R. W. SCOTT.

CIRCULAR KNITTING MACHINE.

APPLICATION FILED MAY 8, 1913.

1,148,055.

Patented July 27, 1915.

10 SHEETS—SHEET 1.

Fig. 1.

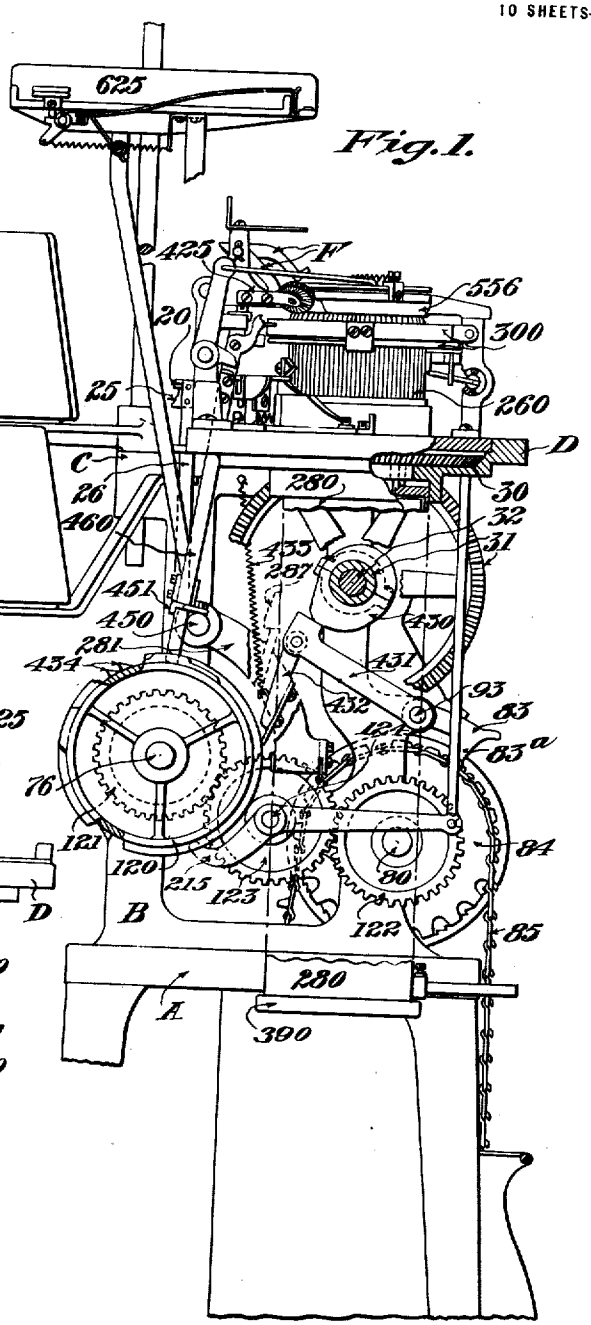
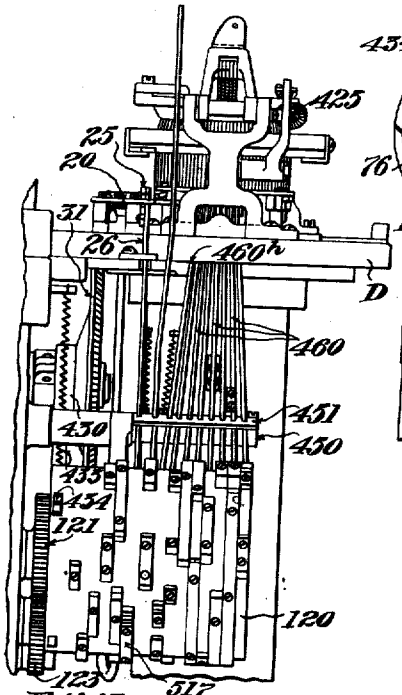


Fig. 2.



Witnesses:

M. F. Crozier.

Mary F. Griffin

Inventor,

Robert W. Scott

by Robert C. Lind

his attorney

R. W. SCOTT.

CIRCULAR KNITTING MACHINE.

APPLICATION FILED MAY 8, 1913.

1,148,055.

Patented July 27, 1915.

10 SHEETS—SHEET 2.

Fig. 3.

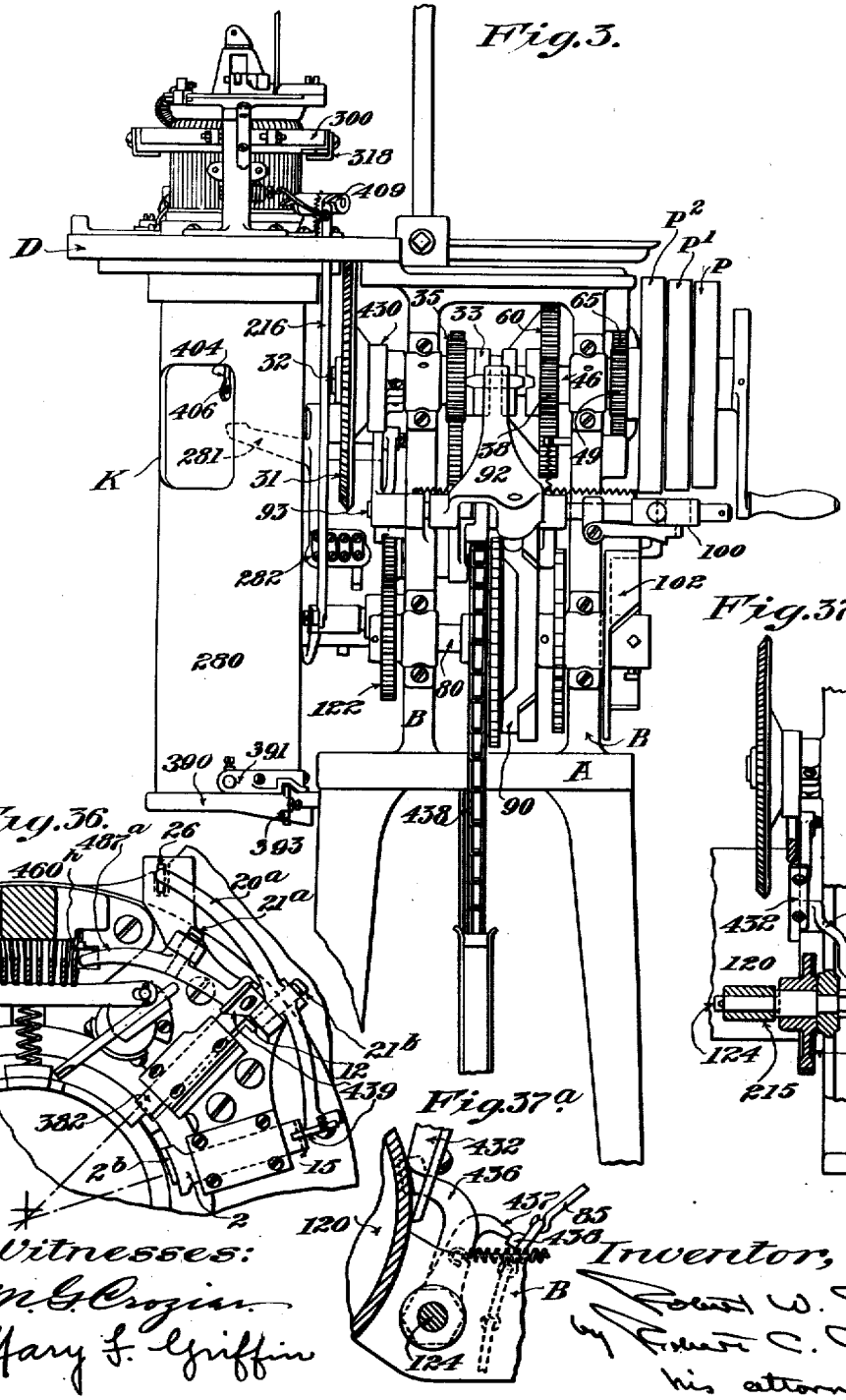


Fig. 37.

Fig. 36.

Fig. 37a

Witnesses:

M. G. Crozier

Mary F. Griffin

Inventor,

Robert W. Scott

by Robert C. Caldwell

his attorney

R. W. SCOTT.

CIRCULAR KNITTING MACHINE.

APPLICATION FILED MAY 8, 1913.

1,148,055.

Patented July 27, 1915.

10 SHEETS—SHEET 3.

Fig. 4.

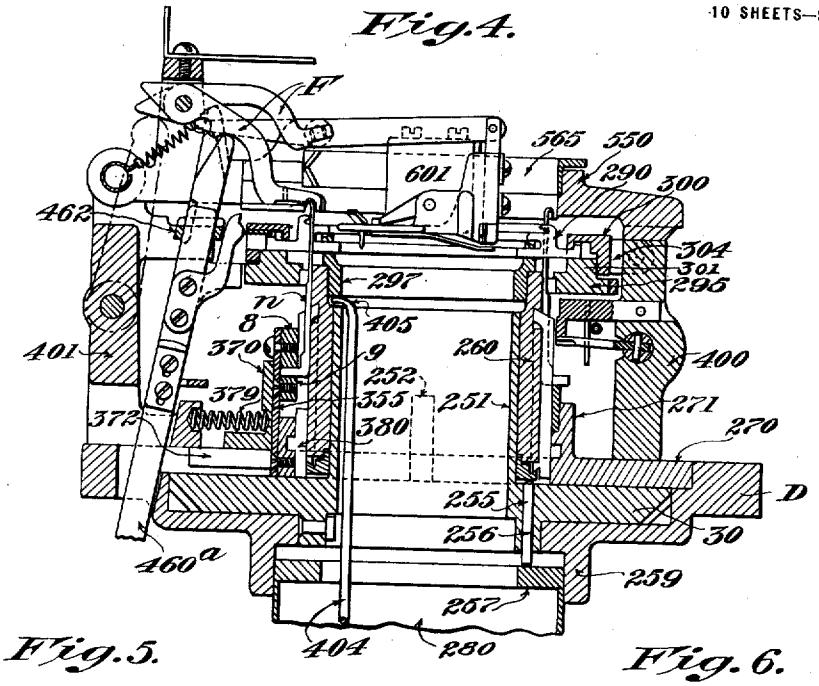


Fig. 5.

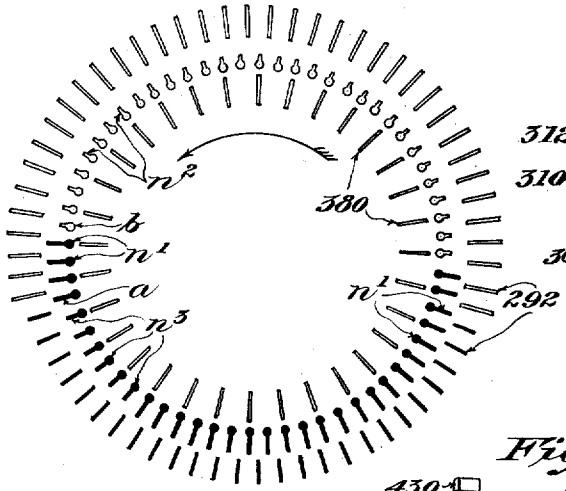


Fig. 6.

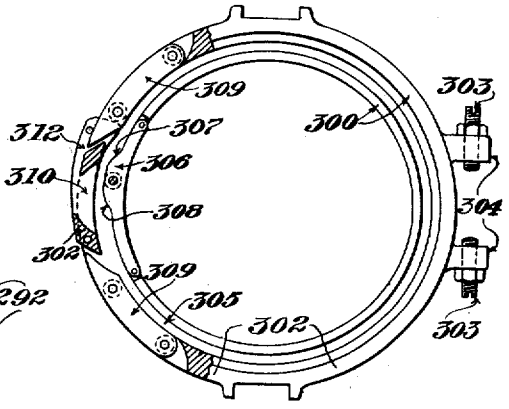
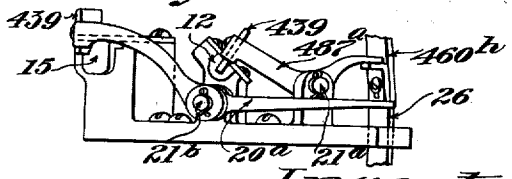


Fig. 38.



Witnesses:
M. L. Crozier,
Mary F. Griffin

Inventor;
Robert W. Scott
by Robert C. Child
his attorney

R. W. SCOTT.

CIRCULAR KNITTING MACHINE.

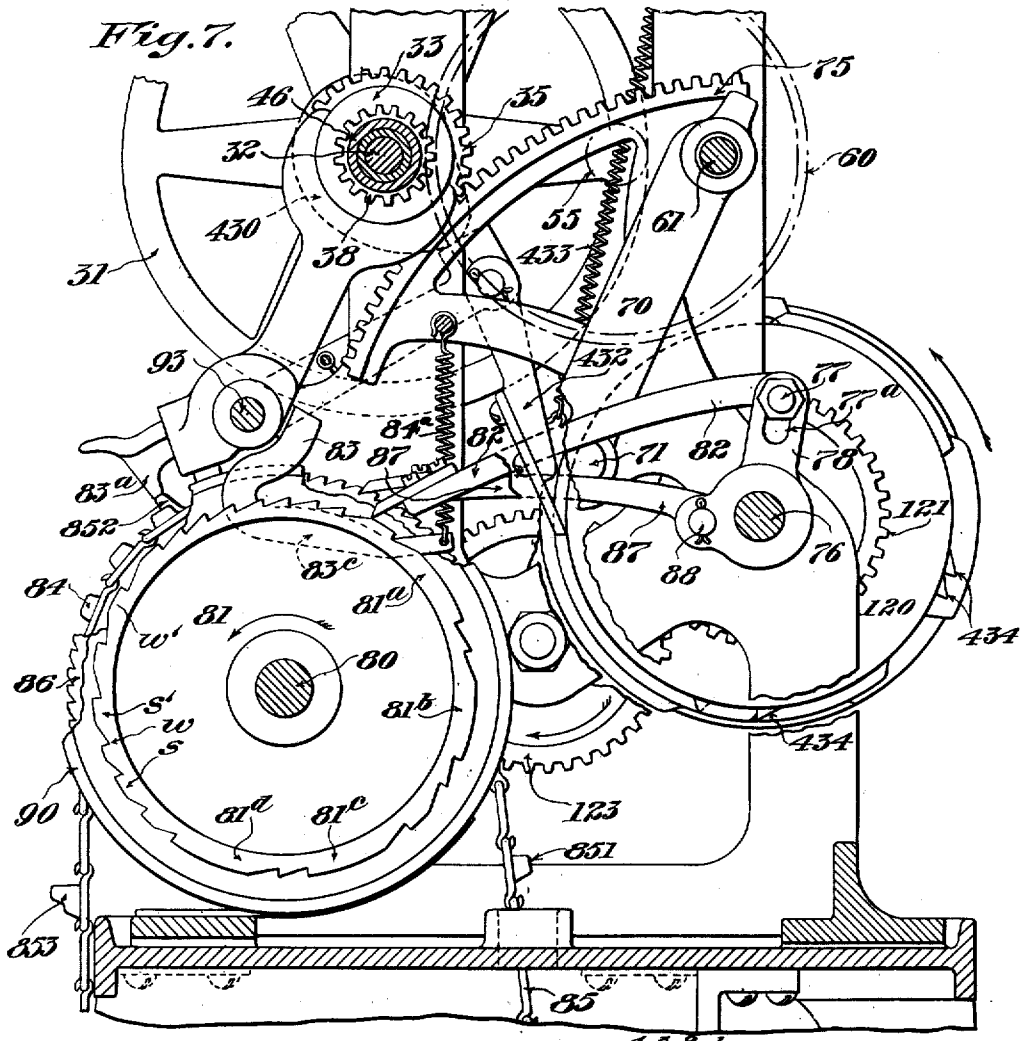
APPLICATION FILED MAY 8, 1913.

1,148,055.

Patented July 27, 1915.

10 SHEETS—SHEET 4.

Fig. 7.



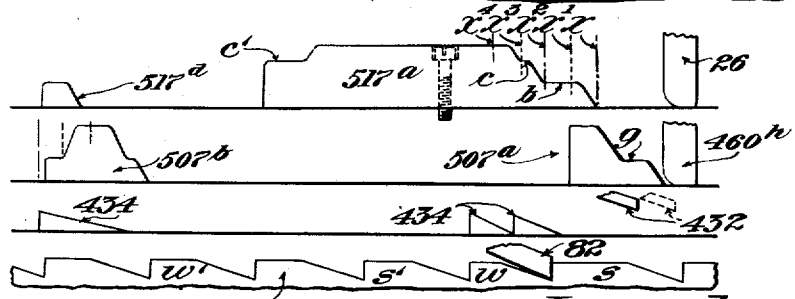


Fig. 8.

Witnesses:
M. L. Crozier,
Mary F. Griffin

Inventor,
Robert W. Scott
by Robert C. Cieus
his attorney

R. W. SCOTT.

CIRCULAR KNITTING MACHINE.

APPLICATION FILED MAY 8, 1913.

1,148,055.

Patented July 27, 1915.

10 SHEETS—SHEET 5.

Fig. 9.

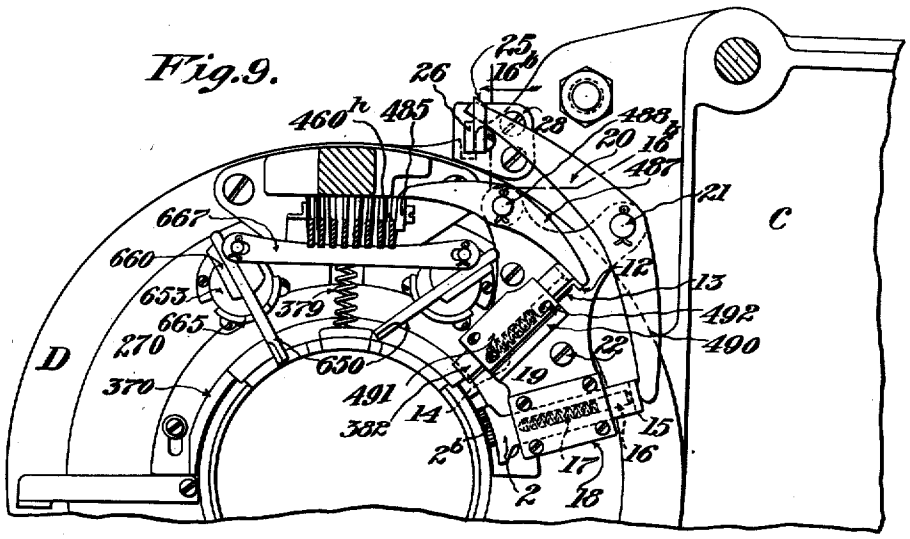


Fig. 18.

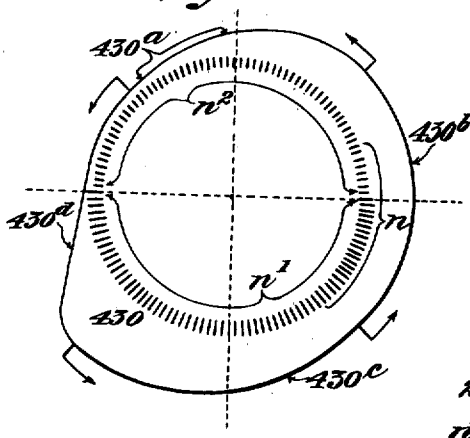


Fig. 19.

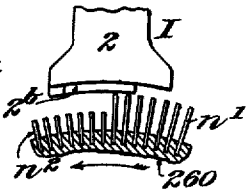


Fig. 20.

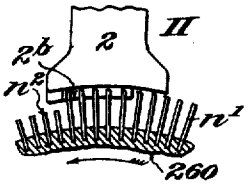


Fig. 21.

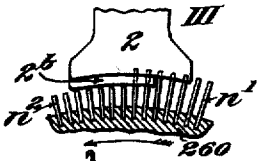
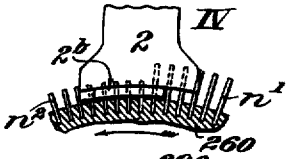


Fig. 22.



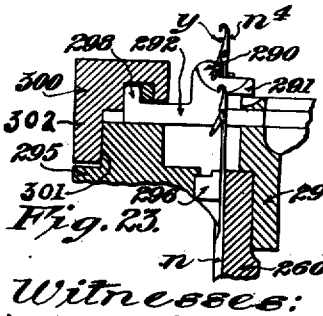


Fig. 23.

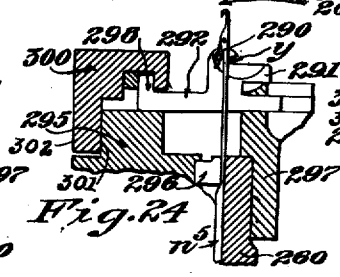


Fig. 24.

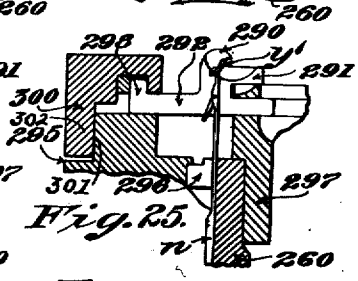


Fig. 25.

Witnesses:

M. S. Crozier.

Mary J. Griffin

Inventor;

Robert W. Scott

by Robert C. Ewald

his attorney

R. W. SCOTT.

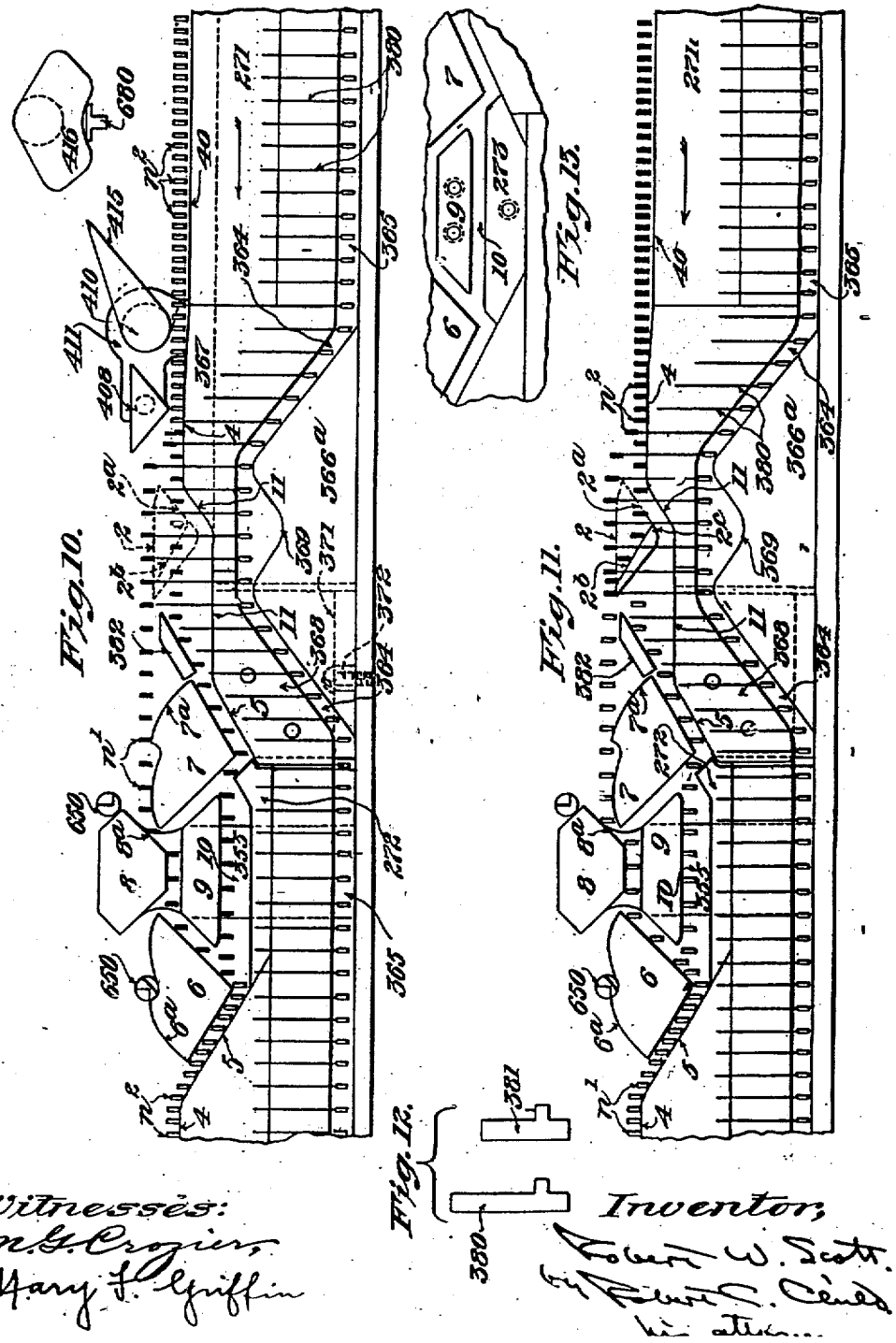
CIRCULAR KNITTING MACHINE.

APPLICATION FILED MAY 8, 1913.

1,148,055.

Patented July 27, 1915.

10 SHEETS—SHEET 6.



Witnesses:
M. G. Crozier.
Mary L. Griffin

Inventor,
Robert W. Scott.
by Robert C. Cook
his attorney

R. W. SCOTT.

CIRCULAR KNITTING MACHINE.

APPLICATION FILED MAY 8, 1913.

1,148,055.

Patented July 27, 1915.

10 SHEETS—SHEET 7.

Fig. 14.

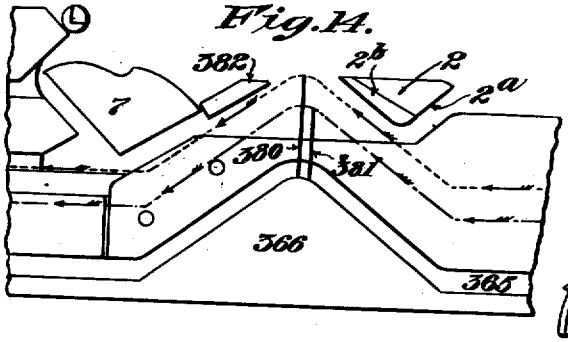


Fig. 39.

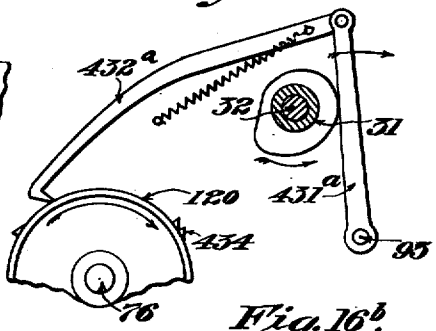


Fig. 16.

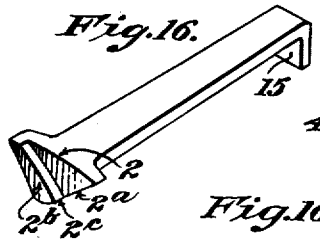


Fig. 16a.

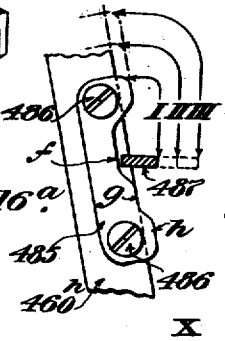


Fig. 15.

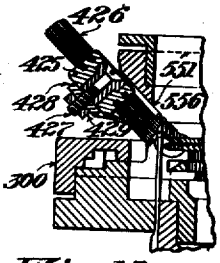


Fig. 16b.

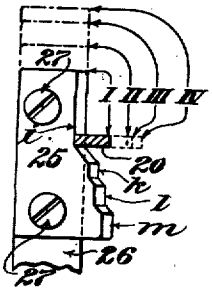




Fig. 17.

Witnesses:

M. E. Crozier.

Mary F. Griffin

Inventor:

Robert W. Scott

by Robert C. Child

his attorney

R. W. SCOTT.

CIRCULAR KNITTING MACHINE.

APPLICATION FILED MAY 8, 1913.

1,148,055.

Patented July 27, 1915.

10 SHEETS—SHEET 8.

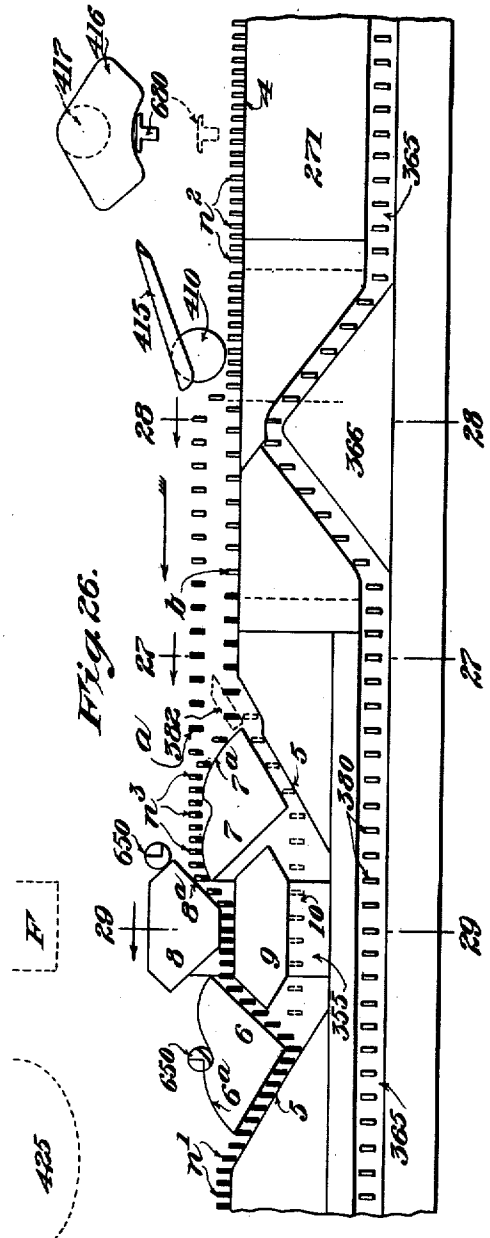


Fig. 26.

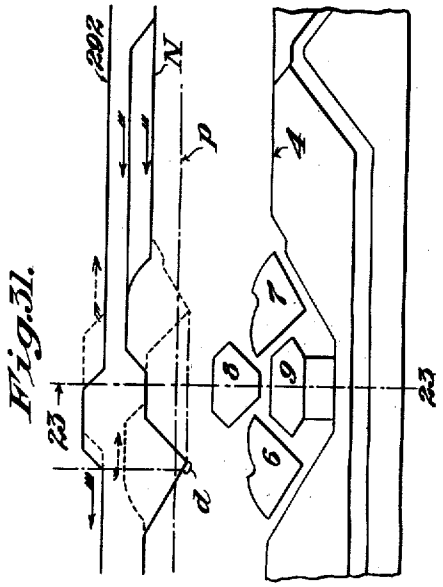


Fig. 31.

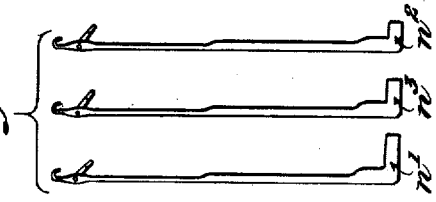


Fig. 30.

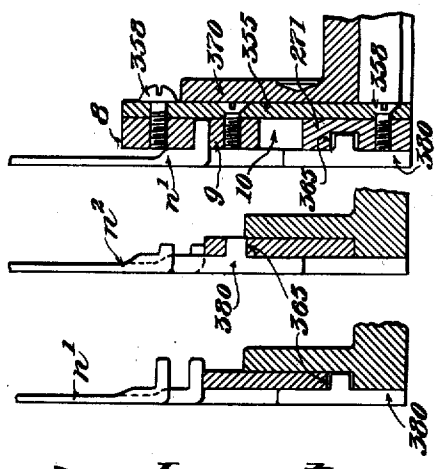


Fig. 27. Fig. 28. Fig. 29.

Witnesses:
M. S. Crozier,
Mary L. Griffin

Inventor,
Robert W. Scott
by Robert C. Child
his Attorney

R. W. SCOTT.

CIRCULAR KNITTING MACHINE.

APPLICATION FILED MAY 8, 1913.

1,148,055.

Patented July 27, 1915.

10 SHEETS—SHEET 9.

Fig. 32.

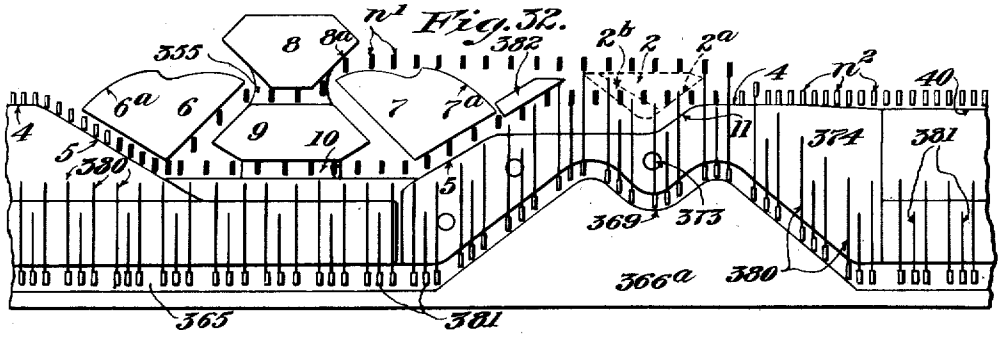


Fig. 33.

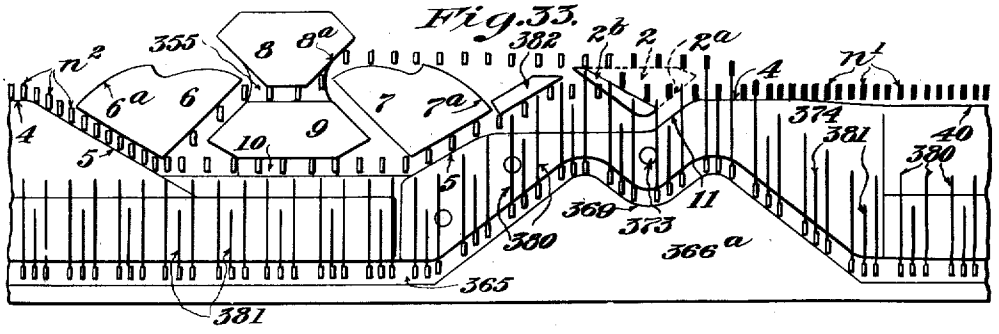


Fig. 34.

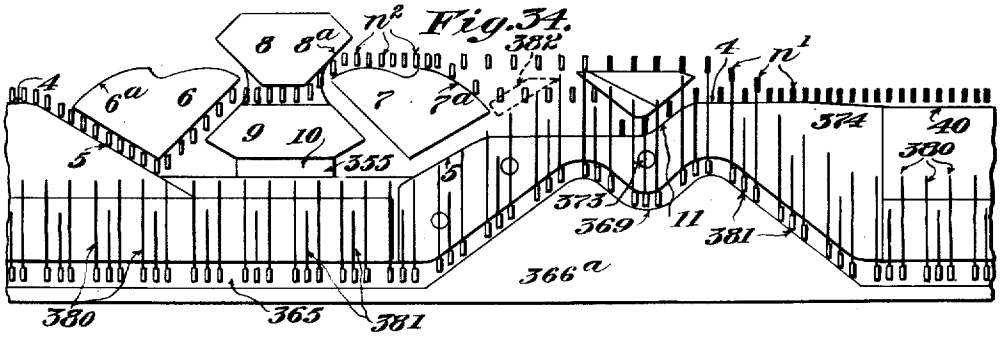
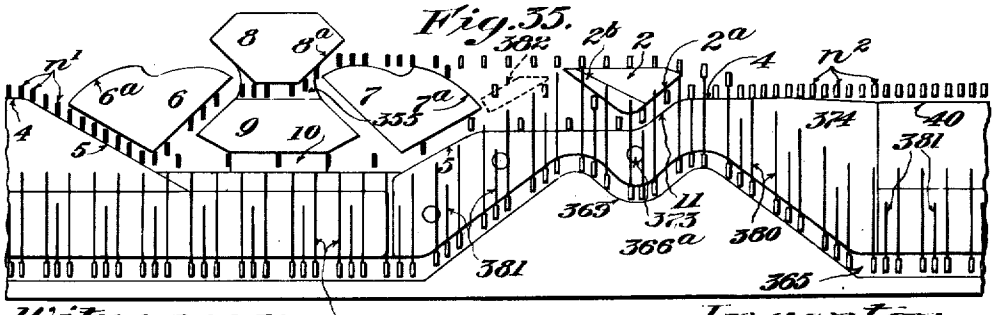


Fig. 35.



Witnesses:

M. G. Crozier,

Mary F. Griffin

Inventor;

Robert W. Scott

by Robert C. Ames

his attorney

R. W. SCOTT.

CIRCULAR KNITTING MACHINE.

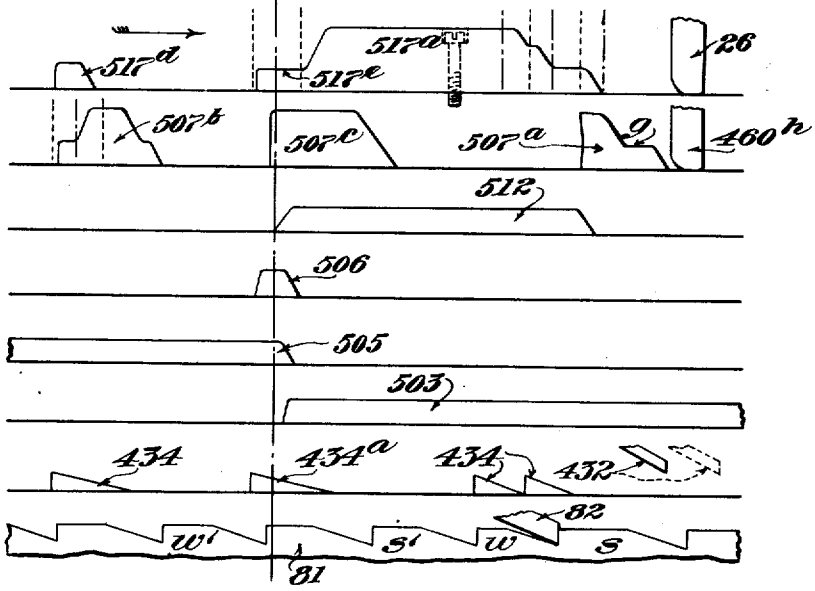
APPLICATION FILED MAY 8, 1913.

1,148,055.

Patented July 27, 1915.

10 SHEETS—SHEET 10.

Fig. 40.



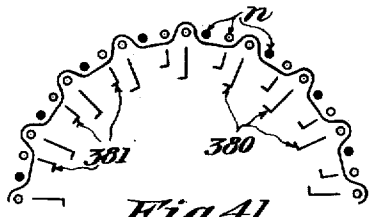


Fig. 41.

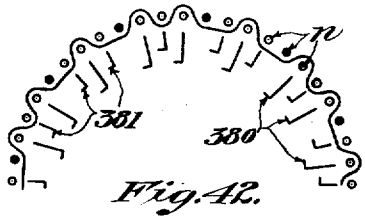


Fig. 42.

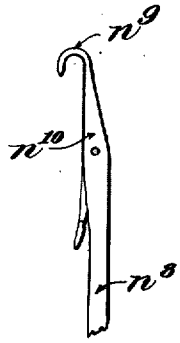


Fig. 44.

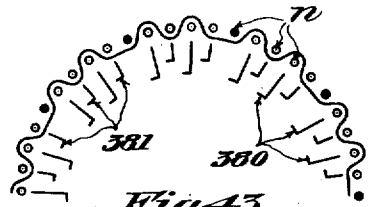


Fig. 43.

Witnesses:
M. B. Crozier
Mary F. Griffin

Inventor,
Robert W. Scott.
by Robert C. Caldwell
his attorney

UNITED STATES PATENT OFFICE.

ROBERT W. SCOTT, OF BOSTON, MASSACHUSETTS, ASSIGNOR TO SCOTT & WILLIAMS, INCORPORATED, OF BOSTON, MASSACHUSETTS, A CORPORATION OF NEW JERSEY.

CIRCULAR-KNITTING MACHINE.

1,148,055. Specification of Letters Patent. Patented July 27, 1915.

Application filed May 8, 1913. Serial No. 766,401.

To all whom it may concern:

Be it known that I, ROBERT W. SCOTT, a citizen of the United States, and resident of Boston, in the county of Suffolk and State of Massachusetts, have invented certain new and useful Improvements in Circular-Knitting Machines, of which the following is a specification.

One object of my invention is to provide a machine capable of knitting articles having a selvage, edge, or end-finish integrally at an end of the article.

Another object is to provide a hosiery knitting machine capable of automatically knitting half hose or stockings having selvages, welts, or hems of the generic character shown, described and claimed in my patents 1,045,620 and 1,045,621, granted November 26, 1912 as well as stockings characterized by out-turned welts or hems having an integrally formed line of uniting stitches and a section or selvaged fabric at the neighborhood of said uniting stitches, and stockings having a welt of fabric knit upon a less number of needles than the adjacent leg or body portions thereof, and a less number of uniting stitches than the wales of the fabric of the welt; and stockings having top sections characterized by integrally formed welts and a following section of fabric having lines of dropped stitches, and other fabrics.

My invention further relates to an improved combination of knitting cams, independently movable needles, and auxiliary devices for use in a circular knitting machine, as well as to the devices for supporting and automatically operating said devices, to cause the automatic actuation of the knitting instruments proper to accomplish the purposes above suggested and other purposes.

For the said objects, my invention relates to a knitting machine having devices for knitting single complete stockings or other articles having a beginning-selvage or a welt, or both, and for automatically knitting and ejecting a succession of such articles or stockings, if desired; and to the provision of means for knitting a drop-stitch ladder stop or preventive structure at desired parts of the article produced, whether single or in a continuous length.

In the accompanying drawings: Figure 1 is a left side elevation of a hosiery knitting machine embodying my invention; Fig. 2 is a fragmentary rear elevation showing the knitting head, the cam drum, and the vertically movable thrust bars coöperating therewith; Fig. 3 is a front elevation of the machine; Fig. 4 is an axial vertical section of the knitting head on a plane parallel to that of Fig. 1; Fig. 5 is a diagram plan showing one arrangement of needles, needle jacks, and web-holders; Fig. 6 is an under plan view of the web-holder cam ring or cap; Fig. 7 is a vertical section taken at right angles to the drive and pattern cam shafts between the supporting frames of the machines, showing the relations of the drive mechanism and the pattern mechanism; Fig. 8 is a diagram elevation of certain cams on the surface of the pattern drum, showing their relation to each other, to the thrust-bars and to an auxiliary pawling device; Fig. 9 is a partial plan, above the table or bed for the knitting head, showing the needle-controlling or supplemental cams, their mountings and part of the devices for actuating them; the needle cylinder, the web-holder dial and cams, and the latch guard ring and yarn feeding devices being removed; Fig. 10 is a development of the interior of the cam cylinder showing the knitting cams and needle controlling devices in one adjustment of the machine and also showing the paths of the needles and needle jacks during the first part of an initial course; Fig. 11 is a view similar to Fig. 10 showing the position of the parts at the end of the same course; Fig. 12 is a detail showing needle actuating jacks; Fig. 13 is a detail development of the cam cylinder showing a modified form of the advancing cam for needles traveling in the idle cam groove; Fig. 14 is a development of a portion of the cam cylinder showing a modified form of needle controlling devices; Fig. 15 is a diametrical section showing the relation of the needles to the latch opener and latch guard ring; Fig. 16 is a detail perspective of one of the cams of the needle controlling devices; Fig. 16^a is a detail elevation showing the relation of one of the thrust bars to the means for moving one of the needle cams of the needle controlling devices; Fig. 16^b is a similar view showing the relation of another thrust bar to the devices for moving another cam of the needle controlling devices; Fig. 17 is a development showing in

diagram the various cams employed on the cam drum when the machine is arranged to knit selvaged articles having stop course therein, without the employment of the auxiliary pawling attachment; Fig. 18 is a diagram horizontal section of the needle cylinder showing the arrangement of long and short butt needles, and the relative position in a rotary sense of the auxiliary rack cam for the pattern mechanism with relation to said needles; Figs. 19 to 22 are detail horizontal sections through the needle cylinder and one of the cams of the needle controlling devices showing successive positions of said cam; Figs. 23, 24 and 25 are diametrical sections showing the relations of a web-holder, the knitting yarn and knitting needles; Fig. 26 is a development of the cam cylinder similar to Figs. 10 and 11, showing a simpler form of the needle controlling devices employing but one supplemental needle cam; Figs. 27, 28 and 29 are sections on the lines 27—27, 28—28, and 29—29 respectively of Fig. 26 showing the needle jacks, needles and needle cams; Fig. 30 is a detail showing the needles; Fig. 31 is a diagram development of the cam cylinder also showing the line of movement of the hooks of the needles and their relation to the movements of the hooks of the web-holders; Figs. 32, 33, 34 and 35 are respectively figures similar to Fig. 10 showing the positions of the parts respectively for the beginning of the first course; the end thereof; the end of the second or a later course, and the middle of the third or a later course, when the machine is adjusted for knitting a certain variety of welt and top; Fig. 36 is a plan illustrating a modified form of the connections for operating the needle controlling devices; Fig. 37 is an elevation partly in section showing a controller for the auxiliary pattern pawl; Fig. 37^a is a similar view at right angles to Fig. 37; Fig. 38 is an elevation of the connections shown at Fig. 36; Fig. 39 is an elevation partly in section showing a modified form of the auxiliary pawl and operating arm therefor; Fig. 40 is a diagram similar to Fig. 8 illustrating one arrangement of certain of the pattern cams; Figs. 41, 42 and 43 are diagrams illustrating particular arrangements of needles and jacks; Fig. 44 is a detail showing a modified form for the hook-end of the needles sometimes employed.

The machine housing or frame comprises a table A mounted upon strong and rigid legs, upon the upper side of which table are erected parallel end frames B, which are in turn surmounted by a table C, together making up a strong box or frame in which the rotary elements for directing and controlling the movements of the machine are housed.

Projecting toward the left of the machine or toward the observer in Fig. 1, from the table C of the frame, is a strong shelf or table D in which is formed an annular bearing, surrounding a central opening in which a bevel gear 30 is held for rotation and against vertical movement. Said bevel gear carries for rotation about a vertical axis central with the opening in the shelf D a longitudinally grooved needle cylinder 260 having independently movable needles *n* therein. Said needle cylinder carries upon its upper end a web-holder dial 295 and web-holder cam 300, and the heads of the projected knitting needles are surrounded by a latch guard ring shown generally at 550, as will be specifically pointed out below. Mounted upon said latch guard ring, as shown generally at F, I may provide a number of yarn changing guides, and as shown at 425 I may provide a brush latch opener to coöperate with the knitting needles. The machine has the remaining adjuncts of a circular hosiery knitting machine, such for instance as the machine shown, described and claimed in my application Serial No. 746,070, filed February 3, 1913 of which the members immediately concerned will be treated more in detail below.

Driving and power connections.—As is usual in the art, motion is communicated to the gear 30 and the knitting head by the bevel gear 31 carried on the left end of the main drive shaft 32, which projects for this purpose beyond the left end frame B, which shaft 32 is driven through a clutch collar 33 splined on said shaft 32, which may be automatically shifted to engage a reciprocal gear 35 or a pinion 38 suitably connected to a source of power, by sliding movements of a slide 92 guided on a fixed rod 93 attached to the end frame, which slide is in turn operated by cam surfaces on the cam drum 90 fast to and rotating with a cam shaft 80 journaled in said end frames. The right end of the shaft 32 carries a loose pulley P and a sleeve 46 for a drive pulley P′, which may directly actuate the pinion 38 through the sleeve 46, Figs. 3 and 7. Suitable speed increasing gearing is provided for the operation of said shaft 32 (which may comprise a pulley P^2 loose on a concentric bushing, and means 100, 102, to shift the drive belt from drive pulley P to pulley P^2) by directly driving the crank shaft 55, carrying the crank pin 61, for instance through the gearing 49, 65, between said pulley P^2 and said crank shaft. The arrangement illustrated is such that rotary movements of the pinion 38, whether the driving or a driven member of the train, are related to movements of the shaft 55 at a greatly reduced or increased rate, as indicated by the circles 60 and 38, representing meshing gears providing a ratio of substantially 1:4, which proportion may, of course, be varied.

As is usual in the art, the crank pin 61 is connected by the pitman 70 and pin 71 with an oscillating sector 75 on the sector shaft 76 at the back of the machine and below the main driving shaft, the radius of the pin 71 with respect to the shaft 76 being greater than the circle swept by the pin 61. Said sector meshes into the reciprocal gear 35, which is clutched to the shaft 32 upon the motion of the slide 92 toward the left of the machine. It should be noticed that one revolution of the shaft 55 and the gear 60 will result in one complete forward and back movement of the gear 35, and thus in one complete or double oscillation of the knitting head, which moves in unison with the shaft 32.

The rocking movements of the sector 75 and its attachments will be related to the main drive shaft and therefore to the rotary motions of the knitting head by a constant ratio determined by the relative diameters of the pinion 38 and the gear 60. As pointed out in my said application, the pinion 38 may be no part of the driving train when the drive shaft is clutched to the reciprocal gear 35 for movements of reciprocation.

The sector 75 carries a crank arm 78 slotted at 77^a to receive for adjustment a crank pin 77 for a reciprocating actuator, such as the pawl 82 coöperating with a rack wheel 81 fast on the shaft 80. Said sector also carries crank pin 88 for a pawl 87 taking into the teeth of the ratchet 86 free on the shaft 80, which ratchet 86 is attached to and operates a primary pattern surface, shown as a sprocket 84 carrying a pattern chain 85. Journaled on the rod 93 is a pawl controller 83 having a chain-reading lug 83^a, and an integral attachment 83^c standing between the faces of the drum 90 and the rack wheel 81. Said pawl controller attachment 83^c determines by its positions under the influence of spring 84^a and lugs 851, 852, 853, etc. of different heights on said pattern chain the extent of the engagement of the active toe of the pawl 82 with the rack wheel 81. Said rack wheel is provided with teeth of a predetermined and irregular pitch in such an order as to enable the pawl 82 to find a tooth at or after the beginning of its constant but adjustable stroke under the control of the pawl controller attachment 83^c, the effective length of stroke thus being in turn under the control of the lugs 851, 852, etc. upon the pattern chain. It will be seen that the wheel 81 will be operative if regularly cut, for instance if provided with forty-six regularly spaced teeth, but I prefer to provide long teeth on said wheel 81 angularly spaced to bring them opposite the pawl in relation to the angular positions of the parts of the various cams necessarily given a long movement, to prevent the possibility of leaving the cam-shaft in an improper position. The clutch shifting cams on the drum 90, for instance, and the associated mechanism for controlling the heel and toe knitting devices, require such a comparatively large angular movement of the shaft 80, and long teeth 81^a and 81^b are provided on the wheel 81 for moving the pattern shaft and appurtenances respectively at the beginning of the heel and the beginning of the foot. Long teeth 81^c and 81^d similarly represent the beginning of the toe and the end thereof. The rate at which the shaft 80 moves under the influence of the pawl 82 is a constant rate of one advance for each revolution of the crank shaft 55 and complete oscillation of the sector 75.

The shaft 80 is the main pattern or cam shaft determining the times of the various operations performed by the machine. The pattern chain 85 determines when any movement of said shaft shall take place, while the rack wheel 81 in coöperation with the lugs of the pattern chain and pawl controller determines the extent of such movement. It is evident that the cycle of operations is repeated after one complete revolution of said cam shaft 80. It is therefore desirable to so order the movements of said shaft as to provide for all of the operations of the machine during one full revolution. Said shaft 80 projects at the left hand side as shown in Fig. 1 to receive a gear 122 meshing with a gear 123 journaled on the stud 124 projecting from the frame B, which in turn meshes with the gear 121, similar to the gear 122, which is attached to a cam drum 120 journaled on the projecting end of the sector shaft 76. Cams removably attached to the surface of said pattern drum, constituting a movable pattern surface, are arranged to contact with and actuate members of a series of thrust bars 460 guided at their lower ends in a comb 451 attached to a stud 450 parallel with the shaft 76 and extending above the surface of said pattern drum and at their upper ends in a comb 462 (Fig. 4) attached to a standard 401 of the shelf D. These thrust bars by their lifting movements in response to the pattern surface control various knitting agencies at the knitting head, as specifically set forth and claimed in my said application, Serial No. 746,070 including yarn changing yarn guides F, one of which may be operated as a yarn splicing device, means 565 for closing the gap in the latch ring 550 through which the yarn guides operate, an internal yarn clamp and cutter 601, a yarn take-up device indicated generally at 625, and other knitting elements.

The above indicated mechanisms in cooperation with usual or known knitting cams and their adjuncts form together an efficient device for the production of stock-

ings, which may be made long or short, and be provided with usual yarn structures at will, by suitable variation of the pattern chain 85.

The needle cylinder and the web-holders.—The central part of the gear 30 is cut away to provide a free opening through which the forming fabric descends, and is surmounted by the upwardly extending integral sleeve 251 upon which the needle cylinder 260 is removably mounted. The cylinder 260 is held to rotate with the sleeve 251 by the key 252 sliding in a longitudinal keyway on the inner side of said cylinder 260. The cylinder 260 may thus be moved in a vertical sense with respect to the gear 30 and the sleeve 251, without disturbing its rotative adjustment with respect to said gear 30 or the other elements of the machine. The cylinder 260 may be of any approved construction but I prefer to employ an inserted wall or built-up needle cylinder, such as that illustrated in the drawings, and which briefly may consist of a grooved casting having independently removable needle guiding walls inserted in the grooves and held in place by a beveled collar attached to the bottom of said cylinder. To provide for such vertical movement the gear 30 is bored through, as at 255, Fig. 4, in three places to receive supports 256, which may be hard steel pins, all of the same length. The bores 255 are in line with the bottom of the needle cylinder, which freely rests upon the ends of said pins by gravity, and by reason of the stress due to the coöperation of needles frictionally held in their grooves with fixed cams whose advancing slopes are flatter than their retracting slopes, when the machine is running. The pins 256 in turn rest upon, and by reason of the motion of the gear 30, rotate with respect to a ring 257, which may be a hardened and polished steel ring, or be provided with a suitable anti-friction surface, as by making it of bronze, which ring has a bearing within the inner machined face of a depending cylindrical flange 259 of the bed-plate D. The ring 257 is vertically movable within said flange 259 by the vertical movement of a hollow tubular column 280 concentric with the knitting axis which fits within said flange 259 at its upper end and upon which the ring 259 rests.

Column 280 is lifted and lowered through short distances to automatically vary the stitch length by means of the two-armed lever 281 (Figs. 1 and 3) journaled on the stud 450 and having a depending head 282 resting near the front face of the drum 120, carrying adjustable plungers to follow cams upon said cam drum as indicated at 511, 512, 515 and 514 in Fig. 7. The other arm of the lever 281 terminates in a flat taking on the under side of a lug 287 screwed on the column 280. The lower end of the said column rests freely in a ring-bearing 390 bolted on the under side of the table A, but is restrained from falling by the cam lug 391 resting upon a plunger 393 in a bore on said ring 390, all as pointed out in detail and claimed in said application, Serial No. 746,070. Column 280 is for convenience provided with a hand-hole K. In order to prevent ends of single stockings, or the beginning of a piece of fabric from being centrifugally thrown through said hand-hole, I provide a fixed drag wire or rod 404, Fig. 4, attached to the column 280 by a screw at 406, (Fig. 3) and having an outward bend 405 at its reduced upper end housed in the annular groove between the sleeve 251 and the nosing 297, in which it has sufficient play to permit the free rotation of said sleeve and nosing. The lower end of the forming tube of fabric is kept twisted and in a central position by striking said drag at each revolution. Completed articles when cast off the needles drop freely through the open lower end of the column 280, under which a basket or receptacle may be placed.

The machine is equipped with independently movable latch needles *n* of a well-known type, which may be tensioned needles, laterally bent to cause friction in their grooves. The knocking-over plane below which the old loops may not be carried is determined by the upper surface of the upper inwardly extending arms 291 of web-holders 292 (see Figs. 4 and 23 to 25) movable in the grooves of a radially grooved bed or dial 295 rigidly mounted upon the extreme upper end of the outer face of the needle cylinder, upon a flange 296 having deep longitudinally milled grooves in line with the needle grooves to provide spaces for the removal of the needles. The grooves of the web-holder bed or dial 295 stand midway between spaces occupied by the needle grooves, and the inboard ends of the web-holders 292 are received and guided by a nosing 297 fast in the enlarged or counterbored end 248 of the needle cylinder 260. The construction of the web-holders 292, of the nosing 297, and the web-holder bed 295, may be the same as that illustrated in the patent to George D. Mayo, 726,178, April 21, 1903.

By reason of the attachment of the web-holder bed 295 and the nosing 297 to the needle cylinder 260, the knocking-over plane defined by the upper surface of the arms 291 of the web-holders may be lifted or lowered to increase or decrease the stitch length at all of the needles with respect to the shelf D, the fixed cam cylinder 271, and the knitting cams carried thereby, by the agency of the pins 256, the movable ring 257, the column 280 and said automatic means coöperating with said column.

At a point directly at the front of the machine the flange 270 of the cam cylinder 271 carries a rigid upright post 400. Mounted on a reduced portion 301 of the web-holder bed 295 by means of depending flange 302, and hold-down clamps 318, a web-holder cam ring 300 is adjustably held against rotation with the needle cylinder in either direction by stop-screws 303 in lugs 304 straddling the post 400, and permitting a sufficient lost motion to render the adjustments for opposite rotations independent of each other.

The underside of the web-holder cam ring (see Fig. 6) is provided with a concentric groove 305 for the control of the butts 298 of the web-holders 292, as usual. At a point opposite the lugs 304 and directly at the back of the machine as viewed in Fig. 3 said ring 290 is provided with a cam portion 306, which cam presents two withdrawing inclines 307, 308 to give the web-holding hooks 290 an outward radial movement at the knitting cams. The incline 308 is displaced toward the following stitch cam, in the direction for rotary work (Figs. 6 and 31) to delay the withdrawal of the web-holders until after the passage of the needles down the face of the top center cam 8. This construction is useful when making a starting selvage, or welt, as will presently appear.

Adjustable cams 309 pivoted on each side of the outthrow cam 306 determine the inward throw of the web-holders 292, which movement is so related to the stitch cams as to cause full insertion of the web-holders at or immediately after the point at which the needles have fully descended. Said cams 309 are housed in deep slots milled through the depending flange 302, which flange is also cut away at 310 to provide a discharge opening for broken parts.

The knitting cams and needle controlling devices.—In common with usual types of hosiery knitting machines, the needles n may comprise a series filling substantially one-half the grooves in the needle cylinder having long butts n', which may be placed out of operation at the instep of the stocking, and a complemental series of short butt needles n^2 filling the remainder of the cylinder, as shown in Figs. 5 and 30.

My present machine is organized to automatically begin knitting upon a sufficient number of its needles to safely institute the formation of fabric. In my said Patent 1,045,621, I have shown and described a beginning selvage for knit webs involving the first two courses of yarn knit upon otherwise bare needles, having many advantages relating to the fabric as an article of use. One of the utilities of said fabric lies in the assistance which it gives to the machine instruments at starting, and the present machine is organized to knit this structure, in aid of its devices for automatically starting tubular knitting with any kind of yarn, including hard, resilient yarns, at high speeds, on previously bare needles, and thus to permit the automatic manufacture of wholly separate stockings, complete except for the closure at the toe.

Referring now to Fig. 26, for the usual stocking-knitting purposes the machine is provided with paired or reciprocal stitch cams 6 and 7 and with top and bottom center cams 8 and 9. The cam cylinder 271 is a short rigid cylindrical structure terminating at its upper end in a ledge 4 upon which the butts of all of the knitting needles n travel when they have finished their stitch forming movements. Said ledge is at a level insufficiently high to carry the needles to a point at which the stitches engaged in the hooks 290 of the web-holders 291 will be cleared below the latches. At a point at the rear of the machine, the cylinder 271 is cut away to form a broad V-shaped opening from which the slopes, 5, 5 lead in opposite directions to return to the ledge the butts of any needles which may be depressed into said opening. Central of this opening at the back of the machine and fast in a vertical slot milled a part way through the thickness of the cam cylinder 271 is a vertical standard 355 (Figs. 10, 26 and 29) upon which the bottom center cam 9 and top center cam 8 having their inner faces flush with that of cam cylinder 271 are mounted by screws 358. The lower surface of the bottom center cam 9, under which there is a free path 10 for the needle-butts, is higher than the lower points of the stitch cams 6 or 7, while its upper surface is level with the ledge 4 and in a position leaving a passage-way between said cams 8 and 9 slightly exceeding in width the width of the needle butts. Cam 8 is flat at the top and is provided with downward slopes 8^a to take and carry down needles approaching it at a level higher than that of the ledge 4.

The stitch cams proper 6 and 7 are triangular bodies having sloped upper surfaces 6^a, 7^a extending from a point beneath the level of the ledge 4 to a point sufficiently high to lift needles encountering said slopes, with respect to the knocking-over line determined by the upper arms of the web-holders 292, to cause the latches of the needles to clear their previous loops. The cams 6 and 7 may be of hardened steel, and in practice are carried upon the inner surface of a half-cylinder or segment 370 (Figs. 4, 9 and 29) held to the surface of the ledge and guided for radial movement by means comprising a gib or key 372, on the plane central between said cams 6 and 7, but normally held inward to hold the cams 6 and 7

flush with the inner face of the cam cylinder 271 by means of the spring 379 reacting against an attachment of the standard 401 at the rear of the shelf D.

The advancing surfaces at 5, 5, 6ª and 7ª are materially flatter than the depressing surfaces of the cams 6, 7, and 8, the effect of which is the secure holding of the comparatively light needle cylinder 260 upon its supports 256, by reason of the reaction of the tensioned needles in their grooves during the operation of the machine. Said cams 6 and 7 are recessed at their tops in a manner familiar in the art, to provide resting points for the narrowing pickers 650, 650, which may be the devices of the prior art, although I prefer to employ those shown, described and claimed in my said application, Serial No. 746,070, comprising briefly two pickers 650 mounted for vertical swinging movements in heads 660 rotatable in vertical bores in brackets 653, which brackets carry cams 665 acting to elevate the pickers when they are moved toward the radial plane passing between them, said heads being connected together by a link 667, so that the operative movement of one picker will position the other for operation.

Preceding the stitch or knitting cams 6, 7, 8 and 9 in the direction for rotary and round-and-round knitting, I provide a switch cam 415, mounted upon a radial stem 410, and having an operating arm 409, Fig. 3 spring-pressed against the top of a vertical rod 216 engaging the forward end of a lever 215, Fig. 1, journaled on the stud 124, the other end of which lever takes against the surface of the pattern drum 120 to be operated by cams 509 thereon. The body of the switch cam 415 may be mounted eccentrically upon the stem 410, as shown in Fig. 26, to provide a free passage under said cam for needles in the elevated or cleared position.

I have shown in Fig. 10 an alternative construction comprising a guide cam 408 fixed to the bracket 411 in which the spindle 410 is journaled, and having down-going slopes to engage elevated needles encountering said cam, to return them to the level of the ledge 4. Either of these constructions may be employed to secure the safe passage of the switch cam 415 by needles left in an elevated path upon a reverse stroke of the machine. The function and operation of the switch cam 415 otherwise may be those of the prior art, for which reference may be made to the said patent to George D. Mayo, No. 726,178.

Preceding the switch cam and conveniently at the front of the machine and mounted in the standard 400, I provide a widening picker 680 and operating means therefor which may be the same as those of my said application, and a positioning cam 416 for said picker. So far as described the said devices constitute means, which upon their operation in an order well known in the prior art will functionate to produce a circular knit tube of fabric, having heel and toe pockets therein, which tube may be made wider and narrower at parts by alterations of the length of the stitch. None of the means so far described will be sufficient to provide an end finish or welt or other permanent edge-structure at the top of the stocking or the toe thereof.

Referring now to Figs. 12 and 26 to 31, I provide in the lower part of the cam cylinder 271 a groove 365 for coöperation with the butts of independently movable jacks 380 carried in the same grooves of the needle cylinder 260 as certain of the needles, in the arrangement shown alternate needles, although it will be understood that a different arrangement of the jacks may be made at will. Said jacks 380 are held from being thrown centrifugally outward by their contact with the inner face of the cam cylinder 271. At a point well in advance of the leading stitch cam 7 for rotary knitting an A-shaped opening is formed in said cam cylinder 271 beneath which a jack cam 366, for advancing the jacks and their associated needles, is suitably fastened. The height of the cam 366 and the length of the jacks 380 are such as to advance those needles *n* provided with jacks sufficiently to clear their stitches, as clearly indicated in Fig. 26. Motion of the jacks with respect to the cam 366 and the needles is thus effective to sort the needles into two different series, but in coöperation with the cams so far described no other effect would follow, since the needles so cleared will merge with and operate like their fellows at and following the cam 7. In the form illustrated in Fig. 26, as well as those of the remaining figures, I utilize said jacks, however, for the performance of special operations calling for the separation of the needles into an idle and operative set intercalated among each other, and to this end the needle controlling devices comprising said jacks also comprise a radially movable supplemental or needle controlling cam 382 preceding the forward end of the leading stitch cam 7, so placed and of such dimensions as to bring the leading end of said cam 382 at a level between the needles *n* advanced by the jacks and the needles without jacks moving upon the ledge 4. Needles affected by said cam are carried beneath the stitch cam 7 and beneath the bottom center cam 9, in a position in which said needles are withdrawn into their carrier, and bodily beneath the knocking-over plane determined by the web-holders 292, and therefore in a position too low to engage the yarn, which is fed from one of the guides F at a position substantially coincident with the center cams 8 and 9.

While I have shown the cam 382 in a position to control needles to cause their entrance into the idle groove 10 through the groove leading under the stitch cam 7, it will be obvious that the entrance to the said groove 10 may be provided as a special groove at any point in the cylinder 271 between the switch cam 415 and said cam 7. Such needles as have been so retracted into their carrier, which are the needles without jacks, it will be noticed have not been previously lifted to a point at which their loops are cleared below their latches, and if the needle has taken yarn at a previous passage the described retraction of the needle will take place while the needle is retaining its loop in its hook. At a point following the stitch cams the needles so retracted rejoin the normal knitting path along the down-going face of the cam 6 at or near its apex, and thereafter ascend the following incline 5 in company with the other needles.

Referring now to Fig. 5, which is a diagram showing a greatly less number of instruments than are actually employed, for clearness, the normal relation of the long and short butt needles, of the web holders 292 and the jacks 380 will be clear. During normal round-and-round knitting, the butts of all of the needles travel on the ledge 4 in the direction of the arrow. The position shown in Fig. 26 is that for such knitting. For the remainder of the rotary operation, the needle butts will travel upon said ledge 4 except as they are interfered with by the knitting cams and the needle controlling devices. Those needles provided with jacks will be cleared at a point immediately following the switch cam 415, while the remaining needles will pass to the surface 7^a of the stitch cam 7, where they will be cleared and rejoin the remaining needles in the normal knitting path passing between the center cams 8 and 9 and down the face of the stitch cam 6, during which passage they take yarn.

To coöperate with that form of my devices shown in Fig. 26 I may provide among the long butt needles n' and near the end of the series n' last encountered by the leading stitch cam 7, in the direction for rotary knitting, a series of medium butt needles n^3 (Figs. 5 and 30) of sufficient length to be operated like the long butt needles by the switch cam, which series exceeds in width the face of the supplemental cam 382, and in practice may be several times the extent of said face, to secure a starting point for the entrance of the cam 382 upon the needles, which are too close together to permit the face of the cam to actuate an unbroken series of alternate needles at a convenient time for the movement of the pattern surface.

Referring to Fig. 5 in which the arrow indicates the direction of rotation of the needle cylinder (which is opposite to the effective direction of the wave in the needles produced by the stationary cams coacting with them) it will be seen that the cam 382 may be inserted during the movement of the needles when opposite the series having the medium butts n^3 and that it will then first encounter and move the needles a of the series n', so much of the butt of the needle a as is represented by the difference between the height of the medium and long butts being acted upon by the active face of said cam 382. Further inward movement of the cam 382 may be made as soon as sufficient of the needles beginning with said needle a have passed down the face of the cam 382 to uncover a gap of the width of the cam. The second stage of the movement of said cam may thus follow its entrance upon the needles at a very short interval. The essential of this movement is that it should be completed so far as to take the cam 382 to a position to encounter and move the leading short butt needle n^2, not provided with a jack, down the face of the cam 382 upon the passage of said needle, which needle is indicated upon Fig. 5 at b. Cam 382 by a two-stage movement has now reached an inward position to encounter and move any length of needle butt. Thus beginning with the needles a each of the needles not provided with a jack 380 will be taken beneath the stitch cams and into its carrier while retaining its previous loop, if the operation is carried out while there is fabric upon the needles. The entrance of the cam 382 into the line of movement of the needles will not affect, however, such needles as are provided with jacks, which needles are cleared by the coöperation of the cam 366 and move in their normal path at and following the cam 8. Said normally operated needles when they pass down the active face of the stitch cam 6 draw the runs of yarns extending between them down against the hooked ends of those needles affected by the cam 382. It is an invariable effect of the described devices to throw the run of yarn so held behind those needles which did not take it. The effect is greatly aided if not entirely due to the movement given to the web-holders 292.

Referring now to Figs. 31 and 23 to 25, the described construction of the retracting cams 307 and 308 for the web-holders results in retaining them in their full advanced position during the passage of the normally operated needles down the face of the top center cam 8. The position of the web-holders at the beginning and end of the movement of recession of the needles in the knitting path due to the cam 8 is the inward position illustrated in Fig. 24. The web-holders now recede to the position of Fig. 23, at the line 23—23 of Fig. 31 to permit the new yarn to be taken to the level

of the upper surface of their arms 291, and beneath their hooks 290, this movement occurring substantially during the passage of the needles across the level at the top of the cam 9. The web-holders are now reinserted at or closely following the completion of the loop drawing movement of the needles passing down the face of the cam 6. These movements will be more apparent from an inspection of the diagram Fig. 31 in which the line 292 (arbitrarily drawn in a vertical plane) indicates the forward and withdrawn positions of the web-holders in comparison with the line N, representing the complemental positions of the heads of the needles. The dotted arrows and dotted lines upon said figure indicate the respective movements upon the reverse or reciprocatory stroke. Notice should be taken that in the direction for rotary knitting, there is no withdrawal of the web-holders at any time when the needles are at an elevation sufficient to clear the yarn held in the hooks 290 beneath the points of their latches. The advancing movement of the needles which have passed beneath the stitch cams in a position of retraction, at the following slope 5, is made in coöperation with web-holders thrust inwardly to their limit of movement, except for a permitted negligible fraction *d* of the needle advancing movement following the lower apex of cam 6, which in dimensions will never exceed the distance of the hook of a retracted needle beneath the knocking-over plane *p* at said apex.

The effect of the above motions of the needles and webholders, if there is previous fabric upon them at the time of the described motions of the cam 382, will be to cause those needles without jacks to withhold their loops, and then to rejoin the remaining needles traveling on the ledge 4, prior to the feeding of the yarn and making of another course, in a position at which the needle holding a withheld loop is in front of the run of yarn joining the adjacent normally operated needles. The resulting stitch is that sometimes known as a "drawstitch", in which a loop of a previous course is interknit at a later, but not a succeeding course, the yarn or yarns of the intervening course or courses not being included in the loop held out, but passing at the back thereof. This structure is effective when occurring in a single course to form a stop for the running of a line of drop stitches, as pointed out in the patent to Loretto A. Costello No. 976,555, November 22, 1910, and it will be understood that I may operate the needle controlling devices at such times during the production of a stocking as to produce the structures covered in the said patent and shown in Fig. 4 thereof, by pattern mechanism presently to be described. I may, for instance, actuate the cam 382 so as to bring it into contact with the leading long butt needle, without a jack, then further actuate it during the next passage of the long butt needles so as to run off the end of the long butts before encountering the leading short butt needle *b*. This will produce a structure in which the stop-course of draw stitches in alternate wales will extend over two intervening courses in the wales from the long butt needles and over but one intervening course in the wales of the short butt needles. As an automatic operation so moving the cam 382 is desirable only in the case of knit structures having a relatively small number of yarn changes, stitch length changing movements, et cetera, in view of the long segment of the surface of the pattern drum necessarily occupied by a cam for this purpose. I therefore usually employ, with the devices of Fig. 26, the arrangement of needles illustrated in Figs. 5 and 6 including the medium butt needles n^3, in which only the few long butt needles following the needle *a* will be actuated for a second time and the elapsed movement of the needle cylinder between the entrance and exit of the cam 382 will be confined to one revolution plus the angular extent of said few long butt needles.

The starting-selvage devices.—If the described operation of the cam 382 should take place, however, prior to the operation of any of the yarn guides F to feed yarn and with respect to bare needles, it will be obvious that only such needles as have jacks will take the yarn at all at the first course, and that the described action of the webholders will cause the runs of the yarn between the needles which have taken it to be thrust behind the needles without jacks, which, having been withdrawn bare into their carrier, pass upwardly at the slope 5 in front of such runs of yarn in the position shown for the needle n^5 in Fig. 24. Said needles without jacks will remain in this position until they are again actuated by the cam 382 or by the slope 7^a of the cam 7, in which latter case they are elevated to the clear position and again retracted to the tuck position illustrated by the needle n^4 in Fig. 23 before they take yarn. The needles with jacks, if the cam 382 should be rendered inoperative at a second or a later course, will thus coöperate, for an initial course, with yarns passing behind the needles flanking them, and because of the described motions of the webholders, said needles which initially took the yarn will descend to the yarn-taking or tuck position of Fig. 24 with respect to a loop of yarn held tautly against the fronts of their shanks by the webholders 292, which do not recede until the needles have reached the tuck position. This secures the entrance of the

yarn of the initial course between the shank of the needle and the end of the open latch, and insures the closure of the latch upon the new yarn at the second course of the needles provided with jacks. The needles without jacks which did not take the yarn at the first course and the needles with jacks, which have a tensioned loop held against their faces, will be again separated before the completion of the first course, but it will be evident from an inspection of Fig. 26 that upon the withdrawal of the cam 382 to a position to cease the special operation of the needles without jacks upon the passage of the last high butt needles, all the said needles without jacks will be lifted by the slope 7^a, still without having received any yarn, and thence enter the knitting cams to first take yarn. The leading needle to be thus actuated at the second or a later course is the leading short butt needle without a jack, in this case the needle *b*, Figs. 5 and 26. During the knitting of the third or next course the behavior of the webholders with respect to the needles without jacks which have been first fed on the second course will be the same as that described for the needles with jacks at the second course, the described movements of the webholders to maintain the yarn between the needles taut during the first part of the retracting movement of the needles again insuring the tensioning of the forming edge of the fabric against the face of the needles during the placing over said yarn of the latches of the descending needles, to close said latches upon the newly taken loop.

I begin knitting by moving one of the yarn changing yarn carriers from an idle position to an active position, all of said yarn carriers having previously been thrown to an idle position, and by simultaneously therewith or previously thereto inserting the cam 382 into its operative innermost position flush with the face of the cam 7. It is not only necessary to insure the taking of the latches of the needles first taking the yarn over said yarn at a second course to enable them to begin to knit, but it is also necessary to open the latches for this purpose.

The latch opener.—The beginning of a stocking or article will usually occur after several revolutions of the machine during which the needles of the machine are bare and move idly. To open the latches during this interval, I provide a brush latch opener 425, Fig. 15, preferably such as that described and claimed in my application Serial No. 845,845 filed June 18, 1914, a division of said application Serial No. 746,070, at the relative position clearly indicated in Fig. 26, where it will encounter needles rising along the slope 5. As shown in Fig. 15, said latch opener comprises a thin brush wheel having radial tufts 426 mounted for rotation on a screw stud 427 projecting at an angle of substantially 45° to the knitting axis from a bore in an arm 428 in which it is locked by a jam nut. Said arm (see Fig. 1) is adjustably screwed upon the latch guard ring 556, which ring is cut away to permit the brush 425 to contact with the needles at a point immediately above the upper part of their rise due to the said slope 5, which is active in the direction for rotary work. The cut out portion 551 of the latch guard ring may be a mere enlargement of the cut usually made at this point to give the opening latches room to swing in it. As is usual in the art, the unbroken wall of the latch ring extends around needles whose butts are traveling on the ledge 4, or in a more elevated position, to prevent the open latches from closing until the needle has been lowered beyond its influence.

The provision of a rotary wheel brush, it will be seen, is not essential, its use being merely for the purposes of increasing the length of wear and providing against accumulation of lint.

The pattern mechanism.—As above mentioned, the devices of the cam cylinder, including the movable member 382 of the needle controlling devices are pattern operated from a connection comprising one of the vertically movable thrust bars 460, Fig. 2, for instance that bar 460^h at the extreme left of the series.

Referring now to Fig. 9, the cam 382 may be made as a radial slide mounted on a standard 490, forming a part of a bracket 19 attached as by screws 22 to the table D, and thrust radially outward from the axis of the knitting head by a spring 14 acting on a plunger 13 in a bore in said standard taking against the down-turned outer end 12 of said cam slide. A lever 487 fulcrumed at 488 upon an attachment of said bracket 19 coöperates at its other end with a cam 485, Fig. 16^a, attached for adjustment to the outer face of the thrust bar 460^h near its upper end by screws 486. The cam 485 is provided with a surface having three heights or levels *f*, *g*, *h*, joined by cam slopes. The elevation of the bar 460^h to the positions indicated at I, II, III will cause the movement of the lever 487 to the positions similarly indicated on Fig. 16^a, and the corresponding movement of the said cam 382. The position I is a position of rest in which the cam 382 will fail to contact with any of the needles; the position II is a position of advance in which said cam will encounter the long butt needles *n'* having no jacks; and the position III is such as to bring said cam nearly into contact with the needle cylinder.

Referring now to Fig. 17, which is a development of the surface of the cam drum

120, illustrating one arrangement of the removable cams mounted upon the surface of said drum, I have shown at 507 pattern cams having an intermediate level 507^{g} at each end thereof, for successively actuating the thrust bar 460^{h} from a position of rest against the face of the drum, corresponding to the position I of Fig. 16^{a}, to the positions II and III, and the return of said bar through said positions in an opposite order.

Recalling that pawl 82 makes one forward stroke during substantially two whole revolutions of the needle cylinder, it will be seen that I may actuate the rack wheel 81, upon one stroke of said pawl 82, through a sufficient angular distance to carry the whole of one of the cams 507 under the end of the thrust bar 460^{h}.

On Fig. 17 the line X—X indicates the position of rest for the pattern drum (some of the cams thereon which actuate levers at 90° or 180° removed from the thrust bars being arbitrarily shown as if rotated to bring them in line with the cams actuating the thrust bars at the same times, for clearness,) when the machine is adjusted to knit a woman's stocking having a selvage at the beginning edge thereof and a drop stich stop line near the top of the leg. It will be seen that prior to bringing the thrust bars to the line X—X, the cam drum was positioned to bring the respective cams 500, 501, 502, 503^{a}, 504, 505, 506, etc. under the entire series of thrust bars, except the thrust bar 460^{h} coöperating with the selvage and stop devices. This operation resulted among other things in adjusting to or retaining each of the yarn guides F controlled by the respective cams 502, 503^{a}, 504 and 505 in their idle position; to cease feeding yarn, to enable the needles, aided by the web-holders, to cast off the previous fabric, and in actuating the yarn cutter 601, by means of a cam 506 and its associated thrust bar, to cut the yarn extending from the previous stocking, and clamp the cut end ready for insertion again; and by means of the cam 512, in positioning the lever 281 to adjust the length of the stitch for the top of the ensuing stocking. This position of the cam drum was reached when the pawl 82 has moved, to the limit of its stroke, the tooth s of the rack wheel 81. This movement of the tooth s was permitted by the action of one of the lugs 851 on the pattern chain 85 upon the chain reading lug 83^{a} of the pawl controller 83, and at the completion of the movement of the rack wheel 81, the pattern shaft 80, and its connected pattern drum 120, the said lug was taken from under the chain reading lug 83^{a} by the operation of the pawl 87, which actuated its ratchet during the back stroke of the pawl 82. The rack wheel 81 will now remain at rest during the idle operation of the machine for a few revolutions, until another lug 852 on the pattern chain moves the pawl controller 83^{c} a sufficient distance to enable the pawl to take into the tooth s', whereupon the pawl 82 will advance the rack wheel 81 through a greater distance. This operation will first result in withdrawing the cam 506 from under the thrust bar connected to the yarn cutter; in withdrawing the cam 503^{a} from the thrust bar connected to a second yarn guide F to drop it into an operative position; in moving the cam 509 with respect to the lever 215 to position first the switch cam 415 and then the widening picker out of contact with any of the needles, and in moving the cam 512 coöperating with the lever 291 to adjust the needle cylinder for a proper length of stitch. Such movement is sufficient in magnitude to take the leading cam 507 on said drum 120 completely under the thrust bar 460^{h} to successively actuate the cam 382 to bring it to the position II to cause said cam to approach the faces of the needles n^{3} then passing its face, and then after a sufficient interval to permit the actuation of the needles a and the following few long butt needles; to move it to the position III before its encounter with the leading needle b of the short butt series; to maintain said cam in the innermost position 3 during the passage of all the short butt needles, the leading long butt needles and the medium butt needles n^{3}, and then to withdraw said cam 382 to the intermediate position II in which position it will actuate the last long butt needle without a jack; and to thereafter withdraw said cam to its position of rest, I. The timing of these operations, it will be noticed depends upon the dimensions of the cam 507, and the rate of movement of the pawl 82. The rate of movement of the pawl 82 is as above pointed out, a constant function of the rate of rotation of the needle cylinder, and I am enabled to accurately position the cam 382 with respect to the rapidly moving needles by accurate adjustment of the cams 507 and 485.

The operation of the cam 382 at a later time, to make the drop-stitch stop device, is accomplished by providing a second cam 507, in all respects similar to the first cam upon the drum 120, and by causing the pawl 82 to coöperate with the rack wheel 81 in the same manner as above described.

It will be noticed that, as one instance of the adjustable arrangement of the cams upon drum 120, I have shown in Fig. 17 a cam 503 for throwing out of action the second yarn guide F and a cam 505 for throwing into action the fourth yarn guide F, as well as a cam 506 for actuating the yarn clamp and cutter, at the beginning of the formation of the selvage stop course. Other exchanges of yarn guides, at any de-

sired time, accompanied by actuation of the cutter and clamp 601, may be provided for by replacement of the proper cams on said cam drum.

By the device of retaining the web-holders in their operative or advanced position during the recession of needles which have been supplied with an initial yarn loop and advanced to clear their latches, I am enabled to secure the certain casting off of said loop at the next succeeding course. By the device of feeding some needles only, in a series intercalated among the others at the first course, I am enabled to form automatically the selvage structure shown, described and claimed in my said patent, No. 1,045,621, but by the practice of a method improving that disclosed in said patent, which new method is fully described and claimed in my Letters Patent No. 1,094,347, dated April 21, 1914.

For certain additional purposes I have provided additional means for coöperation with the pattern drum, which will be described below.

The devices for knitting fabrics having integral welts.—By placing in operation the cam 382, whether or not it has previously been operated to make the selvage structure above referred to, and by holding said cam in its extreme inward position, I am enabled to knit fabric upon the needles having jacks during the retention upon the needles having no jacks of the loops of the last course knit by them. By the coöperation of the web holders, this operation may be carried out during a number of courses to knit a fold, hem or welt of any desired length. By removing the cam 382 from its operative position after the completion of sufficient fabric upon the series or part of the needles in operation for the welt fabric, the initial course knit upon all of the needles, now normally operated, will contain loops impaling the withheld loops of the needles without jacks. The resulting fabric will have, at the end thereof first knit, or at any other desired location, depending upon the relative time of actuation of the cam 382, a closed fold, welt or hem integrally united at both ends of the fabric comprising it to the body of the article knit. This welt will be of farbic having its back or loop side without, and its wale or face side within the inclosed fold.

For the above purposes it is essential to add to the devices already described nothing more than devices to cause the cam 382 to remain in its inward operative position during a predetermined plurality of courses. The mechanism illustrated in Figs. 26 and 17 may be employed for this purpose, without change, by suitably equipping the pattern chain with a lug 851 to cause the pawl 82, as by engaging a tooth w midway between the teeth a and s', to actuate the pattern drum 120 only sufficiently far to elevate the bar 460^h upon the top of one of the cams 507, and to hold it there to retain the cam 382 in its inward position during a sufficient time. But for purposes of convenience in the machine, and in order to enable the full use of all of the devices of the machine without crowding the surface of the pattern drum, and to permit the making of a wider range of fabrics, I prefer to employ in addition to the described devices certain devices now to be described, involving additional needle-controlling mechanism coöperating with the said cam 382, and coöperating mechanism for the pattern devices, when it is contemplated to use the machine for knitting welted fabrics. Said devices constitute means for automatically moving said supplemental or needle controlling cam 382 into and out of operative position at the proper times, and for restricting the activity of said cam at such times to a predetermined relation with the needles, and therefore with the position of the knit structures in the fabric. I have equipped the machine with another supplemental cam 2 (Figs. 10, 11 and 16) and mechanism to cause it to cooperate with the other cams, for the above purposes, as well as for knitting stockings having integral welts, tying-courses and sections containing dropped stitches, when the machine is provided with certain changeable arrangements of needle-jacks, and suitable adjustments of its pattern surfaces.

It is desirable to avoid the use of the medium butt needles n^3, and for many uses it is desirable to limit the withdrawal of the needles by the operation of the needle controlling devices to a single course or multiple of courses, beginning and ending upon adjacent or nearby needles. By the devices about to be described I accomplish these purposes by making use of the presence in the machine of the series of long butt needles n' and short butt needles n^2 for the usual stocking knitting function.

I have shown in Figs 10 and 11 a development illustrating respectively the relative positions of the cams, needle butts and the needle jacks shortly after the beginning of a first course of new fabric upon the bare needles, and near the end of the same course. Fig. 10 also illustrates the condition of the machine at the initial and intermediate courses of the making of a welt upon half of the needles. Fig. 11 also illustrates the condition of the machine just prior to knitting through and casting off of the withheld or tying loops for such a welt.

The cam 2, which precedes the cam 382 with reference to the relative direction of approach of the needles is formed substantially as an isosceles triangle having its base upward, and substantially at the lower limit of the path of the needles at the clear

point. The slope 2^a of said triangle pointing toward the direction from which the needles are approaching constitutes a depressing cam when said slope is radially in a position to encounter the butts of the needles. The body of the cam 2 is cut away to form upon its face a comparatively shallow cam track 2^b (Fig. 16) offset with respect to the face of the needle cylinder from the slope 2^a, of which track 2^b the leading point 2^c is beneath the level of the ledge 4, to constitute an advancing cam when it is in a position to encounter the butts of the needles. The cam 2 is relatively fixed vertically and in a rotary sense, but I have provided for it a mounting permitting substantially radial movement toward and away from the needle carrier.

The cam 2, see Figs. 4 and 16, is formed like the cam 382 as an integral radial slide or bar having a down-turned outer end 15 for contact with the plunger 16 operated by a spring 17 in a bore in a standard 18, which may be integrally formed on the base 19, also carrying the standard 490. The downturned end 15 is thrust radially outward by the spring 17 against one end of a lever 20 pivoted at 21 on a lug projecting from said base 19. The base 19 is rigidly attached to the flange 270 of the cam cylinder 271 as by the screws 22. The other end of the lever 20 is in contact with a cam 25, (see Figs. 2, 9, and 16^b) adjustably fastened by means of screws 27 on the upper end of an additional thrust bar 26 guided near its upper end in a plate 28 attached to the table C, and at its lower end in the comb 451, for operation by cams 517 (Figs. 2 and 8) on the drum 120. Said cam 25 may be provided with four levels connected by slopes, as shown at *i*, *k*, *l*, and *m*. Upward movements of the bar 26 will therefore successively position the cam 2 inwardly at three different positions of adjustment at II, III and IV, in advance of its completely withdrawn position of rest, I, which positions are respectively shown in Figs. 19 to 22. Under the influence of the level *m*, the active faces of the cam 2 are sufficiently far inward to cause its leading slope 2^a to retract the butts of all the needles encountering the cam.

Associated with the cams 382 and 2 for the special operation of the knitting needles, the upper wall of groove 365 is cut away to form a broad A-shaped opening 364 in which a jack cam, which may be of the form shown at 366^a, is mounted to coöperate with the butts of the jacks 380. The cam 366^a is provided with a central depression 369 in its upper portion in line with and of the same slopes as the faces of the cam 2. The slopes of the opening 364 may be formed of hardened plates 367, 368, of which the plate 368 may be adjustable through a limited arc of movement, as by mounting it upon a separate segment having a flange 371, slotted for a holding screw 372, in a break in the cylinder 271, as shown in Fig. 10. In some cases I may replace the plate 367 by a segmental plate 374 of the form shown in Figs. 32 to 35, but without substantial change in the function, in order to provide room for an additional fastening screw 373 for the greater security of said plate.

The jacks traveling in the groove 365 are advanced and retracted by the cam groove between the cam plates 366^a, 367 and 368 at all times. For one product of my machine, the jacks 380 may be all of the same length, and will be placed in the grooves of alternate needles, which needles they will encounter and advance, as shown in Fig. 10, before said needles reach the cam 2. The extent of this advance is enough to clear the loops beneath the latches, and may be the same as that attained by the advancing slope 7^a of the stitch cam 7.

If the machine is about to knit a first course, I move the cam 382 to an intermediate position before the passage across its face of the long butt needles, which are approaching the cam 7 in two sets, those without jacks on a level with ledge 4, and those with jacks at the level of the top of said cam 7. The first long butt needle without a jack will thus be engaged by the down-going face of the cam 382 and will be the first needle to be retired into the groove 10 under the cam 9. For instance, to knit a beginning selvage I may begin the feeding of the yarn during the passage of the short butt needles, and simultaneously therewith insert the cam 382, as described, to its intermediate position. After the entrace upon the face of the cam 382 of a few of the long butt needles, there are no longer any short butt needles opposite its face and said cam may be thrust all the way in, to engage the short butt needles during the ensuing half-revolution. If it is now desired to stop the special operation of the needles with jacks, so as to resume the passage through the knitting cams of all of the needles, the withdrawal of the cam 382 may be made in two similar stages, the first movement taking place during the passage of the long butts, off of the end of which the cam is allowed to run before the final withdrawing movement takes place. But since the operation began with the leading long butt needle, it will now have occupied one and one-half courses. For this particular purpose of forming a set-up or initial course, the second operation of the needles now divided into alternate sets throughout that half of the circle occupied by the long butt needles is immaterial, since by the described action of the web-holders and the movement of the needles, the yarn of the first course will be cast off of all of

the needles which took it, upon their second actuation, to float idly within the cylinder, and so long as alternate needles of a complete circle of needles have been passed through the knitting cams and passed beneath the knitting cams respectively and thereafter elevated with respect to an inwardly thrust web-holder, the result will be merely a setting up or initial course of a single yarn passing alternately back of and into the hooks of the needles so operated throughout the circle in which they are distributed.

It is desirable at a later time in the operation when employing the same actuation of the needles for another purpose, for instance to withhold a course of uniting loops for a welt upon some of the needles only, or to make a stop-course, to limit the actuation of needles to enter the idle path under cam 9 and miss the yarn to an orderly series of needles extending but once around the needle cylinder, and thus limit the effect of the special operation of the needles to a single course of the fabric without repetition and without gaps. This may not readily be done merely by withdrawing the cam 382 (without some special construction of needles, or the provision of jacks 380 for several adjacent needles, which makes an objectionable mark in the fabric) because otherwise some of the needles will be left depressed upon the withdrawal of the cam 382 in a position to be impaled by the point of the cam 7. I employ for this purpose the second supplemental cam 2, which provides means to divert the needles out of the range of cam 382 to secure the vertical separation of the long and short butt needles without jacks before they encounter said cam 382, as well as means to secure the positioning of all the needles without jacks to cause them to enter said idle path 10.

Referring now to Figs. 10 and 11 and 19 to 22, cam 2 when moved toward the needles during the passage of the low butts will cause the leading high butt needle without a jack to encounter its advancing slope 2^b, to lift said needles above the level of the leading point of the cam 382. This will cause the series of needles without jacks, in a position to encounter the cam 382, to end abruptly at the last short butt needle of said series. After said last short butt needle has passed down the face of cam 382, the supplemental cams may both be withdrawn without affecting the passage of all the needles into the stitch cams, which will follow their encounter with the slope 7^a of cam 7. Fig. 10 represents the stage of such an operation at the beginning of the first course, the long butt needles (shown in solid black) being opposite the cams. Fig. 11 represents the approaching end of the same course, the cam 2 having just previously assumed the partial inward position of Fig. 20 to bring its slope 2^b into operation. The operations described are capable in the arrangement shown of knitting a fabric having a beginning selvage of the character shown in my said Patent 1,045,621, dated November 26, 1912. In order to automatically knit a welt of the character disclosed in my said application Serial No. 748,308, (patented Nov. 18, 1913, No. 1,079,267) a beginning selvage and one or more subsequent courses of plain fabric having been knit by the above described operations, the cams may be for a second time positioned as shown in Fig. 10 to secure the operation of the cam 382 to retire every alternate needle, beginning with a certain needle, which in this case is the leading long butt needle, to form a course of withheld uniting loops. Thus, the arrangement of the jacks being as shown in Figs. 10 and 11 knitting may be begun by inserting the cam 382 to an intermediate position and feeding yarn to the needles, whereupon the first long butt needles will alternately take and pass at the back of the yarn; by then moving the cam 382 all the way in, whereupon the following short butt needles will be actuated in the same manner; by then moving the cam 2 partially inward to engage the long butt needles with the face 2^b to occasion a separation of the last short butt needles from the leading long butt needles, and by then removing the cam 382 before the passage of the long butts is ended, whereupon knitting upon all of the needles for one or more courses will follow; by then beginning the welt by successively moving cam 2 inward to the position of Fig. 21 to engage and retract the leading long butts without jacks, and during their passage moving said cam all the way in, to the position of Fig. 22, to retire into the idle groove 10 all the needles without jacks to withhold loops, beginning at the loop of the leading long butt, allocated to the initial loop of the setting up or selvage course. The cam 2 is now held stationary in its inward position during the knitting of the entire welt, which takes place upon those needles provided with jacks only, the needles without jacks being retired at each passage of the cams 7, 8 and 6 into the groove 10 beneath the cam 9 and subsequently advancing upwardly at each course in front of the sinker-wales between stitches knit by the needles with jacks, and after the cast-off of each course of the plain fabric for the welt.

If the machine has 220 needles, the welt fabric will have 110 wales. This fabric may be made laterally wider by increasing the length of loop by the elevation of the needle cylinder by the described devices during the knitting of the welt and again decreasing the stitch length at the end of the welt, or by the exchange of yarn guides F to feed

and again withdraw a heavier yarn or yarns, or by both of said operations.

I have shown in Figs. 10 and 11 and 32 to 35 a cut or lowered section 40 of the ledge 4, sufficiently beneath the level of said ledge to permit free movements of the needle-butts by vertical motions of the cylinder during the lowering of the cylinder to decrease the length of stitch, which I find of advantage in preventing any possible hindrance of the lowering of said cylinder by the tension of the needles in their grooves, such as will occur if some of the needles are abnormally stiff.

The knitting of the welt will cease, by the cast off of the course of knit loops which were in the hooks of the needles beginning with the leading long butt needle, occasioned by the withdrawal of the cam 2 to the position shown in Figs. 11 and 21, to pass off the last long butt needle with a jack, and the subsequent withdrawal of said cam 2, during the passage of the short butts, the effect of which, it has been explained above, is to permit all of the needles to pass into the knitting cams to knit solid plain fabric.

While I have illustrated jacks for alternate needles, it is apparent that if desired I may insert a jack 380 under any selected needle. But the order in which the jacks are placed will be influenced by their use first to form a setting-up course, which should be arranged with respect to alternate needles or alternate groups of a few needles only; and second with respect to their function to determine what needles shall be in use during the knitting of the welt fabric or section of fabric knit on some of the needles only. Unless needles with jacks are comparatively frequent, there is danger of providing a welt fabric insufficiently elastic in a lateral direction, although this quality of the fabric may be much affected by altering the stitch length, as described, by the provision of a cam 512 (Fig. 17) of suitable extent to elevate the needle cylinder at this time only.

Under conditions of extreme difficulty of manufacture, as when it is attempted to form a very long, very elastic, very wide welt for the top of a woman's stocking from hard, springy yarns, it is very desirable that the setting-up course should be laid upon alternate needles, under which said conditions it may be difficult to provide a fabric wide enough for the intended purposes by alteration of stitch length and exchange of yarns if it is to be knit upon alternate needles only of the whole series. Assuming a machine having a circle of 220 needles, a welt formed under these conditions which is only 110 wales wide may, in order to have sufficient capacity for lateral stretching be found to consist of fabric the loops of which are so long as to provide an undesirable texture, although with proper selection of yarns and lengths of stitch useful fabrics of this character are readily produced by my machine. On the other hand, it is unnecessary to attach the beginning edge of the welt to the fabric so frequently as at each alternate wale, especially when a selvage structure is provided at the welt to make the beginning edge thereof fast against raveling.

The device of independently movable jacks and a pair of independently movable supplemental cams herein disclosed forms an efficient instrument for knitting fabrics characterized by a starting or beginning selvage, a welt of outwardly turned plain fabric having a comparatively large number of wales of solid knitting in comparison with the body fabric, and a tying or uniting course containing fewer wales than the fabric of the welt, such as I have shown, described and claimed in my application, Serial No. 748,309, filed February 14, 1913, (patented Nov. 18, 1913, No. 1,079,268) which fabrics avoid the objections above noticed. For this purpose and referring now to Figs. 32 to 35, the arrangement of the alternate jacks 380 is retained intact, but I place in the machine in addition a series of shorter jacks 381, having for their purpose, in coöperation with the cam 2, the separation of the needles into three sets or series upon their approach to the stitch cam 7. Thus the needles without jacks may be depressed by the cam 2 to a low level, the needles with long jacks 380 may be lifted to the clear point, or as far as they would be elevated by the cam 7; and the remaining needles with the short jacks 381 will be elevated to a position intermediate between that of the other sets, for instance to the level of the ledge 4. The described position of the cam 382 is such as to cause said cam in its inward operative position to take needles at the intermediate level into the idle path 10 under the cam 9, while the slope 7^a of cam 7 will take such intermediate needles into the knitting path.

The operation of the devices, when the mutable jacks have been so arranged, will be clear from the figures. Fig. 32 shows the beginning of course 1 and Fig. 33 shows the end of course 1, for which the respective positions and functions of the cams 382 and 2 are identical with those described in connection with the long jacks only, and shown in Figs. 10 and 11. The machine will have been adjusted in the position of Fig. 33 to knit a course upon the needles following the leading long butt needle n' of solid plain fabric upon all of the needles, the cam 382 having been removed during the passage of the long butts, as indicated in Fig. 34. The end of this course is illustrated in Fig. 34, which shows the middle of the series of short butt needles n^2 passing through the stitch cams. At the time of Fig. 33 the cam 2 was thrust inwardly to the position

shown in Fig. 20 so that its slope 2^b might engage and elevate the long butt needles without jacks into engagement with the cams 7 and 8, and the cam 382 was then removed outwardly. I may now permit said cam 2 to remain in the position of Fig. 20 to affect all of the long butt needles, meanwhile removing cam 382; I may withdraw the said cam 2, and after one or more courses thus knit upon all of the needles again move it inwardly to the position of Fig. 21. The slope 2^b of said cam being of a width less than the difference between the heights of the high and low butts, I am enabled to engage and actuate the leading and following long butt needles to withdraw them by the slope 2^a of the said cam 2 when it is in the position shown in Fig. 21, which corresponds with the position III of the cam 25, shown in Fig. 16^b. The leading long butt needles will now engage and drive down with them into depression 369 such short jacks 381 as may be provided. Such of them as were provided with long jacks have been elevated above the influence of the cam 2 by the leading slope of the jack cam 366^a. Such long butt needles as have no jacks will also be moved downwardly by said slope 2^a to the full depth of depression 11. Immediately following the passage of the cam 2 those needles which are provided with short jacks will be again advanced by the following slope of the depression 369 of the jack cam and said short jacks to said intermediate position, as shown in Fig. 35, which illustrates the third or a later course, and the positions of the cams for the remainder of the fabric for the welt. In such position the short jack needles reënter the knitting path and the needles without jacks enter the idle path 10 at each course. The cam 2 having initiated its depressing operation with respect to the needles having short jacks and the needles having no jacks when in the position shown in Fig. 21, it may be advanced during the ensuing passage of the high butt needles to the position shown in Fig. 22 to carry out the same operation with respect to the short butt needles, and hence will have affected all of the needles without jacks or with short jacks. This position is attained when the cam 25 has been elevated to the position IV of Fig. 16^b. Still assuming a machine in which there are 220 needles, there will now be in action 165 needles, arranged, when the jacks are in the order illustrated, in groups of threes, every fourth needle being withheld from action at each course and carrying in its hook the tying loop subsequently employed to unite the second, third, or later course of the welt to the body of the fabric. The welt is cast off and the tying course completed by the withdrawal of the cam 2 from the position of Fig. 22 to the position of Fig. 21 during the passage of the long butt needles, and thereafter to the position of Fig. 19 during the following passage of the short butt needles. It will be noticed that with the devices arranged as indicated the first loop of the selvage course and the first uniting loop withheld on the leading long butt needle without a jack come in the same wale. It is not material if, as in the operation just instanced, when knitting a long welt, the subsequent cast-off begins at a different wale, the sole effect being to knit welt fabric one course longer at the long butt than at the short butt needles. With the arrangement such as that in Figs. 32 to 35, for instance, the first short butt needle without a jack is the first needle carrying a uniting loop to be normally operated to cast off said uniting loop.

It is obvious that many different fabrics limited only by their practicability as garments may be knit with the aid of long and short jacks and properly timed motions of the cams 382 and 2. I may, for instance, move the cam 2 to the position shown in Figs. 35 and 22 prior to the feeding of the yarn, to cause the recession of the needles having short jacks and no jacks into their carrier, and move in the cam 382 at the same time to also retire the needles having short jacks to form a set-up course on the long jacks, and then remove the cam 382 to permit the short jack needles to take a subsequent course, and then re-enter said cam to retire said short-jack needles beneath the yarn feeding level while withholding their loops at each course for a welt knit upon the needles having long jacks; and thereafter remove the cam 382 during the knitting of a section of fabric having no needle wale opposite the needles without jacks, which have not been in operation and will remain out of operation until the cam 2 is retired in the manner described above. Such a fabric may be a stocking top having a short, plain fabric welt and a section following said welt of plain fabric of an increased number of wales ornamented by drop or missed stitch lines formed at the no-jack needles which have not yet taken the yarn, and in turn followed by plain fabric knit on all of the needles, for instance as shown in my Letters Patent No. 1,071,100 dated August 26, 1913. For this purpose, typical arrangements of the jacks 380 and 381 are illustrated in Figs. 41, 42 and 43, which are diagrams in plan of a part of the circle of needles, illustrating the needles without jacks in solid black. These needles do not take yarn or knit until the cam 2 is retired at a predetermined time after the initial course is knit. It will therefore be understood that the arrangement of jacks, and the instances described of coördinated movements of the needle cams 382 and 2 are instances only, and that my invention con-

templates the adjustment, change and rearrangement of said devices to carry out the desired purposes, including the replacement of pattern cams for controlling the said cams 382 and 2 by others of different forms, and the rearrangement of the lugs on the pattern chain 85 to secure the variation of the times of operation of the said devices.

In order to coöperate with needle jacks of two lengths it is not necessary that the cam 366[a] should be provided with two crests separated by the depression 369, as shown in Figs. 10, 11 and 32 to 35, although I prefer the arrangement shown in said figures, which enables the cams 382 and 2 to be brought closely together for an effective arrangement of the crowded devices at the knitting head. As an instance of other modifications, the jacks 380 and 381, and the cams 382 and 2 may be caused to coöperate in the manner described in connection with the Figs. 10 and 11 and 32 to 35 with the jack cam 366, described in connection with Fig. 26, the arrangement of the cams 382 and 2 to coöperate therewith being illustrated in Fig. 14. In this form of my machine such needles as pass down the slope 2^a of the cam 2 will be advanced to the clear point or to the intermediate point by their long or short jacks respectively after their passage of the said cam 2, the resulting order of arrangement of the needles upon their approach to the cam 382 and the knitting cams remaining the same as in the forms described above.

When knitting a long welt, referring now to Fig. 25, it will be understood that the withheld loop y' of the yarn y is upon each passage of the needles through the idle groove 10 carried as far beneath the knocking-over plane determined by the web-holders 292 as when it was originally drawn. The needles being tensioned needles working stiffly in their grooves, the strain upon the withheld loops y' will be maintained throughout the passage from the apex of the cam 7 to the cam 6, whereas for a normal-sized loop, drawn by a recession of the needle into the carrier at the point of the stitch cams as great as that of the idle position of said needles, less yarn is involved, the recovery of the adjacent needles along the slope 5 releasing part of their yarn before the following needle finishes its draft, thus to permit robbing of the first drawn loop by those later drawn.

I decrease the size of the withheld loops due to the strain occasioned by placing so many of them under tension at once by needles in the idle position, by providing a cam for partially elevating the needles passing under the leading stitch cam 7 to permit the following needles to rob the elongated withheld loops immediately after the maximum depression of the loop holding needles due to the said cam has been reached, such as shown for instance at 272 in Figs. 10 and 11, or of the form shown at 273 in Fig. 13. Needles affected by such a relief-cam will rejoin the active needles prior to the completion of their knitting movement by their passage of the active point of the cam 6.

The devices coöperating with the pattern devices for operating the needle controlling devices.—I have described in connection with Figs. 1, 2, 7, and 17 the general construction of the pattern drum 120 and its actuating means, and the connections therefrom leading to the said cams 382 and 2. The motions of the said drum 120 derived from the shaft 80 when gearing of the described ratio is employed between the shaft 80 and the knitting head occur substantially during two complete revolutions of the knitting head, the said drum 120 remaining idle upon the retraction of the pawl 82 during the succeeding two revolutions of the knitting head. For that reason, as described in connection with Fig. 26, while employing the arrangement shown in Fig. 17 of pattern cams 507, etc., to actuate the cam 382 during one long movement of the pattern surface, I was still unable to secure the entrance and exit of the cam 382 at the most convenient time. This condition was due to the relatively short angle of rotation of the shaft 80 which could be devoted to the cams 507, and to the necessity for beginning and ending the operation of the cam 382 near the beginning and end of the stroke of the pawl 82, which for an otherwise desirable design of the parts brought the actuation of cam 382 in relation to the moving needle cylinder at undesirable times. I have therefore provided the machine with attachable devices for actuating the shaft 80 during the recovering or idle stroke of the pawl 82 in order to render the motions of the drum 120 at times independent of the relation of the said pawl 82 to the rotation of the knitting head. The said auxiliary pawling devices for the drum 120 may, for accuracy, especially in the control of the entrance and exit of the cams 382 and 2, directly be actuated from a part moving in unison with the knitting head.

Referring now to Figs. 1 and 2, on the main shaft 32, and conveniently on the hub of and between the face of the bevel gear 31 and the frame of the machine, I mount a cam 430, which may be split as shown, for convenience of attachment by clamping on said hub. Referring now to Fig. 18, I have shown in diagram the relation of the location of the long needle butts n' and the short butt needles n^2 in the needle cylinder, in a rotary sense, to said cam 430, which cam is provided with an increasing quadrant 430^a allocated to the middle of the

short butt needles, a concentric section 430[b] corresponding to the juncture of the last short butt needle and the first long butt needle in the direction of rotation; a further incline 430[c] corresponding to the central part of the long butt needles, and a rapid inward or recovery incline 430[d] to a concentric portion of a short radius, in position prior to the point in rotation corresponding to the last long butt needle. Mounted on a rod 93 a pawl arm 431 carrying a pawl 432 in the plane of the inner end of the drum 120 is, under the stress of the spring 433, held against the surface of the cam 430. Said pawl 432 coöperates with ratchet teeth 434 which may be formed or mounted on the end of the drum 120.

It will be seen from Fig. 18 that the forward motions of the pawl 432, to advance the system made up of the drum 120, the shaft 80 and its attachments, occur during a fixed relation to the quadrants of movement of the needles in the needle cylinder. With respect to the location about the axis of rotation of the needle controlling devices these movements occur in the middle of the passage of the short butt needles and in the middle of the passage of the long butt needles, the rapid recovery of the pawl 432 taking place before the last long butt needle has passed the location of the said devices.

If one of the ratchet teeth 434 is brought into the range of the pawl 432, for instance by the last part of the forward movement of the pawl 82, when in engagement with a selected tooth of the rack wheel 81, it is apparent that the drum 120 will be moved forward by the slope 430[a] of cam 430 during the passage of the short butt needles, while said drum 120 will be held stationary during the passage of the concentric portion 430[b]; that said drum will again be advanced during the passage of the long butt needles by incline 430[c], and that the movements may be repeated during a subsequent revolution of the needle cylinder if another tooth 434 has been brought up by the motion of the drum 120. This movement of the drum 120 will thus occur during the rest period or recovery of the pawl 82, and will be rigidly in time with the rotary movements of the needle cylinder.

I may by this device greatly economize the angular surface of the drum 120 occupied by the necessary cams for carrying out the above described operations of the cams 382 and 2, since it is no longer necessary to provide a sufficient movement of the drum to enable both the entrance and exit timing of said cams to be distributed along the arc through which the drum is impelled by the pawl 82, falling at an arbitrary relation to the position of the needles at the same time. This will be made plain by Fig. 8, which is a diagram of the pattern surface of the drum 120, arbitrarily illustrating, in profile, one arrangement of the relative positions of the teeth of the rack wheel 81, the pawl 82, the teeth 434 of the auxiliary ratchet surface provided on said drum, cams 507[a] and 507[b] for the actuation of the thrust bar 460[h] and the cam 382, and the cams 517[a] and 517[d] for the actuation of the thrust bar 26 controlling the cam 2. Assuming that pawl 82 shall have been permitted to enter behind the tooth *s*, in the position shown, by the intervention of a lug on the primary pattern chain 85, the drum surface 120 will be moved forward permitting the thrust bar 460[h] to ride up the intermediate level *g* of the cam 507[a], thereby positioning the cam 382 half-way in to actuate the leading long butt needles, and producing the condition shown in Fig. 32 of the drawings. This movement will take place prior to or simultaneously with the movement of a cam as the cam 503[a] (shown in Figs. 17 and 40 but not in Fig. 8) from under the end of a thrust bar controlling one of the yarn feed guides to insert yarn for an initial course. The movement of the step *g* of the cam 507[a] under the thrust bar 460[h] took place during a half-revolution (as determined by the motions of the pawl 82) at which the short butt needles were opposite the needle controlling devices, and the first action of the cam 382 will be with respect to the long butt needles. The second half of the motion of the cam 382 will have been given after the surface *g* has traversed the end of the bar 460[h], by the high part of said cam running under said bar 460[h], thus forcing the cam 382 all the way in to the position shown in Fig. 33, for the function above described. Simultaneously with or subsequently to the ascent of the bar 460[h] to the top of the cam 507[a] after the passage of cam 2 by the last long-butt needle, the bar 26 controlling the cam 2 will have ascended the first step or level *b* of the cam 517[a]. This will be the condition at the end of the first revolution of the needle cylinder after the preliminary entrance of the cam 382. The pawl 82 has now nearly finished its stroke, but in order to carry out the sequence of operations illustrated in Figs. 34 and 35, it is necessary first to withdraw the cam 382, then to insert the cam 2 to its third position and finally to insert said cam, during the passage of the high butt needles, to its fourth position, in strict time with the motions of the needle butts. When the pawl 82 had nearly finished its working stroke, the first tooth 434 had come within the range of the comparatively short strokes of the pawl 432 and upon the same passage of the short butt needles the pattern drum was moved by said pawl 432, with respect to the approaching faces of the respective bars 460[h], 26 through the distance *x* to *x'*, Fig.

8, without altering the position of the cam 382. The pawl 432 came to rest, the bars being at line x' during the passage of the quadrant 430^b before completing the remaining half of its stroke, bringing the thrust bars through the distance from x' to x^2 during the ensuing passage of the high butt needles up the slope 2^b of cam 2, during which passage the bar 460^h ran off the end of the cam 507^a, sharply withdrawing the cam 382; and at the next passage of the short butts the bar 26 ascended to the third level c of the cam 517^a at line x^3 to place the cam 2 in the position shown in Figs. 21 and 34. The pawl 432 then rested at line x^3 during the passage of the segment 430^b of the cam 430, but upon passage of the slope 430^c the cam 517^a was moved with respect to the bar 26 to bring the highest level of cam 517^a under said bar 26, and to thrust the cam 2 all the way in to the position of Figs. 22 and 35 during passage of the long butts. The auxiliary pawl 432 will now find no more ratchet teeth and the drum 120 will remain at rest until again advanced by the pawl 82, for instance, by its engagement with the tooth s'. The duration of this rest period will determine the number of courses during which the needles without jacks retain their loops and during which the remaining needles knit and cast fabric off over the heads of said needles without jacks. Such duration is determined by the number of links in the pattern chain 85 intervening between successive lugs 852. The pattern surface may meanwhile be advanced as by engaging the pawl 82 near the end of its stroke with a tooth s' of the rack-wheel, so long as the advance is insufficient to withdraw cam 517^a from beneath the thrust bar 26, to permit the pattern surface to control other operations, for instance to change the yarn, if desired, during the formation of the welt. It will be understood that the yarn changing cams 502, 503, 504, 505 as well as the other cams, mounted by screws, on the face of the drum 120 (Fig. 17) are not permanently fastened thereon, but may be removed and replaced, to produce their desired effect at the proper time. After the sufficient production of fabric for a welt, the pawl 82 will engage the tooth w' of the rack wheel to permit the thrust bar 26 to drop to the level c' to withdraw the cam 2 to the position shown in Fig. 21, during the passage of the long butt needles, and to thereafter permit said bar 26 to descend to withdraw the cam 2 to its position of rest. The last needle to retain its loop in a withheld position will then be the last long butt needle, and upon the next revolution of the machine this needle will enter the stitch cams by reason of the complete withdrawal of the cam 2. To coöperate with the pattern surface so adjusted for making a welt, it will be understood that I usually provide for the ending of one of the yarn guide controlling cams 502, 503, 504 or 505, which cam is that of a guide equipped with a yarn of a different, generally a lighter weight, and the beginning of another one of said cams to take out of work that yarn guide which has supplied yarn for the welt fabric. Thus the yarn for the welt fabric, knit upon a less number of needles, will usually be a heavier yarn; or I may actuate two of the yarn guides to bring them into position to supply the needles while making the welt fabric, and remove one of them; or I may remove both of such a pair of yarn guides and substitute a third guide. Whatever the obvious variation of the devices for controlling the yarn guider may be, I will provide a cam 506 associated with the yarn change, to cut and clamp the yarn taken out of work.

Referring now to Fig. 40, if it should be desired to end the welt after the same number of courses of welt fabric on all parts of the circle of needles, I may reinsert the cam 382 during the holding in its inmost position of the cam 2, as by providing a cam 507^c for the bar 460^h, and I may provide an additional tooth 434^a for the auxiliary pawl, and provide the cam 517^a with a level 517^e to permit the cam 2 to recede to the position of Fig. 20 during the passage of the short butts, of which those without jacks will continue to be affected by the cam 382, thus to cause slope 2^b to elevate the long butts without jacks to first knit and cast off the welt at the long butt series. The last part of the movement due to the pawl 432 will then cause both cams 382 and 2 to be withdrawn, by their respective thrust-bars 460^h and 26 running off the ends of cams 507^c and block 517^e during the passage of the high butts.

I have shown in Fig. 40, as an instance only of many possible arrangements, the relative positions of the needle controlling cams and yarn changer cams 503 and 505, a cutter and clamp actuating cam 506, and a stitch length adjusting cam 512, for changing the yarn and adjusting the stitch simultaneously or in close succession upon the restoration to knitting of the needles operated to withhold a series of tying loops. As also illustrated in Figs. 8 and 40, a typical location and construction of devices on the drum 120 for knitting a stop course, with the aid of the auxiliary pawling device, comprises the cam 507^b, employed to actuate the thrust bar 460^h under the impulse of the pawl 82 to enter the cam 382 to first actuate the long butts and then the short butts. At the conclusion of the movement of the pawl 82, the drum 120 is picked up by the pawl 432 acting on a tooth 434 to insert a cam 517^d to move the cam 2 to the position shown in Fig. 20 to ad-

vance the long butt needles in the manner illustrated in Fig. 33, and after the passage of said long butt needles to withdraw said cam 517^d and the cam 507^b from under their respective thrust bars to remove both supplemental cams before the next passage of the long butt needles. It will be seen that the actuation of the needles to make a draw stitch course is limited by the separation effected by incline 2^b to needles distributed around the periphery of a circle of needles without overlapping, the first needle to be so actuated being the leading long butt needle having no jack and the last needle to be so actuated being the following short butt needle having no jack.

Instead of employing movements of the pawl 82 to bring the ratchet teeth 434 in the field of action of the pawl 432, I may distribute teeth 434 with sufficient frequency to move the pattern drum through the desired intervals, or employ a continuous series of teeth 434, to be actuated by the pawl 432 when permitted by the operation of a pawl-controller 436 (Figs. 37 and 37^a) journaled on the stud 124, inside the frame B, said pawl controller having an arm 437 in line with and to read a series of lugs 438 placed on the left-hand side of the pattern chain 85, as shown in Fig. 37^a.

The lugs 851, 852, etc., occupy the right hand side of the chain, as in the form described. The control of the shaft 80, and the special movements of the drum 120, may thus be independently brought to the same primary pattern surface.

The construction and operation of the pawl controller 436 will be plain from an inspection of Figs. 37 and 37^a.

In Figs. 36 and 38 I have shown a modified form of the connections between the respective thrust bars 460^h and 26. In this case the connections comprise the levers 487^a and 20^a journaled on horizontal axes 21^a and 21^b. Each of said levers extends above and in contact with a portion or attachment of its thrust-bar to permit one end to be moved upward thereby. On the other end of each of said levers is mounted a cam-piece 439, respectively taking against the ends 12 and 15 of the cams 382 and 2. By this device the extent of the movement of the respective cams is related directly to the height of the cam on the drum 120. Said Fig. 36 also illustrates the mounting of the ways for the respective cams 382 and 2 to cause them to move on lines sloped away from their respective radial planes, their inner ends pointing toward the approaching needles, through a slight angle, which device I have found of aid in insuring the certain exit of said supplemental cams from engagement with the needle butts, when released by their controlling connections.

In Fig. 39 I have shown an alternative construction for the auxiliary pawling device shown in Fig. 1 comprising an arm 431^a and the hooked pawl 432^a, for coöperation with the cam 430 and the ratchet teeth 434, the operation of which will be obvious.

Fig. 44 shows a form of needle I have found useful in coöperation with the described devices, especially when loops are to be withheld during the knitting of a comparatively large number of courses for a long welt. Under these circumstances there is a tendency to elongate the withheld loop, which elongation may in extreme cases reach dimensions at which the descending hook of the needle no longer encounters the loop held upon its face and within its latch. Such an effect may be due to the cam action of the needle cheeks at the region of the latch pivot, if the needles are of the form shown in Fig. 30, and to other causes. By the employment of needles n^8, such as those shown in Fig. 44, in which the hook n^9 is displaced forwardly with respect to the shank or cheek section n^{10}, which may be of the comparatively straight or flat form shown, I have found no difficulty in withholding loops for any desired extent of welt with the most refractory yarns. It will be understood that the coöperation of the needles n^8 with the web-holders remains the same as in the case of the needles of the usual form shown in Fig. 30, and that the stages of the operation illustrated in Figs. 23 to 25 remain the same.

I have not herein claimed the new inventions embodied in the disclosure of the driving and power connections, or the construction of the pattern devices, their connections and devices at the knitting head operated by them, except as elements of combinations or as concerned in the operations of the cams 382 and 2; nor have I claimed herein the devices for feeding yarn to the knitting needles incidentally shown and described, except as said devices are elements of combinations with the particular devices of this application; nor have I herein claimed the narrowing and widening devices, the devices for closing the gap in the latch-ring, the latch-opener, or the devices for adjusting the length of the stitch, except as elements of combinations, all of said matters being fully disclosed in my said application, Serial No. 746,070, filed February 3, 1913, and claimed therein.

What I claim is:—

1. In a knitting machine, knitting needles, means for knitting on said needles and means coöperating with said needles to knit an outturned welt and a predetermined extent of fabric integrally united therewith.

2. In a knitting machine, knitting needles, means for knitting on said needles and means acting at predetermined times for withholding certain stitches during the

formation of fabric for an outturned welt whereby said welt may be subsequently united to the remainder of the fabric by said withheld stitches.

3. In a knitting machine, a single set or row of knitting needles, means for knitting fabric on said needles and automatic means for withholding stitches on needles during the formation of a welt of predetermined extent integrally united with said fabric.

4. In a knitting machine, needles and means for knitting fabric on all of said needles, in combination with means for actuating the needles at predetermined times to cause the formation of an integrally united outturned welt.

5. In a knitting machine, automatic means to cause the actuation of the needles to knit a stocking, and means coöperating with said automatic stocking knitting means to knit an integrally united outturned welt.

6. In a knitting machine, automatic means to cause the actuation of the needles to knit a stocking, and means coöperating with said automatic stocking knitting means to knit an outturned welt of fabric integrally attached to said stocking at both ends of said fabric.

7. In a knitting machine, needles and coöperating knitting means, in combination with means to form a beginning selvage upon previously bare needles, and devices to coöperate with needles distributed among the remainder to withhold their loops during the knitting of fabric for an outturned welt upon the remainder of said needles.

8. In a knitting machine the combination of a needle carrier and needles, coöperating means for knitting thereon, and needle controlling devices acting during a plurality of successive courses to withhold from knitting and retain tying loops upon certain of said needles, to unite a welt knit upon other of said needles to an adjacent extent of fabric knit upon said withheld needles and said other needles.

9. In a knitting machine, a needle carrier, needles therein and knitting means coöperating with said needles, needle controlling devices to retire certain of the needles distributed among the others to form a beginning selvage, and means coöperating with said devices to thereafter retire recurrent needles of the series of needles, while retaining their loops, to a path out of contact with the fabric formed by the remaining needles, to thereby withhold a series of uniting loops for a welt.

10. In a knitting machine the combination of a needle carrier and needles, coöperating devices for knitting thereon, and needle controlling devices acting to withhold from knitting, and retain tying loops upon, certain of said needles, to unite a welt knit upon other of said needles to an adjacent extent of fabric knit upon said withheld needles and said other needles, and means to control the time and duration of the operation of said needle controlling devices.

11. In a knitting machine, a needle carrier and needles and coöperating means for knitting an extent of plain fabric upon said needles, in combination with needle controlling devices and pattern means for predetermining the operation of said devices to withhold from knitting certain needles distributed among the others, to retain tying loops for a welt, and to thereafter restore said withheld needles to normal knitting during the formation of a course of fabric having loops impaling said tying loops.

12. In a knitting machine, a needle carrier and needles, pattern devices for predetermining a cycle of knitting operations upon said needles, and means under the control of said pattern devices for withholding certain of said needles out of the field of activity of the remainder, while retaining their loops, during the knitting of a predetermined extent of fabric for a welt upon the remainder, and means for thereafter causing said needles to resume knitting.

13. In a knitting machine, a yarn guide, a needle carrier containing a single row or series of needles, means to move said needles to cause them to knit and devices for operating certain of said needles at predetermined times to cause them each to retain a previously formed loop of yarn and retire to a path out of contact with the fabric formed by the remaining needles, means to knit fabric upon the remaining needles to form a welt, and means whereby all of the needles may be caused to knit normally.

14. In a knitting machine, a needle carrier and needles therein, means coöperating with the needles to knit successive courses and needle controlling means acting during the knitting of each course of a predetermined number of courses to determine the retention of loops previously knit by certain of the needles, including means for the bodily withdrawal of a needle from the field of activity of the remaining needles to permit fabric to be formed and cast off of the remaining needles over the head of the needle withdrawn from action.

15. In a knitting machine, a yarn guide, a needle carrier and needles and coöperating means for knitting thereon, in combination with needle controlling devices capable of actuation to withdraw certain of said needles to a position out of operative contact with the yarn engaged by the remaining needles, a pattern mechanism, and means controlled by said mechanism for causing the needle controlling devices to coöperate with some of the needles during an initial course and to become inoperative on said needles at a succeeding course, to form a

beginning-selvage, said pattern mechanism including means for thereafter causing said needle controlling devices to withhold needles from knitting while retaining tying loops for a welt knit during a predetermined number of courses upon other of said needles.

16. In a knitting machine, a yarn guide, a needle carrier and needles and coöperating means for knitting thereon, in combination with needle controlling devices capable of actuation to withdraw certain of said needles to a position out of operative contact with the yarn engaged by the remaining needles, a pattern mechanism, and means controlled by said mechanism for causing the needle controlling devices to coöperate with some of the needles during an initial course and to be inoperative on said needles at a succeeding course, to form a beginning-selvage, said pattern mechanism including means for thereafter causing said needle controlling devices to withhold needles from knitting while retaining tying loops for a welt during a predetermined number of courses upon other of said needles, and means for subsequently causing said needle controlling devices to withhold needles and their loops to form a stop-course to prevent the running of dropped stitches.

17. In a knitting machine, a yarn guide, a needle carrier and coöperating means for knitting thereon, in combination with needle controlling devices capable of actuation to withdraw certain of said needles to a position out of operative contact with the yarn engaged by the remaining needles, a pattern mechanism and means controlled by said mechanism for causing the needle controlling devices to coöperate with some of the needles during an initial course and to become inoperative on said needles at a succeeding course to form a beginning-selvage, said pattern mechanism including means for subsequently causing said needle controlling devices to withhold needles and their loops to form a stop-course to prevent the running of dropped stitches.

18. In a knitting machine, means for knitting a selvaged welt on an extent of plain fabric comprising means to actuate the needles to cause alternate needles or groups of needles only to take the yarn, and means acting at a subsequent course to cause an increased number of needles to take and cast off the loop to form a selvage section; devices for thereafter causing certain needles distributed among the remainder to retire at each course from the field of action of the remaining needles, while retaining a previous loop, during the knitting of a plurality of courses for the welt, and means acting at a predetermined time thereafter to cause all of the needles to knit.

19. In a circular knitting machine, a needle carrier and independently movable needles therein, a cam carrier and knitting cams, means for rotating one of said elements, means for causing certain of the needles distributed among the remainder at each rotation to pass the knitting cams while retaining their loops, and to thereafter resume the same path as the remainder of the needles, means to render said last mentioned means active at predetermined times to retain tying loops during the formation of fabric for a welt, and inactive at a later time to cause the knitting of fabric having an initial course containing loops penetrating said tying loops.

20. In a knitting machine, a yarn guide, a needle carrier, independent needles therein, a cam carrier and knitting cams, in combination with means to cause certain of the needles distributed among the remainder to retire into their carrier and out of range of the yarn guide while retaining a previously knit loop, at each course, during the successive actuation of other needles, for a plurality of courses, and means to cause the yarn between needles adjacent to said retired needles to be thrown behind said retired needles when said retired needles are advanced, and means acting at predetermined times to render the retiring means inactive.

21. In a knitting machine, a knitting head comprising a rotatable element, needles and knitting means coöperating with said needles, in combination with means to rotate and oscillate said element, a pattern mechanism comprising means to control the times and durations of the rotary and oscillatory movements of said element; devices at said head for coöperation with certain of said needles to knit a beginning-selvage, and means controlled by said pattern mechanism for causing said devices and said means at predetermined times to knit a beginning-selvage and a following extent of tubular fabric.

22. In a knitting machine, a knitting head comprising a rotatable element, needles, and knitting means coöperating with said needles in combination with means to rotate said element, a pattern mechanism comprising means to control the times and durations of the rotary movements of said element, devices at said head for coöperation with certain of said needles to knit a beginning-selvage, and means controlled by said pattern mechanism for causing said devices and said means at predetermined times to knit a beginning-selvage and a following extent of fabric.

23. In a knitting machine, a needle carrier and needles, means coöperating with the needles to knit a predetermined extent of fabric, devices to coöperate with said needles to knit a stop-course to prevent the running of drop stitches at a predetermined point in

said fabric, means to eject said fabric from the needles and means coöperating with said devices to cause their operation during the first and a later course of knitting of a subsequent section of fabric to form a beginning selvage for another section of fabric.

24. In a circular knitting machine a needle cylinder and needles therein, a cam cylinder and knitting cams therefor, means to rotate one of said cylinders, needle controlling elements on said cam cylinder and connections for adjusting said elements, a pattern shaft, and a pattern surface for moving said connections, means for intermittently advancing said pattern shaft and pattern surface at predetermined times, and means for advancing said pattern surface at predetermined times at a rate related to that of the rotating cylinder, whereby the needle controlling elements are adjusted with relation to the passage of predetermined parts of the rotating cylinder.

25. In a circular knitting machine, the combination of a knitting head comprising a needle cylinder and needles therein, a cam cylinder and knitting cams therefor, needle controlling elements on said cam cylinder, driving means to cause rotary or oscillatory movements of one of said cylinders, a pattern shaft, devices on said shaft for controlling said driving means, means to intermittently advance said pattern shaft from said driving means at predetermined times, a pattern surface, and means to cause said surface to be actuated by movements of said shaft, connections from said surface to said needle controlling elements, and independent means to advance said pattern surface from said driving means at predetermined times to cause certain of said needle controlling elements to move into and out of operative relation during their opposition to a predetermined part or parts of said rotating cylinder.

26. In a knitting machine a yarn guide, knitting devices including a needle carrier and needles, a needle controlling device for causing recurrent needles to withhold their loops during knitting upon other needles, a pattern surface, means to advance said pattern surface including an actuator and means to reciprocate said actuator, connections controlled by said pattern surface for the adjustment of one or more of said needle controlling devices, and devices to advance said pattern surface at predetermined times during the back or recovering stroke of said reciprocating actuator.

27. In a knitting machine, the combination of needles and cam carries, knitting cams and needle controlling devices for retracting some of the needles into their carrier while holding their loops, driving means to revolve one of said carriers, a pattern surface and means including a reciprocatory actuator to intermittently advance said surface by movements occurring during a predetermined plurality of revolutions of said carrier, connections to said surface to adjust said needle controlling devices, and means having an element rotating in unison with said devices for actuating said surface during idle intervals of said actuator.

28. In a knitting machine, knitting instruments, and means coöperating with said instruments to knit, in combination with movable needle controlling devices coöperating with certain of the knitting instruments when in one position to operate said instruments without causing them to knit, means to position said devices for operation including a pattern surface, means to move said surface at predetermined intervals, and means to cause said pattern surface to move at predetermined times between said intervals.

29. In a knitting machine, needle and cam carriers, independent needles and knitting cams, a yarn feed guide and devices to cooperate with said yarn guide and knitting cams during the production of an initial course of fabric comprising means to separate the needles prior to their operation at the stitch cam into two intercalated sets or series, one of which will fail to contact with the yarn, and means coöperating with the needles to thrust the yarn behind the needles which did not take it, in combination with operating means to render said devices inactive during at least one course of plain fabric on all the needles, and thereafter to render said devices operative during a plurality of successive courses to cause needles of one set to retain their stitches, and those of the other set to knit during the formation of fabric for a welt.

30. In a knitting machine, needle and cam carriers, independent needles and knitting cams therefor, and a yarn feed guide in combination with means to retire certain of said knitting needles distributed among the remainder into their carrier and out of contact with the yarn at successive courses during the knitting of fabric for a welt on the remaining needles, and means to restore said needles to the same path as the remaining needles before said remaining needles have completed their stitch forming movement.

31. In a knitting machine, needle and cam carriers, independent needles and knitting cams therefor and a yarn feed guide, in combination with needle controlling devices to retract certain of said needles distributed among the remainder into their carrier, and out of contact with the yarn, and a cam to elevate the retired needles without placing them in contact with the yarn immediately following the maximum retracting point of said cam devices.

32. In a knitting machine, a cam structure including means to retire some of the needles from an active path while retaining their loops, and means for preventing undue elongation of the retained loops comprising an advancing cam for the partial elevation of said needles immediately following a retracting cam of the retiring means, whereby a needle retracted to a maximum point may be both preceded and followed by needles sufficiently elevated to relieve the strain upon the loops held by said needles.

33. In a knitting machine, a needle carrier, independently movable needles, a cam carrier and knitting cams therefor, needle controlling devices to engage and retract certain of the needles into their carrier before their encounter with the knitting cams, said devices comprising needle engaging and retracting means, independently movable jacks, and a cam therefor to move some of the needles only out of the field of action of said engaging and retracting means and into the field of action of the knitting cams.

34. In a knitting machine, a needle carrier and independent needles therein, a yarn feed guide, and stitch cams for rotary and reciprocatory knitting, in combination with means to cause the needles to rest at a level at which their latches are not cleared below their loops, means independent of the stitch cams to lift some of the needles only to clear their latches, preparatory to knitting at the said stitch cams, and means to cause the remaining needles to pass the stitch cams and feed guide at a level too low to permit them to contact with the yarn.

35. In a knitting machine, means for rotary and reciprocatory knitting, comprising a needle carrier and independent latch needles therein, a yarn feed guide and symmetrical stitch cams, in combination with means to cause the needles to rest at a level at which their latches are not cleared, independently movable jacks associated with some of the needles, and a cam for moving said jacks to cause said needles to clear their loops below their latches, and means to cause the remaining needles to pass the knitting cams and feed guide while retaining their loops, and in a path out of contact with the new yarn.

36. In a knitting machine, a needle carrier and independent needles therein, a yarn feed guide, symmetrical stitch cams, and means for rotary and reciprocatory knitting, in combination with means to cause the needles to rotate at a level at which their latches are not cleared, independently movable jacks associated with some of the needles, and a cam for moving said jacks to cause said needles to clear their loops below their latches, means to take the butts of the remaining needles under the leading and following stitch cams without lifting them to take yarn, and means to restore said remaining needles to the normal level.

37. In a knitting machine, needle and cam carriers, independent needles and knitting cams therefor and a yarn feed guide, in combination with means to cause certain of the needles distributed among the remainder to enter a path acting to retire them into their carrier and out of contact with the yarn, and means to cause some of said certain needles distributed among the remainder to resume their normal knitting path before their contact with the knitting cams.

38. In a circular knitting machine, needle and cam cylinders, independent needles, a yarn feed guide, and knitting cams therefor, means to retire into their carrier certain needles distributed among the others prior to their taking yarn and means acting subsequently to restore some only of said needles to a normal path at the needle cams, said means permitting the remainder of said certain needles to pass the yarn feed guide while in a position of retraction, and a cam for subsequently moving all the needles to a normal path at each revolution of the knitting head.

39. In a knitting machine, needle and cam carriers, independent needles and knitting cams therefor, and a yarn feed guide, in combination with means to cause certain of the needles distributed among the remainder to enter a path acting to retire them into their carrier and out of contact with the yarn, and means to cause some of said certain needles distributed among the remainder to resume their normal knitting path before their contact with the knitting cams, and pattern controlled devices for causing action or inaction of said means.

40. In a knitting machine, needle and cam carriers, independent needles and knitting cams therefor and a yarn feed guide, in combination with means to cause certain of the needles distributed among the remainder to enter a path acting to retire them into their carrier and out of their normal knitting path, and means to restore some of said certain needles distributed among the remainder to their normal knitting path before their contact with the knitting cams, pattern controlled means to render said means to restore the needles ineffective, and pattern controlled devices for independently causing action or inaction of said means to cause the needles to enter said path.

41. In a knitting machine, needle and cam carriers, independent needles and knitting cams for rotary and reciprocatory knitting, and a yarn feed guide, in combination with means to selectively retire certain of the needles into position to enter a path to lead them beneath the said knitting cams and out of contact with the yarn, independently movable jacks and actuating means there-

for, to restore predetermined needles distributed among the remainder to their normal knitting path before their contact with the knitting cams.

42. In a knitting machine, needle and cam carriers, independent needles and knitting cams therefor, and a yarn feed guide, in combination with a needle controlling cam to retire such needles as encounter it into their carrier before their encounter with the yarn guide and knitting cams, means to move predetermined needles out of position to encounter said cam, and means to restore predetermined needles distributed among those acted upon by said cam to their normal knitting path before their contact with the knitting cams.

43. In a knitting machine, needle and cam carriers, independent needles and cams therefor, and a yarn feed guide, in combination with a supplemental cam device and cam path to retire such needles as encounter it into their carrier and out of contact with the yarn at said feed guide, independent jacks and actuating means therefor to move certain needles out of contact with said cam device, and means to restore predetermined needles distributed among the remainder to their normal knitting path after contact with a part of said cam device and before contact with the knitting cams.

44. In a knitting machine, needle and cam carriers, independent latch needles and knitting cams therefor having an advancing slope for clearing the latches through the loops, a yarn guide and means to cause the cams and needles to approach each other while the needles are in a position at which their latches are not cleared through their loops, means to clear certain needles intercalated among the others, means to depress the remaining needles into their carrier, and means to cause certain of said remaining needles to resume a normal knitting path before contact with the knitting cams.

45. In a knitting machine, needle and cam carriers, independent needles and knitting cams therefor and a yarn feed guide, in combination with a supplemental cam device in advance of the knitting cams to retire such needles as encounter it into their carrier and out of contact with the yarn, independently movable jacks and a cam therefor to cause certain of said needles distributed among the remainder to be carried out of range of said cam device, and another series of independently movable jacks and a cam therefor for causing some of the needles acted upon said cam device to resume their normal knitting path in advance of the knitting cams.

46. In a knitting machine, a needle carrier and independent needles therein, a yarn feed, stitch cams, and means coöperating therewith for rotary and reciprocatory knitting, in combination with means to cause some of the needles to approach the stitch cam at a higher level than others whereby those at the higher level will have cleared their loops beneath their latches, a supplemental cam to carry those needles which have not cleared their latches beneath said stitch cams, and means to move said supplemental cam into and out of operative position at predetermined times.

47. In a knitting machine, a needle carrier and independent needles therein, a yarn feed guide, and stitch cams for rotary and reciprocatory knitting, in combination with independently movable jacks for some of the needles, a cam to cause said jacks to lift their needles to clear their loops below their latches prior to knitting at said cams and a supplemental cam to carry all of the needles without jacks below the stitch cams, to cause them to fail to take yarn, means to restore all of the needles to a level at which their latches are not cleared, and means to move said supplemental cam into and out of action at predetermined times.

48. In a knitting machine, needles, knitting means and devices for causing a predetermined series of needles to retain their previously taken loops and retire to a path out of contact with the fabric formed by the remaining needles, at each course or passage of the knitting means, means associated with said devices for beginning the said operation at a certain needle of said series, and means for restoring said series to normal operation, beginning with said needle.

49. In a knitting machine, independent needles, knitting cams and devices for causing each of a predetermined series of needles to retain a previously taken loop and retire to a path out of contact with the fabric formed by the remaining needles, at each course or passage of the knitting cams, and means associated with said devices to begin the said operation at a certain needle of said series, and to end the operation upon another certain needle.

50. In a knitting machine, needle and cam carriers, independent latch needles and knitting cams therefor, a yarn feed guide, and means to cause the needles to approach the knitting cams without having advanced to clear their latches, means to advance certain of the needles distributed among the others to a position at which their latches will be cleared and at which said needles will operatively encounter the knitting cams, means to retire other needles into their carrier, beginning with a certain needle, and means for operation at a later time to permit the advance of said certain needle and others following it to clear their latches and cause them to enter the knitting cams to take yarn and knit.

51. In a knitting machine, a needle carrier, needles therein and knitting means cooperating with said needles, needle controlling means to retire certain of the needles distributed among the others before said needles have taken the yarn, to form a beginning selvage, and devices for coöperation with said means to thereafter retire certain needles distributed among the others, while retaining their loops, to a path out of contact with the fabric formed by the remaining needles, to thereby withhold a series of uniting loops for a welt, in combination with means to secure the vertical separation of the first of said certain needles from the last of said needles prior to their operation to knit, upon a later passage of the knitting means, whereby the withheld loops may be cast off in all of the wales containing them after the knitting of the same number of courses of welt fabric upon active needles adjacent to them.

52. In a circular knitting machine, a needle cylinder and independent needles therein, a cam cylinder, and means for rotating and oscillating one of said cylinders, a stitch cam carried by said cam cylinder, a supplemental needle cam mounted for movement with respect to said cylinders, means in contact with said cam for moving it, a bar movable in the direction of its length, in contact with said means, a pattern surface for moving said bar, and means for moving said pattern surface at predetermined times.

53. In a knitting machine in combination a needle carrier and needles therein, a cam carrier and knitting cams for said needles, a supplemental needle cam and means for moving said needle cam into and out of position to contact with said needles, comprising means tending normally to withdraw said cam from contact with the needles, a lever in contact at one end with said cam, a thrust bar and means to guide said bar to contact with the other end of said lever, a movable pattern surface, and means thereon to engage said thrust bar.

54. In a knitting machine, a needle carrier and independent needles therein, a cam carrier and knitting cams, means to rotate one of said carriers, in combination with a supplemental cam for actuating some of the needles, a pattern-surface, and means to move said surface forward at predetermined times during more than one revolution of the rotating carrier, connections to said supplemental cam, and means on said pattern surface coöperating with said connections to cause said supplemental cam to become first active and then inactive with respect to the needles operated by it during said forward movement.

55. In a knitting machine, a knitting head, means for rotary and reciprocatory knitting upon said head, including means for the constant forward rotation of an element of said head, and means to vary the speed of said element; a pattern surface, means to advance said pattern surface intermittently through variable distances at a constant rate with respect to the speed of rotation of the knitting element, a supplemental cam at said knitting head, and connections coöperating with a pattern indication on said pattern surface to determine the beginning and the end of the operation of said supplemental cam during one advance of said pattern surface.

56. In a knitting machine, a pattern surface, a needle cylinder and a cam cylinder, and means to rotate one of said cylinders with respect to the other at a certain rate, means to advance the pattern surface through a certain distance at predetermined times at a rate bearing a fixed ratio to the movement of said cylinder, a pattern cam of less extent than said distance on said pattern surface, a supplemental cam on said cam cylinder and connections for contact with said pattern cam and with said supplemental cam for actuating the latter through a cycle of movements and returning it to its original position during the advance of said pattern surface through said distance.

57. In a knitting machine having a yarn guide, a needle carrier and needles, a cam carrier, and knitting cams capable of actuating needles approaching in either direction having an idle path for needles in a retracted position, needle controlling means to encounter needles approaching in one direction prior to their contact with the knitting cams to separate said needles into intercalated series one of which will be actuated by the knitting cams, comprising a supplemental cam movable toward and away from the needle carrier to cause all the needles encountering it to be positioned to enter said idle path, independently movable jacks in the needle carrier, and a cam coöperating with said jacks to advance their needles to a level higher than said supplemental cam prior to their contact with the knitting cams.

58. In a knitting machine having a yarn guide, a needle carrier and needles, a cam carrier, and knitting cams having an idle path for needles in a retracted position, needle controlling means to encounter the needles prior to their contact with the knitting cams to separate said needles into intercalated series one of which will be actuated by the knitting cams, said means comprising two retracting cams independently movable toward and away from the needle carrier to cause all the needles encountering either of them to be positioned to enter said idle path, independently movable jacks for certain of the needles of different lengths and a cam coöperating with said jacks to advance their needles prior to their

contact with one of said supplemental cams and the knitting cams, whereby the needles having the longer jacks will enter the knitting cams at all times, those having shorter jacks will enter said cams or said idle path dependent upon the position of said supplemental cam and those having no jacks will enter the idle groove when either supplemental cam is in operation.

59. In a knitting machine, the combination of a needle carrier and latch needles, a cam carrier and knitting cams, two supplemental cams movable into active and inactive positions having needle retracting faces in advance of said knitting cams, and means for normally holding the needles prior to entering the knitting cams at an idle level insufficiently advanced to clear their latches, in combination with jacks for some of the needles and means to operate them to advance their needles out of range of either of said supplemental cams and into a position to encounter the knitting cams; a second series of jacks, and means to operate them to elevate needles depressed by one of said supplemental cams to a position to encounter the other supplemental cam, when in its active position, and to encounter an advancing slope of the knitting cams when said supplemental cam is in an inactive position.

60. A cam structure for knitting machines comprising a stitch cam and a supplemental needle cam, a mounting for said needle cam permitting movement at an angle to the plane of its working face, means tending to move said cam toward one extreme of its movement and devices for positioning said needle cam at predetermined times with relation to the needles comprising an adjusting cam movable substantially at right angles to the line of movement of said needle cam and pattern controlled means to move said adjusting cam to cause movement of said needle cam from a position of rest out of contact with the needles into a plurality of adjusted positions in advance of its position of rest.

61. In a knitting machine, a needle carrier, independently movable needles, a cam carrier and stitch cams, in combination with a movable supplemental cam having oppositely disposed needle actuating faces offset with respect to their distance from the face of the needle carrier.

62. In a knitting machine, a needle carrier, independently movable needles therein, in series having butts of different lengths, a cam carrier and stitch cams, in combination with a supplemental cam having oppositely disposed needle actuating faces offset to an extent less than the difference between the lengths of the needle butts, with respect to the distance of said actuating faces from the face of the needle carrier.

63. In a knitting machine, a needle carrier, independently movable needles and stitch cams, in combination with a supplemental cam having oppositely disposed needle-contacting faces offset with respect to their distance from the face of the needle carrier, and means whereby said cam may be positioned to cause needles with butts of a certain length to contact with one face on one passage and with the other face on another passage.

64. In a circular independent needle knitting machine a cam structure having an idle level for maintaining the needles partly projected in combination with a needle cam having a depressing face and an elevating face intersecting at a point beneath said idle level.

65. In a circular independent needle knitting machine, a needle carrier, needles therein, a cam carrier, and a cam structure thereon having an idle level for maintaining the needles partly projected in combination with a needle cam having a depressing face and an elevating face intersecting at a point beneath said idle level, and means whereby said needle cam may be positioned to cause needles at the idle level to contact with either of said faces.

66. In a circular independent needle knitting machine, a needle carrier and needles therein in series having butts of different lengths, a cam carrier and knitting cams therefor having an idle level, in combination with a needle cam having a depressing face and an elevating face intersecting at a point beneath said level, and means whereby said needle cam may be positioned to cause one series of said needles to be elevated at one passage and to be depressed at another passage of said cam.

67. In a circular knitting machine, needle and cam cylinders, a circle of independent latch needles in said needle cylinder, knitting cams in said cam cylinder, means cooperating with the needles to retire some only of said needles in a predetermined order throughout the circle, and thereafter to cause said retired needles to advance in front of the yarn fed to the remaining needles, means to cause all of the needles at a following course to take yarn and knit, in combination with means to retire some only of all of the needles among those first retired during a plurality of courses of knitting upon the remaining needles, and means to cause the restoration of all of the needles to action.

68. In a knitting machine, a needle carrier and independent latch needles therein, a yarn feed guide, a cam carrier and stitch cams for rotary and reciprocatory knitting, means for moving one of said carriers for rotary and reciprocatory knitting and web-holders for determining the position of yarn loops on said needles, in combination with

means to cause the needles to remain at a level at which their latches are not cleared above the loops engaged by said web-holders, means to lift some of the needles to clear their latches and means to cause the remaining needles to pass said stitch cams and feed guide beneath the level determined by said web holders.

69. In a knitting machine, a needle carrier and independent latch needles therein, a yarn feed guide, a cam carrier and stitch cams, means for moving one of said carriers for rotary and reciprocatory knitting and web-holders for determining the position of loops on said needles, in combination with means to cause the needles to remain at a level at which their latches are not cleared above their loops, independently movable jacks and a cam therefor to lift some of the needles to clear their latches through loops engaged by said web-holders, and means to cause the remaining needles to pass the stitch cams and feed guide without contact with the new yarn during a predetermined rotary movement of the movable carrier.

70. In a knitting machine, a needle carrier and independent latch needles therein, a yarn feed guide, a fixed cam carrier and stitch cams, and means for rotary and reciprocatory knitting by movements of said needle-carrier in combination with means to hold the loops at a level at which the needle latches are not cleared above said loops, means to lift some of the needles to clear their latches, and means to cause the remaining needles to pass the stitch cams and feed guide without contact with the new yarn during a predetermined rotary movement of the movable carrier.

71. In a knitting machine, a needle carrier and independent needles therein, independently movable web-holders and means to move them, a yarn guide, and stitch cams, and means for moving one of said carriers for rotary and reciprocatory knitting, in combination with means to cause said needles to remain at a level, with respect to the web-holders, at which their subsequent retraction will cause their loops to remain in their hooks, means (independent of the stitch cams) to lift some of said needles to place their loops upon their shanks, and means to cause the remaining needles to pass the stitch cams and yarn guide without contact with the new yarn during a predetermined rotary movement of the movable carrier.

72. In a knitting machine, a needle carrier and independent needles therein, independently movable web-holders and means to move them, a yarn feed guide, a cam carrier and stitch cams, and means for moving one of said carriers for rotary and reciprocatory knitting at said stitch cams, in combination with means to cause said needles to remain at a normal level, with respect to the web-holders, at which their subsequent retraction will cause their loops to remain in their hooks, means independent of the stitch cams to lift some of said needles to place their loops upon their shanks, means to cause the remaining needles to pass the stitch cams with their hooks below the level defined by said web-holders, without advancing them to contact with the yarn from the yarn guide, and means to cause said remaining needles to return to the normal level.

73. In a knitting machine, means for knitting a stop course or beginning selvage comprising independently movable needles, stitch cams, a yarn feed guide, independently movable hooked web-holders, and means to actuate said instruments for normal knitting, including means to withdraw a predetermined number of needles distributed among all the needles from their normal knitting path and to a level at which their hooks are beneath the level determined by the hooks of the web-holders, means to retain said needles in said position until after the remaining needles shall have taken yarn and knit, and a cam to return said withdrawn needles to their normal level, with respect to web-holders then in an advanced position, whereby the yarn joining the needles operated to knit passes behind said withdrawn needles.

74. In an independent needle knitting machine having a yarn guide, a stitch cam, and devices for carrying certain of the needles beneath a normal path at said stich-cam, web-holders and means to hold said web-holders in an inward position, means to withdraw said web-holders at the stitch-cam, and means to restore said certain needles to their normal path co-acting with such needles only as are adjacent to web-holders in an inward position, to cause yarn not taken by said needles to float behind them.

75. In an independent needle knitting machine having a yarn-guide, a stitch cam, and devices for separating the needles into two intercalated series, means acting at a predetermined time to carry certain of the needles beneath a normal path at said stitch-cam, web-holders and means to hold said web-holders in an inward position, means to withdraw said web-holders at the stitch-cam, and a cam at a point at which the web-holders are in an inward position to restore said certain needles to their normal path after their adjacent needles have been actuated to knit, to cause yarn not taken by said needles to float behind them.

76. In an independent needle knitting machine having a yarn guide, a stitch cam, and devices for separating the needles into two intercalated series, means acting at predeter-

mined times only to carry certain of the needles beneath a normal path at said stitch-cam, web-holders and means to hold said web-holders in an inward position, means to withdraw said web-holders at the stitch cams, and a cam at a point at which the web-holders are in an inward position to the web-holders are in an inward position to restore said certain needles to their normal path, after their adjacent needles have been actuated to knit, to throw the yarn behind said certain needles, and a cam following said needle separating devices but preceding the means for withdrawing the web-holders, for restoring all the needles to a normal path when said means for taking the needles beneath their normal path is inactive.

77. In a circular knitting machine, a needle carrier and needles therein, web-holders, and knitting means comprising needle-advancing means and retracting cams, in combination with means to move said web-holders to an inward position, means to retain said web-holders in an inward position at the needle advancing means, and means to withdraw said web-holders to an outward position acting after the needles have been moved by their retracting cams.

78. In an independent needle knitting machine, needles, a yarn feed guide, and devices for knitting a beginning selvage on previously bare needles comprising means to retract the needles, means to cause alternate needles to take the yarn, means to cause said needles and the remaining bare needles to be advanced, web-holders, means to cause said web-holders to advance to hold the yarn between said alternate needles toward the backs of the advancing needles, and means permitting said web-holders to remain in an advanced position during a part of a subsequent retraction for a second course of the needles taking yarn at the first course, to retain the yarn of the first course against said needles.

79. In a knitting machine, a yarn guide, independently movable latch needles, independently movable webholders, devices to advance and retract said needles with respect to a plane defined by said web-holders, for knitting, means to advance said webholders with respect to said needles to maintain tension upon the knitting yarn and means to retract said web-holders, said means being active upon web-holders associated with such needles only as are retracted to a point at which their open latches are beneath said plane.

80. In a knitting machine, a yarn guide, a needle carrier and movable webholders, independently movable latch needles, means normally to maintain said needles with respect to said webholders and needle carrier at an intermediate idle level at which their latches are not cleared through their previous loops, means to elevate said needles to clear their latches, means to retract said needles substantially to the said level, and means to further retract said needles beneath said level to knit and to again advance them to said level, in combination with means to retract said webholders, and means to maintain said webholders in an advanced position and in engagement with the web during each advancing movement of said needles and throughout their occupation of an advanced position above said level.

81. In an independent needle knitting machine, a needle carrier and needles, yarn feeding means, and means to cause the needles to rest normally at an intermediate level, means to cause a wave of motion in the needles having a high area above said level to bring the loops upon the shanks of the needles, and a low area beneath said level to cause a knitting movement and the return of each of said needles to said intermediate level, independently movable web-holders, means normally to maintain said webholders inward to engage the fabric, and means to cause a wave of motion outwardly thereof whose area is restricted to the position of a part of the said low area of the needle wave and the preceding intermediate level.

82. In a knitting machine, a needle carrier, and a series of needles therein, means coacting with the needles to cause them to knit and means to feed yarn to the needles, in combination with means whereby recurrent needles distributed throughout the series of needles may be withheld from knitting, means acting at a predetermined time to cause knitting upon said recurrent needles, and means acting coordinately therewith for changing the knitting yarn.

83. In a knitting machine, a needle carrier and a series of needles, yarn changing yarn guides and pattern-controlled devices for predetermining a cycle of knitting operations thereon, means whereby recurrent needles distributed throughout the series of needles are operated to cause them to fail to take yarn during a predetermined extent of knitting on the other needles, and to restore them to knitting, and means coöperating with the yarn guides to change the yarn when the said recurrent needles are restored to knitting.

84. In a knitting machine, a needle-carrier and a series of needles, yarn-changing yarn guides, and pattern controlled devices for predetermining a cycle of knitting operations thereon, means whereby recurrent needles distributed among all the needles are operated to cause them to fail to take yarn during a predetermined extent of knitting on the other needles, and to restore

them to knitting, comprising a pattern surface and means to advance said surface; and a series of independently movable thrust bars coöperating with said surface and with the yarn-guides to change the yarn when said recurrent needles are restored to knitting.

85. In a knitting machine, a needle carrier and needles therein, means coacting with the needles to cause them to knit, and means to feed yarn to the needles distributed at intervals throughout all the needles, means whereby certain of the needles may be withheld from knitting, means acting at a predetermined time to cause knitting upon said needles and means acting coördinately therewith for changing the knitting yarn, in combination with means for changing the length of the knit stitch at predetermined times.

86. In a knitting machine, a needle carrier and needles therein, means coacting with the needles to cause them to knit, and means to feed yarn to the needles, in combination with means whereby certain of the needles distributed at intervals among the others may be withheld from knitting, means acting at a predetermined time to cause knitting upon said needles and means acting coördinately therewith for changing the knitting yarn, and changing the length of the knit stitch.

87. In a knitting machine, a needle carrier and needles, coöperating devices for knitting thereon and needle controlling devices acting to withhold from knitting and retain tying loops upon certain of said needles, to unite fabric for a welt knit upon other of said needles to an adjacent extent of fabric knit upon said withheld needles and said other needles, in combination with means for knitting loops of different length in said fabric for the welt and said adjacent fabric.

88. In a knitting machine, a needle carrier and needles and coöperating devices for knitting an extent of plain fabric upon said needles, needle controlling devices, and pattern means for predetermining the operation of said devices to withhold from knitting certain needles distributed among the others to retain tying loops for a welt and to thereafter restore said withheld needles to normal knitting to form a course of plain fabric having loops impaling said tying loops, in combination with means for varying the length of stitch controlled by said pattern means.

89. In a knitting machine, a needle carrier and needles therein, and coöperating devices for knitting an extent of plain fabric upon said needles, in combination with needle controlling devices and pattern controlled means for predetermining the operation of said devices to withhold from knitting certain needles distributed among the others to retain tying loops for a welt, and to thereafter restore said withheld needles to normal knitting to form a course of plain fabric impaling said tying loops, in combination with means for changing the length of the stitch when said withheld needles are restored to normal knitting.

90. In a circular knitting machine the combination of a needle cylinder and needles, coöperating devices for knitting a stocking thereon, and needle controlling devices acting to withhold from knitting and retain tying loops upon certain of said needles to unite a section of welt fabric for the top of the stocking to an adjacent extent of fabric, pattern means for predetermining the time and duration of the operation of said stocking knitting devices and said needle controlling devices, and means for moving the needle cylinder, to vary the length of the knit stitches, controlled by said pattern means.

91. In an independent needle knitting machine, a needle carrier having grooves therein, needles in said grooves, and means to cause said needles to frictionally engage said grooves, and a cam carrier and cams for actuating said needles, in combination with means to adjust the stitch length by movements of one of said carriers, and a ledge or idle cam level on said cam carrier having a cut-away portion to permit free adjusting movement between said ledge and a plurality of said needles.

92. In a knitting machine having devices for withholding loops upon needles retracted into their carrier with respect to inwardly positioned web-holders, the combination of said web-holders with knitting needles having shanks and latch cheeks, and hooks in front of the line defined by the front or face of said shanks and said cheeks.

93. In a knitting machine having a needle carrier and needles, the combination with devices for retracting recurrent needles into their carrier without knitting upon said needles during normal knitting upon other needles to form an outturned welt, of means coacting with the loops upon said retracted needles to prevent said loops from being cast from the said needles when they are retracted.

94. In a knitting machine having a needle carrier and hooked needles, devices for repeatedly retracting recurrent needles into their carrier without knitting upon said needles during normal knitting upon other needles to form an outturned welt, and means coacting with the loops upon said retracted needles to cause said loops to be retained in the hooks of said recurrent needles during said repeated retractions.

95. In a knitting machine, needle and cam carriers, independent needles, and knitting

cams, a yarn feed guide, and devices for acting on the needles during the production of an initial course of fabric on previously bare needles to separate said needles prior to their actuation at the knitting cams into a plurality of intercalated series, one of which will fail to contact with the yarn, and for action thereafter to permit all of the needles to take yarn for a second course, and means for actuating said devices.

96. In a knitting machine, needle and cam carrier, independent needles and knitting cams, a yarn feed guide and devices for moving some of the needles intercalated among the others into an idle path at the knitting cams during the production of an initial course of fabric on previously bare needles, to prevent said needles from taking yarn, and for moving said needles at the next passage of the yarn feed guide to a position to enter and be actuated by said knitting cams, whereby all of the needles take yarn at the second course.

97. In a knitting machine, needle and cam carriers, independent needles and knitting cams, a yarn feed guide and devices for moving some of the needles intercalated among the others into an idle path at the knitting cams during the production of an initial course of fabric on previously bare needles, to prevent said needles from taking yarn, in combination with means coöperating with the needles to thrust the yarn behind said needles which did not take yarn, and means to operate said devices for moving said needles at the next passage of the yarn feed guide to a position to enter and be actuated by said knitting cams, whereby all of the needles take yarn at the second course.

In testimony whereof, I have signed my name to this specification in the presence of two subscribing witnesses.

ROBERT W. SCOTT.

Witnesses:
M. G. CROZIER,
CASPAR C. SCHREIDER.

Corrections in Letters Patent No. 1,148,055.

It is hereby certified that in Letters Patent No. 1,148,055, granted July 27, 1915, upon the application of Robert W. Scott, of Boston, Massachusetts, for an improvement in "Circular-Knitting Machines," errors appear in the printed specification requiring correction as follows: Page 1, line 11, before the word "integrally" insert the word *formed;* same page, line 22, for the word "or" read *of;* page 15, line 8, before the pronoun "I" insert the word *or;* page 18, line 84, for the word "guider" read *guides;* page 22, line 61, claim 27, for the word "carries" read *carriers;* page 28, claim 76, strike out line 8; and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 7th day of September, A. D., 1915.

[SEAL.]

J. T. NEWTON,

Acting Commissioner of Patents.