed and a main stitch cam for actuating the needles to knit the main yarn and thereby produce plain fabric with regular loops; individually withdrawable auxiliary yarn feeds and auxiliary stitch cams at auxiliary stations spaced circumferentially of the needle cylinder from each other and from the main station; means operative just prior to withdrawal of the auxiliary feed with its yarn to cause a small group of selected needles rearward, with regard to the direction of cylinder rotation, of a definite needle at which the knitting at the corresponding auxiliary station is terminated, to take such yarn in readiness to be knitted into plain or regular fabric loops in a succeeding course through actuation of said selected needles by the stitch cam at the next station with attendant concealment by a crosswise segment of yarn, of an eyelet which would otherwise occur at the point of withdrawal of the auxiliary yarn.

5. In a circular knitting machine, a cylinder with needles; a main station with a main yarn feed and a main stitch cam for actuating the needles to knit the main yarn; a withdrawable auxiliary feed and an auxiliary stitch cam at an auxiliary station spaced circumferentially of the cylinder from the main station; means operative, just prior to withdrawal of the auxiliary feed from feeding position, to select a few needles rearward of a definite needle in the direction of cylinder rotation, at which the knitting of the auxiliary yarn at the auxiliary station is terminated and elevating said selected needles to take the auxiliary yarn; and means for controlling the auxiliary stitch cam to depress said selected needles to the tuck level only while depressing the following needles to the stitch drawing level.

6. In a circular knitting machine, a cylinder with needles; a station with a main yarn feed and a main stitch cam for actuating the needles to knit the main yarn; a withdrawable auxiliary feed and a retractable auxiliary stitch cam at an auxiliary station spaced circumferentially of the cylinder from the main station, said auxiliary stitch cam having a primary section for depressing needles to the stitch forming level and a separately movable secondary section for depressing needles to the tuck level only; means for withdrawing the auxiliary feed from feeding position; means for selecting a few needles rearward of a definite needle in the direction of cylinder rotation at which needle the knitting of the auxiliary yarn is terminated, and for elevating the selected needles to take the auxiliary yarn just prior to its withdrawal at the auxiliary station; and means for retracting the main section of the auxiliary stitch cam for suspension of the knitting at the auxiliary station to permit depression of the selected needles to the tuck level by the secondary section of said cam, and for subsequently retracting said secondary section.

7. The method of closing eyelets such as are formed upon individual withdrawal of an auxiliary yarn during the knitting of tubular fabric with a main yarn in a circular knitting machine having a rotary cylinder with needles, a main feeding and knitting station, and auxiliary feeding and knitting stations at spaced intervals circumferentially of the cylinder all operative to produce plain fabric with regular loops, which method comprises withdrawing an auxiliary yarn for suspension in the knitting thereof at a definite needle at the corresponding auxiliary station; and causing said yarn to be taken just prior to its withdrawal by a few selected needles following said definite needle in the direction of cylinder rotation in readiness to be knitted into plain or regular fabric loops at the next knitting station with attendant concealment by a crosswise segment of the yarn, of an eyelet which would otherwise occur at the point of withdrawal of the auxiliary yarn.

8. In a circular knitting machine, a rotary cylinder with needles; a withdrawable yarn feed; a stationary clamp for holding the end of the yarn while the feed is in its idle position; a retractable stitch cam for actuating the needles to knit the yarn; means for inserting the feed for initiation of the knitting at a definite needle in the cylinder; means for selecting a small group of needles in advance of said definite needle as considered with respect to the direction of cylinder rotation and causing presentation of the yarn to said group upon insertion of the feed but just prior to insertion of the stitch cam, with the yarn positioned at the front of end needles and at the back of an intermediate needle of such group, thereby to bind upon the yarn and prevent reeving thereof through the needle hooks as it is being drawn from the clamp.

9. In a circular knitting machine, a rotary cylinder with needles; a withdrawable yarn feed; a clamp for holding the end of the yarn while the feed is in idle position; a retractable stitch cam for actuating the needles to knit the yarn; means for inserting the feed to determine the initiation of the knitting at a definite needle in said cylinder; means for selecting a small group of needles in advance of said definite needle, as considered in respect to the direction of cylinder rotation, and elevating the needles of said group except one needle in the midst of them, to receive the yarn end just prior to insertion of the stitch cam; and means for thereafter causing said single needle to be elevated to the level of its fellows with the yarn positioned in the back thereof,

thereby to bind upon the yarn end and prevent reeving thereof in the needle hooks as it is being drawn from the clamp.

10. In a circular knitting machine, a rotary cylinder with needles; a withdrawable yarn feed; a clamp for holding the end of the yarn while the feed is in idle position; a stitch cam for actuating the needles to knit the yarn, said cam having a primary section capable of depressing needles to the stitch forming level and a separately movable secondary section capable of depressing needles to the tuck level only; means for selecting a small group of needles in advance of a definite needle in the cylinder, as considered with respect to the direction of cylinder rotation, at which needle the knitting is to be initiated, and for elevating said group to the yarn taking level; and means for inserting the secondary section of the stitch cam to depress the selected needles to the tuck level as they receive the yarn; means for incidentally causing the yarn end to be placed back of at least one needle in the midst of the selected group to bind the yarn end and prevent it from reeving through the needle hooks as it is drawn from the clamp; and means for thereafter inserting the primary section of the stitch cam to start the knitting.

11. A method of insuring the removal of a yarn end from the stationary holding clamp of a circular knitting machine having a rotary cylinder with needles and a withdrawable feed for the yarn, which method involves at the time of insertion of the feed, the step of causing the yarn end to be placed to the front of end needles of a small selected group in advance, as considered with respect to the direction of cylinder rotation, of a definite needle at which the knitting is to be initiated and to the back of at least one needle in the midst of said selected group to bind the yarn end and prevent it from reeving through the needle hooks.

12. In a circular knitting machine, a rotary cylinder with needles and cooperative sinkers; a main station with a yarn feed and a main stitch cam for there actuating the needles to knit the main yarn; individually withdrawable auxiliary yarn feeds and auxiliary stitch cams at auxiliary stations spaced circumferentially of the cylinder relative to each other and to the main station; means operative upon insertion of an auxiliary yarn to cause a small group of needles in advance, as considered with regard to the direction of cylinder rotation, of a definite needle at which the knitting is to be initiated by the stitch cam at the corresponding auxiliary station, to take such auxiliary yarn for formation into plain or regular fabric loops in the succeeding fabric course through actuation of said selected needles and all the other needles at the next knitting station, with consequent concealment by a crosswise segment of the yarn, of an eyelet which would otherwise occur at the point of introduction of the auxiliary yarn; draw cams for retracting the sinkers at the respective knitting stations; means for determining definite positions for the draw cams circumferentially of the cylinder relative to the respective stitch cams; and means operative upon insertion of the auxiliary feeds, to change the position of the sinker draw cams, thereby to prevent pinching of the yarns by the sinkers.

13. In a circular knitting machine, a rotary cylinder with needles and cooperative sinkers; a main station with a yarn feed and a main stitch cam for there actuating the needles to knit the main yarn; individually withdrawable auxiliary yarn feeds and auxiliary stitch cams at auxiliary stations spaced circumferentially of the cylinder relative to each other and to the main station; means operative upon insertion of an auxiliary yarn to cause a small group of needles in advance, as considered with regard to the direction of cylinder rotation, of a definite needle at which the knitting is to be initiated by the stitch cam at the corresponding auxiliary station, to take such auxiliary yarn for formation into plain or regular fabric loops in the succeeding fabric course through actuation of said selected needles and all the other needles at the next knitting station, with consequent concealment by a crosswise segment of the yarn, of an eyelet which would otherwise occur at the point of introduction of the auxiliary yarn; clamps positioned adjacent the respective yarn feeds at different levels for holding the individual yarn ends when the feeds are withdrawn; and means operative upon insertion or withdrawal of the feeds to keep the yarns separated while guiding them to and from the respective clamps at the different levels.

14. In a circular knitting machine, a rotary cylinder with needles and cooperative sinkers; a main station with a yarn feed and a main stitch cam for there actuating the needles to knit the main yarn; individually withdrawable auxiliary yarn feeds and auxiliary stitch cams at auxiliary stations spaced circumferentially of the cylinder relative to each other and to the main station; means operative upon insertion of an auxiliary yarn to cause a small group of needles in advance, as considered with regard to the direction of cylinder rotation, of a definite needle at which the knitting is to be initiated by the stitch cam at the corresponding auxiliary station, to take such auxiliary yarn for formation into plain or regular fabric loops in the succeeding fabric course through actuation of said selected needles and all the other needles at the next knitting station, with consequent concealment by a crosswise segment of the yarn, of an eyelet which would otherwise occur at the point of introduction of the auxiliary yarn; clamps positioned adjacent the respective yarn feeds at different levels for holding the individual yarn ends when the feeds are withdrawn; means operative upon insertion or withdrawal of the feeds, to keep the yarns separated while guiding them to and from the respective clamps at the different levels; and means for concurrently relieving the pressure of the clamps to prevent straining of the yarns.

15. In a circular knitting machine, a rotary cylinder with needles and cooperative sinkers; a main station with a yarn feed and a main stitch cam for there actuating the needles to knit the main yarn; individually withdrawable auxiliary yarn feeds and auxiliary stitch cams at auxiliary stations spaced circumferentially of the cylinder relative to each other and to the main station; means operative upon insertion of an auxiliary yarn to cause a small group of needles in advance, as considered with regard to the direction of cylinder rotation, of a definite needle at which the knitting is to be initiated by the stitch cam at the corresponding auxiliary station, to take such auxiliary yarn for formation into plain or regular fabric loops in the succeeding fabric course through actuation of said selected needles and all the other needles at the next knitting station, with consequent concealment by a crosswise segment of the yarn, of an eyelet which would otherwise occur at the point of introduction of the aux-

iliary yarn; clamps positioned adjacent the respective yarn feeds at different levels for holding the individual yarn ends when the feeds are withdrawn; respectively associated yarn cutters; means operative upon withdrawal of the feeds, for guiding the yarns to the respective clamps and cutters at the different levels; and means for concurrently easing the pressure of the clamps and actuating the cutters to sever the yarns.

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