(No Model.) 12 Sheets—Sheet 1.

L. N. D. WILLIAMS & H. SWINGLEHURST.

AUTOMATIC KNITTING MACHINE.

No. 552,806. Patented Jan. 7, 1896.

FIG. 1.

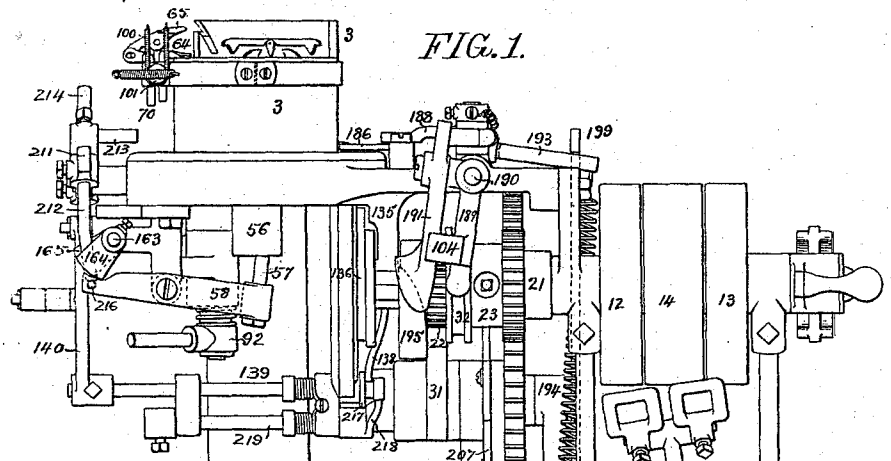
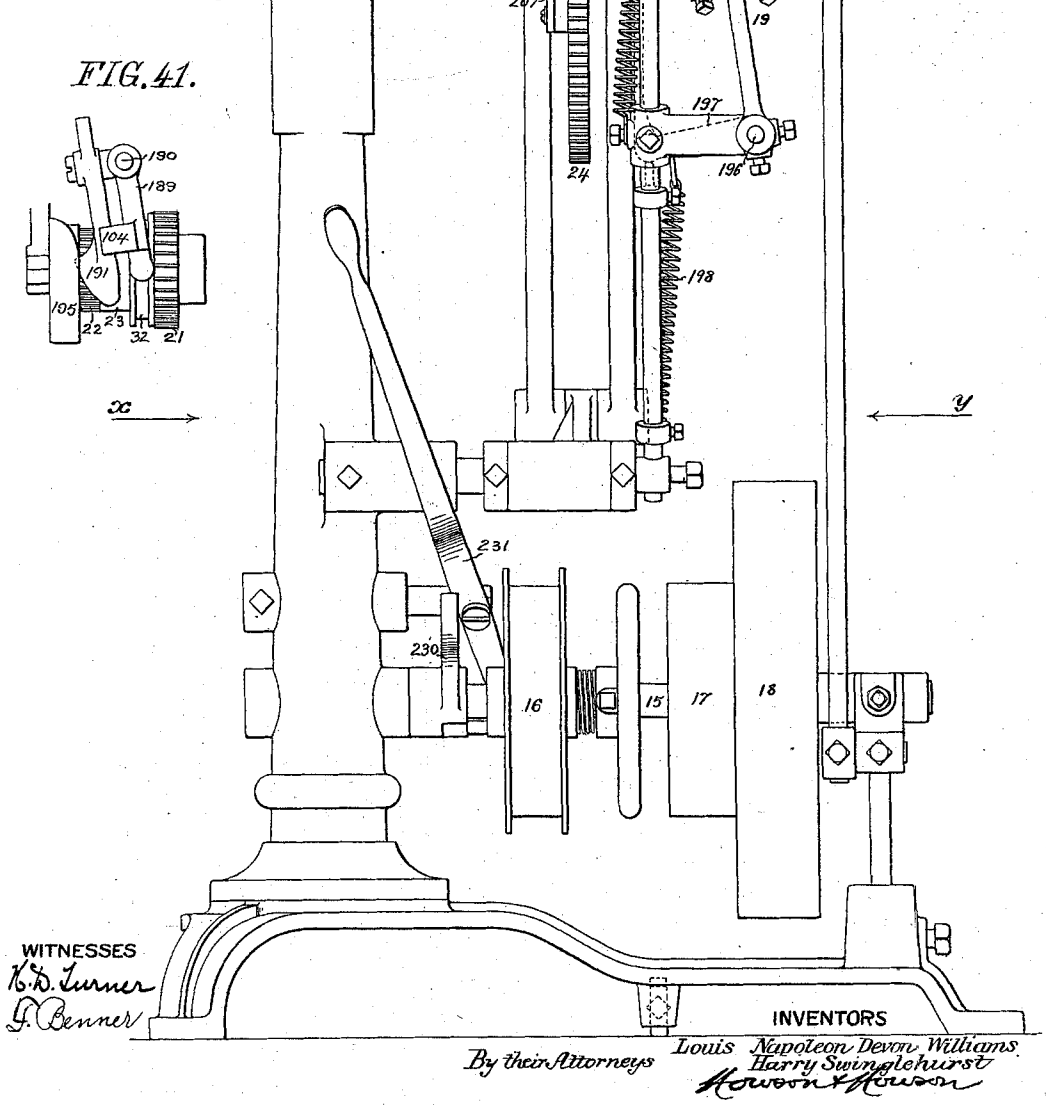


FIG. 41.



WITNESSES

K. D. Turner

J. Benner

INVENTORS

Louis Napoleon Devon Williams

Harry Swinglehurst

By their Attorneys Howson & Howson

(No Model.) 12 Sheets—Sheet 2

L. N. D. WILLIAMS & H. SWINGLEHURST.

AUTOMATIC KNITTING MACHINE.

No. 552,806. Patented Jan. 7, 1896.

FIG. 2.

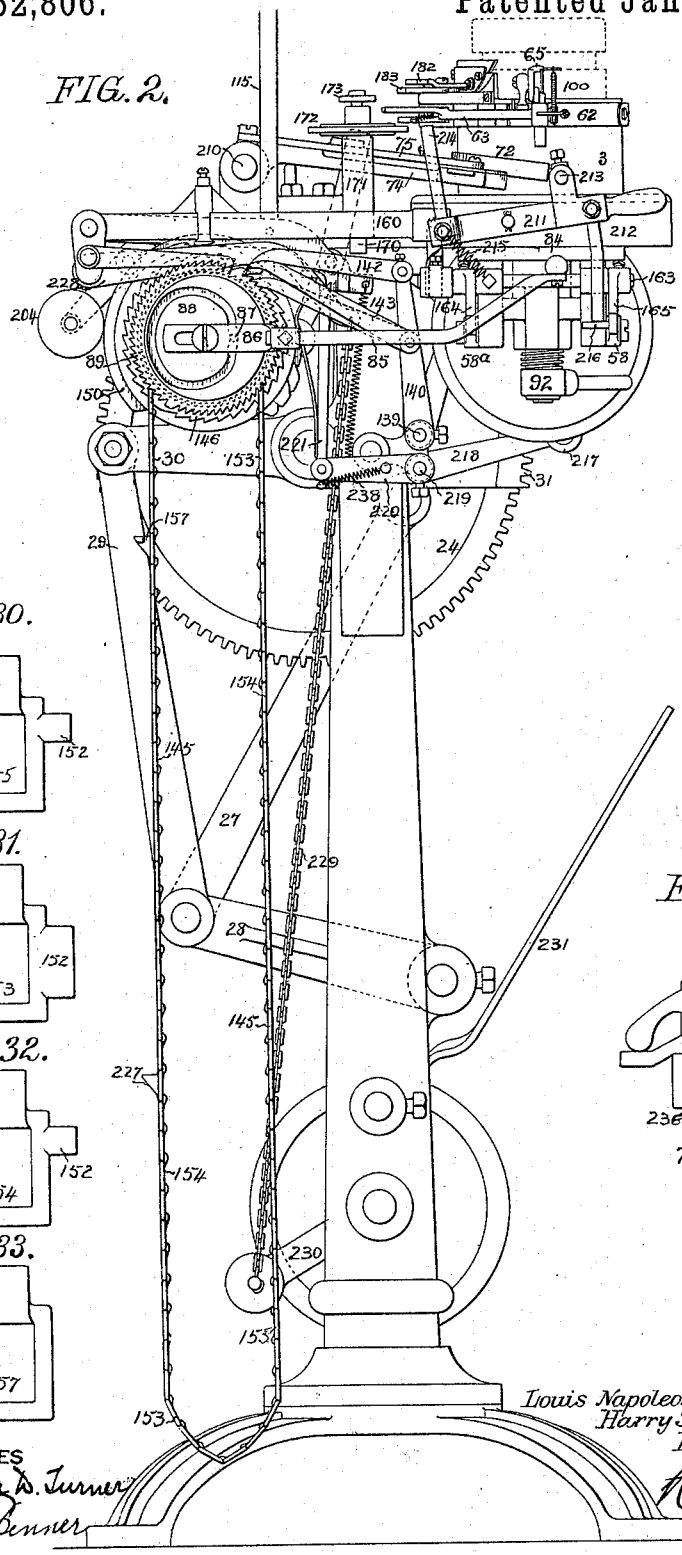


FIG. 30.

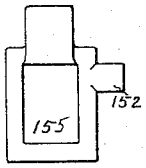


FIG. 31.

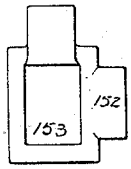


FIG. 32.

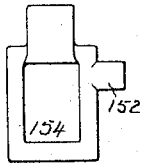


FIG. 33.

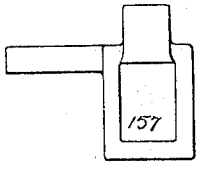
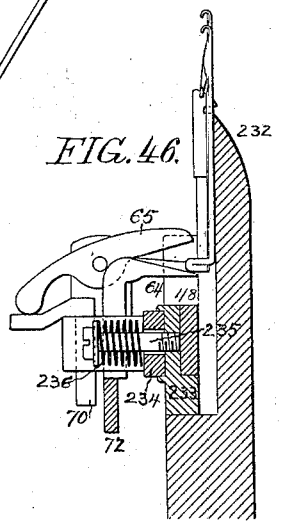


FIG. 46.



INVENTORS

Louis Napoleon Devon Williams
Harry Swinglehurst
By their Attorneys
Howson & Howson

WITNESSES

Hamilton D. Turner
Fred Benner

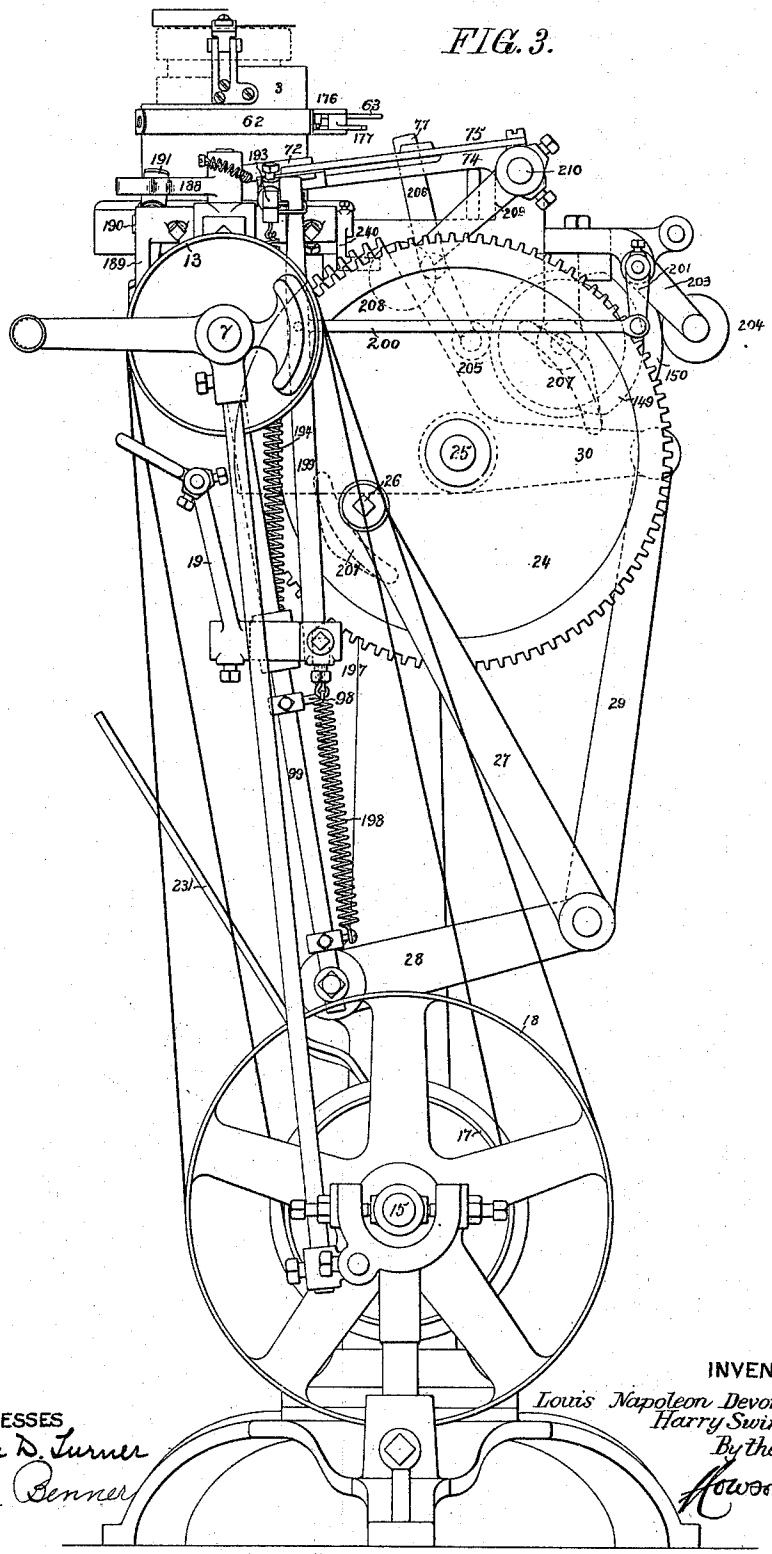
(No Model.) 12 Sheets—Sheet 3.

L. N. D. WILLIAMS & H. SWINGLEHURST.

AUTOMATIC KNITTING MACHINE.

No. 552,806. Patented Jan. 7, 1896.

FIG. 3.



WITNESSES

Hamilton D. Turner

Fred Benner

INVENTORS

Louis Napoleon Devon Williams

Harry Swinglehurst

By their Attorneys

Howson & Howson

(No Model.) 12 Sheets—Sheet 4.

L. N. D. WILLIAMS & H. SWINGLEHURST.

AUTOMATIC KNITTING MACHINE.

No. 552,806. Patented Jan. 7, 1896.

FIG. 4

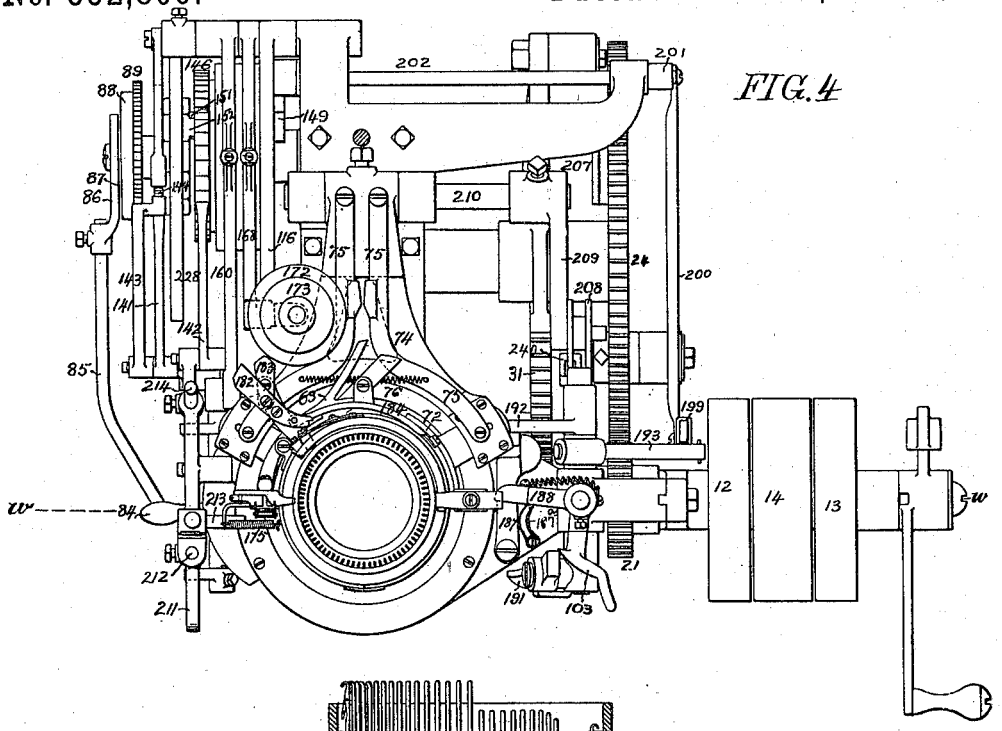


FIG. 15.

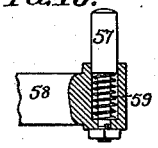


FIG. 5.

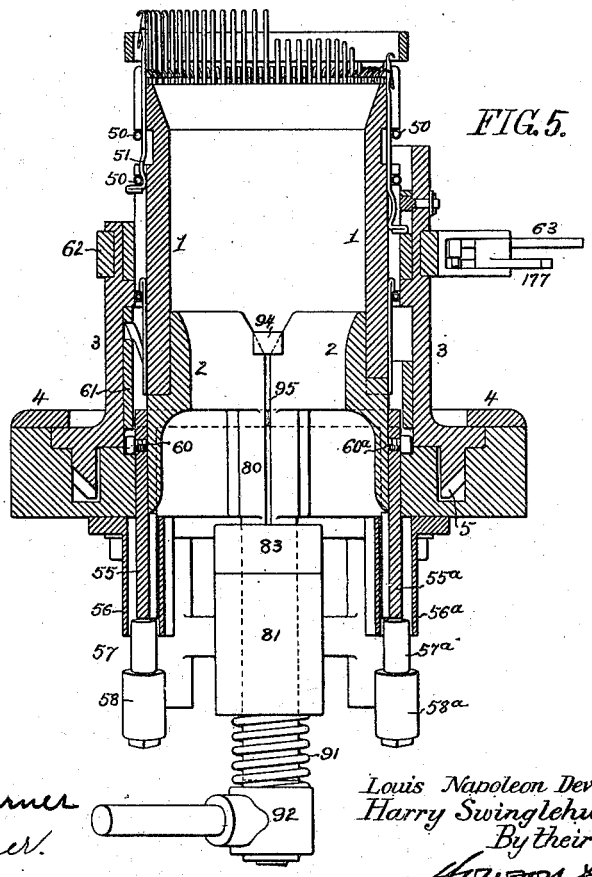


FIG. 35.

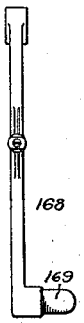
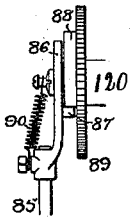


FIG. 24.



WITNESSES

Hamilton D. Turner

Fred Benner.

INVENTORS

Louis Napoleon Devon Williams

Harry Swinglehurst.

By their Attorneys

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L. N. D. WILLIAMS & H. SWINGLEHURST.

AUTOMATIC KNITTING MACHINE.

No. 552,806. Patented Jan. 7, 1896.

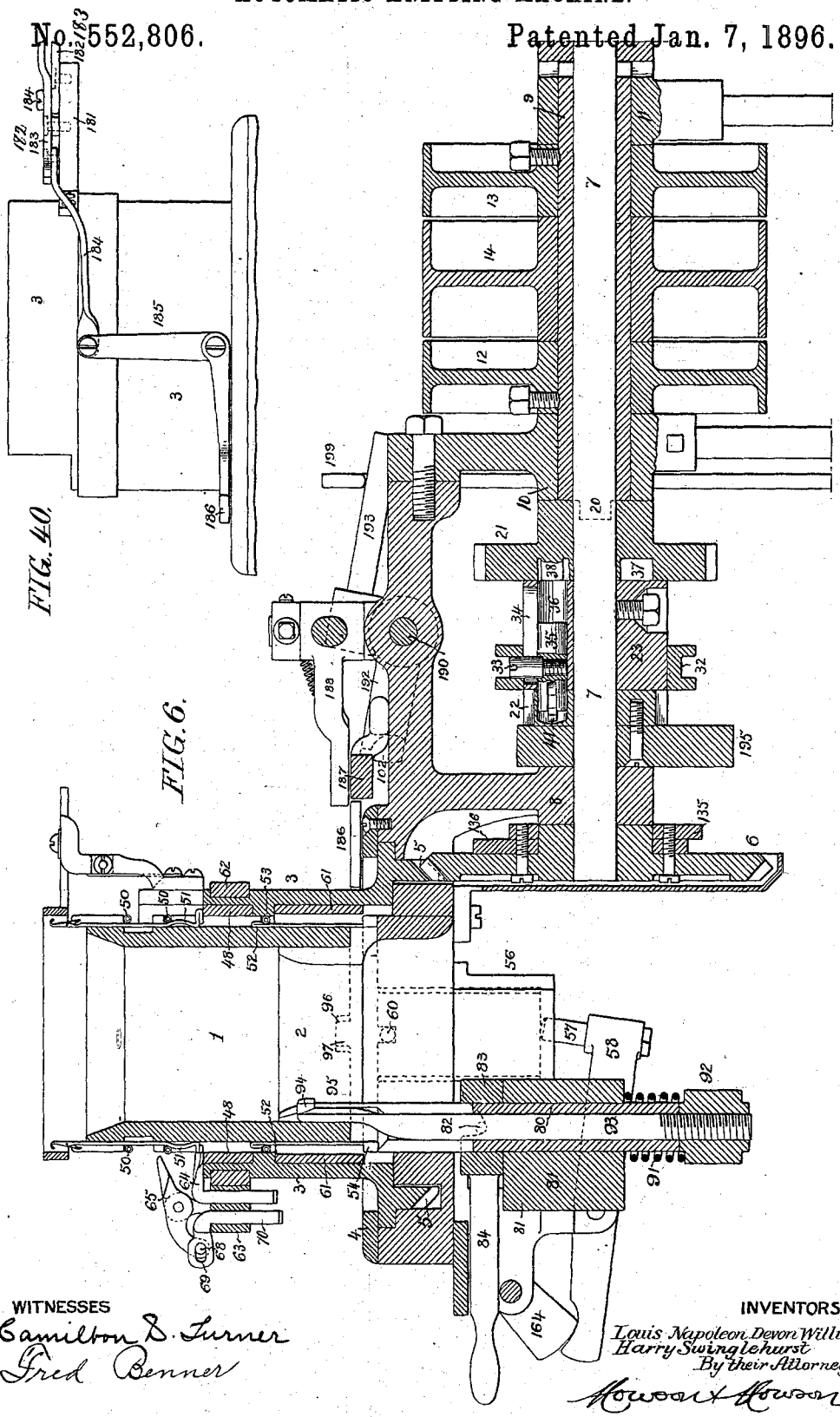

FIG. 40.

FIG. 6.

WITNESSES

Hamilton D. Turner

Fred Benner

INVENTORS

Louis Napoleon Devon Williams

Harry Swinglehurst

By their Attorneys

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L. N. D. WILLIAMS & H. SWINGLEHURST.

AUTOMATIC KNITTING MACHINE.

No. 552,806. Patented Jan. 7, 1896.

FIG. 7.

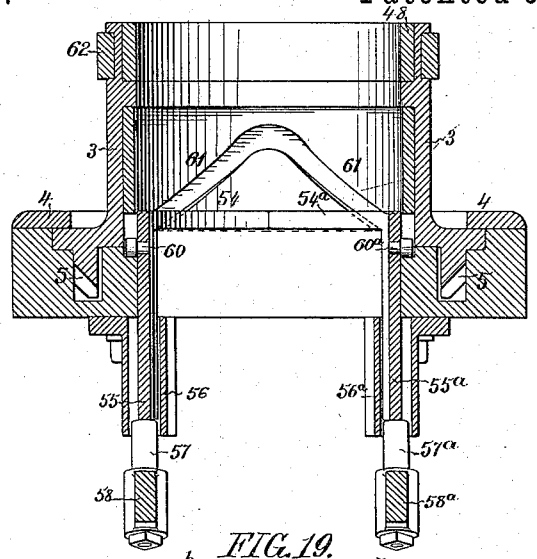


FIG. 19.

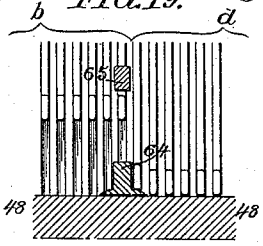


FIG. 16.

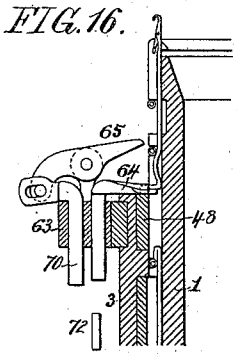


FIG. 17.

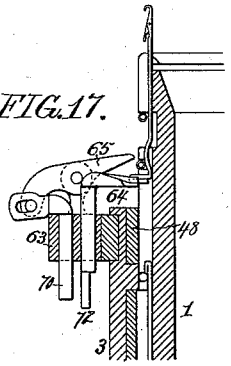


FIG. 18.

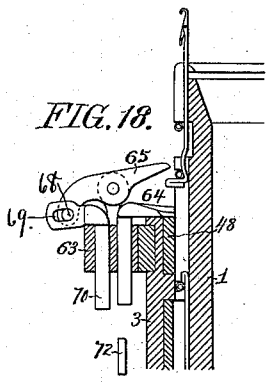


FIG. 20.

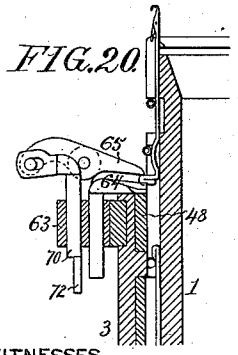


FIG. 22.

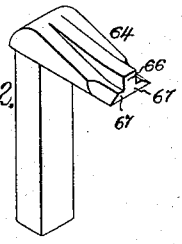
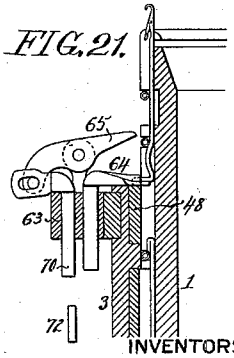


FIG. 21.



WITNESSES

Hamilton D. Turner

Fred Bermier

INVENTORS

Louis Napoleon Devon Williams

Harry Swinglehurst

By their Attorneys

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L. N. D. WILLIAMS & H. SWINGLEHURST.

AUTOMATIC KNITTING MACHINE.

No. 552,806. Patented Jan. 7, 1896.

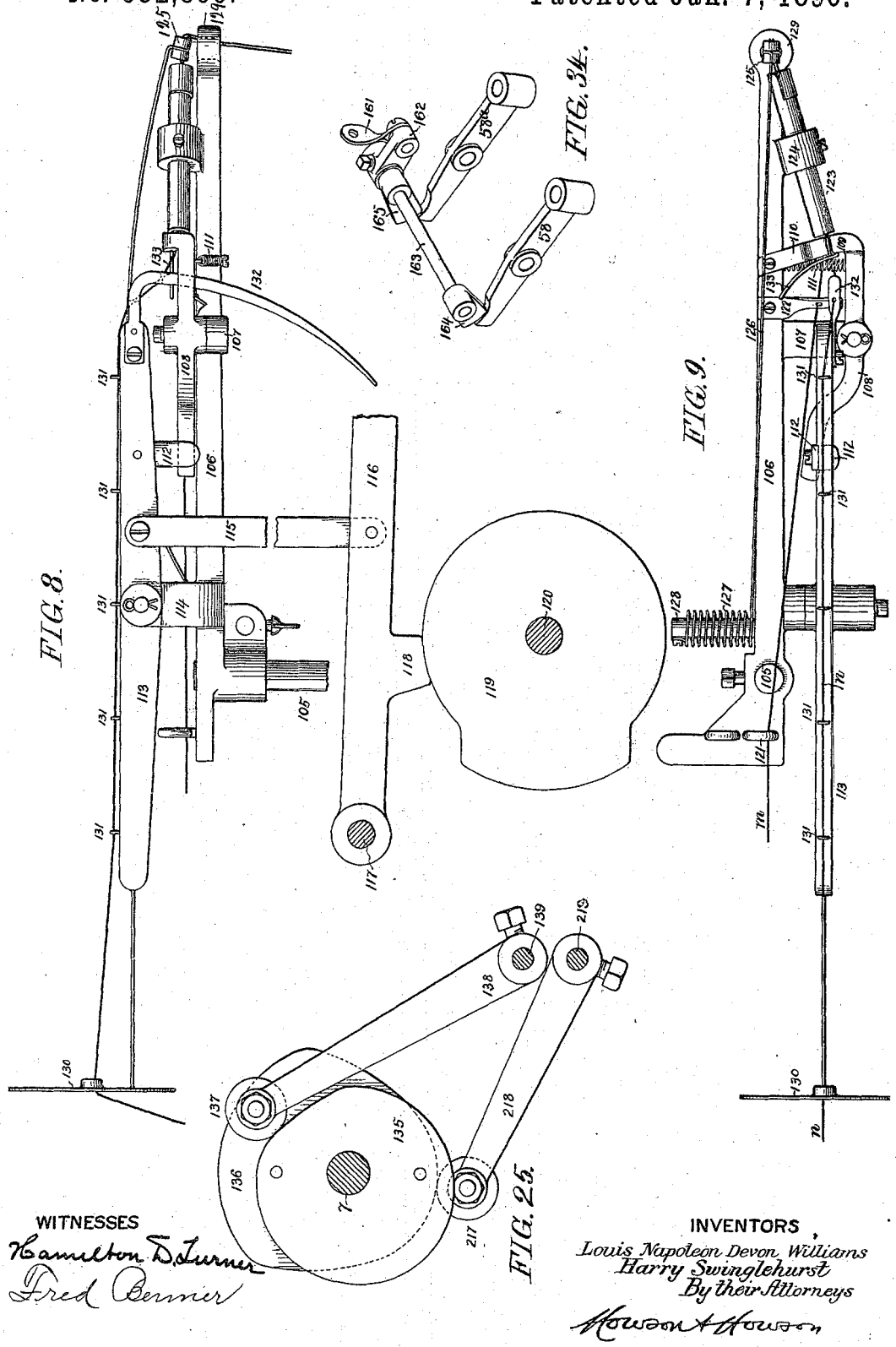

FIG. 8.

FIG. 24.

FIG. 9.

FIG. 25.

WITNESSES

Hamilton D. Turner

Fred Bennier

INVENTORS

Louis Napoleon Devon Williams

Harry Swinglehurst

By their Attorneys

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L. N. D. WILLIAMS & H. SWINGLEHURST.

AUTOMATIC KNITTING MACHINE.

No. 552,806. Patented Jan. 7, 1896.

FIG. 10.

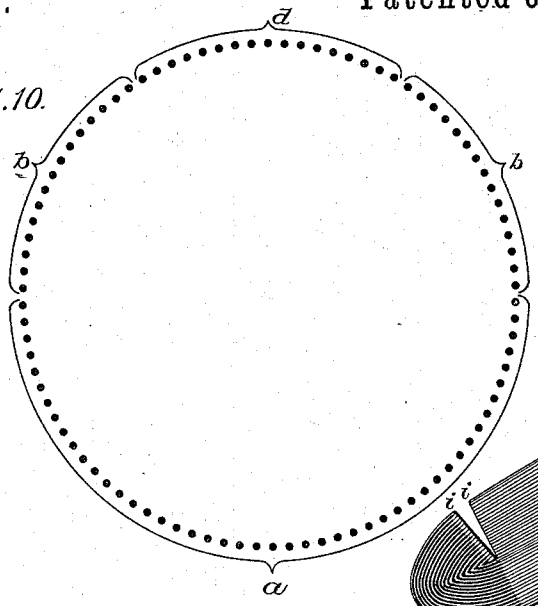


FIG. 11.

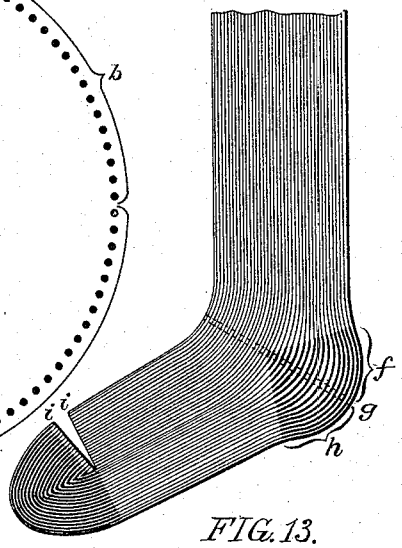


FIG. 12A.

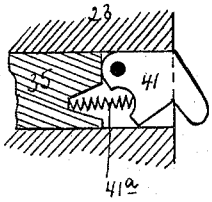


FIG. 12.

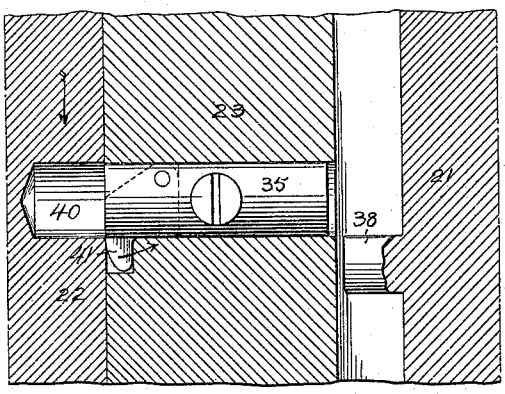


FIG. 13.

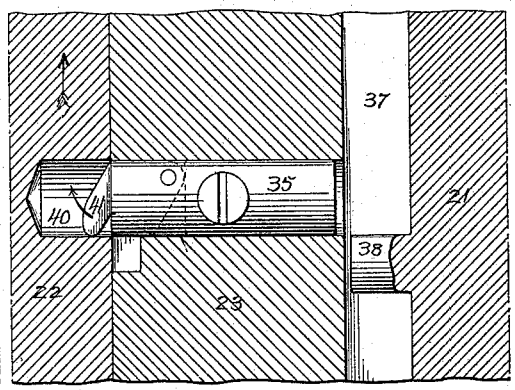
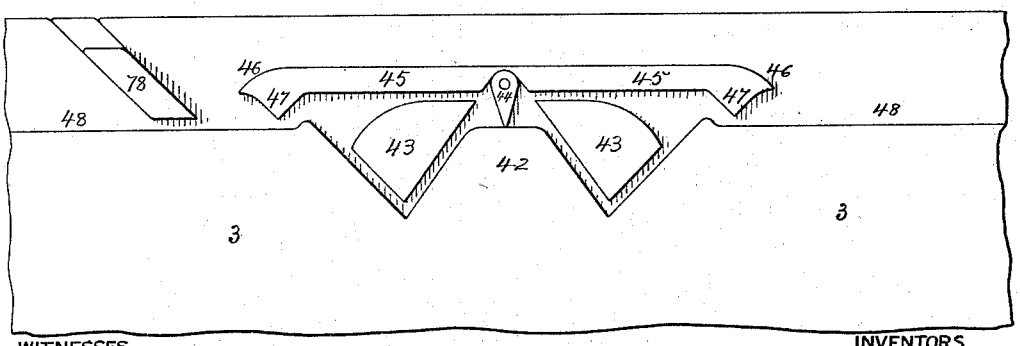


FIG. 14.



WITNESSES

Hamilton D. Turner

Fred Bennier

INVENTORS

Louis Napoleon Devon Williams

Harry Swinglehurst

By their Attorneys

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No Model.) 12 Sheets—Sheet 9.

L. N. D. WILLIAMS & H. SWINGLEHURST.

AUTOMATIC KNITTING MACHINE.

No. 552,806. Patented Jan. 7, 1896.

FIG. 23.

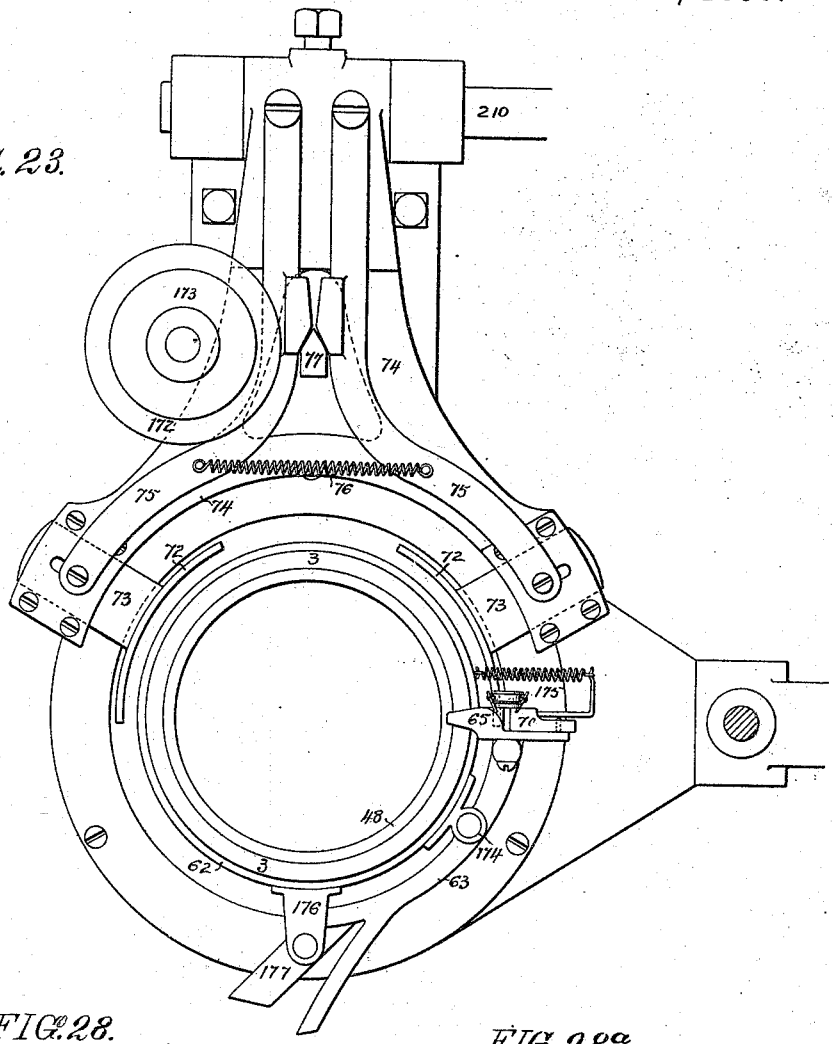


FIG. 28.

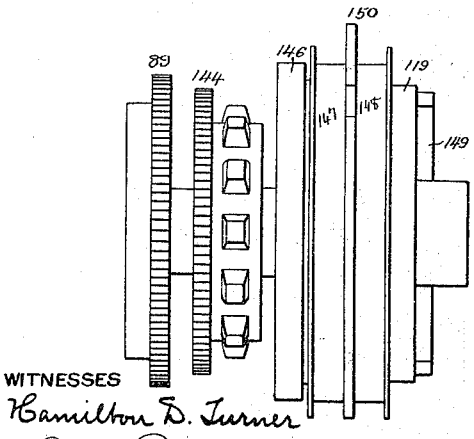
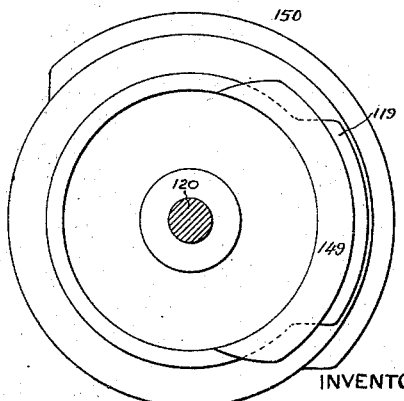


FIG 28a



WITNESSES

Hamilton D. Turner

Fred Benner.

INVENTORS

Louis Napoleon Devon Williams

Harry Swinglehurst

By their Attorneys Howson & Howson

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L. N. D. WILLIAMS & H. SWINGLEHURST.

AUTOMATIC KNITTING MACHINE.

No. 552,806. Patented Jan. 7, 1896.

FIG. 26.

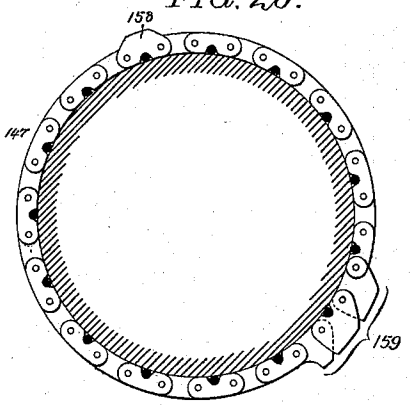


FIG. 27.

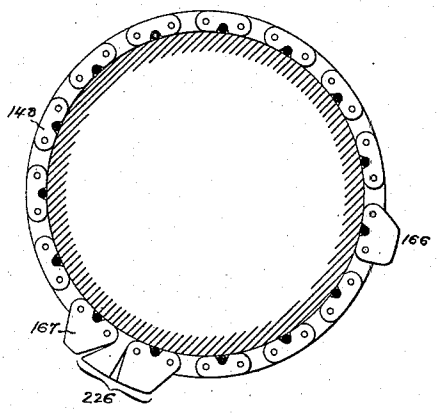
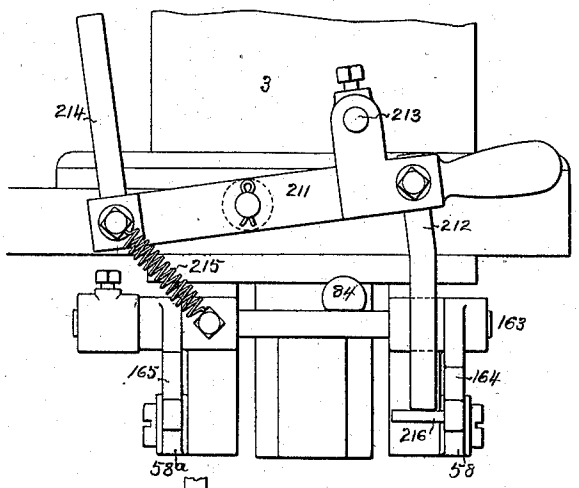


FIG. 42.



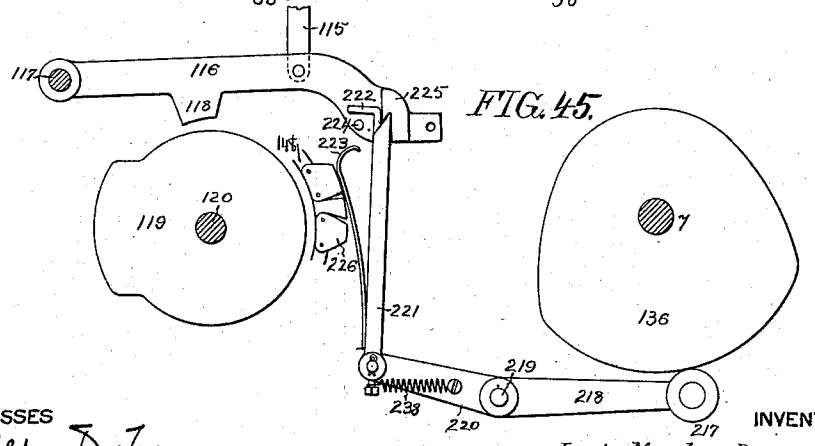


FIG. 45.

WITNESSES

Hamilton D. Turner

Fred Benner

INVENTOR

Louis Napoleon Devon Williams
Harry Swinglehurst
By their Attorneys

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(No Model.) 12 Sheets—Sheet 11.

L. N. D. WILLIAMS & H. SWINGLEHURST.

AUTOMATIC KNITTING MACHINE.

No. 552,806. Patented Jan. 7, 1896.

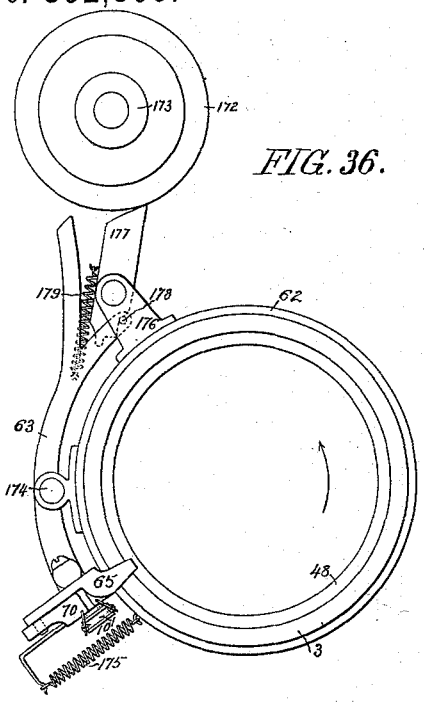

FIG. 36.

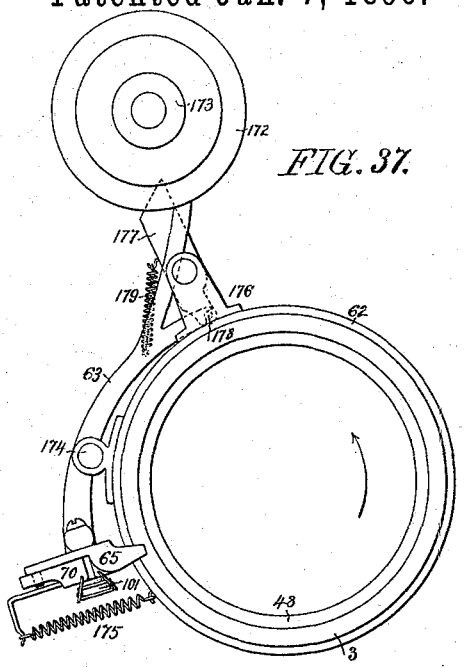

FIG. 37.

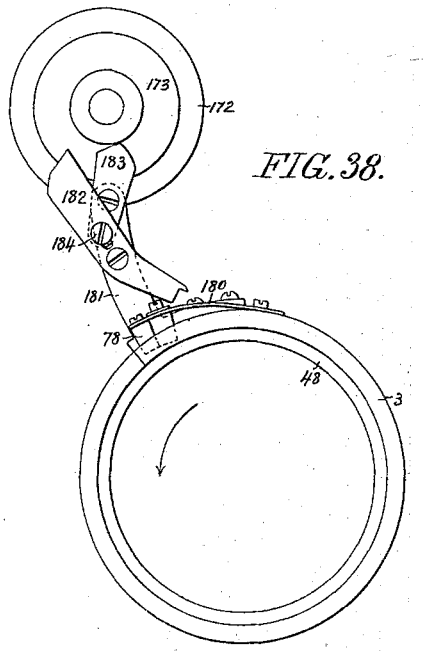

FIG. 38.

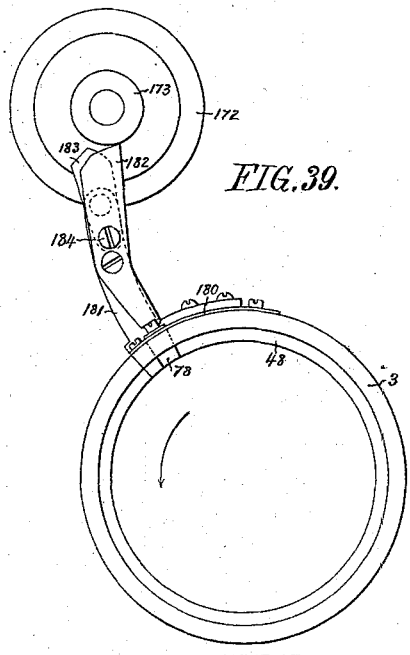

FIG. 39.

WITNESSES

Hamilton D. Turner

Fred Benner

INVENTORS

Louis Napoleon Devon Williams
Harry Swinglehurst
By their Attorneys

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(No Model.) 12 Sheets—Sheet 12.

L. N. D. WILLIAMS & H. SWINGLEHURST.

AUTOMATIC KNITTING MACHINE.

No. 552,806. Patented Jan. 7, 1896.

FIG. 43.

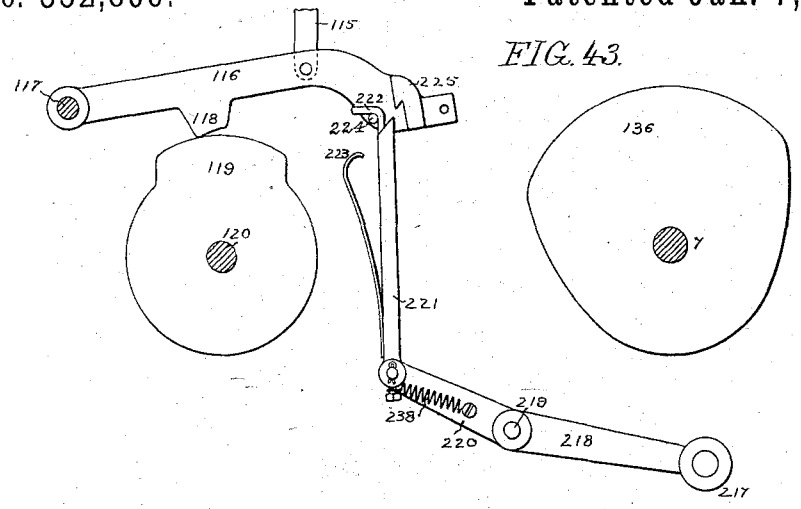


FIG. 44.

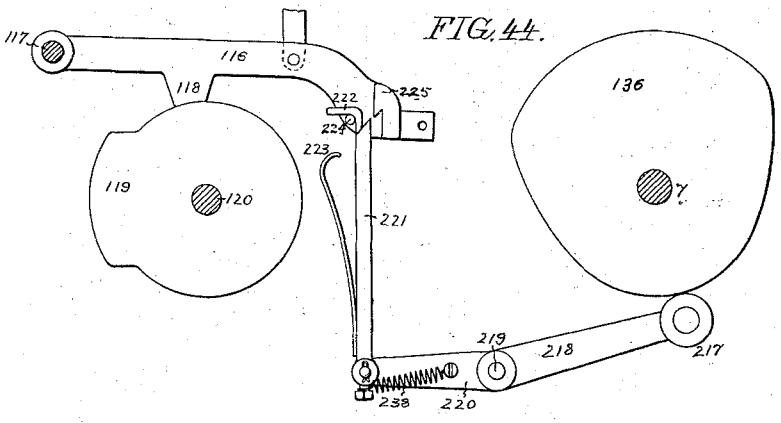
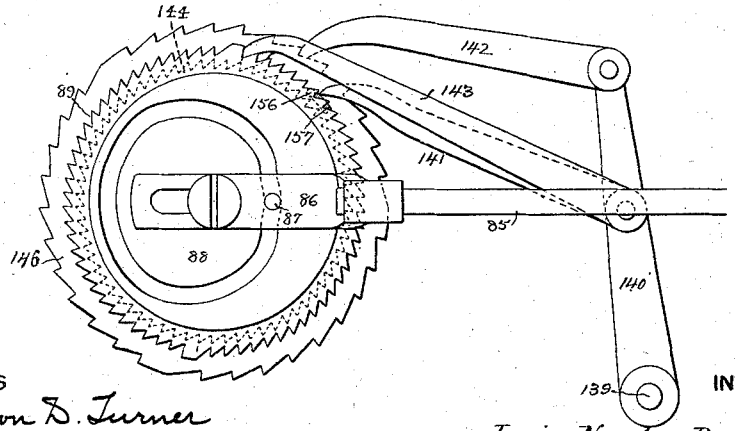


FIG. 29.



WITNESSES

Hamilton D. Turner

Fred Benner

INVENTORS

Louis Napoleon Devon Williams

Harry Swinglehurst

By their Attorneys Howson & Howson

UNITED STATES PATENT OFFICE.

LOUIS N. D. WILLIAMS, OF ASHBOURNE, AND HARRY SWINGLEHURST, OF PHILADELPHIA, PENNSYLVANIA.

AUTOMATIC KNITTING-MACHINE.

SPECIFICATION forming part of Letters Patent No. 552,806, dated January 7, 1896.

Application filed September 22, 1894. Serial No. 523,850. (No model.) Patented in England June 12, 1894, No. 11,421; in France June 12, 1894, No. 239,224; in Switzerland June 12, 1894, No. 8,726; in Spain June 15, 1894, No. 15,951; in Belgium June 30, 1894, No. 110,446, and in Austria October 16, 1894, No. 44/5,485.

To all whom it may concern:

Be it known that we, LOUIS N. D. WILLIAMS, a resident of Ashbourne, and HARRY SWINGLEHURST, a resident of Philadelphia, Pennsylvania, citizens of the United States, have invented certain Improvements in Automatic Knitting-Machines, (for which we have obtained Letters Patent in Great Britain, No. 11,421, dated June 12, 1894; in France, No. 239,224, dated June 12, 1894; in Switzerland, No. 8,726, dated June 12, 1894; in Belgium, No. 110,446, dated June 30, 1894; in Spain, No. 15,951, dated June 15, 1894, and in Austria, No. 44/5,485, dated October 16, 1894,) of which the following is a specification.

Our invention relates to a machine for the automatic knitting of what are known as "seamless" stockings—that is to say, stockings in which the heel and toe portions are formed by knitting a bag or pocket at one side of a tubular web which constitutes the leg and foot of the stocking.

The machine embodies the invention forming the subject of Letters Patent No. 521,066, dated June 5, 1894, and certain other features, the whole constituting an automatic machine of which the essential features of novelty may be stated as follows: first, minor features of the mechanism for picking the fashioning-needles into and out of operative position; secondly, mechanism for effecting the production of a series of complete tubular courses between the fashioning courses of the heel; thirdly, means for effecting the automatic change from rotation to reciprocation, and vice versa, in the operation of the machine; fourthly, means for driving the machine at higher speed when producing tubular work than when engaged in fashioning the heel or toe; fifthly, means for clamping and releasing the needle-cylinder so that the same can be readily inserted and removed to provide for the application of a section of tubular ribbed fabric to the needles for forming the top of a sock, and, sixthly, means for introducing a thickening-thread during the fashioning operation and for removing said thread during the production of tubular fabric.

The invention also comprises the sock or stocking produced upon the machine.

In the accompanying drawings, Figure 1 is a front view of the machine. Fig. 2 is an end view looking in the direction of the arrow *x*, Fig. 1. Fig. 3 is an end view, looking in the direction of the arrow *y*, Fig. 1. Fig. 4 is a plan view of the machine. Fig. 5 is a transverse section, on a larger scale, through the needle and cam cylinders, showing some of the adjunctive devices in elevation. Fig. 6 is a longitudinal section on the line *w w*, Fig. 4, also on a larger scale, and showing some of the devices in elevation. Fig. 7 is a transverse sectional view of the lower portion of the cam-cylinder and of some of the parts operating in conjunction therewith. Fig. 8 is a side view, on an enlarged scale, of the devices for controlling the feeding of the extra or thickening thread to the needles. Fig. 9 is a plan view of the same, and Figs. 10 to 46 are views illustrating details of construction of parts of the machine or views of a diagrammatic character intended to give a clear idea of the operation of various parts of the machine.

It may be best at the outset to give a brief description of the operation of knitting a sock or stocking upon the machine, reference being had to the diagrammatic view, Fig. 10, in which the circular series of small dots represents the needles of the machine.

The needles may be said to be divided into sets, one set—namely, those inclosed within the bracket *a*—extending, say, one-half way around the machine, two sets *b b* each extending about one-sixth or more of the way around the machine on opposite sides of the same, and adjoining the ends of the set *a*, and a set *d* extending between the sets *b*.

Supposing that the knitting of the sock or stocking is begun at the top of the leg, a thread (which, however, may be composed of more than one strand) is fed to all of the needles and the machine is rotated so as to produce by round-and-round knitting continuous circular courses of stitches until the desired length of tubular fabric for the leg has been

formed and it becomes necessary to form the heel.

Just here it may be stated that in knitting a sock the stitches of a short length of ribbed tubular fabric may be applied to the needles of the machine before commencing to knit the leg of the sock, so that when the sock is completed, the leg will have a ribbed top, while in knitting long stockings where the ribbed top is not required, the needles may have greater draft while knitting the upper or calf part of the leg than while knitting the lower or ankle part, so as to shape the leg by drawing longer stitches and making a tube of greater diameter in the calf portion than in the ankle portion. After the proper length of tubular fabric has been produced the needles of the set *a* are, while still retaining their stitches, raised out of action—that is to say, they are raised so that their bits will be above and free from the influence of the knitting-cams—these cams being those which effect the vertical reciprocation of the needles at the proper time so as to cause them to catch the thread and draw the stitches. This leaves only the needles *b* and *d* in action, and the motion of the machine is then changed from a rotary to a reciprocating motion and at the same time the extra or thickening thread (which also may be composed of more than one strand if desired) is introduced, the double thread being carried back and forth around that part of the needle-cylinder having the needles *b* and *d*, so as to form stitches upon said needles by to-and-fro knitting. The needles *b* being those upon which the fashioning of the toe and heel pocket is effected are termed "fashioning-needles."

At the end of each reciprocating motion a needle of one of the sets *b* at that end of the set adjacent to the needles *a* is thrown out of action—that is to say, is raised so that its bit is free from the influence of the knitting-cams—the needle thrown out of action, however, retaining its stitch. The end needle first of one fashioning set *b* and then of the opposite fashioning set *b* is thus thrown out of action so that with each reciprocating movement the flat web produced is narrowed to the extent of one needle first at one edge and then at the opposite edge of said flat web; and this narrowing operation is continued until all of the needles of both fashioning sets *b* have been thrown out of action. It is now advisable to produce a series of, say, two or more courses of stitches extending completely around the cylinder, so as to give greater depth or fullness to the center of the heel and prevent the stocking from binding at the instep. In order to effect this result all of the needles *a* and *b* are temporarily lowered so that their bits are again brought under the influence of the knitting-cams and the motion of the machine is changed from reciprocating to rotary until the desired number of circular courses have been produced, the stitches carried by the needles *a* and *b* joining those of the first of the circular courses. It is also advisable to remove the thickening-thread during the formation of that part of each circular course which extends over the instep portion of the stocking. As soon as the circular courses have been completed all of the needles *a* and *b* are again raised out of action and the reciprocating motion of the machine is resumed. As soon as this has been done, needle after needle, first a needle of one fashioning set *b* and then a needle of the other set, is brought into action by lowering the same so as to bring its bit under the control of the knitting-cams, the needles being brought into action in the reverse order from that in which they were thrown out of action—that is to say, the needles are brought successively into action at the ends of the fashioning-sets adjacent to the set *d*. This operation results in the production of a gradually-widened flat web and in the uniting of said gradually-widened web to the last of the circular instep courses, owing to the fact that each of the fashioning-needles *b* retained its stitch as it was thrown out of action after the formation of said circular courses and casts this stitch and catches a new loop formed upon the needle in effecting the production of the widened web. When all of the fashioning-needles have been thus brought into action the thickening-thread is removed, the needles *a* are lowered so as to bring their bits under the control of the knitting-cams and the motion of the machine is again changed from reciprocating to rotary.

The effect of the fashioning operations just described has been to produce a seamless bag or pocket upon one side of the knitted tube, which bag or pocket constitutes the heel of the finished stocking, as shown in Fig. 11, in which *f* represents the narrowed web, *g* the central circular courses, and *h* the widened web. After the production of this bag or pocket has been completed the production of the tubular web is resumed and continued until the same is of the length desired for the foot of the stocking, whereupon the operations resorted to in order to form the heel are repeated for the production of the bag or pocket for the toe of the stocking, although the introduction of the circular courses between the fashioning courses in this case may be omitted. In some cases also the circular courses may be omitted from the instep and center of the heel without departing from the main features of our invention, the narrowed web *f* in this case being united directly to the widened web *h*, or in other cases a series of courses extending around the entire heel, but not over the instep, may be formed after the narrowing operation and before the widening operation, the needles *b* only in this case being thrown into action after narrowing and being again thrown out of action after the desired full courses for the center of the heel have been produced.

After the completion of the bag or pocket for the toe a few tubular courses are knitted

and if the socks or stockings are being produced singly the stitches may then be cast off of the needles of the machine, so as to free the web therefrom preparatory to starting a new stocking or applying a new ribbed top, or if the machine is intended to operate continuously and produce stocking after stocking in succession the production of tubular web may, after the formation of each toe-pocket, be continued to form the leg of the next stocking, and so on, the web being afterward severed adjacent to each toe-pocket, so that each stocking-blank will present the appearance shown in Fig. 11, the toe being completed by uniting the edges *i i*.

Having thus described the general operation of the machine, we will now proceed to describe in succession the various parts of said machine to which our invention particularly relates, deferring the description of the general construction and minor details of the machine to the final part of the specification, and first we will describe the means whereby the motion of the machine is changed from rotating to reciprocating, and vice versa.

1 represents the needle-cylinder of the machine, which, when the machine is in operation, is rigidly mounted in a suitable clamping-frame 2 supported upon the fixed frame of the machine, as hereinafter described. Surrounding the lower portion of the needle-cylinder is the cam-cylinder 3 which is so mounted in the fixed frame that it is free to turn therein, said cam-cylinder being vertically confined to the fixed frame by means of a ring 4 overlapping a flange at the base of the cylinder, as shown in Fig. 6.

Upon the lower portion of the cam-cylinder is formed a bevel-wheel 5 which meshes with a bevel-wheel 6 secured to a shaft 7 adapted to a bearing 8 on the fixed frame of the machine and to a bearing in a tubular shaft or sleeve 9, which turns freely in suitable bearings 10 and 11 on the fixed frame and has secured to it the two belt-pulleys 12 and 13, between which is interposed a pulley 14 turning loosely on said tubular shaft or sleeve 9.

At the base of the machine is the shaft 15, and connected to this shaft by any ordinary form of clutch is a pulley 16 which receives a belt from a pulley on any convenient line-shaft, and secured to said shaft 15 are two pulleys 17 and 18, the latter being of greater diameter than the former.

The belt from the pulley 17 is intended to drive the pulley 12, and the belt from the pulley 18 is intended to drive the pulley 13, these belts being controlled by a double belt-shifter 19, so that when the belt from the pulley 17 is shifted onto the pulley 12 the belt from the pulley 18 will be shifted onto the loose pulley 14, and consequently the tubular shaft 9 will be driven at slow speed; but when the position of the belt-shifter 19 is reversed the belt from the pulley 17 will be shifted onto the loose pulley 14 and the belt from the large pulley 18 will be applied to the pulley 13, so that said tubular shaft 9 will be driven at higher speed.

At its inner end the tubular shaft 9 has a projection 20, as shown by dotted lines in Fig. 6, this projection being adapted to a recess in the hub of a spur-wheel 21 turning loosely on the shaft 7, and upon the latter also turns loosely a second spur-wheel 22, while between these two spur-wheels is a clutch-drum 23 secured to said shaft 7 by any suitable means—as, for instance, by a set-screw, as shown in Fig. 6. The spur-wheel 21 therefore receives a continuous rotary motion from the shaft 9, this motion being fast or slow, depending upon whether the pulley 13 or the pulley 12 is the driving-pulley.

The spur-wheel 21 meshes with a larger spur-wheel 24, which turns upon a stud 25 secured to and projecting from the fixed frame of the machine, and this spur-wheel 24 has a crank-pin 26 which is connected by a rod 27 to the outer end of an arm 28 hung to the fixed frame, said arm 28 being also connected by a rod 29 to an arm 30 on a toothed segment 31 hung to the same stud which carries the spur-wheel 24. (See dotted lines in Fig. 3.)

The toothed segment 31 meshes with the spur-wheel 22. Hence as the spur-wheel 24 rotates a rocking motion is imparted to the toothed segment 31 and a back-and-forth movement to the spur-wheel 22.

Mounted upon the clutch-drum 23 is a grooved and sliding collar 32 having a pin 33 which passes through a slot 34 in the clutch-drum 23 and carries at its inner end a sliding bolt 35 adapted to a transverse opening 36 formed in said clutch-drum, as shown in Fig. 6.

In that face of the spur-wheel 21 which is adjacent to the clutch-drum 23 is formed an annular groove 37, and into this groove projects a pin 38. Hence when the sleeve 32 is moved so as to project one end of the bolt 35 into the groove 37 the pin 38 will engage with said bolt and impart the rotating motion of the spur-wheel 21 to the clutch-drum and shaft 7 and thence to the cam-cylinder 3 of the machine.

In that face of the spur-wheel 22 which is adjacent to the clutch-drum 23 is formed a recess 40, as shown in Fig. 12, and when the end of the bolt 35 is in engagement with the pin 38 of the spur-wheel 21 its opposite end is withdrawn from the spur-wheel 22; but when it is desired to change the motion of the machine from a rotary to a reciprocating motion the sliding collar 32 and bolt 35 are shifted so as to project the end of said bolt 35 into the opening 40 of the spur-wheel 22, and thus impart reciprocating motion therefrom to the clutch-drum 23, shaft 7, and cam-cylinder 3.

The movement of the sleeve 32 and bolt 35 toward the spur-wheel 22 is controlled by a spring, as hereinafter described. Hence if the opening 40 is not in line with said bolt at the time such movement takes place the movement of the bolt will be arrested until

such time as the opening 40 comes into line therewith, whereupon the bolt will enter the opening and clutch the drum 23 to the wheel 22. As it is advisable, however, always to effect this clutching operation when the spur-wheel 22 is traveling in one and the same direction, we slot that end of the bolt 35 which engages with the opening 40 and hang to said slot a pivoted toe 41, the action of which will be best understood on reference to Figs. 12 and 13.

When the spur-wheel 22 is traveling in the direction of the arrow, Fig. 12, the projecting end of the toe 41 will extend in the rear of the bolt 35 and will, by its bearing upon the face of the spur-wheel at the rear of the opening 40, prevent the end of the bolt 35 from entering said opening, any yielding movement of the toe in the direction of the arrow shown upon it being prevented by reason of the fact that the inner portion of said toe bears against the base of the slot formed in the end of the bolt 35. The projecting toe thus keeps the bolt 35 in the retracted position until its forward end has passed beyond the front edge of the opening 40. When, however, the spur-wheel 22 is moving in the direction of the arrow, Fig. 13, the projecting portion of the toe 41 will, as soon as it reaches the opening 40, enter the same, owing to the action of a spring 41^a, Fig. 12^a, the toe being free to move in the direction of the arrow shown upon it in said Fig. 13. Hence by the time the bolt 35 is in line with the opening 40 no portion of the toe 41 will project laterally beyond the bolt. Hence the latter is free to enter said opening 40 and thus clutch the drum 23 to the spur-wheel 22.

We will now describe the devices for lifting out of action the needles comprising the set *a* after the completion of a length of tubular web and before the formation of a heel or toe pocket.

The knitting-cams of the machine, which are carried by the upper portion of the cam-cylinder 3, are shown on an enlarged scale in Fig. 14 and comprise a central lift-cam 42, drawing-down cams 43 flanking said central lift-cam, a central pivoted toe-cam 44 and a top cam 45, the latter extending in both directions beyond the cams 43 and having at each end a lifting curve or incline 46 and a depressing incline 47.

When the needles are at rest and are depressed the bits of said needles bear upon the supporting shelf or shoulder 48 of the cam-box, as shown in Fig. 6, and consequently said bits will come under the influence of the knitting-cams when the cam-cylinder is traveling in either direction, the toe-cam 44 swinging first against one draw-down cam 43 and thence against the opposite draw-down cam 43 when the cam-box is being reciprocated, but said toe-cam preserving its position against one of the draw-down cams 43 during the time that the cam-box is being rotated. In order, therefore, to throw any needle out of action—that is to say, to remove it from the influence of the knitting-cams—it is only necessary to raise said needle until its bit is above the point of the advancing end of the top cam 45, the bit being thereby caused to travel over the top of said cam 45 instead of passing under the same to be depressed by the action of the toe-cam 44 and one of the draw-down cams 43.

The needles are acted upon by spring bands 50 which encircle the series of needles and press the same so firmly into the needle-grooves that they will be retained by friction when elevated, a slight bend or offset, such as shown, for instance, at 51, being, if desired, formed in the lower portion of the stem or shank of each needle, as shown in Fig. 6, so as to insure this result.

In the grooves of the needle-cylinder, beneath the needles comprising the set *a*, are guided jacks 52, which are likewise retained in any vertical position of adjustment by means of an encircling spring-band 53 and the lower ends of said jacks are acted upon by a segment 54, said segment having a depending stem 55 contained within a shield or casing 56 depending from the under side of the table or bed upon which the cam-cylinder is mounted. The lower end of the stem 55 is acted upon by a pin 57 carried by the inner end of a lever 58 to which vibrating motion is imparted at the proper time by means hereinafter described, the pin 57 being backed by a spring 59, as shown in Fig. 15, so that in case the segment 54 is not free to rise when the inner end of the arm 58 is raised the pin can yield until such a time as the upward movement of the segment is not interfered with.

The stem of the segment 54 has a projecting lug or pin 60 which, when said stem is raised by the action of the pin 57, is brought into the path of a grooved cam 61 contained in the lower portion of the cylinder 3, as shown in Figs. 5 and 7, said cam serving to impart a further rise to the segment, so that the latter will lift the jacks 52 and raise all of the needles of the set *a* to such an extent that their bits will pass above the top cam 45 and will be free from the influence of the knitting-cams, the segment 54 being restored by the cam 61 to its normal or depressed position as soon as this operation has been completed.

The means employed for moving the needles of the fashioning set *b* successively into and out of action are shown in Figs. 1, 2, 4 and 6, and more in detail in Figs. 16 to 22, and are as follows: Mounted upon the cam-cylinder 3 is a friction-ring 62, and hung to the latter is a lever 63, one end of which carries a pair of needle-pickers comprising a lifter 64 and a depressor 65. The needle-lifter 64 consists of a stem or shank passing vertically through the lever 63 and bent inward at the upper end so as to overlap and rest upon the top of the shoulder 48 of the

cam-cylinder, as shown in Figs. 6 and 16, so that the inner end of said lifter is in position to come into contact with the bit of a needle resting upon said cam-shoulder, as shown in Fig. 19. That portion of the lifter which overlaps the shoulder 48 comprises a central vertical lug 66 and opposite laterally-projecting base flanges or fins 67 tapering to a comparatively sharp edge, as shown in Figs. 19 and 22, so that when the lifter is carried around by the friction-ring 62 its lug 66 will strike the bit of the end needle of either set *b* and its motion will be arrested thereby, the frictional hold of the ring 62 upon the cam-cylinder being so slight that this arrest of motion can be very easily effected. By imparting a slight upward movement to the vertical stem or shank of the lifter 64 when its lug is thus in contact with the bit of a needle, one of the fins 67 which has been projected under said bit will act upon the same to lift the needle to the extent shown in Fig. 17—that is to say, to such an extent that its bit will clear the point at the forward end of the top cam 45—which will complete the lift of the needle out of operative position, as shown in Fig. 18. As the cam-cylinder is reciprocated, therefore, the lug 66 of the lifter strikes first the end acting needle of one set of fashioning-needles *b*, and then the end acting needle of the opposite set of fashioning-needles, it being understood that the lifter and depressor are reciprocated around that portion of the cylinder containing the inactive needles—that is to say, the needles of the set *a* and those of the sets *b* which have been lifted out of range of the knitting-cams.

The depressor 65 consists of a lever hung to a bracket on the lever 63 and having at its outer end a pin 68, which is adapted to a slot 69 in the outwardly-bent upper end of a rod or bar 70, which is vertically guided in the forward end of the lever 63 in the same manner as the stem or shank of the lifter 64, but in a position which is somewhat farther beyond the axis of the cam-cylinder than said shank.

The inner end of the depressor 65 occupies a position directly above the central lug 66 of the lifter 64, and when all of the needles of both fashioning sets *b b* have been successively raised out of action by the action of said lifter 64, the vertical movement of the latter is arrested and vertical movement is imparted to the operating rod or bar 70 of the depressor 65.

The central lug 66 of the lifter is so much wider than the gage of the needles that when it is in contact with the bit of one needle the inner end of the depressor will be directly in line with the bit of the next adjoining needle. Hence when all the needles *b* have been lifted, the contact of the lug 66 of the lifter with the bit of the end needle of the acting set *d*, as shown in Fig. 19, will bring the inner end of the depressor directly above the bit of the adjacent inactive needle at the end of the set *b*, as also shown in said figure. Hence on the operation of the depressor said bit will be moved downward, as shown in Fig. 20, this movement being sufficient to carry it beneath the point of the advancing end of the top cam 45. Hence the needle will be further depressed by the action of said cam, as shown in Fig. 21, and it will be thereby thrown into action by being brought under the influence of the knitting-cams. This action will be repeated at the end of each reciprocating movement until all of the needles of each set *b* have been successively brought into action again.

If desired, the complete upward or downward movement of the needles necessary to throw them out of or into action may be effected by the lifter or depressor without the co-operation of the cam 45, by simply increasing the throw of said lifter or depressor to a slight extent.

The lifter and depressor are operated by segmental bars 72, occupying a relation to the needle-cylinder corresponding with the sets *b* of fashioning-needles, and these segmental bars have stems 73 which, as shown in Fig. 23, are adapted to guides at the inner ends of a forked frame 74 to which vibrating movement is imparted in the manner hereinafter described so as to give the segmental bars the desired vertical reciprocating movement.

As it is desired that the bars 72 shall act first upon the stem of the lifter 64 and then upon the operating rod or bar 70 of the depressor 65, said bars 72 are moved from one position to the other by means of arms 75 hung to the vibrating frame 74, these arms being drawn inward by means of a spring 76 and being separated by means of a wedge 77 which is operated at the proper time by mechanism hereinafter described.

The inner ends of the arms 75 have pins connected to the stems of the segmental bars 72 and the guides for said stems are slotted for the passage of these pins, as shown in Fig. 23.

In order to depress the lifter 64 or depressor 65 when the segmental bar 72 is lowered, a coiled spring 100 passes around a pulley 101 at the end of the lever 63, the upper ends of this spring being connected to pins projecting upwardly from the lifter 64 and the depressor-operating rod or bar 70. (See Figs. 1, 2 and 4.)

After the narrowing operation has been effected upon the fashioning-needles *b* and all of said needles have been lifted so that their bits are out of range of the knitting-cams, it becomes necessary to restore these needles, as well as the needles of the set *a*, to action again in order to provide for the formation of the series of circular courses at the center of the heel and over the instep, as described in an earlier portion of the specification. This result is attained by means of a primary draw-down cam 78, (shown in Fig. 14,) this cam occupying a position adjacent to one end of the top cam 45 and, during the narrowing operation, being retracted so as to fail to act upon the bits of the needles.

When, however, it is necessary to throw the needles into action the cam 78 is thrust inward, so that on the first movement of rotation of the cam-box the bits of all of the needles will be thrust downward into the path of the knitting-cams. After the formation of the continuous circular courses of stitches at the center of the heel the cam 78 is again withdrawn, and before the widening operation can begin it is necessary to again move out of action the needles of the set *a* and also the needles of the sets *b*. The needles *a* are lifted out of action by the operation of the lever 58, segment 54 and cam 61, as before described, but in order to likewise lift out of action the needles *b* we employ a second segment 54^a having a shank 55^a acted upon by a spring-pin 57^a on an arm 58^a, as shown in Fig. 7, it being understood that the needles of the sets *b* are provided with lifting-jacks beneath them in the same manner as the needles of the set *a;* but the needles of the set *d* have no such lifting-jacks beneath them. Hence the rise of the segment 54^a exerts no influence upon said needles *d*, which therefore remain continuously in action.

Variation in the draft of the needles so as to effect the formation of long or short stitches is occasioned by raising and lowering the needle-cylinder, it being understood that the needles are always drawn down to the same point by the knitting-cams of the cam-cylinder 3. Hence a rise of the needle-cylinder will cause the needles to draw longer stitches than would be drawn by said needles if the needle-cylinder occupied a lower position. In other words, when the cylinder is raised the hooks of the needles in their descent will be carried to a greater extent below the top or web-supporting edge of the cylinder than when the latter occupies the lower position. In order to effect such rise and fall of the cylinder the clamp 2, which carries the same, is free to slide vertically in an opening in the bed-plate forming part of the fixed frame of the machine, and said clamp has a tubular stem 80, guided in a boss 81 of the fixed frame and having at either or both sides a projecting pin 82, which rests upon a cam-ring 83 mounted upon said boss 81 and having an outwardly-projecting arm 84, this construction being shown in Fig. 6. The outer end of the arm 84 is connected by a rod 85, Figs. 2 and 4, to a slide 86, which is loosely mounted upon the outer end of a shaft 120 at the rear end of the machine, and upon said shaft is also loosely mounted a ratchet-wheel 89. Secured to this ratchet-wheel is a grooved or slotted cam 88 which acts upon a pin 87 on the slide 86. Hence as the cam is turned the slide will be moved back and forth, and the arm 84 will be operated so as to raise or lower the needle-cylinder.

Instead of using a slotted cam 88, as shown in Fig. 2, a single-acting cam can be used, as shown in Fig. 24, the pin 87 being held in contact with the cam by means of a spring 90 acting upon the slide 86.

The clamp 2 is depressed so as to keep its pin or pins 82 firmly seated upon the cam-ring 83, by means of a spring 91 interposed between the bottom of the boss 81 and a lever-nut 92 adapted to the threaded lower end of a rod 93 which has at the upper end a wedge 94 adapted to the tapered upper end of a slot 95 formed in the clamp 2, as shown in Figs. 5 and 6.

The lever-nut 92 bears against the lower end of the tubular stem 80 of the clamp 2. Hence if said lever-nut 92 is turned in one direction it will so act upon the threaded rod 93 as to draw the same downward and thus cause its wedge 94 to expand the clamp 2 and firmly grip the lower portion of the needle-cylinder so as to hold the same in place, but by turning the lever-nut in the oppsite direction, the wedge 94 will be slackened and the clamp 2 will be permitted to contract (this being its normal tendency) so as to release the needle cylinder and permit the removal of the same and the insertion of a new one.

Reliance may ordinarily be placed upon the frictional hold of the clamp 2 upon the needle-cylinder to prevent any rotating movement of the latter with the cam-cylinder; but as an additional safeguard we provide the clamp 2 with a projecting lug 96 at one side, this lug being adapted to a recess 97 formed in the bottom of the needle-cylinder, as shown by dotted lines in Fig. 6. This provision for the ready application and removal of the needle-cylinder is of importance in cases where the stockings are knitted to tubular webs of ribbed fabric which constitute the ribbed tops of the stocking-legs. In such cases the stitches of the ribbed web are applied to the needles of the cylinder before the latter is placed in the machine and after the knitting of the stocking with its heel and toe pocket has been completed, the cylinder is removed and a second cylinder having a new tube of ribbed fabric upon its needles is inserted in the machine, the tube of ribbed fabric being applied to the needles of one cylinder while the knitting of the stocking is being effected upon the needles of the other cylinder.

The means for controlling the feeding of the thread or threads to the needles of the machine are shown in Figs. 2, 4, 8 and 9, on reference to which it will be observed that a post 105 projects upwardly from the rear portion of the fixed frame, this post having at the upper end a projecting arm 106. To a projecting lug 107 on the latter is hung a lever 108 one arm of which has a jaw 109 constituting the movable jaw of a clamp, the fixed jaw 110 of said clamp being secured to and projecting from the arm 106, as shown in Fig. 9.

A spring 111 tends to draw the jaw 109 toward the jaw 110, and in order to effect the separation of these jaws whenever such sepa-

ration is desired, the opposite arm of the lever 108 is acted upon by a cam 112 carried by a lever 113 which is hung to an upwardly-projecting lug 114 on the arm 106 and is connected by a rod 115 to a lever 116 which is hung to a fixed rod 117 at the back of the machine and has a lug 118 adapted to be acted upon at the proper time by a cam 119 which can turn upon the shaft 120 mounted in bearings at the rear of the machine.

The main knitting-thread *m* which is to be fed to the needles passes first through a guide-eye 121 upon the arm 106, thence through an eye in a guide-finger 122 projecting from said arm, thence under the jaws 109 and 110, thence into and through a guide-tube 123 carried by a tubular stud 124 on the arm 106, thence through an eyelet 125 carried by an elastic arm 126, and thence through a guide-eye 129 at the front end of said arm 106 to the guide which feeds the thread to the needles of the machine. The elastic arm 126 forms one termination of a spring 127 coiled around a pin 128 projecting from the arm 106 as shown in Fig. 9. The extra or reinforcing thread *n*, which is only to be inserted at intervals, passes first through a guide-eye in a disk 130 carried by the lever 113, thence through eyes 131 on the back of said lever, thence through guide-openings in a curved arm 132 at the front end of said lever, thence under a guide-wire 133 carried by the lever 108, and finally between the jaws 109 and 110 and into the guide-tube 123, after which it follows the same course as the main or continuous knitting-thread. When, therefore, it is desired to feed the reinforcing-thread to the needles of the machine the parts are permitted to assume the position shown in Figs. 8 and 9, the lever 116 occupying its depressed position so as to lower the front end of the lever 113 and cause its cam-lug 112 to act upon the lever 108 so as to open the jaw 109 and permit the extra thread to be carried along the needles by contact with the continuous knitting-thread.

When it is desired to stop the feeding of the extra thread to the needles, the arm 116 is lifted by the action of the cam 119 so as to raise the front end of the lever 113, thereby withdrawing the cam-lug 112 from contact with the lever 108 and permitting the spring 111 to draw the jaw 109 of said lever into contact with the fixed jaw 110 so as to clamp and hold the extra thread, which will consequently be broken off at a point close to the needles. When the extra thread is again released by the opening of the clamp-jaws 109 and 110, said extra thread will be again drawn into the needles by contact with the main knitting-thread.

In order to form slack in the extra thread *n* after the closing of the clamp-jaws, so that said thread will for a time be free from tension when the jaws are again opened and can thus be readily drawn forward by the main thread *m*, fresh thread will be drawn from the bobbin on the rise of the forward end of the lever 113, the thread lying along the curved arm 132 until the forward end of the lever 113 again descends. At the same time that the forward end of the lever 113 rises the rear end descends; but the disk 130 prevents any lapping of the thread around the lever during either movement of the same, such as might be caused by the swaying movement of the thread in the absence of such guard-disk.

During the reciprocating movement of the machine slack is formed in the threads on each reversal of the direction of movement of the cam-cylinder and the thread-guide carried thereby; but the elastic arm 126, carrying the eyelet 125, takes up this slack, the eyelet rising as the slack is formed and being drawn down as the slack is taken up by the needles. By this means the thread is always kept under the desired degree of tension during the knitting operation and the proper feeding of the thread to the needles by the guide is insured.

Having thus described the construction and operation of the various special features of novelty in the machine, we will now describe the general mechanism whereby these parts are operated at the proper times.

On the back of the bevel-wheel 6, which drives the cam-box of the machine, are two cams 135 and 136. (Shown in Figs. 1 and 6 and also in Fig. 25.) The cam 135 acts upon an antifriction-roller 137 on an arm 138, secured to a rock-shaft 139, which is free to turn in a suitable bearing on the fixed frame and has another arm 140, provided with three pawls 141, 142, and 143, as shown in Figs. 2, 4, and 29, the pawl 141 engaging with a ratchet-wheel 144 on a drum which carries the pattern-chain 145, (shown in Fig. 1,) and the pawl 142, acting upon a ratchet-wheel 146, on a sleeve which carries two pattern-chains 147 and 148, (shown respectively in Figs. 26 and 27,) said sleeve also carrying the cam 119, which operates the extra thread-feeding devices, and two other cams 149 and 150, as shown in Figs. 28 and 28ª, both ratchet-wheels and the parts connected therewith turning freely on the shaft 120.

The ratchet-wheel 146 has three long teeth, as shown in Figs. 2 and 29, and when the pawl 142 rests upon one of these long teeth the throw of the pawl is not sufficient to clear the tooth. Hence the ratchet-wheel 146 and the parts operated thereby remain stationary until a pin 151 on the face of said ratchet-wheel is struck by a projection 152 upon a link of the pattern-chain 145, there being three pairs of these links, numbered, respectively, 153, 154, and 155, in Fig. 2, said links being shown in side elevation in Figs. 30, 31, and 32.

The pawl 143 acts upon the ratchet-wheel 89 which operates the cam 88 for controlling the arm 84, whereby the draft of the needles is regulated, as hereinbefore set forth, said ratchet-wheel also having two long teeth, as

shown in Fig. 29. When the pawl 143 rests upon a long tooth of the ratchet-wheel 89 the movement of the latter is stopped until a pin 156 on the back of the ratchet-wheel is struck by a pin on a link 157 on the pattern-chain 145, said pin being long enough to overlap the ratchet-wheel 144 for this purpose. A side elevation of the link 157 is shown in Fig. 33. The pin of the link 157 will temporarily lift out of action the operating-pawl 141 after starting the movement of the ratchet-wheel 89. Hence the pawl 143 which acts upon said ratchet-wheel 89, has a wide end overlapping the ratchet-wheel 144.

As long as the end of the pawl 143 is resting upon the long tooth of the ratchet-wheel 89 it is held clear of the teeth of the rachet-wheel 144 and the latter is operated by its own pawl 141, but as soon as the wheel 89 has been moved by contact of the pin of the link 157 with the pin 156 the end of the pawl 143 drops from the long tooth of the rachet-wheel 89 and falls into engagement with the teeth of both ratchet-wheels 89 and 144, so that it serves to continue the movement of the latter wheel when its own pawl is lifted out of engagement with it by the passage of the pin of the link 157 beneath the same. This will be understood on reference to Fig. 29, in which the pin of the link 157 is shown as in the act of lifting the pawl 141 in passing beneath the same after having started the movement of the ratchet-wheel 89. There is thus provided, at suitable intervals, a movement of the arm 84, to effect, first, a rise of the needle-cylinder and then a depression of the same so as to draw longer stitches in the calf portion of the knitted tube than are drawn in the ankle and foot portions of the same. When this change is not required—as, for instance, in the knitting of socks—the automatic operation of the draft-changing mechanism may be arrested.

The pattern-chain 147 is composed mainly of low links, as shown in Fig. 26, but there is one link 158 higher than these low links and a set of links 159 higher than the links 158, and a lever 160 has a shoe resting upon the links of the chain 147, the free end of this lever being connected by a link 161 to an arm 162 on a rock-shaft 163, said rock-shaft having two cams 164 and 165, the cam 164 acting upon a notched portion of the arm 58 and the cam 165 acting upon the notched portion of the arm 58^a, as shown in Fig. 34.

The cam 165 is set so as to act later than the cam 164, the latter acting upon the arm 58 when the lever 160 is raised by the link 158 so as to throw out of action the needles of the set *a* in starting to knit the heel, the movement of the cam 165 at this time, however, not being sufficient to operate the lever 58^a, so that the needles of the set *b* remain in operation. When, however, the lever 160 is acted upon by the high links 159, both levers 58 and 58^a will be acted upon by the cams 164 and 165, and both sets of needles *a* and *b* will be thrown out of action at the completion of the circular courses at the centre of the heel.

The chain 148 has besides the usual low links other links 166 and 167, as shown in Fig. 27, the links of said chain 148 acting upon a shoe carried by a lever 168, which has at the free end a laterally-projecting lug 169 (see Fig. 35) extending beneath a vertical stem 170 guided in a suitable bearing 171 on the frame of the machine and provided at the upper end with two disks 172 and 173, as shown in Fig. 2.

The links 166 of the pattern-chain 148 are not as high as the links 167. Hence said pattern-chain provides for such an operation of the lever 168 as to permit of three vertical adjustments of the disks 172 and 173—that is to say, an extreme lower position, an intermediate or partly-lifted position and a high or fully-lifted position. The disks 172 and 173 act upon the means for operating the primary draw-down cam 78, the needle lifter and depressor 64 and 65, and the clutch-shifting mechanism of the machine in the following manner, reference being had particularly to Figs. 36, 37, 38, 39 and 40.

The needle lifter and depressor are, as before stated, carried by a lever 63, which is hung to the friction-ring 62 mounted upon the cam-cylinder 3.

As shown in Fig. 23, the pivot of the lever 63 is in a lug 174 upon said friction-ring 62, the front end of the lever being acted upon by a spring 175, the tendency of which is to draw said front end of the lever and the parts carried thereby inward toward the needle-cylinder and thereby project the rear end of the lever, as shown in Fig. 36.

Hung to a bracket 176 on the friction-ring 62 is a lever 177, which acts upon a pin 178 carried by the rear end of the lever 63, said lever 177 occupying a horizontal plane somewhat below that of the lever 63, as shown in Fig. 2.

When the inner end of the lever 177 acts upon the pin 178, as shown in Fig. 37, it retains the rear end of the lever 63 in its innermost position and consequently holds the forward end of said lever in the outermost position, so that the lifter and depressor are outward beyond the shelf 48 of the cam-cylinder, and hence are not in position to act upon the needle-bits. When it is desired to bring the lifter or depressor into action, the rod 170 is raised to the intermediate position, so that the disk 172 will act upon the lever 177 (Fig. 36) and withdraw the same from engagement with the pin 178 of the lever 63, thus permitting the forward end of said lever to be drawn inward by the spring 175, so as to move the lifter and depressor into operative relation to the bits of the needles.

When it is desired to again move said lifter and depressor out of operative position, the rod 170 is lifted to its highest position, so that the disk 172 will act upon the rear end of the

lever 63 and will push the same inward until its pin 178 is again engaged by the lever 177, a spring 179 moving said lever into engagement with the pin. (See Fig. 37.)

The primary draw-down cam 78 is carried by a spring-arm 180 mounted upon the cam-cylinder 3, said cam 78 working through a slot in the cam-cylinder.

Hung to a bracket 181 on the cam-cylinder are two levers 182 and 183, the lever 183 having a pin 184 adapted to a slot or opening in the lever 182 beyond the pivot of the same, as shown in Figs. 28 and 39.

When the machine is producing continuous tubular fabric the cam 78 is pushed inward by the action of the inner end of the lever 182, as shown in Fig. 39, and when it is desired to withdraw said cam 78 the rod 170 is partially raised so as to bring the disk 173 into line with the lever 183, which, on being struck by the disk, causes the retraction of the inner end of the lever 182 so as to permit the spring-arm 180 to effect the withdrawal of the cam 78, as shown in Fig. 38, this operation taking place immediately before the lever 177 is acted upon by the disk 172, so as to throw the needle lifter and depressor into operative relation to the bits of the needles.

When it is desired to again push the cam 78 inward the rod 170 is lifted to its highest position, so that the disk 173 will act upon the outer end of the lever 182, thereby bringing forward its inner end, so as to push the cam 78 inward and hold it there, as shown in Fig. 39, this operation being effected immediately before the action of the disk 172 upon the rear end of the lever 63, so as to throw the needle lifter and depressor out of action.

Connected to the inner end of the lever 182 is a link 184, which is also connected to one arm of a bell-crank lever 185 hung to the cam-box, the other arm of said lever having a lug 186 which projects beyond the cam-box close to the base of the same, as shown in Figs. 6 and 40, and when this lug is lowered it is adapted to strike a catch-arm 187 and when raised is adapted to strike one arm of a lever 188, both catch-arm and lever being suitably pivoted to the fixed frame of the machine.

The sliding collar 32 of the clutch-drum 23 is engaged by a fork 189 carried by a rock-shaft 190, and upon one side of the hub of this fork is mounted a swinging lever 191, Figs. 1, 4, and 41, while the opposite end of the rock-shaft is provided with two arms 192 and 193, Figs. 1, 4, and 6, rigidly secured upon said rock-shaft, the arm 193 being acted upon by a spring 194, Fig. 1, the tendency of which is to so turn the rock-shaft as to cause the grooved collar 32 of the clutch-drum to move toward the reciprocating spur-wheel 22.

When the machine is rotating so as to produce continuous tubular work, however, the collar 32 is moved in the opposite direction, so that the sliding bolt 35 of the clutch-drum 23 engages with the rotating spur-wheel 21, the parts being held in this position by the engagement of the free end of the catch-arm 187 with a lug 102 on the arm 192. When, however, the lever 182 is moved so as to permit of the withdrawal of the cam 78 the lug 186 of the lever 185 is thrown downward so as to be in position to engage with the catch-arm 187, and just as the cam-box is completing its last rotation before beginning the to-and-fro movement said lug 186 strikes the catch-arm 187 and pushes the same outward so as to withdraw its free end from engagement with the lug 102 of the arm 192, and thus permit the spring 194 to pull down the arm 193 and swing the rock-shaft 190 so as to throw the grooved clutch-collar 32 over toward the reciprocating spur-wheel 22, as shown in Fig. 1, in order to provide for clutching the drum 23 to said reciprocating spur-wheel and thus cause back-and-forth movement of the cam-cylinder.

Just before resuming the rotating movement the lever 182 is moved so as to throw the cam 78 again inward, and this movement is transmitted to the lever 185, so as to raise its lug 186 into line with the lever 188, and just before the cam-box completes its last reciprocation the lug 186 strikes said lever 188 and moves the same, so as to cause a cam 103, forming part thereof, to act upon the upper end of the lever 191, thereby thrusting the same outward and moving the lower end of the lever inward, where it comes into the path of a cam 195, secured to the spur-wheel 22, as shown in Fig. 6, this cam acting upon the lower end of the lever 191 so as to move the same laterally, and thus cause such a rocking of the shaft 190 as will carry the grooved collar 32 toward the rotating spur-wheel 21, so as to again effect the clutching of the drum 23 to said spur-wheel. (See Fig. 41.) A stop-lug 104 on the depending arm 189 of the shaft 190 prevents undue outward movement of the lever 191, and the catch-arm 187, under the influence of the spring 187ª, Fig. 4, again engages with the lug 102 of the arm 192 to retain the latter in the position to which it has been adjusted.

When the machine is rotating, the belt from the large pulley 18 is driving the pulley 13 at high speed, the belt from the small pulley 17 running to the loose pulley 14, and hence being "dead" or inoperative.

Before effecting the change from rotating to reciprocating motion it is advisable to shift the driving-belt from the fast-running pulley 13 onto the loose pulley 14 and to carry the dead-belt from the latter onto the slow-running pulley 12, so as to reduce the speed of the machine during the reciprocating movements, and when the change is effected from the reciprocating movement to the rotating movement the position of the belts should be reversed—that is to say, the driving-belt should be shifted from the slow-running pulley 12 onto the loose pulley 14 and the dead-belt should be shifted from the latter onto the fast pulley 13. This operation is effected in

the following manner: The rock-shaft 196, which carries the belt-shifter 19, has an arm 197, (shown by dotted lines in Fig. 1,) which arm is acted upon by a spring 198, tending to depress it and thus move the belt-shifter to the position shown in said Fig. 1—that is to say, with the belts respectively upon the loose pulley 14 and slow-running pulley 12. Hung to the arm 197, however, is a rod 199, the upper end of which is hooked for engagement with the arm 193 on the rock-shaft 190 of the clutch-shifter, so that when said clutch is moved so as to cause the clutch-drum to engage with the rotating spur-wheel 21 the rod 199 will be lifted by the arm 193, so as to throw the belts respectively onto the loose pulley 14 and fast-running pulley 13. The upper end of the rod 199 is connected by a link 200 to an arm 201 on a rock-shaft 202 at the rear of the machine, and said rock-shaft has at its other end an arm 203, which carries a disk 204 adapted to be acted upon by the cam 150 before referred to. (See Figs. 2, 3, and 4.) Just before the arm 192 of the clutch-shifter is released by the withdrawal of the catch-arm 187, the rod 199 is withdrawn from engagement with the arm 193 by the action of the cam 150, thus permitting the spring 198 to act upon the arm 197 of the belt-shifter in order to throw the belts upon the loose and slow-running pulleys so as to reduce the speed of the machine prior to the starting of the reciprocating movement, the belts being shifted back onto the loose pulley and fast-running pulley by the engagement of the rod 199 with the arm 193 on the upward movement of the latter, effected in shifting the clutch into engagement with the rotating spur-wheel 21 on the resumption of the rotating movement. Downward movement of the arm 197 and rod 199 under the action of the spring 198 is restricted by means of a stop-pin 98 projecting from a collar secured to a rod 99 forming part of the fixed structure of the machine, as shown in Fig. 3.

As before described, it is necessary to shift the segmental bars 72 from a position beneath the stem of the lifter 64 outward to a position beneath the rod 70, which operates the depressor 65 when all of the fashioning-needles have been raised out of operative position and it is desired to again restore them to operative position, this outward movement of the bars 72 being effected by means of the wedge 77 thrust between the arms 75 which carry said bars. The operation of this wedge at appropriate times is effected by the cam 149, which acts upon an antifriction-roller 205 carried by a lever 206, as shown by dotted lines in Fig. 3, the upper end of said lever being so formed as to constitute the separating-wedge 77. The rocking of the frame 74, which carries the segmental bars 72, is effected by means of cams 207 carried by the inner side of the spur-wheel 24, as shown in Figs. 1, 3, and 4, these cams acting upon a roller 208 carried by an arm 209 hung to the rock-shaft 210, which carries said vibrating frame 74. The roller 208 is movable laterally on a pin projecting from the arm 209, the inner flange of said roller being engaged by jaws on an arm 240 depending from the rock-shaft 190, which shifts the clutch-sleeve 23.

When the machine is rotating, the roller 208 is moved outward on its pin and the cams 207 then play in the groove of the roller and do not impart any movement thereto, but when the shaft 190 rocks so as to move the clutch-collar 32 over toward the reciprocating spur-wheel 22 the roller 208 is moved inward on its pin, so that its outer flange is brought into the path of the cams 207, and movement is therefore imparted to the roller by said cams.

When it is desired to remove the needle-cylinder from the machine, it is necessary to raise one-half of the needles until their bits are above the top knitting-cam 45, and also to withdraw the cam 78, the cam-cylinder being then turned so as to bring its cams underneath the bits of the raised needles, and thus permit of the rise of the other half of the needles with the needle-cylinder as the latter is withdrawn. In order to readily effect these results we hang to the frame of the machine at one side of the cam-box a lever 211, which has at the front end a downwardly-projecting pin 212 and an inwardly-projecting pin 213, and at the rear end an upwardly-projecting pin 214. (See Figs. 2, 4, and 42.)

Normally the front end of the lever 211 is held in an elevated position by the action of a spring 215 at the rear, but when the said front end of the lever is depressed the pin 212 strikes a pin 216 projecting rearwardly from the jack-lifting lever 58, hence the jack-lifting segment around the front half of the needle-cylinder is raised into the path of the cam 61, and is thereby further raised so that the bits of the needles are above the top cam 45.

When the cam-cylinder has been turned so that the cams are directly under the bits of the raised needles, movement of said cam-cylinder is arrested by the contact of the lug 186 of the lever 185 with the inwardly-projecting pin 213 of the lever 211, and just before this stoppage of the movement of the cam-cylinder the pin 214 of the lever 211 struck the operating lever 183 of the cam 78 and effected the withdrawal of said cam. On removing pressure from the forward end of the lever 211 the latter is restored by the spring 215 to inoperative position, so that the machine can be started as soon as a new cylinder has replaced the one which was removed.

When the heel of the stocking is being fashioned, the extra thread *n* is being inserted, the clamping-jaws 109 and 110 being open and the forward end of the lever 113 depressed, as shown in Fig. 8. When, however, the narrowing operation has been completed and one-half of the heel-pocket formed and

it becomes necessary to introduce the series of full circular courses around the heel and instep, the extra thread must be broken out, while the stitches are being formed upon the needles of the front half of the machine, corresponding to the instep portion of the stocking, as the introduction of the extra thread in the instep for these few courses would be objectionable. In order to effect this result, therefore, we employ the mechanism shown in Figs. 2, 25, 43, 44, and 45, which we will now proceed to describe.

The cam 136 before referred to acts upon an antifriction-roller 217, mounted upon an arm 218 of a rock-shaft 219, adapted to bearings on the fixed structure of the machine, as shown in Fig. 2. This rock-shaft 219 has another arm 220, and pivoted to the latter is a rod 221 with a hook 222 at the upper end, the rod also being provided with a spring-arm 223.

On the lever 116, which operates on the extra thread-feeding mechanism, is a pin 224 and a notched lug 225, as shown in Figs. 43 to 45. When the lever is elevated, during the rotation of the machine to produce tubular fabric, the pin 224 engages with the hook 222 of the rod 221 and lifts the arm 220, so as to thrown down the roller 217 of the arm 218 out of the range of the cam 136, as shown in Fig. 43. When, however, the lever 116 drops, in order to permit of the feeding in of the extra thread, the corresponding fall of the pin 224 and rod 221 permits the rise of the roller 217 into range of the cam 136, so that a vertical reciprocating movement is imparted to the rod 221, the latter, however, being held free from engagement with the notched lug 225 by means of a spring 238. The rod remains free from engagement with the notched lug 225 of the lever 116 during the formation of the first half of the heel, as shown in Fig. 44, but as soon as the machine begins to rotate in order to form the continuous courses of stitches at the instep, lugs 226 on the pattern-chain 148 act upon the spring-arm 223 and push the rod 221 forward into position for engagement with the notched lug 225, as shown in Fig. 45, hence during part of each rotation of the cam-box while the continuous heel courses are being formed the lever 116 is raised, so as to close the jaws 109 and 110 and break out the extra thread, and during the remainder of each rotation the lever 116 is permitted to drop, so as to open the jaws and permit the extra thread to be fed in. It will therefore be seen that the stitches in one part of each of the continuous circular heel and instep courses will be formed by the main thread only, while the stitches in the remaining portion of each of said circular courses will be formed by both the main and supplementary threads, and the machine is, of course, so timed that these latter stitches are those around the heel. The lugs 226 are not wide enough to act upon the shoe of the lever 168, hence the position of the disks 172 and 173 is not affected by said lugs 226.

When socks or stockings are being formed independently upon the machine, it is usual to stop the machine after the completion of the toe-pocket, a few circular courses being, however, first knitted, so that in closing the toe a continuous course of stitches is presented to be looped together.

In order to effect the automatic stoppage of the machine, we provide the pattern-chain 145 with a link having a lug 247, which at the proper time acts upon a lever 228, which is connected by a chain 229 to a weighted lever 230. When the weighted end of said lever 230 is depressed it engages with a lever 231 adapted to hold in action any suitable form of clutch whereby the belt-pulley 16 is caused to drive the shaft 15. When the weighted end of the lever 230 is raised, therefore, the lever 231 and the clutch are released and the machine is stopped.

The use of the needle-pickers, constructed in such a manner that their movement is arrested by the bits of the needles, may be resorted to in straight-knitting machines as well as in circular-knitting machines, such as we have heretofore described.

Fig. 46 represents a section of part of a straight-knitting machine illustrating the application of the pickers thereto, the straight needle bar or plate being shown at 232 and the reciprocating cam-box at 233.

The pickers are carried by a bar 234, which is slotted for the reception of bolts 235, whereby it is supported on the cam-box, and springs 236, interposed between the heads of the bolts and the bar, serve to press the latter into frictional contact with the cam-box, so that it will move with the same in the absence of any obstruction to such movement, such as the contact of the lifter 64 with the bit of a needle.

When the needles are to be thrown into and out of action only at one end of the machine, one set of pickers only need be employed; but when the needles at both ends of the machine are to be thrown into and out of action two sets of pickers, one for each end of the machine, will be required. Of course it will be understood that in a machine of this class the picker-actuating bar or bars 72 will be straight instead of segmental.

Having thus described our invention, we claim and desire to secure by Letters Patent—

1. The combination of the needle carrier and its needles, the cam box, pickers comprising a lifter and a depressor adapted to act upon the bits of the needles, a frictional carrier for said pickers, picker actuating bars, a lever carrying the pickers, a disk movable into different vertical positions, and means whereby said disk, when in one position, is caused to move the picker carrying lever into position for causing the operation of the pickers, and when in the other position, is caused

to move said lever so as to throw the pickers out of operative position, substantially as specified.

2. The combination of the needle carrier and its needles, the cam box, the pickers adapted to act upon the bits of the needles, a frictional carrier for said pickers, a lever upon which the pickers are mounted, a draw down cam for throwing the needles into operative position, a pair of disks movable into different vertical positions, and means whereby one of said disks is caused to operate the drawing down cam, and the other is caused to effect movement of the lever upon which the pickers are mounted, substantially as specified.

3. The combination of the needle carrier and its needles, the cam box, and means for moving a series of needles out of action simultaneously, said means comprising a series of jacks in line with the needles, a bar for acting upon said jacks, a cam for operating said bar, and means for moving the bar into range of said cam, substantially as specified.

4. The combination of the needle carrier and its needles, the cam box, lifting jacks guided in line with the needles, a bar for lifting a series of said jacks simultaneously, a cam for acting upon said bar, a lever for moving said bar into range of the cam, means for vibrating said lever and a spring supported pin through the medium of which the lever acts upon the bar, substantially as specified.

5. The combination of the needle carrier and its needles, the cam box, jacks in line with the needles, bars for acting upon said jacks, a cam for operating said bars, and means for moving the bars successively into range of said cam so as to move first one set of needles and then another set out of operative position, substantially as specified.

6. The combination of the needle carrier and its needles, the cam box, jacks guided in line with the needles, bars for moving said jacks, a cam for actuating said bars, two levers adapted to move said bars into range of the cam, two cams set so as to follow each other in their action on said levers, and means for operating said cams, substantially as specified.

7. The combination of the driving shaft of the machine, a pair of loose pinions on said shaft, means for rotating one of said pinions and for imparting to-and-fro movement to the other pinion, a clutch hub secured to the shaft, and a sliding collar having a pin adapted at one end to engage the rotating pinion and at the other end to enter an opening in the vibrating pinion, the latter end of the pin having a pivoted toe providing an unyielding support for the pin when the pinion is traveling in one direction, but adapted to enter the opening in advance of the pin when said pinion is traveling in the opposite direction, substantially as specified.

8. The combination of the reversing clutch, the rock shaft, a spring for moving the same in one direction, an arm engaging with a retaining catch for holding said rock shaft in one position, a lever hung to the rock shaft, a cam acting upon said lever to move the rock shaft against the action of the spring, a second lever for moving said first mentioned lever into the path of said cam, and a trip lug adapted to engage successively with said second lever and with the retaining catch substantially as specified.

9. The combination of the needle cylinder and its needles, the cam box having a draw down cam movable into and out of operative position, means for operating said draw down cam, a reversing clutch, operating mechanism therefor, one of the elements of which is a trip lug adapted to engage successively with the setting and releasing devices of said mechanism, and a connection between said trip lug and the devices for operating the draw down cam of the cam box, substantially as specified.

10. The combination of the driving shaft of the machine, the fast and slow pulleys, the loose pulley between them, the duplex belt shifter, the reversing clutch mechanism, the shifting rod constructed to engage with an arm on said reversing clutch mechanism, and mechanism for releasing the shifting rod from such engagement, substantially as specified.

11. The combination of the needle cylinder and its needles, the cylinder carrier consisting of a split ring having a downwardly projecting tubular lug, a wedge adapted to expand the split ring so as to grip the cylinder, a wedge rod passing through the tubular lug of the cylinder carrier, and a nut applied to a threaded portion of said wedge rod, substantially as specified.

12. The combination of the guide common to both the main and extra threads, a clamping device for the extra thread, a lever carrying said extra thread and adapted to act upon the movable jaw of the clamping device to open the same, and a finger formed on said lever and serving as a bearing for the thread behind the clamping jaws as said lever rises, substantially as specified.

13. The combination of the guide common to both the main and extra knitting threads, a clamping device for the extra thread, and a pivoted lever carrying said extra thread and having at its outer end a guard disk with guide eye for the passage of said thread, substantially as specified.

14. The combination of the movable clamp operating lever of the thread feeding mechanism, means for operating the same at the start and finish of the narrowing and widening operation and a supplementary operating mechanism whereby the extra thread can be cut out for part of a course, substantially as specified.

15. The combination of the clamp operating lever of the thread feeding devices, a lever connected thereto, a cam for acting upon said lever, a bar adapted to engage with said lever,

means for reciprocating said bar, and pattern mechanism for moving the bar into engagement with the lever, substantially as specified.

16. The combination of the clamp operating lever of the thread feeding mechanism, a lever connected thereto, a cam for acting on said lever, a bar also acting upon the same, means for reciprocating said bar, a pin projecting from the lever and engaging with the bar, and a pattern chain acting upon the bar to throw it into engagement with a lug or projection on the lever, substantially as specified.

17. The combination of the needle cylinder, the cam box, mechanism for moving a series of needles out of action simultaneously, the preliminary draw down cam of the cam box, lever mechanism for actuating the same, and a lever having a pin for acting upon the mechanism for raising the needles simultaneously out of action, and another pin for acting upon the lever mechanism of the preliminary draw down cam, substantially as specified.

18. The combination of the needle cylinder, the rotating cam box, mechanism for moving needles out of action simultaneously, the preliminary draw down cam of the cam box, lever mechanism for actuating the same, and a lever having a pin for acting upon the mechanism for raising the needles simultaneously out of action, a second pin for acting upon the lever mechanism of the preliminary draw down cam, and a third pin acting as a stop to prevent the rotation of the cam box, substantially as specified.

19. The combination of the needle cylinder and its needles, the needle pickers, the frame carrying the bars for operating said pickers and means for vibrating said frame, said means comprising an arm on the shaft of the frame, an antifriction roller laterally adjustable on said arm, a rotating wheel having cams, a reversing clutch forming part of the driving mechanism of the machine, and a connection between said reversing clutch and the said antifriction roller whereby the latter is moved into and out of range of the operating cams therefor on the shifting of the clutch, substantially as specified.

20. A sock or stocking having a heel composed of narrowed and widened webs, knitted with main and extra threads and having a series of continuous circular courses of stitches interposed between the gradually narrowed and gradually widened webs which form and shape the heel, the extra thread being removed from that portion of each of the interposed circular courses which extends over the instep, substantially as specified.

In testimony whereof we have signed our names to this specification in the presence of two subscribing witnesses.

LOUIS N. D. WILLIAMS.
HARRY SWINGLEHURST.

Witnesses:
GEO. E. POTTS,
HARRY SMITH.