

J. D. HEMPHILL.
 CIRCULAR AUTOMATIC STOCKING KNITTING MACHINE.
 APPLICATION FILED MAR. 26, 1906.

933,443.

Patented Sept. 7, 1909.
 10 SHEETS—SHEET 1.

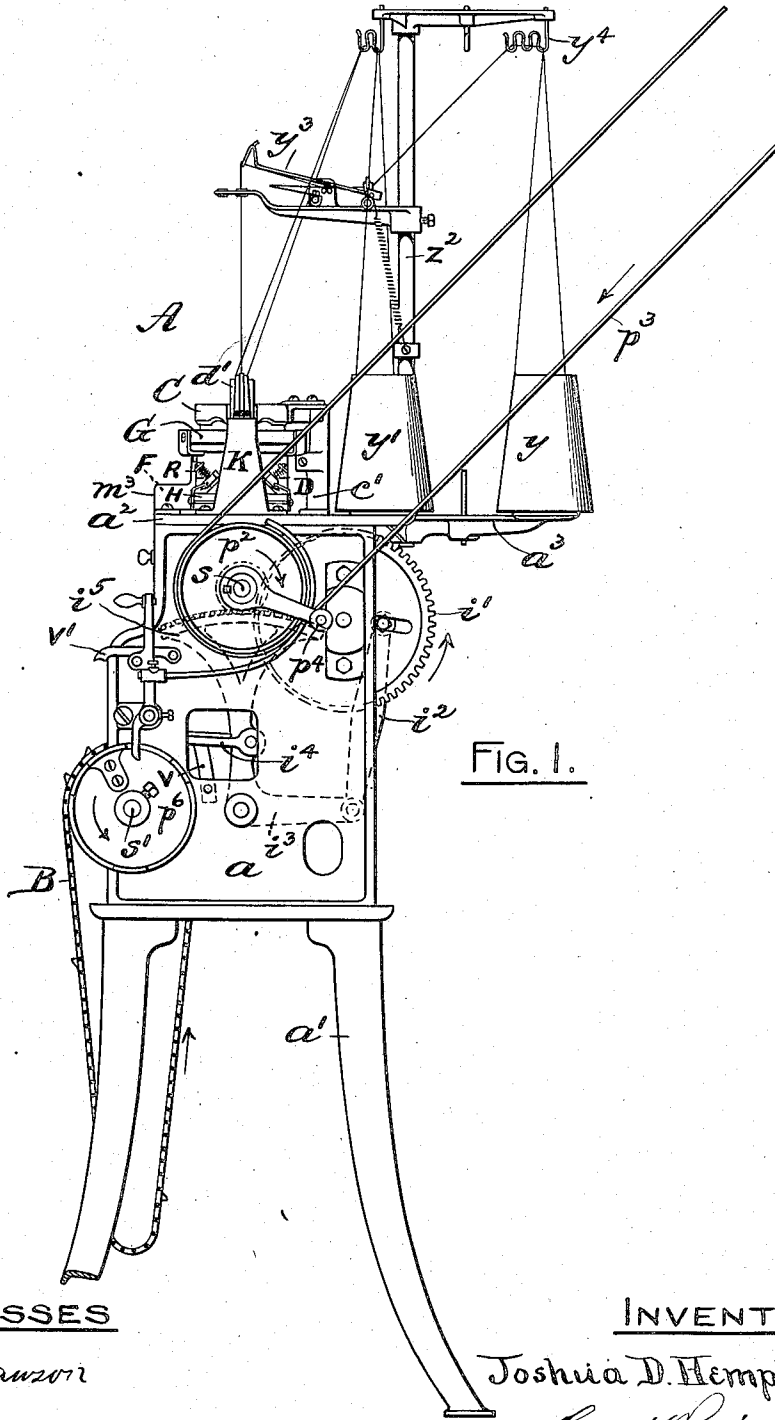


FIG. 1.

WITNESSES

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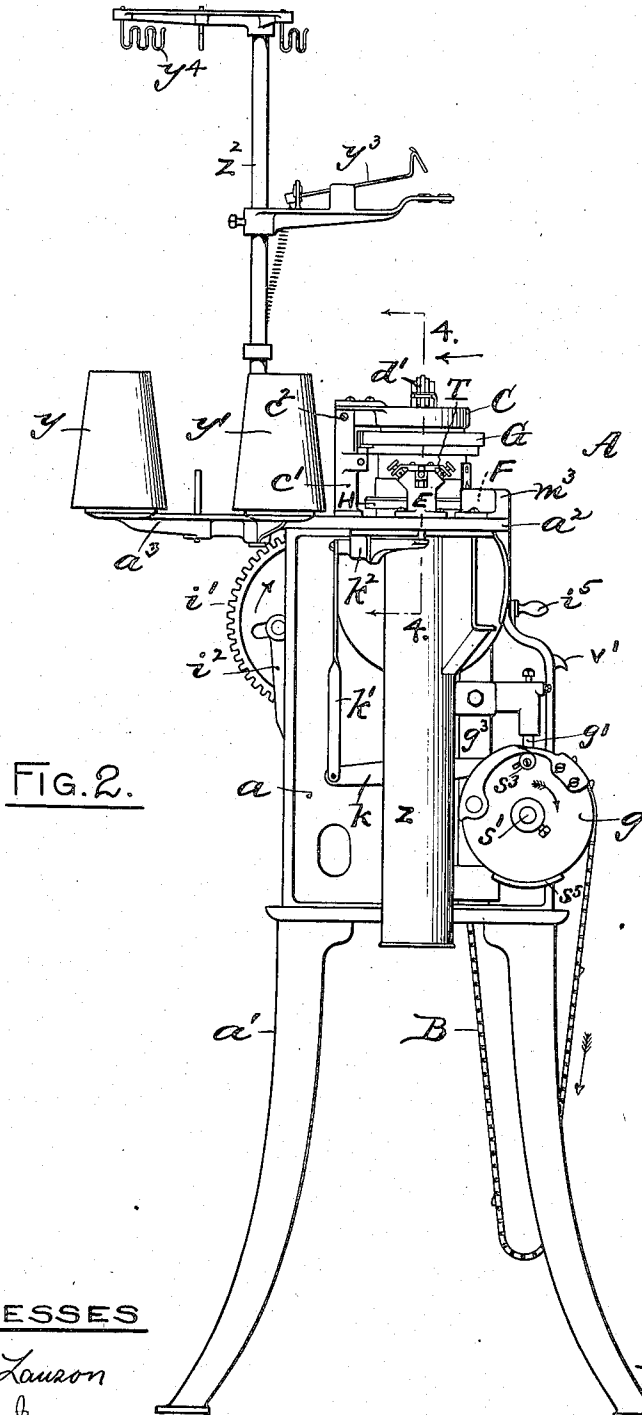


FIG. 2.

WITNESSES

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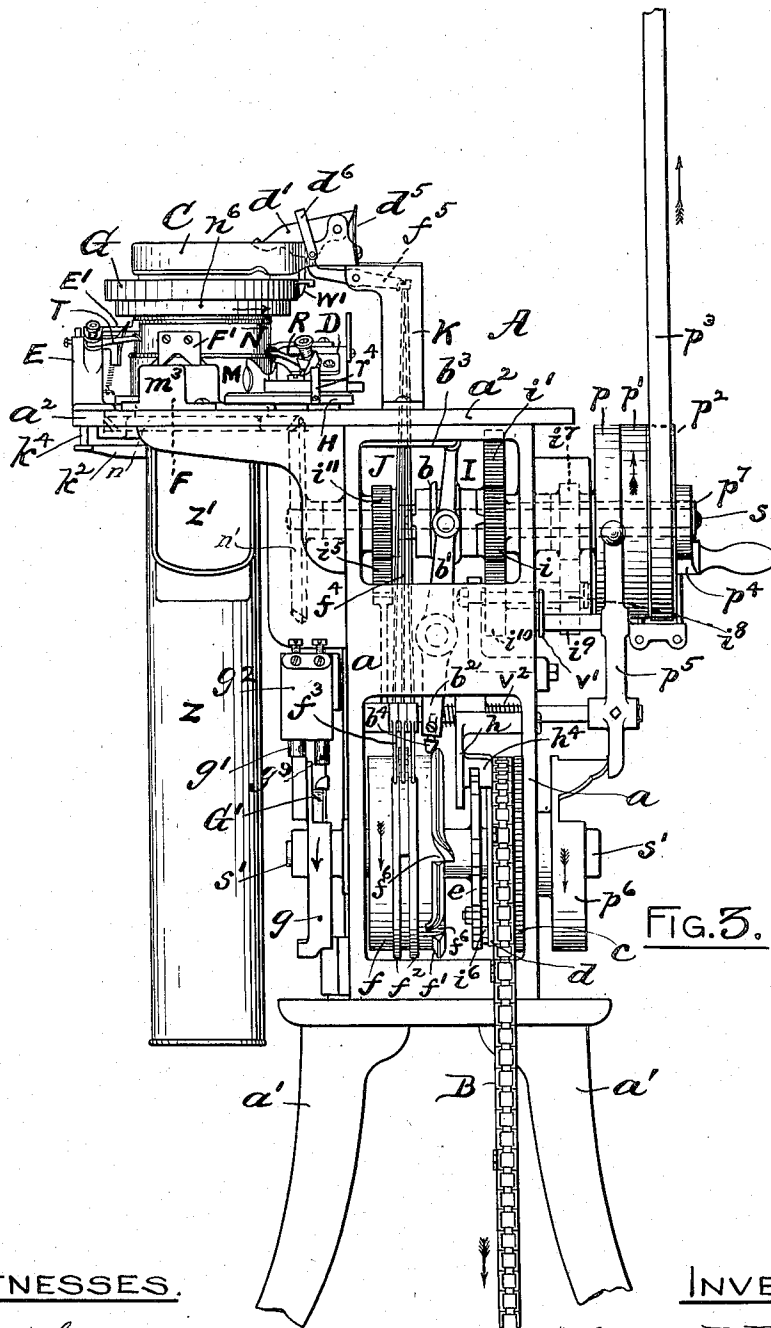
By *Wm. A. Remington*
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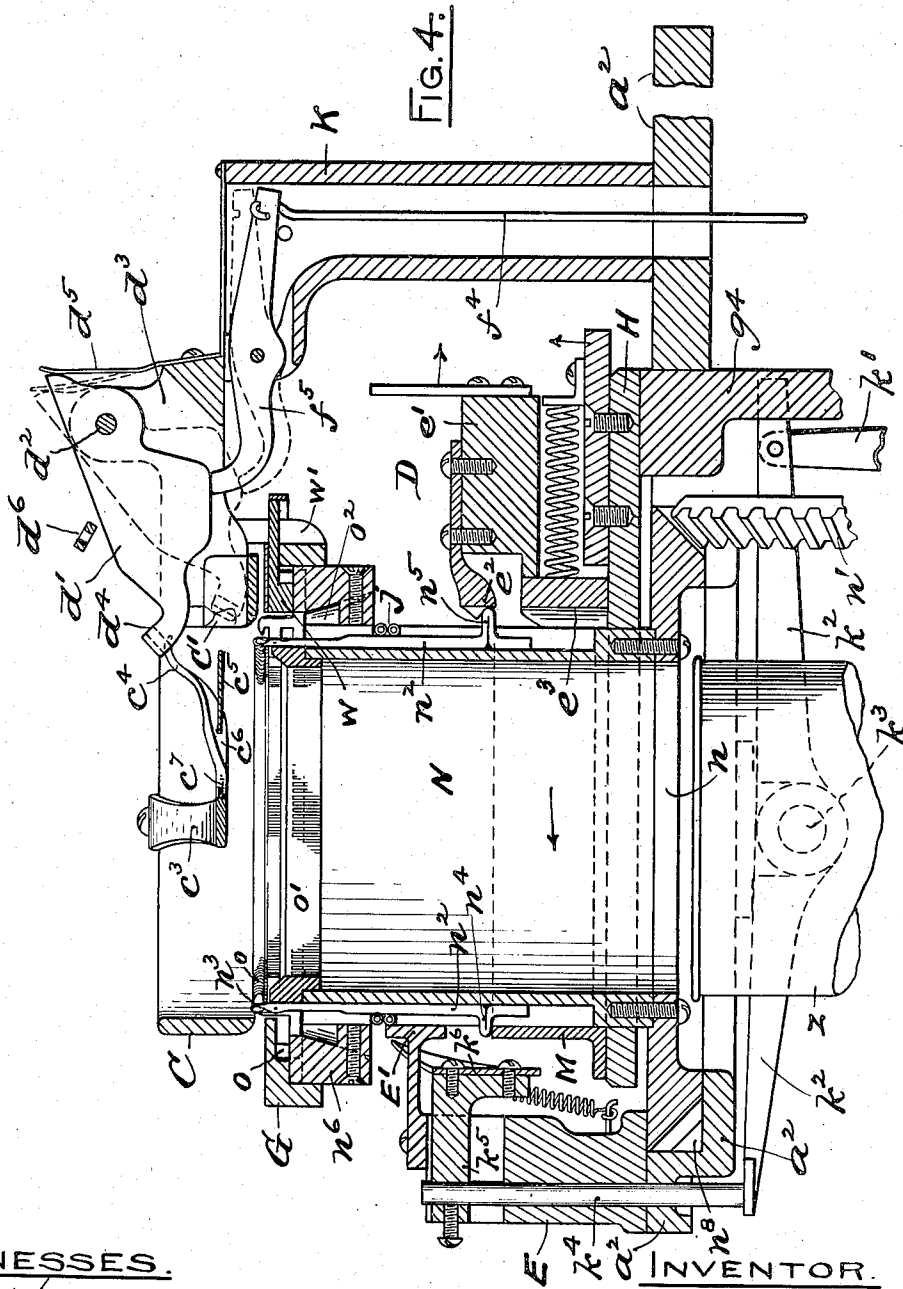
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WITNESSES.

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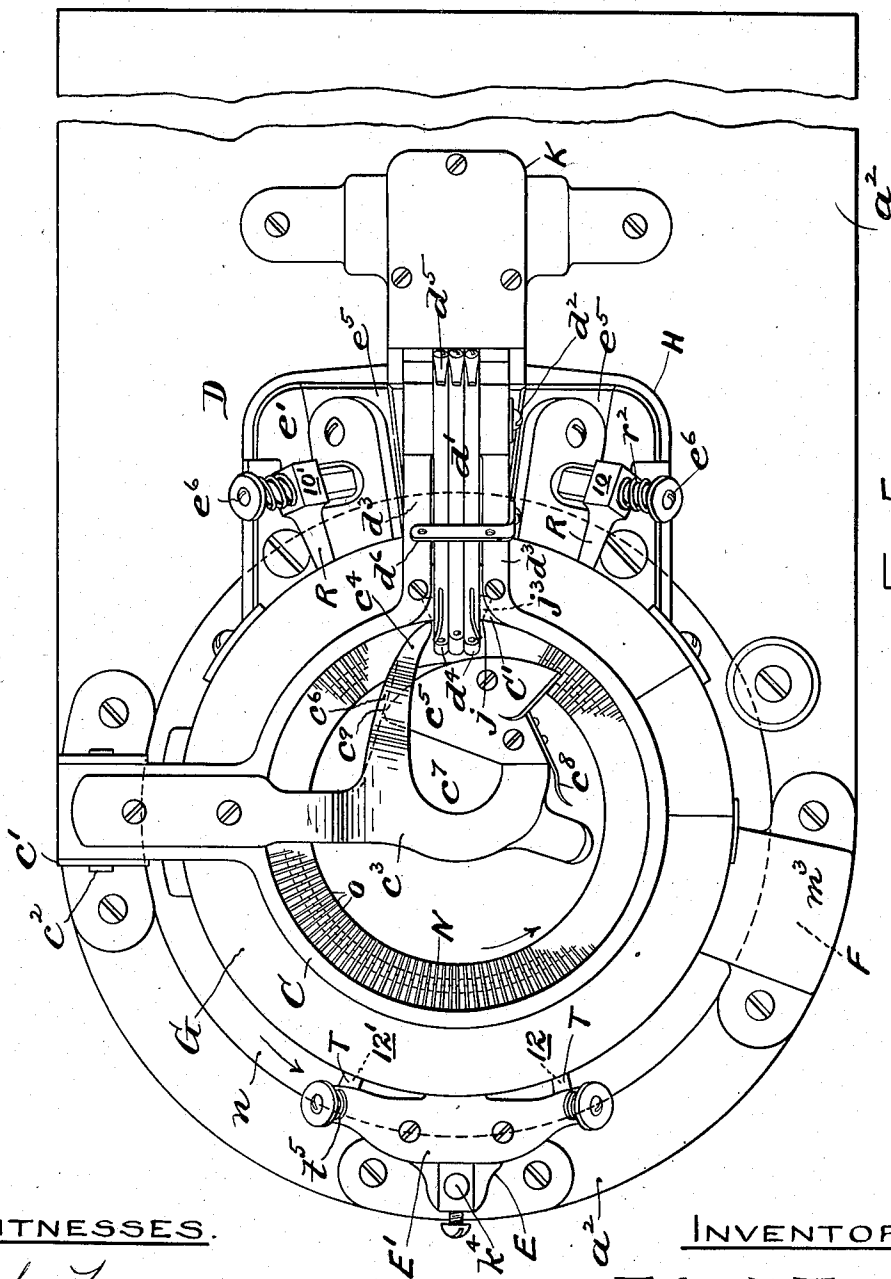


FIG. 5.

WITNESSES.

John Lawson
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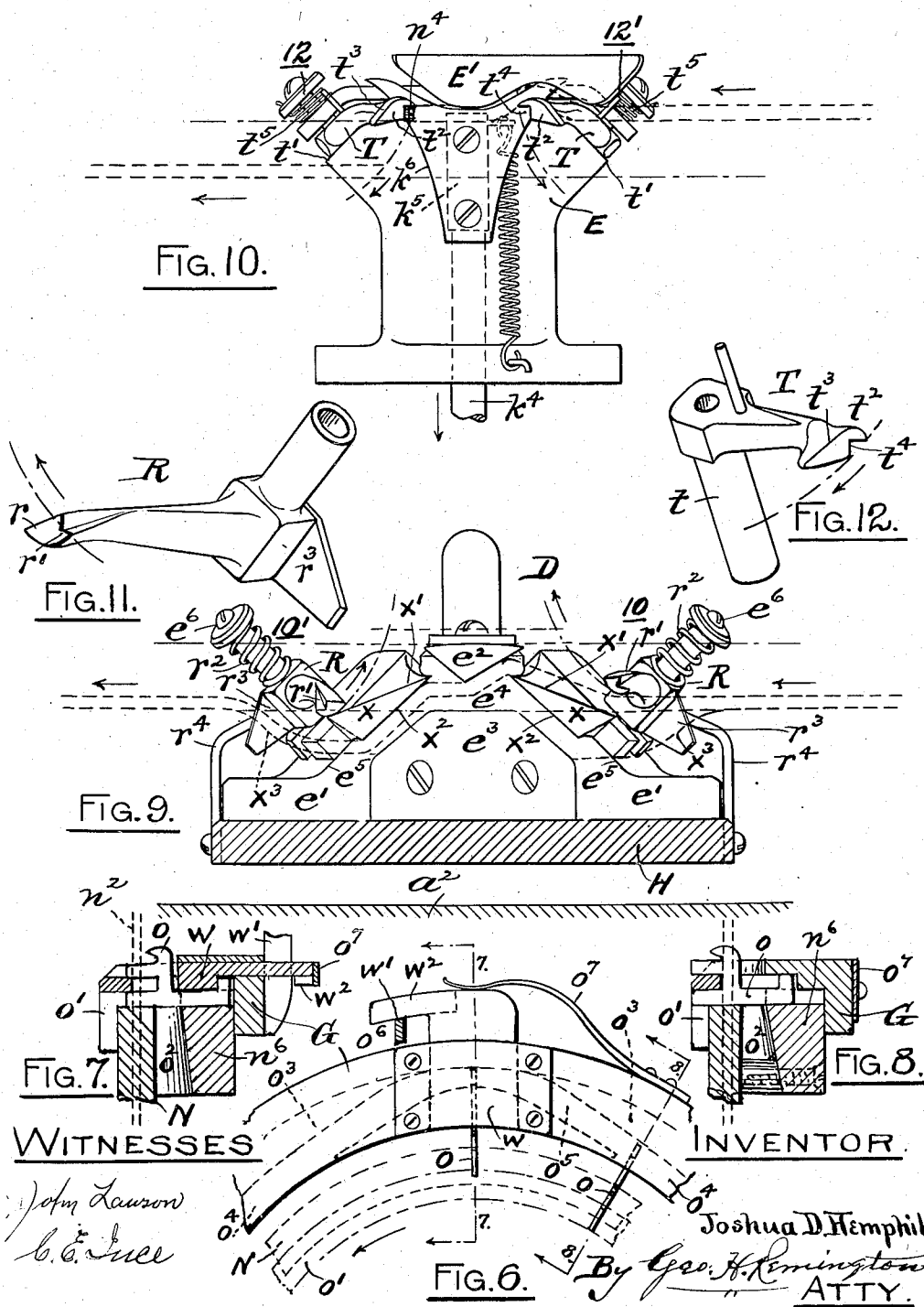
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 10 SHEETS—SHEET 6.



WITNESSES

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FIG. 6.

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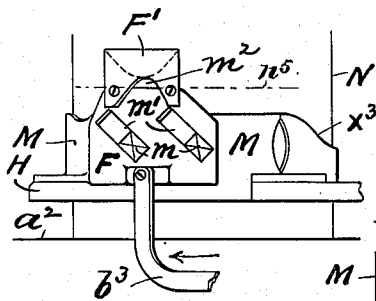


FIG. 14.

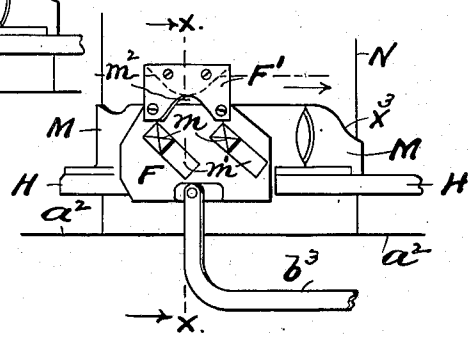


FIG. 13.

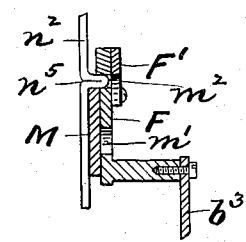


FIG. 15.

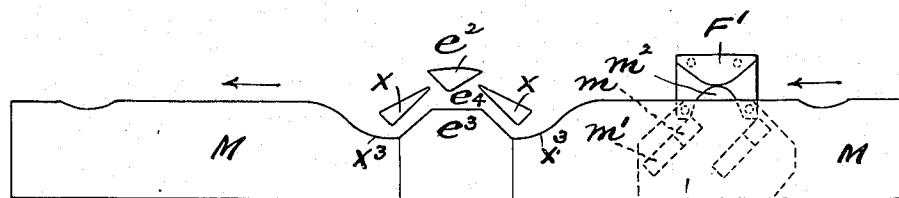


FIG. 16.

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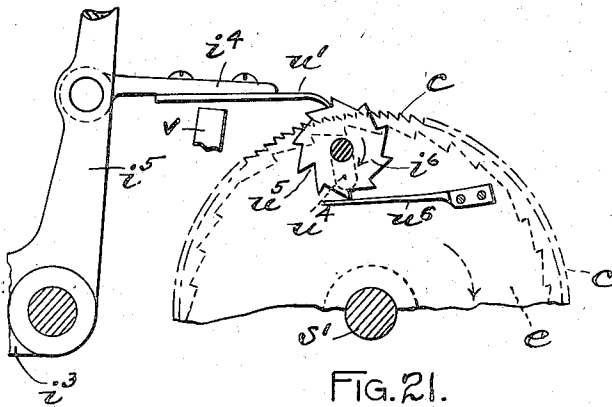


FIG. 21.

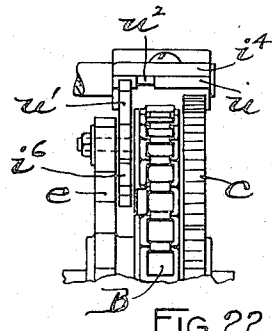


FIG. 22.

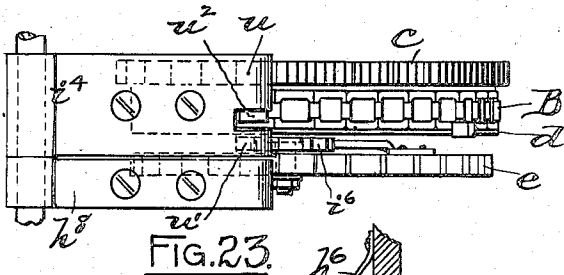


FIG. 23.

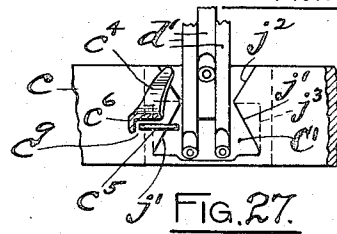


FIG. 27.

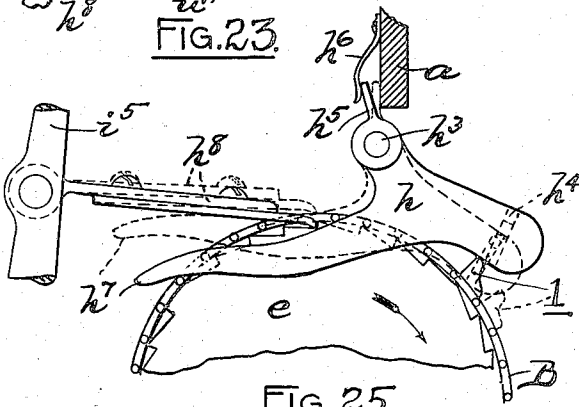


FIG. 25.

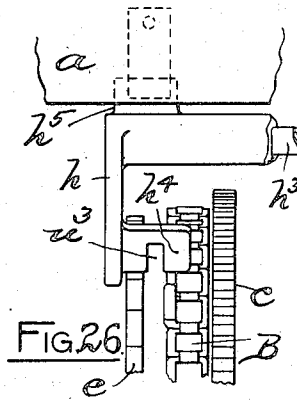


FIG. 26.

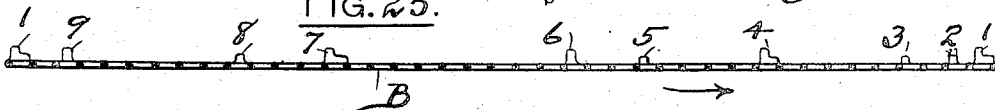


FIG. 24.

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FIG. 28.

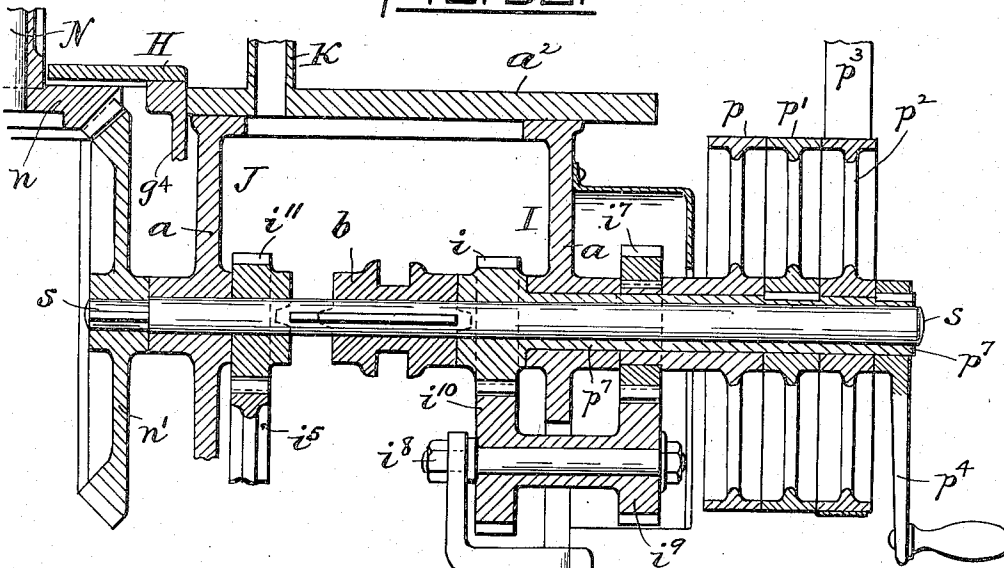


FIG. 29.

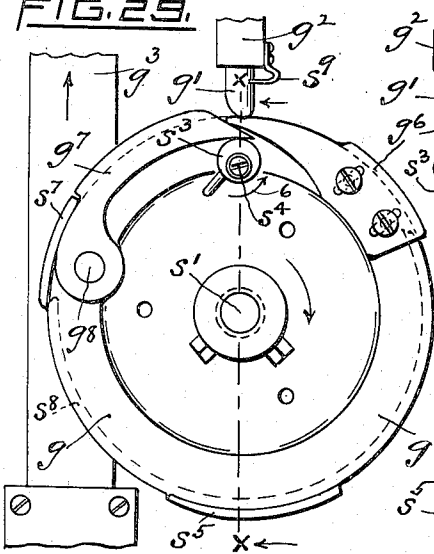


FIG. 30.

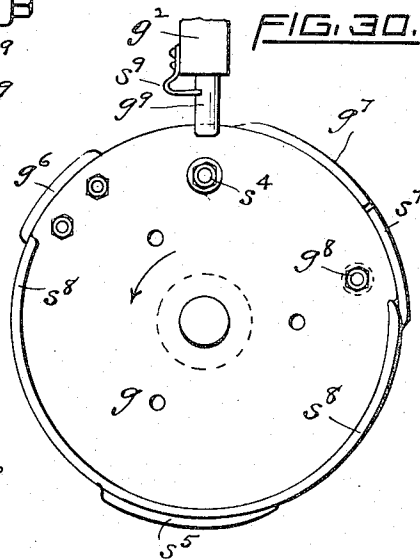
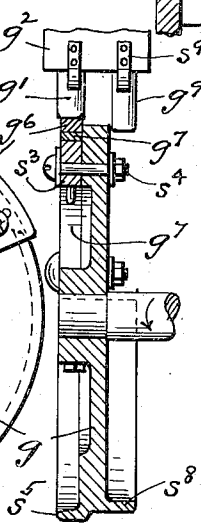


FIG. 31.



WITNESSES.

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CIRCULAR AUTOMATIC STOCKING-KNITTING MACHINE.

933,443.

Specification of Letters Patent. Patented Sept. 7, 1909.

Application filed March 26, 1906. Serial No. 308,106.

To all whom it may concern:

Be it known that I, JOSHUA D. HEMPHILL, a citizen of the United States of America, and a resident of Central Falls, in the county of Providence and State of Rhode Island, have invented certain new and useful Improvements in Circular Automatic Stocking-Knitting Machines, of which the following is a specification.

My invention relates to improvements in automatic knitting machines of the class or type more especially constructed and adapted for knitting stockings.

The machine forming the subject of this application for Letters Patent is provided with a vertically arranged revoluble annular cylinder carrying in its outer periphery endwise movable knitting-needles and co-operating sinkers, the needles being acted upon at the proper times by non-revoluble cams and picking devices, having their movements primarily controlled through the medium of an intermittingly traveling endless pattern-chain, so-called, provided with suitably disposed or positioned lugs or dogs movable in unison therewith. Said dogs further control the action of speed-changing, yarn-introducing and yarn-changing devices and also the movements of means for stripping the finished or knitted work from the needles and at the same time automatically stopping the machine, all as will be more fully hereinafter set forth and claimed.

I am, of course, well aware that machines for automatically knitting stockings have been produced prior to my improved knitting machine. Such former machines, too, were provided with lug-carrying pattern-chains and coöperating devices for changing the knitting action from circular to reciprocating-rotary and vice versa, &c.

The objects I have had in view in devising and developing my present invention were to eliminate as much as possible the disadvantages or objectionable features of former machines and to produce a knitting-machine adapted to be run successfully with less power and at an increased rate of speed, thereby correspondingly increasing the output or product, the machine, at the same time being materially lighter, smaller and more easily operated.

To that end my invention relates to improvements in the cylinder, whereby the ac-

cumulation of lint, &c., between it and the sinker-ring is prevented.

It further relates to an improved cam-block, whereby the same is adapted to be retracted so that the adjacent needles can be readily depressed by the attendant preliminary to the "topping" operation.

It further relates to means connected with the swinging latch-ring, whereby upon dropping the latter into the working position the sinker-cam is automatically positioned for service in advance of knitting.

It further relates to an improved yarn-changing device having swinging independent yarn-guides supported and actuated by members whose movements are automatically controlled at predetermined intervals.

It further relates to an improved latch-ring having yarn-guides pivoted therein, whereby when it is dropped to its normal position the said guides are brought into engagement with and supported by levers or members forming a part of the movement-controlling means.

It further relates to an improved latch-ring having members arranged to form an outer and a center opening united by a continuously open contracted communicating passage, whereby the float yarn is automatically deflected from the latter into said center opening and retained therein.

It further relates to a pair of improved self-dropping picks mounted on the main cam-block, each arranged to alternately receive a needle-butt and carry its needle to a higher plane during the narrowing process, and also arranged whereby upon manually retracting the cam-block the picks are automatically made inactive by swinging them from the path of the needles.

It further relates to the construction and arrangement of a pair of improved self-rising picks, each having its free end elongated and inclined to the shank's axis, its upper part having a recess thereunder adapted when positioned in the path of the advancing needle-butts to receive a pair of them therein from the front of the column and carry them to a lower plane, as in widening.

It also relates to an improved device for positively insuring the opening of any partly-closed latches of the traveling needles, whereby they are deflected downwardly to the full open position before reaching the yarn-receiving point.

It also relates to improvement in means for automatically controlling the action of the cams and picks, whereby the needles are vertically actuated while revolving in a circular path by and in unison with the knitting-cylinder.

It also relates to improvements in means for automatically changing the speed ratio of the cylinder, faster or slower, as required, with respect to the uniformly revoluble driving-pulley.

It also relates to improved means for stripping the knitted work from the needles, the same being automatically effected without raising the latch-ring and without disconnecting the yarn-changing means.

It also relates to an improved device or "multiplier" arranged to be automatically brought into and out of action at predetermined intervals during the knitting of the stocking, whereby the normal intermittent movements of the pattern-chain are temporarily suspended while the multiplier is in action.

In view of my said improvements, which form an essential part of and are more particularly adapted for use in the revoluble cylinder knitting-machine illustrated and described herewith, the following additional advantages may be referred to: The area or floor-space occupied by it is much less than is usually required; it is especially adapted to use a greater variety of knitting-yarns, because the loaded bobbins, being stationary, may be conveniently located and have any desired size and weight; it is adapted to work with greater smoothness and with much less momentum and vibration at the instant the change in speed takes place, that is, when the movements of the cylinder and other quick-moving parts of the machine are converted from a continuous rotary to a reciprocating-rotary action; the machine is comparatively simple and all its parts readily accessible; it is self-contained, neat and attractive in appearance, and the cost of manufacture is greatly reduced.

In the accompanying ten sheets of drawings, illustrating my improved circular knitting-machine, Figure 1 is a front or right end elevation, the relative position of the parts corresponding say to that at the completion of a stocking, wherein the machine is stationary, the work being omitted. Fig. 2 is a similar view, showing the opposite, or left end of the machine. Fig. 3 is a front elevation, in enlarged scale, some of the minor parts being omitted. Fig. 4 is a vertical central sectional view, still further enlarged, taken through the needle-cylinder, &c., on line 4 4 of Fig. 2. Fig. 5 is a plan view, corresponding with Fig. 4. Fig. 6 is a partial plan view of the cap-ring, showing the sinker-cam, &c., when in the normal operative position. Fig. 7 is a detail trans-

verse section, taken through the upper part of the cylinder, &c., as on the central line 7 7 of Fig. 6, showing the sinkers in action. Fig. 8 is a similar view taken on line 8 8 of Fig. 6, showing the normally inactive position of the sinkers. Fig. 9 is an end elevation, enlarged, of the main cam-block and its swinging needle-raising or narrowing-picks, viewed from the inner or concave side of the device, and also indicating in dotted lines the path of the needle-butts as in normal or plain knitting, the block being in the elevated position. Fig. 10 is a similar view, also viewed from the inner side, showing the widening device provided with the improved swinging self-rising needle-dropping picks in action, as in widening. Fig. 11 is a perspective view of the said narrowing-pick. Fig. 12 is a similar view of the widening-pick. Fig. 13 is a front elevation of the instep-cam device in the normal inoperative position, the housing being omitted. Fig. 14 represents the same positioned for action, as when elevating the long-butt needles. Fig. 15 is a transverse section taken on the central line *x x* of Fig. 13. Fig. 16 represents a development of the cams and needle-supporter surrounding the revoluble needle-carrying cylinder, and as viewed from the inner or concave side. Fig. 17 is an end elevation showing more in detail the means for normally actuating the pattern-chain, cam-shaft, etc., the pawl-controlling device being omitted. Fig. 18 is a similar view showing the means for releasing and actuating the yarn-carrying levers or fingers. Fig. 19 is an end view, corresponding with Fig. 2, showing in enlarged scale the means for vertically operating the horizontal or main cam-plate, the latter being shown in the temporarily dropped position, and also corresponding with Figs. 1 to 4. Fig. 20 is a similar detail view of the mechanism for controlling the movements of the widening-picks, &c. Fig. 21 indicates in dotted lines an enlarged end view of the main-cam or feed-wheel, and also showing the "multiplier" device, &c., when the latter is in normal action. Fig. 22 is a corresponding front view. Fig. 23 is a corresponding plan view of the parts. Fig. 24 is a diagram illustrating the pattern-chain and the relative position of its dogs or lugs thereon. Fig. 25 is an end elevation, corresponding partly with Fig. 21, but showing the pawl-controlling device. Fig. 26 is a corresponding front view. Fig. 27 is an elevation viewed from the inner side of the latch-ring, showing the latch-opening device, &c. Fig. 28 is an enlarged longitudinal sectional view taken through the center of the pulleys, gearing, &c., of the driving shaft; the relation of the parts corresponding with Fig. 3. Fig. 29 is an enlarged front elevation of the cams, &c., corresponding with Fig. 19; cam

G¹ being omitted. Fig. 30 represents a corresponding back elevation, and Fig. 31 is a vertical sectional view taken on line *x x* of Fig. 29.

5 I would state as briefly as may be that in my improved automatic stocking-knitting machine the needle-carrying or knitting-cylinder is revoluble, but not endwise movable, the needle-actuating devices or cams and also the yarn-holding bobbins being non-revoluble and normally stationary. The pattern-chain, as well as the wheels, &c. mounted on the cam-shaft, are intermittently rotated at predetermined intervals and in one direction only by means of controlling mechanisms operatively connected with devices through the medium of which the cylinder is rotated at a relatively increased rate of speed while plain or circular knitting is being produced and revolved at a greatly reduced speed while being actuated in a rotary-reciprocating manner during the formation of the heel and toe portions of the stocking. The power used is transmitted, as indicated in the drawings, through a belt adapted to run in one direction only and at a substantially uniform speed, the arrangement being such that when it is shifted onto one pulley the speed of the needle-cylinder is relatively increased, and when in engagement with the other pulley the speed is materially reduced, the machine automatically stopping and locking itself in the stationary position when the belt is shifted onto the idler pulley.

35 The following is a detailed description of my improved knitting-machine and including the manner of its operation:

The frame or box-like housing *a* of the machine is of neat design and supported by 40 legs *a*¹. The main driving mechanism, as well as the instrumentalities operatively connected therewith for actuating the revoluble knitting or needle-carrying annular cylinder *N* and the mechanisms for controlling the action of the speed-changing, yarn-changing and needle-moving devices, &c., are compactly mounted, conveniently accessible and practically inclosed in said housing. To the top of the frame is rigidly secured a flat table *a*², 50 the same being laterally extended at the left to support the cylinder *N* and the several cams and other devices arranged to cooperate with the needles for automatically throwing the latter into and out of action at predetermined intervals during the cylinder's rotation.

Located directly below and communicating with the bore of the needle-cylinder is fixed a vertical tube *z* into which the knitted 60 work is discharged from the needles, access to the tube being provided by means of the front side opening *z*¹, Fig. 3. Said table is also provided with a rearward extension *a*³ (Figs. 1 and 2) for supporting the stationary yarn-holding bobbins *y*, *y*¹, and suitable

yielding yarn-tension devices *y*², *y*⁴, adjustably secured to a vertical rod *z*² fixed in said extension *a*³. The yarn-holders, &c., are omitted from Fig. 3 of the drawings.

The relative arrangement, proportions, &c., 70 of the principal operative parts are, as drawn, such that the needle-cylinder is revolved once per revolution of the primary driving-shaft *s*. The shaft *s*¹ on which the speed and yarn-changing cams, &c., are secured or mounted makes one complete revolution during the production of each stocking or piece of knitted work. The ratchet or feed-wheel *c* and the sprocket-wheel *d* for carrying the endless pattern-chain *B* move 80 in unison, being secured to, or integral with each other, and are loosely revoluble on said shaft *s*¹. The pattern-chain, carried by the member *d*, is composed of a suitable number of connected links, and is provided with a 85 predetermined number of properly disposed lugs, later described. In the machine, as drawn, the wheel *c* is advanced in a well-known manner, say one tooth per four revolutions of the shaft *s*, while twelve revolutions of the latter advances the chain one 90 link.

It is to be understood that the length of the chain governs or controls the length or 95 number of courses of knitting in the stocking to be produced, and that the chain is continuously advanced in an intermittent manner until the entire length thereof has passed over the wheel *d*, the number of the latter's revolutions being equal to the circumference 100 thereof divided into the length of the chain, and does not necessarily have any direct relation to the rotation of said cam-shaft *s*¹. In other words, the total number of the whole and fractional courses of knitted 105 stitches to be made in the stocking is therefore normally twelve times the number of links constituting the length of the pattern-chain.

In order to avoid a material lengthening 110 of the chain, as would otherwise be usually required in producing the leg portions of ladies' long stockings, I use the device represented more clearly in Figs. 21, 22 and 23, wherein in lieu of employing an added number 115 of plain links in the chain, the coarse cam or ratchet-wheel *e* has adjustably pivoted thereto and carries, say a small ten-toothed ratchet-wheel *e*², which I term the "multiplier," adapted to be intermittently 120 rotated on its axis by a pawl *e*⁴ pivoted to and actuated by the bell-crank or quadrant-lever *e*³, one member *u* of said pawl meanwhile being automatically and temporarily disengaged from the teeth of the chain-moving 125 wheel *c* through the medium of the interposed said small wheel and other means later described. The form and the relative arrangement or timing of said lugs or dogs along the chain *B* are indicated in Fig. 24 of 130

the drawings, the same, as represented, being nine in number, and designated 1, 2, 3, 4, 5, 6, 7, 8, and 9, successively cooperate with and control the movements of the devices hereinafter described which are employed for speed-changing, yarn-changing, needle-actuating, &c., during the knitting of the stocking.

In my improved knitting machine I employ a suitably mounted revoluble driving-shaft s having a miter or bevel-gear n^1 secured to the inner or left end thereof and intergearing with a similar gear n rigidly secured to the lower end of the needle-carrying cylinder N , Figs. 3, 4 and 28. A clutch-hub b is slidably mounted in a well-known manner on a key or feather secured to the shaft, all the other members, except gear n^1 , being loosely mounted on it. At the right of the clutch-hub, being the quick-speed side, I , is a small clutch-gear i having a long integral hub or sleeve p^7 extending outwardly through the frame a and carrying at its outer end the loose or idle pulley p^2 and the fixed crank p^4 . A pulley p^1 is fast to said hub of the spur-gear i and a pulley p loosely revoluble thereon, the last-named pulley having the small spur-gear i^7 , indicated in Fig. 28, secured to or integral therewith. Parallel with and located below shaft s is supported a stud i^8 on which the double-gear, i^9 i^{10} , loosely revolves. The arrangement of all said gears constitutes a form of compound speed gearing. In practice I make the gears i^7 and i^{10} alike in diameter and somewhat larger than the gears i^9 and i , also alike. The said pulleys are or may be uniform in size and always revolve in one direction, one driving-belt p^3 only being employed. The pulley p , revoluble on said hub p^7 , I designate as the "quick-speed" pulley, because one revolution thereof will, through the gear-train i^7 , i^9 , i^{10} and i , rotate the shaft, and therefore the knitting-cylinder N (when gear i is in clutch with b) more than one turn, as determined by the proportions of the gearing all as clearly shown in Fig. 28. Intergearing with, located at the back of, and actuated by the continuously revoluble small gear i (which turns in one direction only) is suitably mounted a larger gear i^1 , Fig. 1, (the ratio being, say 4 to 1) having a crank-pitman i^2 jointed thereto and to the short arm i^3 of the pivoted rocking bell-crank lever, its long arm, i^5 , being segment-shaped and having gear-teeth cut in its outer periphery, the latter being in continuous working engagement with the loosely mounted spur-gear i^{11} to drive it in a rotary-reciprocating manner. The action of the other or "slow-speed" pulley p^1 keyed to gear i , as before stated, operates by means of gear i^1 , segment i^5 , gear i^{11} , &c., to rotate the shaft and cylinder back and forth when the clutch-hub b is moved toward the left and interlocks with said gear i^{11} of

the slow-speed side J , the last-named gear then revolving the shaft, its speed ratio being very much reduced thereby. Or, in other words, the driving-belt will revolve pulley p^1 several revolutions to one of the cylinder. By means of the arrangement of gearing, &c., thus described the speed of the revolving knitting-cylinder is increased (with respect to the speed of the driving-belt) when producing circular work, and materially decreased while knitting the heel and toe portions, as when the cylinder is actuated in a rotary-reciprocating manner.

To the front end of the intermittingly movable cam-shaft s^1 is secured a cam p^6 for controlling the movements of the spring-pressed belt-shipper p^5 , the latter being in yielding contact therewith. Fig. 3 represents the position of the cam and shipper when the machine is stopped, as at the completion of a stocking, the driving-belt p^3 then running on the idle pulley p^2 . At the instant of stopping the latch v^1 drops by gravity into engagement with the shipper thereby locking the latter in position. See also Fig. 1.

The cylinder N (see enlarged sectional view Fig. 4) is tubular, its lower end being secured to a horizontal bevel-gear n intermeshing with a fellow or driving-gear n^1 , in turn secured to the inner or left end of the driving-shaft s , substantially as before stated. Said gear n is fitted and supported in a circular recess n^8 formed in the upper face of the table a^2 . The cylinder, which is of less diameter than the said gear, has its peripheral or barrel portion provided with uniformly spaced longitudinal grooves to receive the movable knitting-needles n^2 therein. Needles of this class each have a hook n^3 at the upper end thereof and a lateral projection or butt at or near the lower end. Usually about one-half of the total number of needles have what are termed "long butts", as n^5 , the remaining needles having "short butts", n^4 .

To the top of the cylinder N is secured an inner ring member o^1 having radial grooves formed in its upper and lower portions and alternating with said needle-supporting grooves formed in the cylinder proper. The outer edge of the ring projects above but does not, however, extend laterally beyond the bottom of the said cylinder-grooves. A laterally extending flange n^6 , termed the sinker-ring, encircles the upper outer part of and extends a short distance above the cylinder barrel, the same having radial grooves registering with those of said ring o^1 and in which are seated and supported the thin horizontally movable sinkers o , the function of the latter being in general substantially the same as that of sinkers as usually employed. The inner wall of the sinker-ring is cut away so as to form a con-

continuously open enlarged annular clearance space o^2 between it and the adjacent outer surface of the wall of the cylinder for the free escape of lint, &c. The ring is rigidly secured to the cylinder by means of screws passing through inner bosses integral with the ring, all as clearly shown in Figs. 4 and 8.

The sinker-carrying ring portion of the revoluble cylinder is surmounted by a recessed stationary cap-ring G; the latter being supported by said ring member n^o and held in the horizontal position against rotation by suitable means connected therewith and with the standard c^1 carrying the latch-ring C. The under side of the cap-ring is provided with a fixed cam o^3 and concentric groove o^4 in operative engagement with the outer end portion of the said supported sinkers, whereby the latter are reciprocated in their seats, while at the same time being carried bodily around and inactive in said concentric groove o^4 by the revolving cylinder. The ring G, see Figs. 4, 6 and 7, is further provided with a suitably mounted normally stationary horizontal cam w , also located in the path of the sinkers and at the usual knitting or stitch-forming portion. The cam extends through the side of the cap-ring and terminates in a bent arm w^2 arranged to form a space or opening o^6 between it and the adjacent peripheral surface of the ring; the arrangement being such that a downwardly extending dog or finger w^1 fixed to the under side of the latch-ring member and positioned in said opening o^6 maintains the cam in the normal retracted or operative position to properly actuate the sinkers.

Upon stopping the machine, as at the completion of the work, the act of lifting the latch-ring withdraws said finger w^1 from the cam, a push-spring o^7 at the same time automatically advancing the latter inwardly to its limit, thus temporarily moving the corresponding sinkers thereon out of the normal working position, all the sinkers then registering or lying in the circular path and being inoperative. By means of this device the points of the transfer-ring readily position themselves back of the respective needles when the operator applies it to the cylinder preparatory to the "topping" operation. This latter consists in placing the transfer-ring, having the previously knitted ribbed "top" mounted as usual on the grooved points thereof, so that the latter rest on the top end of the ring o^1 of the cylinder. While the cam is in this position the cylinder with the transfer-ring thereon may be readily turned in either direction by the attendant without injury to the transfer-points by the sinkers; this I consider of especial practical value. After the topping process has been effected the act of return-

ing the latch-ring to the normal position reintroduces the said finger w^1 into the space o^6 and automatically forces the cam w and the sinkers thereon back to the operative position immediately preceding the resumption of knitting.

The latch-ring C (see Figs. 2, 4 and 5) is pivoted or jointed to the standard c^1 located at the rear of the needle-cylinder, its axis c^2 and also the axes d^2 of the yarn-guides d^1 (later described) being located in horizontal planes and at right angles to each other. The latch-ring is provided with a guard or arm c^4 and a spring plate c^5 having a curved lip c^6 arranged to form a narrow yarn passage communicating with the main or central opening c^7 . I make no specific claim herewith to this construction. The latch-ring is provided with another novel device, the same being employed for positively insuring the opening or dropping of the latches of the needles, that is, means for automatically dropping the latches without injuring them while the cylinder is in action and before they pass the stitch-forming point. The construction is shown more clearly in Fig. 27, which is an end elevation viewed from the center of the ring. The free ends of two of the yarn-guide levers d^1 are represented in the normal working position, the other lever being elevated or temporarily inoperative, all being located in the mouth portion of the opening C¹. The lateral sides j^1 of the lower or major portion of said opening have a dovetail form or undercut, and also rearwardly beveled, see also dotted lines j^3 , the upper part j^2 being flaring in an upward direction. As thus devised the face of the needles, while the cylinder is revolving in either direction, pass comparatively close to the face or edge of the opening C¹, so that the partly open latches upon striking the beveled edge j^1 will be deflected downwardly to the normally wide open position before the hooks of the needles will have reached the yarn-receiving point.

A non-revoluble, but vertically movable horizontal flat plate H, Fig. 4, which I term the cam-plate, is bored to receive the revoluble needle-cylinder therethrough and is located above and contiguous to the said gear n . To the upper side of the plate, and at the right of the cylinder, is mounted the improved slidable spring-pressed cam-block device D carrying the main knitting or needle-operating cams and narrowing-picks, later described, which are brought into action during the knitting of the stocking. See also Fig. 9, the latter figure being in enlarged scale and viewed from the inner or concave face of the device.

The block proper, e^1 , has secured thereto on its inner or working face the upper central guide member e^2 , the lower central guard member e^3 , (the space e^4 between them form-

ing a path for guiding the needle-butts) and the oppositely disposed or right and left wedge-shaped members or knitting-cams w , usually termed "raise and draw cams"; the upper sides w^1 thereof when in use deflect the needles upwardly and the lower beveled sides w^2 deflect or draw the needles downwardly, the latter after passing thereunder engage the recessed cam surface w^3 of the non-revoluble annular needle-supporting member or cam M and deflect the needles to the top edge thereof, all-arranged whereby the device is adapted to impart to the traveling needles the usual wavelike movement at the knitting point, while the cylinder may be revolving in either direction. The cam M (see Figs. 13 to 16) practically surrounds the lower part of the cylinder and is secured to and vertically movable with said cam-plate H, and is also adapted to support the inactive needles at the normal lower level while circular knitting is being produced.

The front and rear sides e^5 of said block D are oppositely beveled, each side being provided with a fixed pin e^6 perpendicular thereto on which swing the respective narrowing-picks R, later described. The fixed axes or pins e^6 extend upwardly at an angle in opposite directions, Fig. 9.

The horizontal spring-pressed cam-carrying block D is movably guided in an endwise direction toward and from the cylinder, the inner or convex face of the cam members, w , e^2 , e^3 , being normally contiguous to the peripheral surface of the revolving cylinder. In order to depress to the normal lower level the few needles remaining in an elevated position at the completion of the work the block is adapted to be pressed rearwardly from the cylinder by hand (or toward the right), thereby forming a space between the cams and cylinder to permit the free passage of the butts of said elevated needles when the latter are pushed downwardly by the attendant. See corresponding position, Fig. 4. The act of thus retracting the block causes the arms r^3 of the two narrowing picks R to engage stationary stops r^4 (Fig. 3) secured to plate H, thereby swinging the shanks of the picks upwardly and outwardly out of position so as to allow the needles to be depressed, as just stated.

The means as drawn and employed for effecting the comparatively short vertical movement of the said cam-plate H and the devices carried by it are constructed and arranged substantially as follows: A cam-wheel or member g is secured to the rear or left end of the cam-shaft s^1 . See Figs. 2, 3 and 19. To the front periphery of said wheel (Figs. 19 and 29) are adjustably secured the curved cam-members g^6 , g^7 , the latter being pivoted at g^8 , its opposite end being supported by the small eccentrically mounted short roll s^5 arranged to be secured

in the adjusted position by the pin or bolt s^4 . The rear peripheral portion of said wheel or cam member g is also suitably shaped. That is to say, referring more particularly to Figs. 29 to 31, it is provided with a concentric flanged rim s^3 , a portion of the latter being cut away. The front face of member g is also provided with short concentric rim sections, s^5 and s^7 ; the outer radii of said sections being substantially the same as said cam members g^6 and g^7 , as clearly indicated in the drawings.

The main cam-plate H has a bent supporting arm g^4 secured to its under side, in turn secured to the flat vertically guided bar g^3 80 to which is secured the offset holder g^2 , in which latter the two vertical cam contact pins, g^1 and g^9 , are adjustably mounted. The front pin g^1 is adapted when in use to engage the corresponding or front cam members, and the other or rear pin, g^9 , the flanged portion s^5 of the cam-wheel g . The upper ends of the contact-pins bear against the lower ends of screws adjustably mounted in said holder g^2 . Fig. 19. The two pins are maintained in yielding engagement with the respective screws by means of light springs s^6 secured to the holder, the free ends of the springs being fitted in notches cut in the pins, substantially as indicated in Figs. 29 95 to 31. In the production of half-hose the periphery of cam g^7 is concentric with the shaft s^1 , but when long hose are to be made its free end is lowered slightly by turning said member s^3 a short angular distance in the arrow direction 6 and resecuring it in position. See Fig. 29. As thus constructed and positioned the cam-plate H and the members secured to it operate to gradually shorten the stitches during the knitting of the leg portion of the long stocking. The normal short length of the stitches is attained when the front pin g^1 passes from the rear end of said members, g^7 and s^7 , corresponding with the completion of the ankle portion and immediately preceding the introduction of the heavier yarn and the knitting of the heel. At the same time that the pin g^1 passes from the cam the other or rear pin g^9 engages the rim s^5 , thus limiting the cam-plate's short downward movement. The last-named pin and its cam or rim s^5 control the movement of the cam-plate, &c., during the knitting of the heel and toe portions. The front pin g^1 , &c., control the knitting of the circular work only. At the completion of the heel the concentric front member s^5 will have engaged the pin g^1 , thereby again elevating the plate, &c., to the normally high level, corresponding to the said short-length-stitch position, to produce the circular portion of the foot of the stocking. At the termination of the last-named action the front pin drops from the cam, thus again lowering the cam-plate, the rear pin g^9 at

the same time engaging the rim s^3 whereby the heavier yarn is reintroduced to produce the toe portion. Thus it will be seen that during one complete revolution of the cam-shaft the cam-plate is raised and lowered a short distance at intervals corresponding with the arrangement and "lift" of the cams or projections positioned around the periphery of the cam-wheel or member g .

10 The plate drops by gravity as the cam members pass from under the said contact-pins.

The following is a description of the said narrowing-picks R and the manner of their operation: I would state in advance, however, that in narrowing all the long-butt needles are first mechanically elevated from the working or normal circular knitting position to the non-working level; the elevated needles then forming a continuous semi-circular row or column, the gap or space between the ends of the row then being semi-circular also. At the same time all the short-butt needles are standing in the lower or working plane; these needles also form a semi-circular column (but opposed diametrically to the said column of elevated needles) having a semi-circular gap between the ends of the column. Now, upon actuating the cylinder in a rotary-reciprocating or oscillatory manner the action of the narrowing-picks R alternately elevates out of action a short-butt needle from each end of its column, the operation being continued until the desired narrowing point is attained.

35 Said action adds the short-butt needles alternately to the ends of the row of the elevated long-butt needles thereby decreasing the gap in the latter column and correspondingly increasing the gap in the lower or working column of needles.

40 In the widening operation, which commences immediately succeeding the said narrowing part, each pick T throws down two needles alternately from each end of the column of elevated or non-working needles to the normal working plane, thereby correspondingly adding to the length of the then remaining comparatively short column of working needles and at the same time increasing the gap between the ends of the column of the non-active needles. This statement, however, is not literally true because the narrowing picks are continued in action throughout the widening process, and until the completion of the knitting of the heel or toe portion, as the case may be, and the resumption of circular knitting, at which instant all the picks are rendered automatically inoperative.

60 Referring now more particularly to the narrowing picks R: The outer or free end r of the shank of each of said picks is suitably shaped and provided with a narrow shouldered seat r^1 . See also Fig. 11. When circular or plain knitting is being made the

revolving cylinder, moving in the arrow direction, Fig. 9, carries the needles around with it, all the needle-butts then traveling in the path indicated by dotted lines in said figure; the arrangement being such that the outer end of the front pick 10 normally rests upon and is supported by the moving butts of the then continuous series of needles; the corresponding part of the other or rear pick 10¹ is then in its lowermost normal position and resting upon the upper side of the corresponding knitting-cam x , the butts at the same time being deflected below the pick by said cam while the stitches are being produced. A light helical spring r^2 insures the dropping of the picker-arm to its lowermost position. The bottom of the seats, r^1 , of the picks, when the latter are resting upon the cams x , are adapted to be in alinement with the underside of the needle-butts when the needles are in the normal working plane, the butts then moving in a straight path, except when being temporarily deflected below the knitting-cam, as before stated. The rear pick, 10¹, represented in Fig. 9, is shown as being in position to receive in its seat the butt of the advance working needle when the direction of rotation is reversed, as in narrowing.

The narrowing process begins immediately succeeding the elevation of all the long-butt needles to the upper or non-working plane, indicated by the upper set of dotted parallel lines in Fig. 10; the direction of the cylinder at the same time being automatically changed from continuous rotary to an oscillatory movement. Now, the action of the cylinder in the first reverse stroke carries the butt of the first needle of the then advancing row of short-butt working needles into the seat r^1 of the rear pick 10¹ (the latter then resting on the corresponding cam x , as indicated in Fig. 9, and lying in the normal working plane or path). The combined action of the moving cylinder and the butt of the advance needle seated in said pick swings the latter upwardly in a circular arc, thereby placing the needle in the said upper plane and out of action and adding it to the corresponding end of the row of non-working needles. This result is due to the fact that as the pick is pivoted in an angular plane, its free end gradually recedes from the cylinder in moving upwardly through said arc until it slides from the butt, thus placing the needle at the higher or non-working level, as just stated. At substantially the same instant the spring r^2 swings the pick downwardly, its free end then being arrested by and resting upon the upper side of the butts of the still advancing row of working needles. These latter advance in a straight line or path until they successively engage the beveled side x^2 of the front cam x whereby they are deflected under it, the movement being continued until

all the then working needles have been deflected upwardly by the corresponding rising cam α^3 into the normal working level and past the front pick 10, the arm of the latter then being in the lowermost position and resting upon the corresponding cam α . The rear or last one of the column of short-butt needles will upon the reversal of the cylinder's stroke then become the advance needle and seat itself in the said then stationary and positioned front pick 10; the succeeding action for placing the needle upwardly out of service and adding it to the corresponding end of the row of non-working needles being the same as before stated with respect to pick 10¹.

It may be explained here that in producing circular knitting wherein the cylinder is rotated continuously in one direction the arm of the spring-pressed front narrowing pick 10 rests upon and is supported by all the needles, both long and short-butts; the rear pick 10¹ at the same time resting stationary upon the rear knitting cam α , the butts of the needles being successively deflected downwardly by the corresponding cam α^2 and thence upwardly by the rising-cam α^3 , as indicated in Fig. 9. No gaps are present in the column of needles except when the cylinder is actuated in an oscillatory manner, as in narrowing and widening. The oscillating or reciprocating movements elevate a needle alternately from each end of the column until the desired narrowing has been produced, and as controlled by the means later described.

The needles mounted in the revolving cylinder are always normally immovable in a longitudinal or endwise direction, except when they are being actually engaged by and acted upon by the cams and picks. The needles are slightly resilient in a lateral direction whereby they are supported by frictional contact against the adjacent walls of the grooves in a well-known manner. At the same time the needles are kept properly seated in said grooves by means of the encircling resilient band j mounted in the peripheral groove formed in the cylinder, the band bearing against the front of the needles also, as usual.

To the top of the table α^2 and at the extreme left thereof is secured a vertical stand or bracket E in which are pivotally mounted the pair of oppositely disposed spring-pressed or self-rising widening-picks T, 12 indicating the front, and 12¹ the rear one, the same being located contiguous to the knitting-cylinder and opposite the said narrowing-picks R. The hubs t of the picks T are fitted to swing in holes drilled at right angles or perpendicular to the plane of the front and rear oppositely beveled sides t^1 of the stand, substantially as described with respect to the narrowing-picks. See also

Fig. 10. At the end of the said narrowing process all the long-butt needles and all the then inactive or elevated short-butt ones will form a continuous series or long row of idle needles, the two ends of the row being separated by a short gap equal and diametrically opposed to the length of the short column of needles remaining in the lower or working plane. The latter is indicated by the lower parallel dotted lines in Fig. 10 and corresponding with said lower lines represented in Fig. 9. The relative position of the butts of the inactive needles is indicated by the upper parallel dotted lines in Fig. 10. In widening two needles are forced down alternately by picks 12 and 12¹ from each end of the said long row of idle needles during each double-stroke of the cylinder, thereby at the same time correspondingly increasing the length of the lower short row of working needles. The narrowing picks, however, do not cease from action after the widening commences but continue to throw up a needle from each end of its increasing column alternately and until the action of the widening picks has returned all the short-butt needles back to the lower or normal working plane, at which instant all the picks are rendered inactive and continuous circular knitting again commenced. The inner or free end portion t^2 of each widening pick T is arranged at an angle with the shank's axis and is considerably elongated, its upper side t^3 being inclined or cam-shaped, the under side having an open recess t^4 at the upper portion adapted to receive therein the butts of a pair of needles. When the picks T are in use, as in widening, the cylinder meanwhile being reciprocating, said side t^3 forms a guide for the then elevated or non-working short-butt needles previously positioned by the said narrowing-picks. The forward or advancing end of the column of needles after riding say over the rear pick member 12¹ (see arrow direction, &c., Fig. 10) engages the stationary cam E¹ which in turn positively guides or vertically positions the butts so as to be in horizontal alinement with the open recess or seat t^4 of the other or front pick member 12 in yielding engagement with and temporarily arrested by the adjacent slightly curved edge of the then elevated gage-plate k^0 , so that when the butts engage the abutment of said recess the joint action of the moving cylinder and said inclined pick swings the two needles downwardly in a circular arc into the lower or normally level working path. The said pick-action is substantially the same as before described with respect to the narrowing-picks. At the instant the pick releases the two thus dropped needles the light spring t^5 automatically returns it (said pick 12) upwardly, it being temporarily arrested in said movement by the contact of its upper or

cam side t^3 with the underside of the butts of the still advancing idle needle column. As the last butt of the column passes over the two picks the force of the respective springs t^5 swings the pick's arms upwardly and against the underside of the normally positioned gage-plate k^6 , so that upon the return stroke of the cylinder the needle column will be guided over the cam end of the front pick 12 and be deflected downwardly by cam E^1 , whereby the butts of the two forward needles (being the last two needles of the previous stroke) will properly enter the positioned open seat t^4 of the rear pick 12¹, the resulting action swinging the two corresponding needles downwardly in a circular arc into the lower or working path, as described with respect to the front pick member; the operation being continued to throw down a pair of short-butt needles from each end of the oscillating column until the widening process is completed. During the production of normal circular and normal narrowing knitting, however, the free ends of the widening-picks are kept inactive and stationary at a short distance above the normal level or horizontal working line of the active needles by means of the correspondingly positioned gage-plate k^6 .

The following describes the mechanism represented for controlling and positioning the widening picks T. To the back of the intermittingly movable cam-plate g is secured a suitably shaped cam member G^1 (shown detached in Fig. 20) having one end of the lower horizontal lever k in continuous frictional engagement with its periphery, the other end being jointed to the vertical link k^1 , in turn jointed to the bent horizontally arranged lever k^2 . The last-named lever extends partly around the left end of the machine and toward the front and is pivoted at k^3 to the back of table a^2 . The free end of the lever carries a rod k^4 vertically guided in the bracket E, said rod having a horizontal spring-retracting arm k^5 adjustably secured to its upper end. See also Fig. 4. To the inner end of said arm is secured the substantially V-shaped vertical gage-plate member k^6 , the underside of the diverging wings or members thereof being in practically continuous yielding frictional contact with the upper side of the shanks of the respective widening picks. The periphery of said cam G^1 (Fig. 20) is disk-like and provided with a number of true arc-shaped sections, 1, 2, 3 and 4, having uniform radii, alternating with notches, 5, 6, 7 and 8 respectively. The arrangement being such that the diverging wings (Fig. 10) of said gage-plate k^6 automatically govern the position of the picks T. The plate, &c., being so connected, positioned and timed that when the lever k is in contact with the longer section 1 of the cam the

picks are thereby placed in the maximum elevated position, shown in Figs. 4 and 10, while the leg or circular knitting part of the stocking is being produced. All the needles then being in the lower or normal working plane. At the termination of the ankle part, being at the commencement of the heel-narrowing operation, the cam will have moved so that the lever drops into the first notch, 5, thereby lowering the plate k^6 and its picks, the latter then standing stationary in the lowest position, or about midway between the upper and lower rows of butts, the long-butt or idle needles meanwhile having been elevated and constituting the said upper row. At the completion of said narrowing part, and immediately preceding the commencement of the heel-widening portion, the cam will have been advanced again thereby elevating the lever from said notch or recess, 5, onto the concentric section 2 thereby correspondingly elevating the plate and picks to the said upper position, the seats t^4 of the picks then being again in normal alinement with the path of the butts of the non-working needles so as to throw down a pair of the latter from the corresponding end of the column at each oscillation of the cylinder, as before described.

At the completion of the heel-widening portion the free end of lever k enters the notch 6 for an instant, thereby dropping the picks during a partial revolution of the cylinder N so as to avoid the long-butt needles while the latter are being dropped into action by the instep-cams F, F¹, to place all the needles in the lower or working plane. The thus short quick movement of the cam G^1 immediately places the section 3 in position, thereby again elevating the picks and commencing the knitting of the circular work, *i. e.*, the foot part of the stocking. When the latter is completed the cam will have been advanced so that the recess or notch, 7, will register with the lever; the latter now in dropping into the recess depresses the picks out of action, all the long-butt needles being elevated at substantially the same instant, followed by knitting the toe-narrowing portion substantially as before described with respect to cam-notch 5. The toe-widening operation is effected in the same manner as in the heel-widening process: that is the cam section, 4, and its co-related members elevate the widening-picks, the latter then acting to throw down to the working plane two needles alternately from each end of the column of elevated needles while the narrowing-picks at the same time throw up one needle from each end of the column of lower or working needles.

When the toe portion of the stocking is completed the lever k quickly passes into

and out of notch 8, substantially as before stated with respect to notch 6, thereby while the picks T are depressed permitting all the elevated or long-butt needles to be deflected into the lower or normal knitting plane.

At the same time the said quick movement of the cam advances the adjacent part of the plain section, 1, under the lever *k* to again elevate the picks to the upper level, all the needles then being in the lower plane. After producing a few courses of circular knitting the machine automatically stops.

I may add that in my improved picking devices the construction is extremely simple and inexpensive and also positive in working; the movements being produced without any intervening instrumentalities whatever. Usually the movements of picks are effected and controlled by means of complicated mechanisms which are thrown into and out of action by devices actuated by the cam-shaft, &c., and which also includes the raising and lowering of the needle-cylinder.

The said circular cam or needle-support M, vertically movable with the cam-plate H as before stated, has a pair of suitably arranged, outwardly projecting short pins or lugs *m* (Figs. 13 to 16) located on the front side thereof and movably fitted in a pair of parallel inclined slots *m*¹ formed in a front thin cam-plate F axially and vertically slidable on member M. The plate F has a cam F¹ secured to its upper part and forming between them a narrow horizontal passage *m*² adapted to receive the long butts of the needles. When the several members are in the normal working position, shown in Figs. 13, 15 and 16, all the needle-butts are in engagement with the member M and substantially level while they are passing between cams F and F¹. At the narrowing and widening parts of the knitting, however, all the long-butt needles must be temporarily thrown out of action, or to a higher level than the other needles, the latter continuing in service as before described. The means for rendering said long-butt needles inoperative consists, as drawn, of a bent horizontal front link *b*³ jointed to the lower part of member F and to the upper end of the automatically controlled swinging clutch-shifting lever *b*¹ (see also Fig. 3) whereby the movements of the latter, say to the left, correspondingly move the plate F, &c., the fixed lugs *m* at the same time causing it to rise, thereby carrying the movable parts to a higher position (Fig. 14) so that as the cylinder revolves the long-butt needles are thus, by means of the newly positioned cam F, deflected upwardly out of action and into the said passage *m*², the latter then being in alinement with the cam E¹ and in the normal working plane of the widening picks T. The needles then rotate back and forth in that plane with the cylinder until the re-

sumption of circular knitting, at which instant the shipper *b*¹ returns to the right or normal position, thereby moving the connected members F, F¹ downwardly again to the normal position shown in Fig. 13, the long butts meanwhile being correspondingly deflected by the oppositely beveled edges of cam F¹, all as clearly shown. I prefer to incase or house the cam F by a casting *m*³ as indicated in Fig. 3. The means for controlling and actuating the said clutch-lever will be later described.

The yarn-selecting and changing device (as drawn three sets are represented, see Figs. 3 and 5) consists of the drum *f*, fast to the cam-shaft *s*¹, provided with a plurality of suitably disposed interrupted peripheral cam-ribs *f*², arranged side by side, each having the front or free end of a swinging lever *f*³ in yielding frictional contact therewith, see also Fig. 18. To the opposite or rear end of each lever is attached an upwardly extending wire connection *f*⁴ which is hooked into the rear end of a swinging horizontally arranged fellow lever or finger *f*⁵, the latter in turn being mounted in the upper end of and inclosed in the hollow standard K secured to the top plate or table *a*². See also Figs. 4 and 5. The other portion of the device is attached to and movable with the swinging latch-ring C, the latter having a horizontal double-arm or extension *d*³ in alinement with the center of the needle-cylinder. In the free end of said arm are pivoted, at *d*², the three small swinging yarn-guides *d*¹, normally resting upon and supported by the free ends of the respective levers *f*⁵. A spring *d*⁵ maintains each pair of members, *d*¹ and *f*⁵, in normal contact. The outer end of said extension *d*³ is adapted to rest upon said support K, thereby at the same time positioning the ring C, see also Fig. 4. The inner or free end of each of said guides *d*¹ is drilled at *d*⁴ to receive the knitting-yarn and is located contiguous to the upper end of the needles, the arrangement being such that when the ring C is dropped to its normal level position, the cylinder then being in action as in knitting, the members *f*⁵ and *d*¹ will then be in the normal depressed position, indicated by dotted lines in Fig. 4, whereby the feed-yarn (not shown) is properly introduced into the then open hooks of the needles preparatory to being inclosed therein and knitted into the fabric as they are successively depressed by members of the said cam-block D and raise cam *a*³. It may be added that said levers, &c., are depressed only when the free end of the corresponding lever *f*³ has dropped from the cam *f*² onto the plain or barrel portion of the drum *f*. When the members *f*³ and *f*² are in engagement the corresponding yarn-guide *d*¹ will then be elevated, thus throwing its yarn

out of position with respect to the circular path of the traveling needles. See corresponding full line representation of the guide in Fig. 4. Or, in other words, the yarn will then be projected inwardly past the back of the needles and out of action. The latch-ring is also provided with a guide d^0 for the yarn which is to be knitted into the circular work, said guide being adjustably secured to said ring and extending in a horizontal direction across the top of said guides d^1 , all as clearly shown. The said main cam or drum f (Fig. 3) secured to shaft s^1 has a V-shaped peripheral rib f^1 formed on its front or right end, the same being cut transversely at suitable intervals to form cam-shaped or flaring openings f^0 adapted to be engaged by and to cooperate with the correspondingly V-shaped vertical dog or member b^1 , adjustably mounted in the lower end b^2 of the pivoted clutch-shifting lever b^1 , for guiding and throwing the said revoluble driving clutch-hub b into and out of action with the small gears i and i^{11} of the corresponding "fast" and "slow" working sides I and J, respectively, and also for actuating said instep-cam connection b^3 . By providing the cam-rib f^1 with beveled sides the lever b^1 is operated more readily and with less working friction, the arrangement also being such that variations in the lateral movement or "throw" of the clutch may be easily and quickly made by simply changing the vertical position of the said member b^1 with respect to the top of the drum f .

The means represented for intermittingly rotating the cam-shaft s^1 and the members secured thereon, and also the mechanism for controlling said movements may be described substantially as follows: The fine-toothed feed-wheel c and chain-carrying sprocket-wheel d are intermittingly revoluble in unison on the shaft s^1 by means of the positively reciprocating suitably mounted feed-pawl i^1 taking its movements from the revolving gear-wheel i^1 , &c., as before stated. A coarse ratchet-toothed cam-wheel e is fixed to said shaft and is adapted to be rotated at varying intervals by a swinging pawl h^8 , movable back and forth in unison with said other pawl i^1 .

The pattern-chain B is provided with the desired number of links and lugs or dogs. The relative arrangement of the latter (nine in number, as drawn) is indicated in the diagram, Fig. 24, and are designated 1, 2, 3, 4, 5, 6, 7, 8, and 9. Numbers 1, 4, 6, 7, and 9 being high, or "double-feed" lugs, that is, they cooperate with the swinging pawl-holder h whereby the pawl-action is adapted to rotate the cam-wheel e an angular distance equal, say to two of its teeth; each of the other, or lower lugs, corresponding with a one-tooth movement. The said holder or pawl-sup-

porter member h (Figs. 23 to 26) swings on a stationary pin h^3 . The forward end of the holder has a lateral lug or bracket h^4 extending at right angles therefrom, and is located above and in the path of the said chain-lugs. The holder is also provided with a short vertical arm h^5 arranged to normally bear against the rear side of the front tie member of the frame a , whereby the lower side of the said bracket is kept just clear of the intermittingly traveling chain-links, the spring h^6 serving to maintain the holder in the normal position indicated by dotted lines in Fig. 25. The rear or tail portion h^7 of the holder extends beyond the wheel e , its upper side forming a bearing or support for the free end of the swinging reciprocating driving-pawl h^8 while normally resting thereon, whereby the pawl is rendered temporarily inoperative and slides idly back and forth by and in unison with the swinging lever i^1 , to which latter it is pivoted. See dotted lines. Whenever a low or single-feed lug of the chain engages the extension h^4 of member h the rear portion h^7 of the latter is correspondingly depressed and practically uncovers or exposes one tooth of the wheel e whereby the free end of the advancing pawl resting on the holder will upon its engagement with said exposed tooth rotate the wheel and shaft s^1 ahead a distance equal to the pitch or one tooth space. The action is substantially the same when the member h is actuated by a high or double-feed lug of the chain, except that in the latter case it exposes two teeth and permits the pawl to correspondingly advance the wheel. After the lug has passed the contact member h^4 the spring h^6 swings the holder to the normal or dotted position, thereby elevating the free end of the pawl and rendering it inoperative, the cam-shaft then remaining stationary until the moving chain B advances another lug into engagement with the pawl-supporter. The said multiplier-wheel i^0 (see Figs. 21, 22 and 23) is, as drawn, revoluble on a stud adjustably mounted in a radial slot u^4 formed in the web of the feed-wheel e . The member i^0 is positioned on the front, or right, end of wheel e and, as drawn, has ten ratchet-shaped teeth, one, u^5 , being much deeper than the others. A light spring or check u^6 is secured to the wheel e and is in continuous engagement with the teeth of the smaller wheel. This latter is in effect an idler device also in that when operatively positioned or elevated it temporarily prevents the pawl i^1 from rotating the chain-feeding wheel c but will rotate the multiplier wheel instead. It will be seen, referring to Fig. 23, that the free end of the pawl is comparatively wide, one portion, u , thereof being adapted to normally engage and actuate wheel c , the other, u^1 , arranged to work the small wheel in a similar manner

when it is in the operative position. The pawl end has a notch w^2 therein for the free passage of the chain-lugs. As thus constructed, assuming the small wheel to have been mounted and adjusted so that it extends the proper distance above the top of wheel c , (wherein the bottom of the highest tooth in i^0 is slightly above the top of the adjacent tooth of wheel c) the normal action of the pawl will rotate wheel c as usual, say until the correspondingly advanced pattern-chain and its lugs together with the controlling means before described will have rotated the cam-shaft and its wheel e , as well as the other members secured thereon, the desired or predetermined distance, the shaft then stopping, thus automatically positioning the wheel i^0 so that its teeth are then adapted and in position to be engaged by the corresponding part w^1 of the pawl. The result being that the advancing pawl engages the first tooth of i^0 in its path, thereby rotating the latter on its axis an angular distance equal to one tooth and concurrently elevating the pawl part u from the wheel c .

The continuous reciprocating pawl-action causes wheel i^0 to make one revolution on its axis in a step-by-step manner, or until it engages the deep tooth w^3 . During the pawl's engagement with the last-named tooth the pawl is thereby dropped sufficiently so that the part u will engage a tooth of wheel c and rotate the latter one of its spaces, which action at the same time rotates the smaller wheel and raises the pawl from wheel c , the latter then remaining stationary until the small wheel has again made another revolution. The action is thus continued while the shaft s^1 remains stationary and until the succeeding chain-lug, operating through the pawl-holder h , releases pawl h^3 to advance the shaft and wheel e an angular distance as before described. The last named movement carries the small wheel away from its pawl, thereby permitting the part u thereof to reengage and normally actuate the feed-wheel c until the shaft has completed its revolution. The light spring w^6 is employed to prevent the wheel from accidentally turning on its axis.

The reciprocating pawl i^4 is prevented from dropping too far, or below the normal working plane, by means of the vertically arranged accurately adjusted stationary supporting member or stop v . See also Fig. 1. During the greater part of the pawl's movement it rests upon the stop. The arrangement of the connections, &c., for imparting motion from gear i^1 to the arm i^5 to which the pawl is pivoted is such that the feed-action is performed easily, noiselessly and without shock, the actual work taking place while the connection i^2 , jointed to said gear-wheel i^1 , is moving at its slowest rate, as at or near the "dead center".

It may be added, referring again to the multiplier device, that, as drawn, the machine is adapted to normally produce four rows or courses of knitted work per tooth movement of the wheel c , but when the multiplier is in action forty rows are produced per single-tooth feed of wheel c , or as determined by the number of teeth in wheel i^0 . By means of this device, when cooperating with the other mechanisms, the number of plain links in the pattern-chain may be greatly reduced, especially so in the production of stockings having long legs. When not in service the wheel i^0 is dropped in the slot and secured in place, the teeth then being below the range of the pawl i^4 . See Fig. 17.

I may state that in general the drawings represent my improved knitting-machine as having the several devices thereof positioned and adapted to produce, say half-hose (although it is equally well adapted to make full-length stockings) in which the circular-knit portions of the leg and foot are formed of two threads or yarns, thus making "plaited-work", so-called, the heel and the toe portions being formed of a different thread or yarn.

The yarns are conducted from suitable bobbins and devices into the mechanically actuated spring-pressed yarn-guides d^1 pivotally mounted in the latch-ring C, and from the under side of the free ends d^4 of the guides to the hooks n^3 of the traveling needles.

Assuming the machine to be in the normally stationary position, substantially as represented in Figs. 3 and 4, wherein the immediately preceding coaction of chain lug l and the holder h caused the pawl h^3 to actuate shaft s^1 , which resulted also in moving cam p^6 and forcing the spring-pressed shipper p^5 outwardly to its limit and shipping the continuously running belt onto the idler pulley p^2 , the self-dropping shipper latch v^1 at the same instant locking the member p^5 in position; also in moving cam f , &c., to elevate the guides d^1 to throw the several yarns out of action; also in moving cam g , &c., to drop the cam-plate H and the several devices carried by it to the lowest position, thereby too at the same time dropping the needles and causing the last-knitted stocking to be run off or stripped from the needles. The attendant now raises the latch-ring C, thereby releasing the sinker-cam w , the latter at the same instant while moving inwardly automatically placing its sinkers in the inactive or circular path; he then severs the yarns connected with the work and secures the free ends under the clip e^8 , followed by removing the stocking from the tube z . He next, by hand, retracts the main cam-block D (see corresponding position, Fig. 4), thereby automatically swinging the narrowing-picks

(not shown) upwardly and away from the cylinder, and, also by hand, presses the adjacent long-butt needles downwardly past the picks, the tops of all the needles then being substantially level. Upon releasing the cam-block its spring advances it until arrested by the said long-butts of the just depressed needles. He next places the "top"-carrying transfer-ring in position on top of the cylinder, the several grooved points thereof then being at the back of and registering with all the needles n^2 , as hereinbefore described. The operator next, by means of the crank p^4 secured to the small gear i , manually turns the cylinder, and the said transfer-ring positioned thereon, about one complete revolution. Said movement at the same time, through the medium of pawls i^4 , h^8 , &c., advances the pattern-chain, cam-wheels e and p^8 , and shaft s^1 a short angular distance, the holder-supporter lug l of the chain meanwhile passing from under and freeing the holder h , at which instant the latter in dropping automatically lifts pawl h^8 from wheel e , thus rendering it temporarily inactive. The immediate results produced by the manual action are the release of the cam from the shipper-arm, the locking-latch v^1 then holding it in position, and also, through the medium of cam g and its connections g^1 , g^2 , &c., to elevate the cam-plate H and the parts or devices mounted thereon to the normal working position, thereby simultaneously advancing the upper portion of the needles through the loops or stitches of the "top" mounted on the transfer-ring's points, the "top" extending downwardly in the cylinder. An example of transfer-ring well adapted to be employed in said "topping" operation, is clearly illustrated and described in U. S. Patent No. 801,457, granted to me October 10, 1905. At the end of said manual movement the forward long-butts of the corresponding column of needles will be supported by the upper surface w^1 of the front cam w of the cam-block and under the free end of the corresponding pick 10, the advance needle of said column then standing at the upper end or apex of said cam. The contiguous or rear end portion of the advance column of short-butt needles is substantially level, the cam-block D, or rather the rear cam w thereof then being in yielding engagement with the adjacent butts of the last-named needles, thus temporarily preventing it from advancing to its normal working position.

After removing the transfer-ring the operator presses downwardly by hand the few short-butt needles contiguous to center cam e^2 , followed by swinging the latch-ring downwardly to its normal position, it then resting on top of the support K, thereby placing the ends of the knitting-yarn carried by the then fully depressed guides d^1

so as to be engaged by the needles and knitted into the "top", then mounted on the needles as stated. Said downward movement of the latch-ring also automatically introduces the wedge-pin w^1 between the stationary sinker-cap G and the outer portion w^2 of the spring-pressed sinker-cam w (see Fig. 6), thereby forcibly retracting the latter and the sinkers thereon to the outward or normal working position, whereby, when the machine is in action, the sinkers are adapted to be successively brought into and out of service during their engagement with the cam while they (the sinkers) are being revolved by and in unison with the cylinder to assist in the usual stitch-forming process at the knitting point. The operator now sets the machine in normal action; this is effected by means of the spring-retracting shipper-arm (after first lifting said latch v^1 therefrom), thereby automatically shifting the driving-belt from the idler pulley onto the loosely revoluble quick-speed driving-pulley p integral with the small spur-gear i^7 , as before stated. The belt while thus passing onto the driving-pulley p will necessarily cross the intermediate or slow-speed driving-pulley p^1 , thus starting the machine into knitting action more slowly and with less strain upon it than if the pulley p were located immediately contiguous to the idle pulley. If desired the entire stocking may be produced at the slow-speed rate by simply limiting the shipper's movement so as to prevent the belt from engaging the pulley p . The first result of the revolving knitting-cylinder carries the said depressed short-butt needles in a straight line past the face of said rear cam w , the outer ends of the immediately following long-butt needles at the same time engaging the cam e^2 and being deflected into the path e^4 , thereby positioning them to engage the downwardly deflecting surface of said rear cam w and passing thereunder while making the first stitch and at the same instant that the last of the short-butts pass the face of cam w , as just stated; at which instant too the cam-block's spring automatically advances it and its narrowing-picks to the normal working position close to the surface of the revolving cylinder, the relation of the several members being substantially as represented in Fig. 9, wherein the irregular parallel dotted lines indicate the normal working path of the butts and corresponding with the production of circular or plain knitting. The cooperation of the revolving knitting-cylinder and the members of the now positioned cam-block together with the sinker-actuating cam w cause the moving needles to successively receive therein the yarn from the properly positioned guides d^1 , thereby converting it into new loops and at the same time casting off the old loops or stitches from the tops of

the needles into the web revolving with the cylinder. I would state that while the needles are passing the face C^1 of the opening in which said guides are located any of the partly closed or laterally extending needle-latches will be deflected downwardly to the full-open position by their engagement with the beveled edge f^1 in advance of the introduction of said yarn into the hooks of the needles and the subsequent closing of the latches before the old loops are cast off. The said action of the machine then producing plain or circular knitting, each revolution of the cylinder corresponding with one row or course of stitches.

The machine now continues at the normal fast speed and without change to knit circular work, as in producing the leg portion of the stocking, until the advancing chain brings the double-lug 4 in cooperative relation with the said swinging pawl-controlling member h . Meanwhile, however, the passage of the two intermediate low lugs 2 and 3 past member h has dropped the pawl h^s into action twice, thus further advancing the cam-shaft, say about one-sixth of a revolution. At this point, or as determined by the relative position of the lug 4 and the members controlled by the resulting movement of shaft s^1 , the first yarn and speed-changing actions take place to produce the "narrowing" part of the heel of the stocking. That is to say, the engagement of the member h with the lug 4 allows the latter (by means of said pawl) to move ratchet-wheel e two teeth, thereby correspondingly rotating the cam-wheel f and its shaft, and at the same time causing the lower end b^4 of lever b^1 to be deflected laterally through an opening f^6 of the cam-rib f^1 to the outer or right side, thus sliding the clutch member b to the left into gear i^1 , that is, out of the fast-gearing side I into the slower one J, thereby also shifting the continuously running belt from pulley p onto the pulley p^1 secured to the hub of gear i , thus materially reducing the speed and at the same time changing the movement of the cylinder from continuous circular to reciprocating-rotary. Concurrently with said change the instep-cam device F is elevated by means of the horizontal connection b^s jointed to the clutch shipper-arm or lever b^1 , whereby all the long-butt needles are deflected upwardly by said cam out of action. Fig. 14 represents the corresponding position. While this is taking place the action of the main cam f and the yarn-changing devices operatively connected therewith draws the heel-yarn guide downwardly and positions or substitutes its yarn for the last employed yarn, the guides d^1 of the latter meanwhile being elevated, thereby rendering said yarn inactive or "floating" in the central opening c^1 of the latch-ring. All the long-butt needles, being about one-half of the total

number in the cylinder, are now elevated and out of action while the machine in its reciprocating movements forms the narrowing part of the heel. This is effected by the joint action of the cylinder and the self-dropping angularly swinging narrowing-picks R, R, whereby a short-butt needle is thrown up alternately out of action from each end of the column of moving needles during each double-reciprocation of the cylinder, as hereinbefore fully described.

It may be stated that since the heel and toe yarns used are thicker or heavier than the yarn employed in circular knitting the corresponding stitches of the former are usually lengthened; this being effected when the shaft was last rotated by slightly dropping the cam-plate H by means of the back contact-pin g^9 and its cam, as before described.

The narrowing process is continued until the next succeeding previously positioned short lug 5 of the chain, coacting with said member h , &c., releases pawl h^s to correspondingly rotate the cam-shaft, thereby, through the medium of cam G^1 , members k , k^1 and k^2 , elevating gage-plate k^3 and the two self-rising widening-picks T controlled by said plate member, so that the recessed portion t^4 of said picks are positioned in the path of the inactive short-butt needles just elevated by the picks R, the cylinder still moving in a rotary-reciprocating manner. The function of the thus positioned widening-picks T is to alternately deflect or throw down into action a pair of said short-butt inactive needles from each end of the gap in the column of elevated or idle needles during each double-reciprocation, as hereinbefore described. While this is taking place the narrowing-picks R are kept working, thus producing the well-known "two-and-one" knitting action. This latter is continued until the intermittingly advancing pattern-chain carries the double-lug 6 into engagement with member h , whereby the pawl h^s is then released and rotates the cam-shaft and its members a corresponding angular distance, and thus revolving the cam-wheel f , the lower end of the clutch-lever being guided through a then positioned opening f^6 , thus sliding the clutch-hub from the "slow gear" side J back into the "speed gear" side I, and at the same time by means of cam p^6 , shifting the driving-belt onto pulley p to resume the regular or quick-speed circular knitting to produce the foot portion of the stocking. At the same time, too, the said cam-action throws out the heel-yarn by elevating its lever d^1 , the yarn then "floating" in the said central opening c^1 ; simultaneously therewith the other yarn-guides are dropped, as before described, thereby reintroducing the main knitting-yarn to the needles. The said act of shifting the clutch into engagement with small gear i also re-

tracts the connection b^3 jointed to cam F^1 , thereby dropping the latter to the normal position shown in Fig. 13, whereby also all the then elevated needles will, by means of cam F^1 secured to cam F , be deflected downwardly to the normal working level, or top of the needle-supporter M , to resume circular knitting.

The continued quick-speed rotation of the cylinder, &c., operates to knit the circular or plain portion of the foot, as just stated, and until the double-lug 7 of the moving chain engages the pawl-supporting member h , the resulting action being, through the medium of cam p^6 and shipper p^5 to shift the belt from pulley p back onto the pulley p^1 , whereby rotary-reciprocating reduced-speed movement is again imparted to the cylinder, substantially as before described, the final action of lug 7 being to drop the pawl h^3 to further advance the cam-shaft, thereby again elevating the long-butt needles and rendering them inoperative; substituting the toe-yarn for the main knitting-yarn, and producing the narrowing part of the toe portion of the stocking by the alternate action of the picks R upon the short-butt needles in the same manner as before described with respect to lug 4 and the consequent formation of the narrowing part of the heel. At the completion of said narrowing operation the continued movement of the chain will have advanced the short lug 8 thereof into engagement with the pawl-controller h , whereby the pawl again rotates the cam-wheel e one tooth, thus making operative the other set of picks T to produce the widening of the toe portion, substantially as before stated relative to the action of lug 5. Both sets of picks then being in action and working in the same manner as when the said heel portion was being formed. At the instant the said widening of the toe portion is finished the chain will have advanced its high lug 9 under the pawl-controller h , the resulting changes or movements of the devices being practically the same as before described with respect to lug 6; that is to say, the clutch-hub b is moved endwise into the speed-gear side I , the widening-pick controller h^6 and the in-step cams F , F^1 , are dropped to the normal position, thus again placing the long-butt needles in knitting action, followed by continuing the knitting of the toe-yarn into a few circular courses, which later are utilized in seaming in a well-known manner. The said lug 9 is located on the chain B just in advance of the first-named double-lug l (see Fig. 24) so that when the latter arrives in position or coöperative relation with the pawl-controlling lever h the resulting action is to elevate all the yarn-guides d^1 , thereby placing the several yarns out of action, thus casting off all the stitches from the needles

and stripping the thus completed stocking from the machine; the work then being suspended in the tube z by the yarns still connected with the respective bobbins. The cam-plate H is immediately thereafter dropped to its lowest position by means of cam g , &c., thereby rendering inactive the several devices or elements carried by it, the result being to draw down all the needles (except the few then resting on the top of the front draw-cam x) to a point just above the top of the sinkers. -At practically the same instant that the plate H is depressed the action of cam p^6 , shipper p^5 , &c., will shift the running driving-belt onto the outer or idler pulley p^2 , thus automatically stopping the machine, the latch v^1 at the same instant dropping into a member of the belt-shipper and locking the latter in position. The attendant now elevates the latching C and severs the yarns, at the same time securing the free ends of the latter under the clip c^2 and removing the stocking from the work-tube z , thus completing the operation.

It may be added that the function of spring v^2 (Fig. 3) is to automatically retract the shipper after the attendant elevates the latch v^1 , thereby shifting the belt onto a driving-pulley, as in starting the machine.

When the stockings are to have what are termed long legs I employ the "multiplier" device hereinbefore described (Figs. 21 to 23), the arrangement in such case being that the small revoluble wheel i^6 , carried by the cam-wheel e and positioned in the outer end of slot u^4 thereof, will be so timed and located with respect to the teeth of wheel e and the other members secured on shaft s^1 that the "multiplier" will be automatically brought into engagement with pawl i^4 before the speed-changing lug 4 engages the other pawl-controller h , as for example when lug 2 of the chain (which then may be a high one as indicated by dotted line Fig. 24) engages member h and permits pawl h^3 to rotate shaft s^1 , thereby at the same time advancing wheel i^6 to the operative position represented in Fig. 21. By this arrangement only one-tenth of the number of extra links that would otherwise be required need be added in the chain between, say lugs 2 and 3, the number of course corresponding with or being determined by the length of the leg portion.

I would add that while the several chain-lugs or dogs follow one another in the order or sequence named and coöperate with the pawl-controlling member h , &c., to effect the changes and results hereinbefore stated, it is obvious that at times two or more of the devices may be in concurrent or simultaneous action.

I may further state that generally through-

out the specification and claims the terms needle-cylinder and knitting-cylinder include not only the longitudinally grooved barrel proper for the needles, but also the 5 radially grooved inner ring σ^1 and the correspondingly grooved outer or sinker-ring ω^0 for the sinkers, both being rigidly secured to the top of the barrel and movable with it.

I claim as my invention and desire to secure by United States Letters Patent:—

1. In a circular automatic knitting-machine, the combination with the revoluble needle-carrying cylinder, of a normally stationary cam-block bodily movable toward and 15 from the face of the cylinder having narrowing picks and knitting-cams mounted on and carried by said block, and means for raising and lowering the latter at fixed intervals.

2. In a knitting-machine of the character described, the combination with a revoluble knitting-cylinder and needles and sinkers mounted therein, of a cam-block having suitable fixed cams for controlling the move- 25 ments of the needles, and means for vertically moving the cam-block at predetermined intervals for varying the length of the stitches, said devices being provided with means for permitting the cam-block to be 30 manually moved horizontally in an endwise or radial direction, for the purpose hereinbefore set forth.

3. In a knitting-machine of the character described, the combination with the revoluble knitting cylinder and needles movably mounted therein, of a single non-rotatable cam-block radially movable with respect to said cylinder having both front and rear knitting or draw-cams and an intermediate 40 needle-guiding cam fixed to the inner or concave face of the block, arranged so that upon manually retracting the block from its normal working position all the said cams are bodily moved with it, whereby the elevated needles adjacent thereto may then be 45 depressed by hand past the cams, substantially as hereinbefore described.

4. In a knitting-machine of the character described, the combination with a revoluble 50 knitting-cylinder, and needles and sinkers mounted therein, of a horizontally mounted radially movable cam-block, knitting-cams secured thereto arranged to actuate said needles in a vertical direction, and mechanism 55 for vertically moving the cam-block for changing the length of the stitches and also for dropping said block to its limit, whereby the needles adjacent thereto are correspondingly depressed.

5. In a knitting-machine of the character described, the combination with a revoluble 60 knitting-cylinder, and needles and sinkers mounted therein, of a horizontally disposed radially movable cam-block, knitting-cams and narrowing-picks mounted thereon and

carried therewith, and mechanism for vertically moving the cam-block and its said members bodily at predetermined intervals.

6. In a knitting-machine of the character described, the combination with a revoluble 70 knitting-cylinder, and needles and sinkers mounted therein, of a horizontally mounted radially and vertically movable cam-block, knitting-cams and narrowing-picks suitably mounted thereon and bodily movable there- 75 with, means for effecting and controlling the vertical movements of said cam-block, and means for simultaneously swinging said picks out of the normal operative position concurrently with the act of retracting the 80 cam-block radially.

7. In a knitting-machine of the character described, the combination of the knitting-cylinder, a horizontally slidable cam-block 85 having oppositely beveled sides, front and rear knitting-cams secured to the inner or concave face of the block, a pair of self-dropping swinging narrowing-picks mounted on pivots extending perpendicularly from 90 said beveled sides, and means cooperating with the picks for automatically swinging the latter upwardly and away from the cylinder to an inoperative position upon moving 95 the block rearwardly.

8. In a knitting-machine of the character 95 described, the combination with the vertically movable cam-plate and means for actuating the same, of the horizontally movable block D carried by said plate, knitting-cams 100 secured to the block, a pair of swinging self-dropping narrowing-picks mounted on and carried by said block, and means for limiting the downward angular movements of 105 the picks to position the free ends of the latter in the path of the butts of the working needles.

9. In a knitting-machine of the character described, the combination with the knitting-cylinder and needles mounted therein 110 having outwardly extending butts, of a self-dropping swinging angularly mounted narrowing-pick having its inner or free end provided with a seat normally positioned in 115 the path of and adapted to receive therein a needle-butt, a manually slidable cam-block carrying said pick, and a knitting-cam secured to the inner end of the block, said cam forming a stop for limiting the pick's downward movement.

10. In a knitting-machine of the character 120 described, the combination with a revoluble knitting-cylinder, and needles and sinkers mounted therein, of a horizontally mounted radially slidable and vertically movable cam- 125 block, knitting-cams and narrowing-picks mounted thereon, and mechanism for actuating the block in said vertical direction at predetermined intervals, constructed and arranged so that upon retracting the block radially the said cams and picks are simulta- 130

neously withdrawn from the operative position to permit the adjacent needles to be depressed in advance of starting the machine.

11. In a knitting-machine of the character described, the combination with a revoluble knitting-cylinder, and needles and sinkers movable therein and revoluble therewith, of a horizontally mounted radially slidable and vertically movable cam-block, knitting-cams secured to the inner end of the block contiguous to the cylinder, a pair of oppositely disposed self-dropping picks mounted on said cylinder, each pick arranged to alternately receive a needle-butt and carry its needle to a higher plane during the narrowing process, the picks resting upon and being supported by the butts of the working needles during the circular knitting; constructed and arranged so that the act of retracting the cam-block from the cylinder in said radial direction operates to simultaneously withdraw the cams and picks from the needles to render them temporarily inoperative.

12. In a knitting-machine of the character described, the combination with a revoluble knitting-cylinder and needles and sinkers mounted therein, of a suitably mounted spring-pressed cam-block D, swinging narrowing-picks and knitting-cams mounted thereon and carried therewith, and means for automatically raising and lowering said block and its members at certain points in the knitting of the stocking, said devices being provided with means for permitting the cam-block to be manually moved horizontally in an endwise or radial direction, for the purpose hereinbefore set forth.

13. In a knitting-machine of the character described, the combination with a mechanically revoluble knitting cylinder, and needles and sinkers movably mounted in and carried by the cylinder, of a stationary bracket E, a central upper cam E^1 secured thereto, a pair of oppositely disposed self-rising widening-picks T adapted to swing on pivots supported by said bracket, the axes of the picks being inclined to the axis of the cylinder, a gage-plate located between the bracket and the face of the cylinder having said picks in yielding contact therewith for limiting their upward movements, and means for automatically changing and controlling the position of the gage-plate at predetermined points during the knitting of the stocking.

14. In a knitting-machine of the character described, the combination with the revoluble knitting-cylinder, and butt-needles and sinkers movably mounted therein, of a stationary cam E^1 for guiding or positioning the needles in the non-working plane, a pair of swinging self-rising widening-picks T having the inner or free ends thereof adapt-

ed to alternately receive each from the ends of the gap two of said positioned non-working needles, whereby the joint action of the latter while revolving with the cylinder and the resulting swinging movement of the pick depresses them to the lower or working position, and a device for positioning the picks with respect to the needle-butts whereby the former remain stationary or inoperative while continuous circular knitting is being produced.

15. In a knitting-machine of the character described, a vertically arranged annular knitting-cylinder, butt-needles and sinkers slidably mounted therein and carried by it, means for introducing the knitting-yarns to the needles, and a suitably supported revoluble bevel gear rigidly secured to the lower part of said cylinder, in combination with a vertically movable normally elevated cam-plate H having the cylinder revoluble therein, needle-actuating and needle-supporting cams secured to and vertically movable with said cam-plate, means for rotating said gear to actuate the cylinder, and devices for swinging the knitting-yarns out of operative position and for automatically dropping the cam-plate, whereby the needles are correspondingly depressed and the work cast off.

16. In a knitting-machine of the character described, the combination with a knitting cylinder, needles and sinkers independently movable therein, devices both for rotating and oscillating the cylinder during the production of a stocking, and a vertically movable non-revoluble cam-plate H having a cam-ring M secured thereto and practically encircling the cylinder, of a manually movable cam-block mounted on said plate and provided with knitting-cams, a pair of swinging inclined narrowing-picks mounted on said cam-block, means for elevating and lowering the cam-plate a short distance, mechanically actuated instep-cams, a pair of swinging widening-picks mounted on oppositely disposed inclined pivots, and means for automatically changing the position of the last-named picks so as to render them active and inactive with respect to the needles.

17. In a knitting-machine of the character described, the combination with the cam-shaft, a wheel or member revoluble thereon, a pattern-chain mounted on and carried by said wheel, and pawl-and-ratchet members, i^4 and e , for intermittingly actuating said wheel, of a ratchet-wheel e fixed to said shaft, a pawl h^8 reciprocating in unison with said other pawl i^4 for actuating the wheel e means coöperating with said chain for rendering the pawl h^8 temporarily inoperative, a small ratchet or multiplier wheel intermittingly revoluble on its own axis and revoluble bodily in unison with the ratchet-wheel e , a member w^1 concurrently movable with

pawl z^4 for axially rotating the multiplier-wheel, the latter having one or more of its teeth extending radially above or beyond the adjacent teeth of wheels e and c so that when it is brought into operative position the engagement of the pawl member w^1 rotates it and at the same time automatically swings the pawl from its wheel c to render the latter temporarily stationary, and having the depth of one of the teeth, w^5 , of the multiplier-wheel lower than the others so that when it registers with that of the contiguous tooth of wheel c the pawl z^4 re-engages the latter to resume normal action, substantially as described.

18. In a knitting-machine of the character described, the combination with an endless pattern-chain, and means including a pawl-and-ratchet device for normally feeding or advancing the chain in an intermittingly continuous manner, of a cam-shaft, means including a pawl-and-ratchet device for rotating the shaft, a small revoluble ratchet-wheel z^6 eccentrically journaled on and carried by the ratchet member of the last-named device, and means for automatically advancing and positioning said wheel so as to be engaged and rotated by said chain-feeding means at a predetermined point in the knitting operation, thereby for the time being utilizing said feed action for revolving the wheel in lieu of advancing the chain, and having a point in the periphery of said wheel adapted to permit automatic reengagement of the pawl with the ratchet to again advance the chain, and means cooperating with the moving chain for rotating the cam-shaft a short angular distance thereby correspondingly advancing the wheel z^6 from its former rotative position.

19. In a knitting-machine of the character described, the combination with a feed-wheel, an endless pattern-chain movable in unison therewith, and a reciprocating pawl for normally feeding or advancing the chain in an intermittingly continuous manner, of a small suitably mounted toothed wheel adapted to be axially revolved by said pawl, having its upper or outer teeth when positioned for use extending radially beyond the adjacent teeth of said feed-wheel, the bottom of one of the teeth of the smaller wheel being deeper than the others and arranged to register with the teeth of the larger wheel, and means for automatically advancing the smaller wheel into and out of operative engagement with said moving pawl, constructed, arranged and adapted for use substantially as hereinbefore described.

20. In a knitting-machine of the character described, a main or cam-shaft, a revoluble feed and sprocket-wheel, a continuously reciprocating pawl or member for rotating said wheel, and an endless-lug-carrying pattern-chain mounted on and movable by and

in unison with said wheel, in combination with a cam-wheel or member secured to said shaft, a reciprocating pawl movable, in unison with said other pawl for rotating the cam-wheel and shaft, means actuated by said chain-lugs for moving the cam-wheel's pawl into and out of operative engagement with the cam-wheel, a multiplier device or toothed wheel z^6 movable with said cam-wheel, and means for temporarily suspending the normal intermittent movements of the pattern-chain while the multiplier is in action.

21. In a knitting-machine of the character described, the combination of speed-changing gears, an intermittingly revoluble drum provided with a substantially concentric peripheral cam-rib f^1 having a V-shaped form cross-sectionally and having a plurality of transverse openings f^6 formed therethrough, the forward ends of the ribs forming deflectors to the right and left alternately at said openings, and a pivoted clutch-actuating lever adapted to engage said speed-changing gears having its lower end V-shaped and adapted to bear against the adjacent beveled side of said cam-rib, arranged whereby the lever is automatically swung laterally from its position upon its engagement with said deflector members while the drum is moving, substantially as set forth.

22. In a knitting-machine of the character described, the combination of a revoluble needle-carrying cylinder, a device for automatically changing its speed of rotation at predetermined intervals, said device including in its construction a pivoted clutch-lever having its lower end provided with a vertically adjustable tip member b^4 having beveled sides, and an intermittingly revoluble drum or member having a peripheral rib or flange substantially V-shape cross-sectionally against the adjacent side of which the said tip member bears, arranged so that upon changing the position of the tip endwise with respect to the rib the degree of lateral movement or throw of the clutch is slightly altered.

23. In a knitting-machine, a needle-carrying cylinder, means for moving some of the needles upward out of action, a pair of cooperating pivoted throw-down or widening pickers, each provided with a spring for swinging it upward, a device actuated at predetermined points in the production of the article being knitted for limiting said upward movements of the pickers so as to place their free ends in the normal operative position in the path of the butts of the inactive needles and also for holding the pickers in the lower or normal inoperative position away from the needles, means positioned above the pickers and forming with each of the latter a track for moving the row of inactive needles upward from their

normal inoperative plane so as to positively position one or more of the advance needles of the row in the free end of the other or companion picker, and means for deflecting the pickers downward to place the inactive needles in the lower or normal knitting position.

24. In a knitting-machine, a needle-carrying cylinder, means for moving some of the needles upward out of action, a spring-elevating throw-down or widening picker formed with a cam surface on its upper side to further elevate the needles above their normal non-working plane, said picker being mounted for movement into its upper and lower operative and inoperative positions respectively, means for effecting said movements of the picker, a stationary cam arranged to cooperate with the said cam surface of the picker so as to successively depress the further elevated needles back to the non-working plane, and a picker-lifting spring whose tension is sufficient to overcome the friction of the needles in their grooves.

25. In a knitting-machine, a needle-carrying cylinder, a stationary bracket member, a pair of cooperating throw-down or widening pickers, each formed with a cam surface on its upper side to further elevate the needles above the normal non-working plane and being pivotally mounted on said bracket, means for moving the pickers into the lower inoperative position, a positioning member having the pickers in normal yielding contact therewith, a fixed cam cooperating with the said cam surface of the pickers arranged to depress the said further elevated needles back to the normal non-working plane so as to positively position them with relation to the notch of the fellow picker, and a spring for moving each picker back to its normal elevated position after it has placed its needles downward into the knitting plane, the tension or force of said spring being sufficient to cause movement of the needle butts when they encounter the

said cam surface and insufficient to prevent the operation of the picker to depress a needle encountering said notch.

26. In a knitting-machine, a cam-cylinder having a stitch-forming cam and a lifting-picker, both mounted for movement into their operative and inoperative positions respectively, and means for positively moving the stitch-forming cam into its inoperative position, and the latter having means for causing the lifting-picker to move to its inoperative position on the movement of the stitch-forming cam into its inoperative position.

27. In a knitting-machine, a cam-cylinder having a stitch-forming cam and a lifting-picker, both mounted for movement into their operative and inoperative positions respectively, means for positively moving the stitch-forming cam into its inoperative position, and the latter having means for causing the lifting-picker to move to its inoperative position on the movement of the stitch-forming cam into its inoperative position, and a spring acting against the lifting-picker and tending at all times to move the same into its operative position.

28. In a knitting-machine, a cam-cylinder having a stitch-forming cam and a lifting-picker, both mounted for movement into their operative and inoperative positions respectively, the cylinder being slotted for the movement of said stitch-forming cam and lifting-picker, and one of said movable parts having means associated therewith and adapted, on the movement thereof toward its inoperative position, to cause the movement of the companion movable part toward its inoperative position, and a member mounted exteriorly of the cylinder, on which the lifting-picker is mounted for movement.

Signed at Providence, R. I., this 23d day of March, 1906.

JOSHUA D. HEMPHILL.

Witnesses:

GEO. H. REMINGTON,
CHARLES C. REMINGTON.