No. 656,216

Patented Aug. 21, 1900.

J. A. RICARD.

KNITTING MACHINE.

(Application filed June 21, 1895.)

(No Model.)

8 Sheets—Sheet 1.

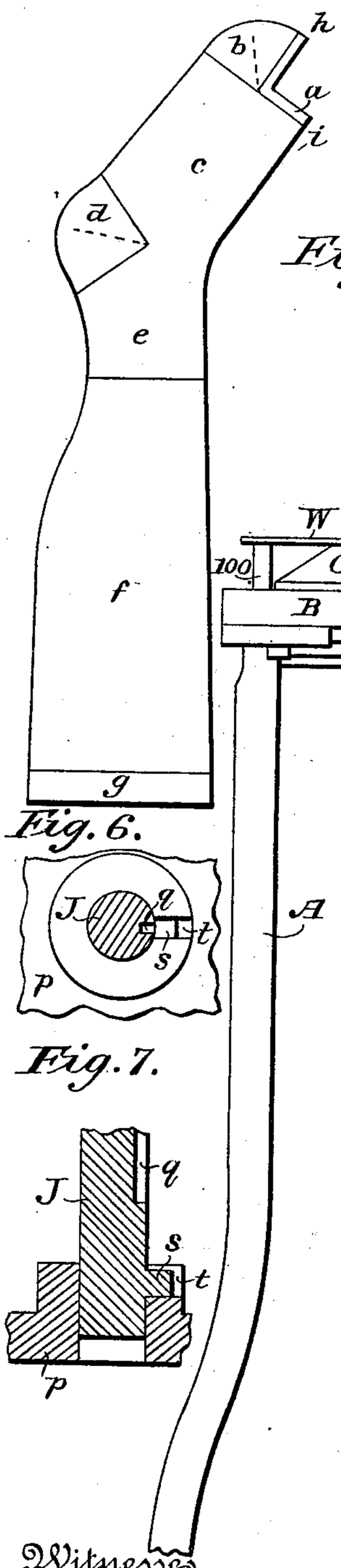

Fig. 1.

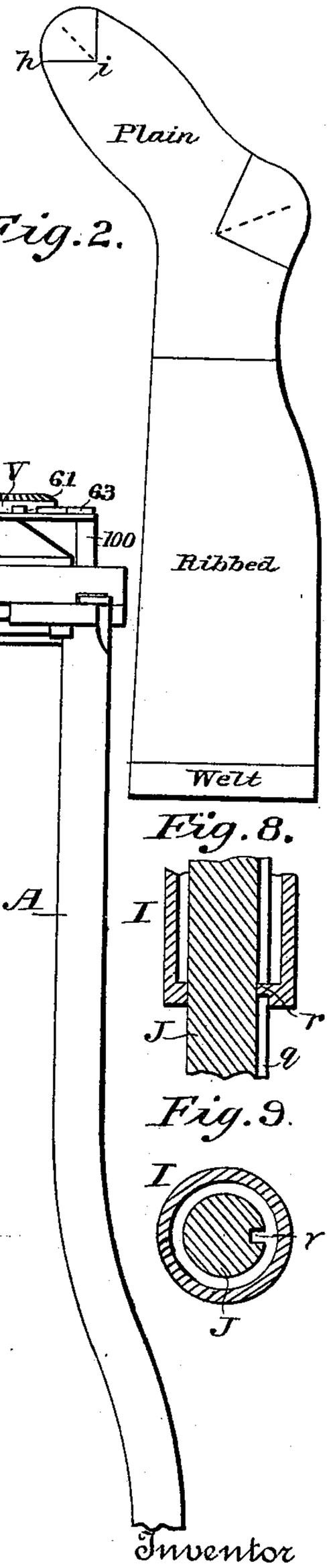

Fig. 2.

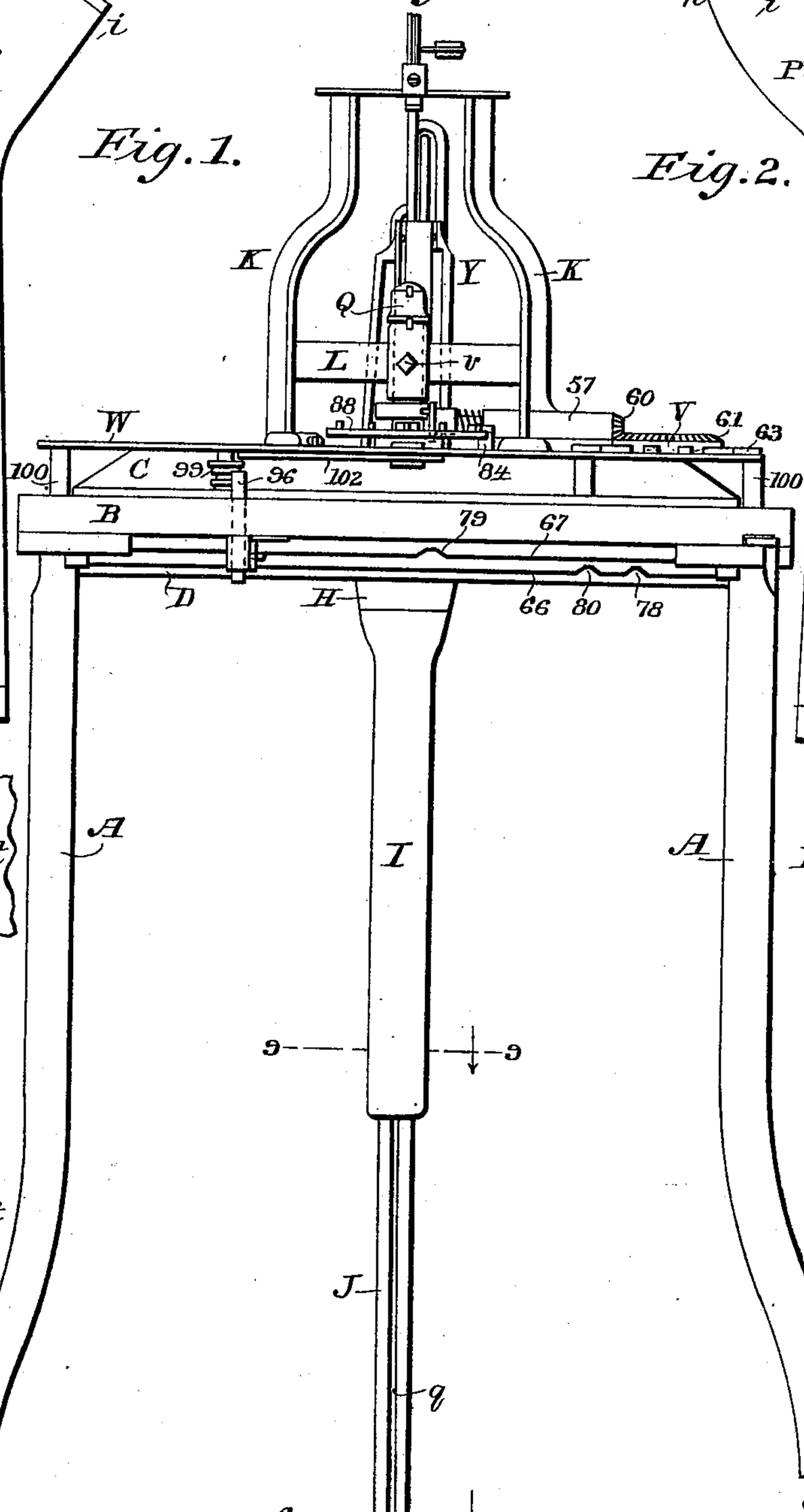

Fig. 3.

Fig. 6.

Fig. 7.

Fig. 8.

Fig. 9.

Witnesses:
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Carter & Snell

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Joseph A. Ricard
by Wilkinson Brown
his Attorney

No. 656,216. Patented Aug. 21, 1900.

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(No Model.) 8 Sheets—Sheet 2.

Fig. 10.

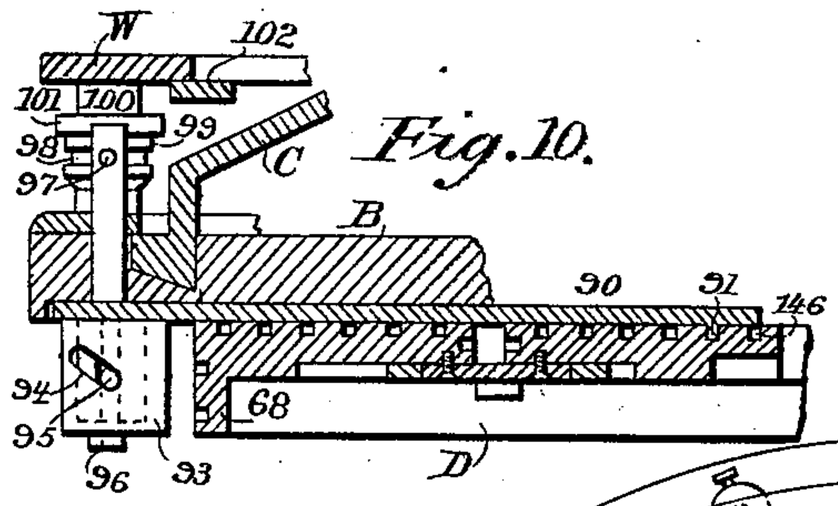


Fig. 12.

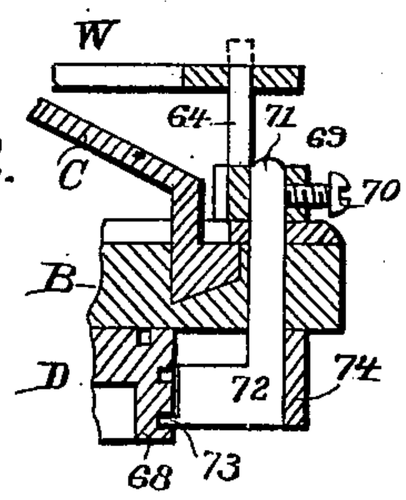


Fig. 4.

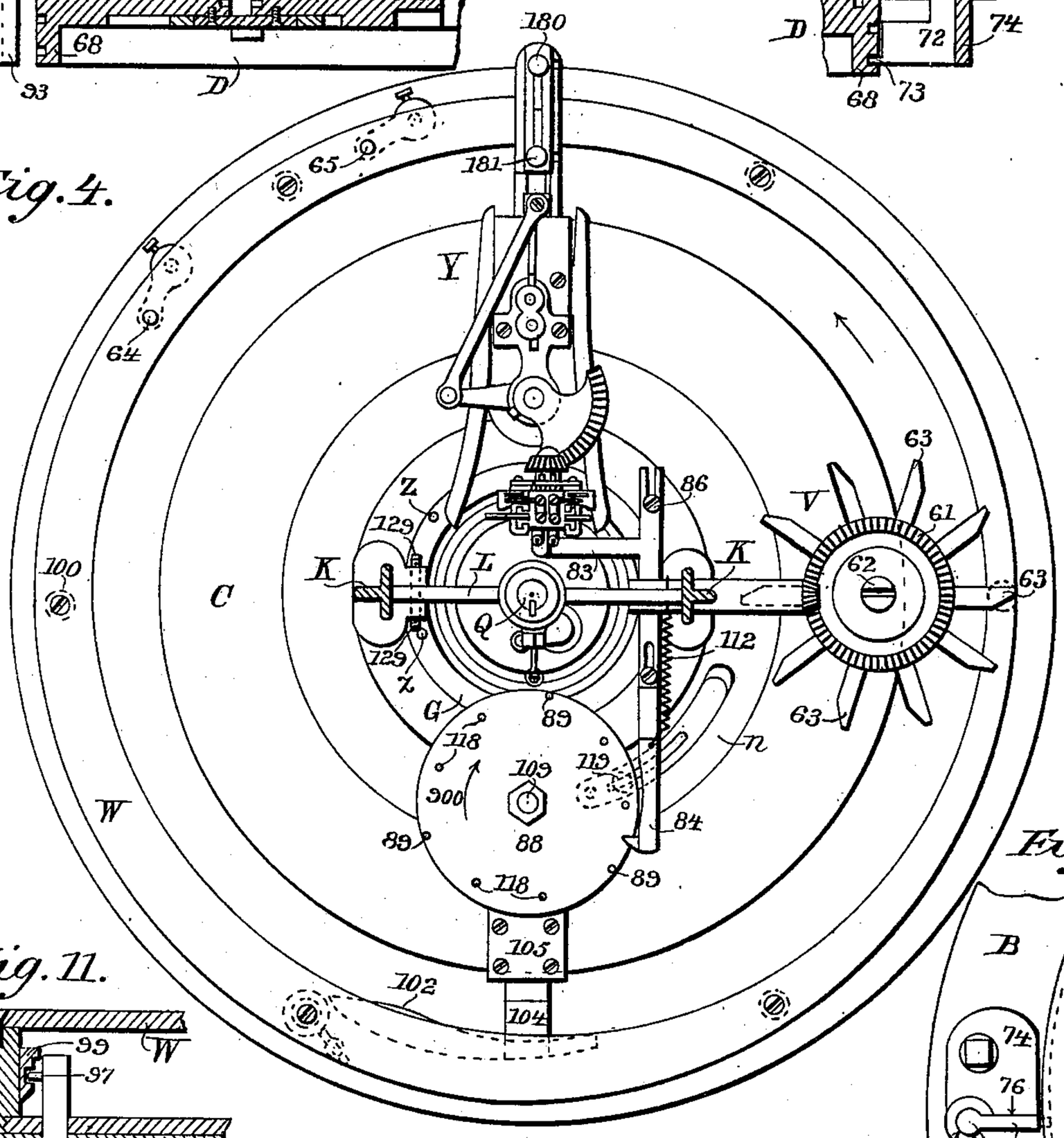


Fig. 11.

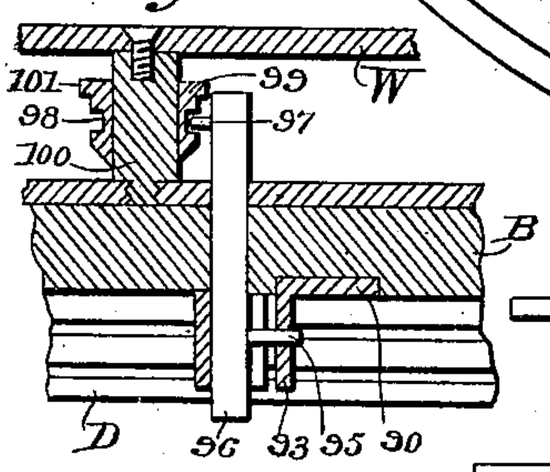


Fig. 13.

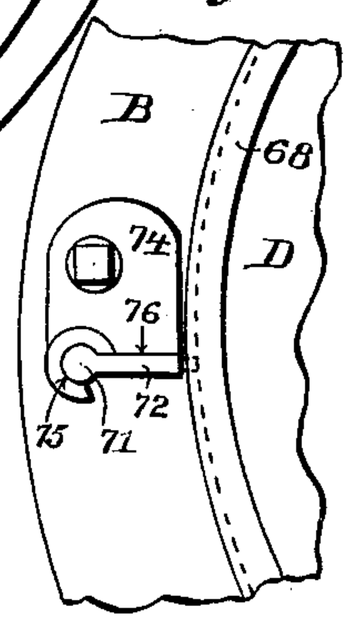
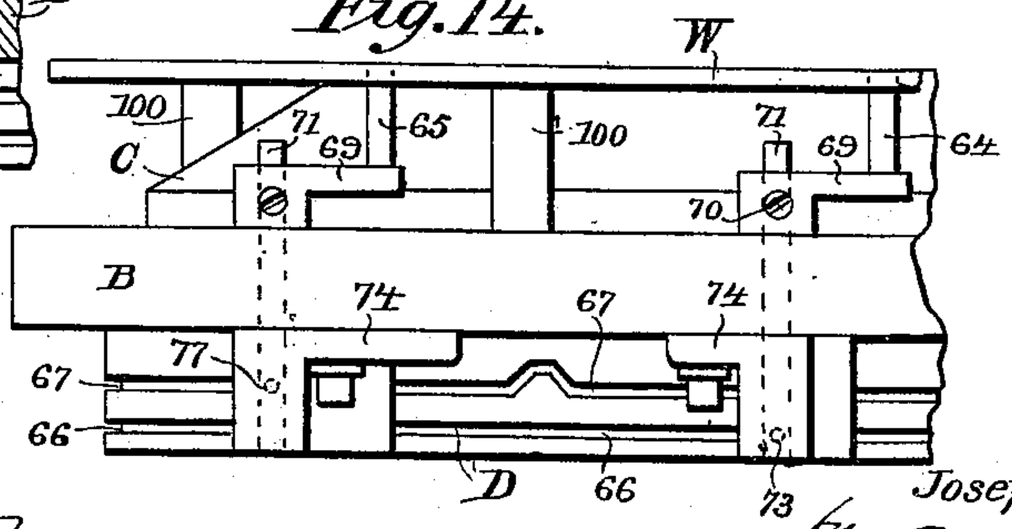


Fig. 14.



Witnesses
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No. 656,216. Patented Aug. 21, 1900.

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(No Model.) 8 Sheets—Sheet 3.

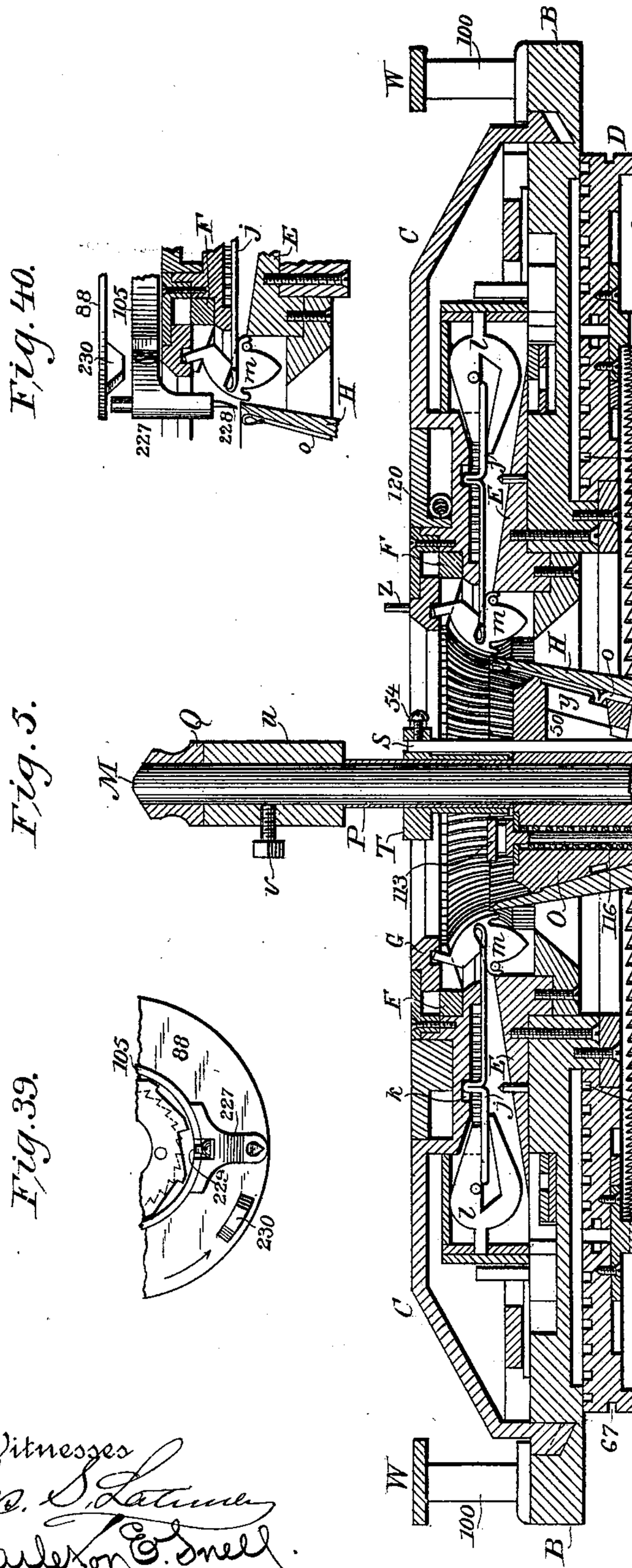


Fig. 40.

Fig. 42.

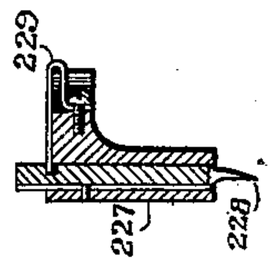
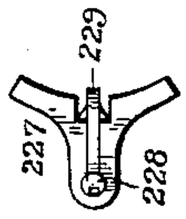


Fig. 39.

Fig. 41.



Witnesses
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J. A. RICARD.

KNITTING MACHINE.

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(No Model.) 8 Sheets—Sheet 4.

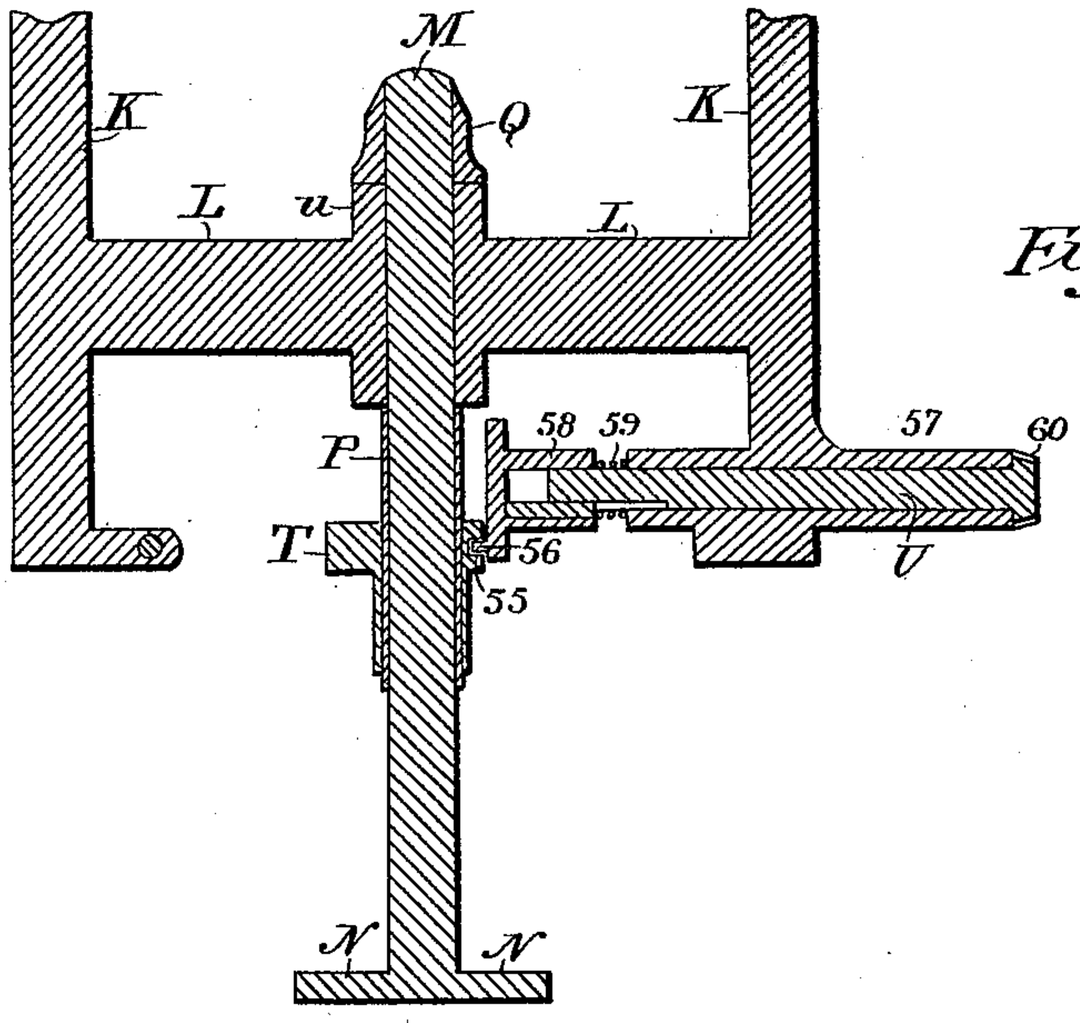

Fig. 15.

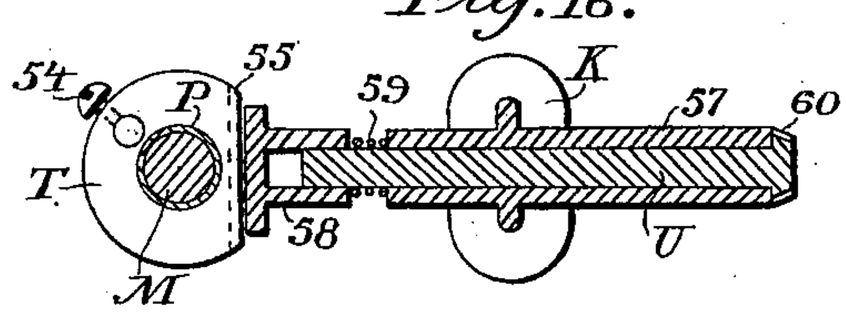

Fig. 16.

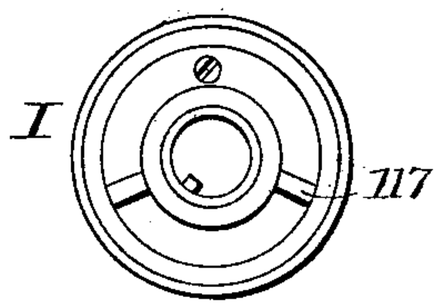

Fig. 20.

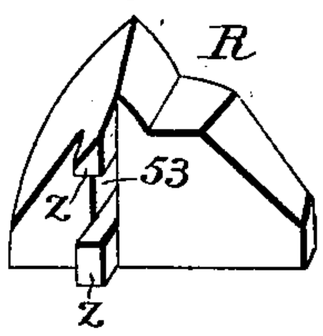

Fig. 19.

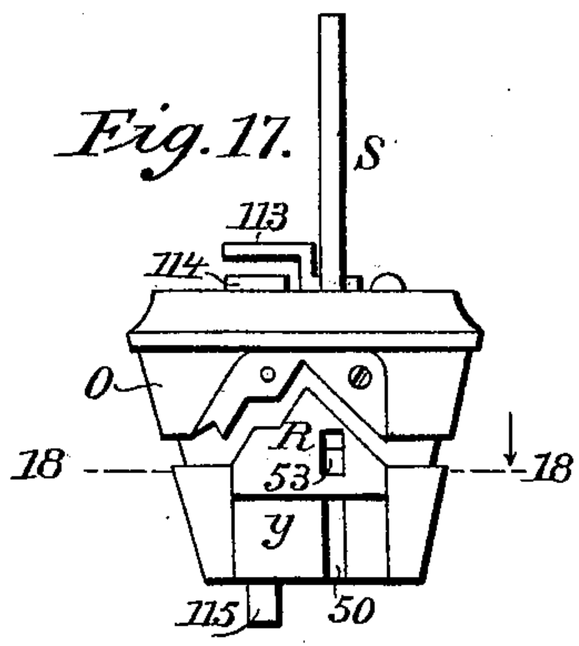

Fig. 17.

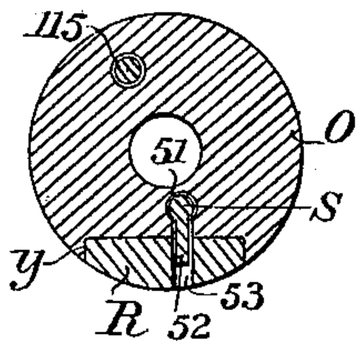

Fig. 18.

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No. 656,216. Patented Aug. 21, 1900.

J. A. RICARD.

KNITTING MACHINE.

(Application filed June 21, 1895.)

(No Model.) 8 Sheets—Sheet 5.

Fig. 21.

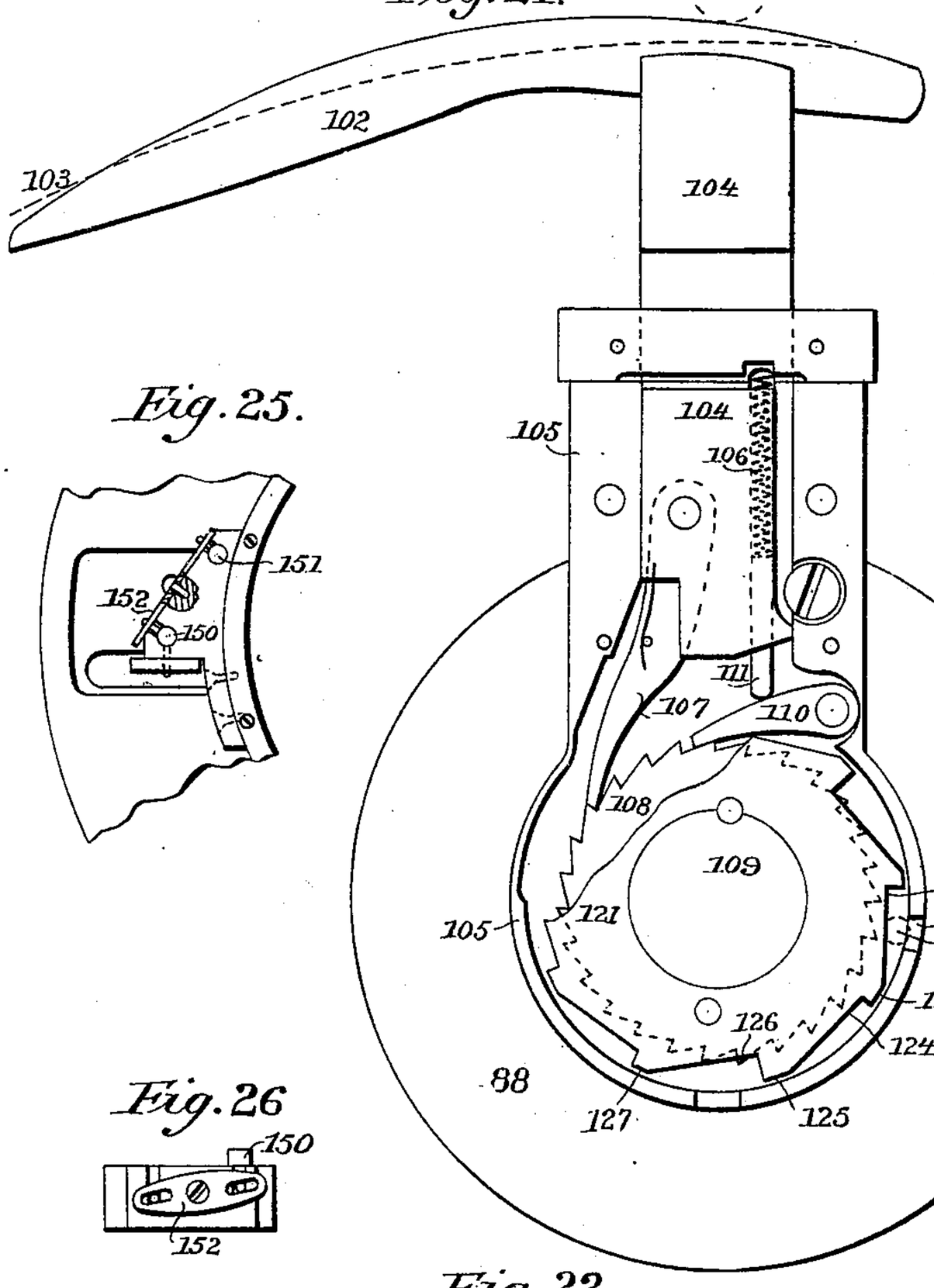


Fig. 23.

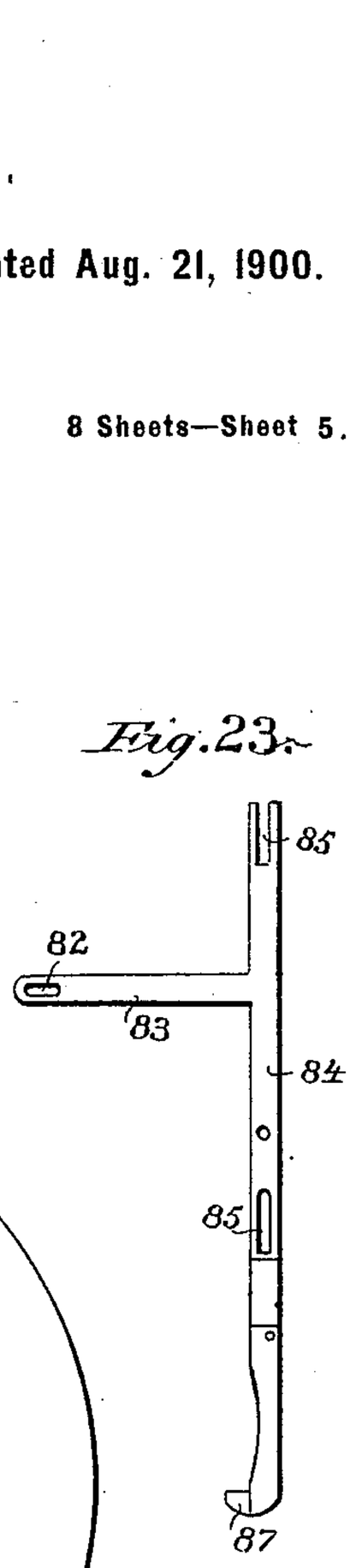


Fig. 25.

Fig. 26

Fig. 22.

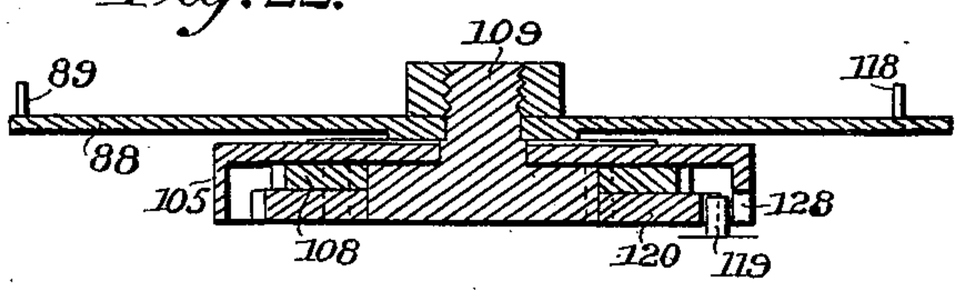
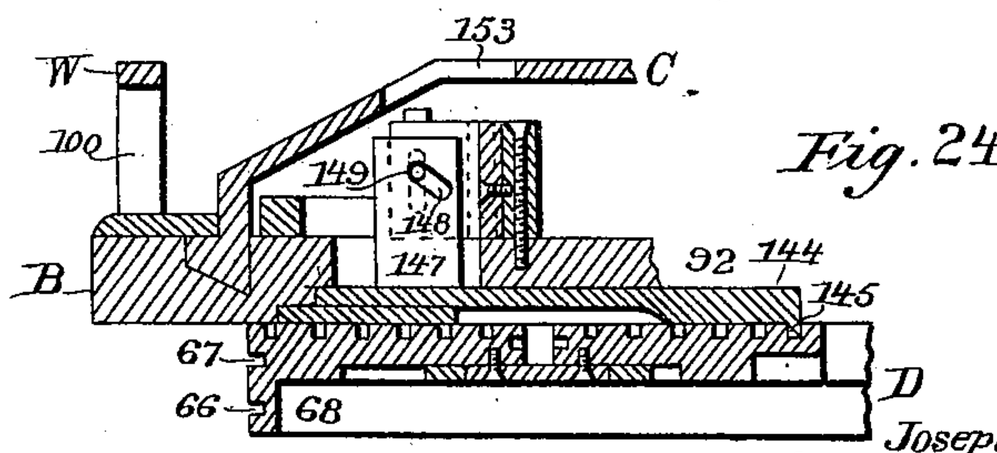


Fig. 24.



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No. 656,216. Patented Aug. 21, 1900.

J. A. RICARD.

KNITTING MACHINE.

(Application filed June 21, 1895.)

(No Model.) 8 Sheets—Sheet 6.

Fig. 30.

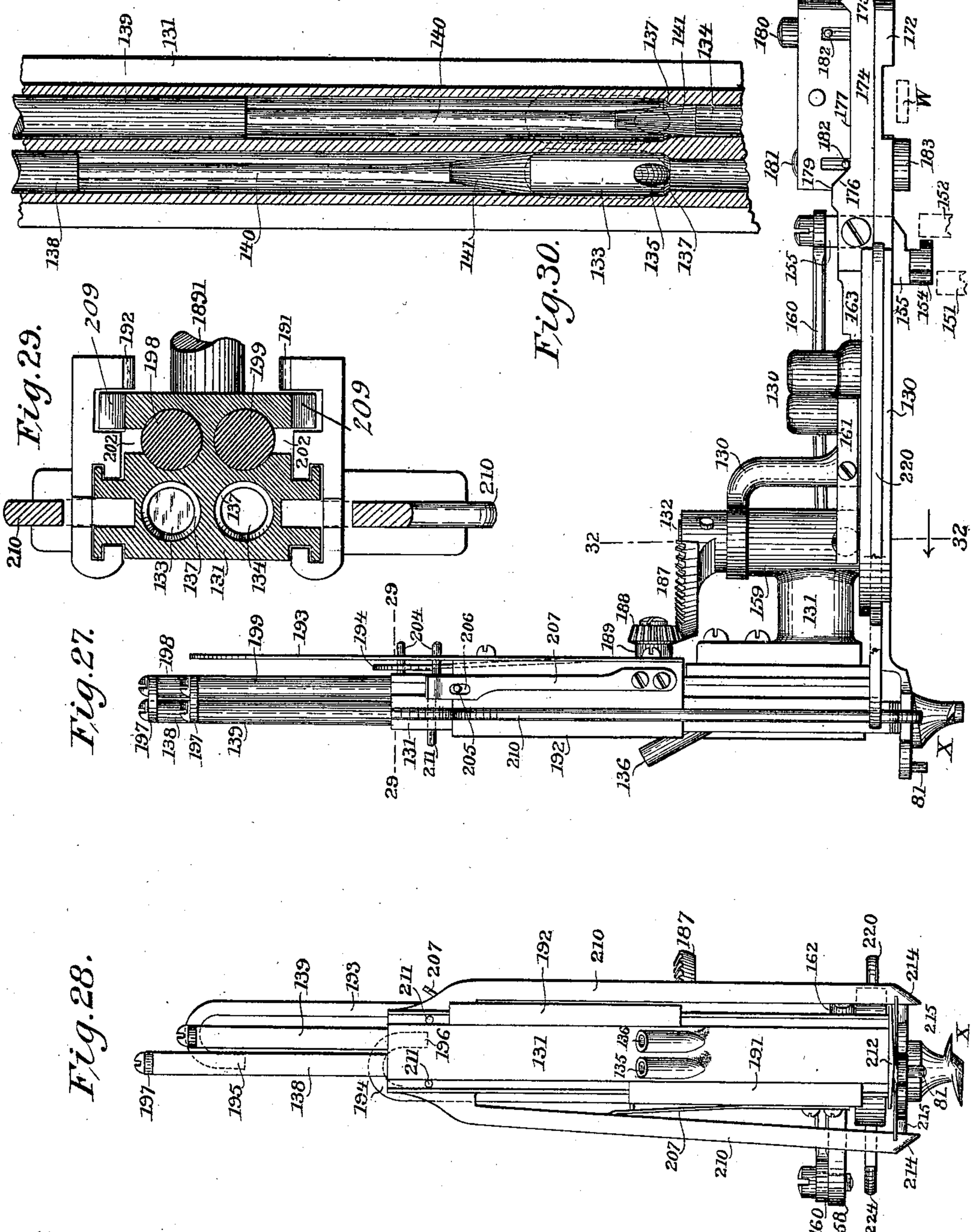

Fig. 29.

Fig. 27.

Fig. 28.

Witnesses
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No. 656,216. Patented Aug. 21, 1900.

J. A. RICARD.

KNITTING MACHINE.

(Application filed June 21, 1895.)

(No Model.) 8 Sheets—Sheet 7.

Fig. 31.

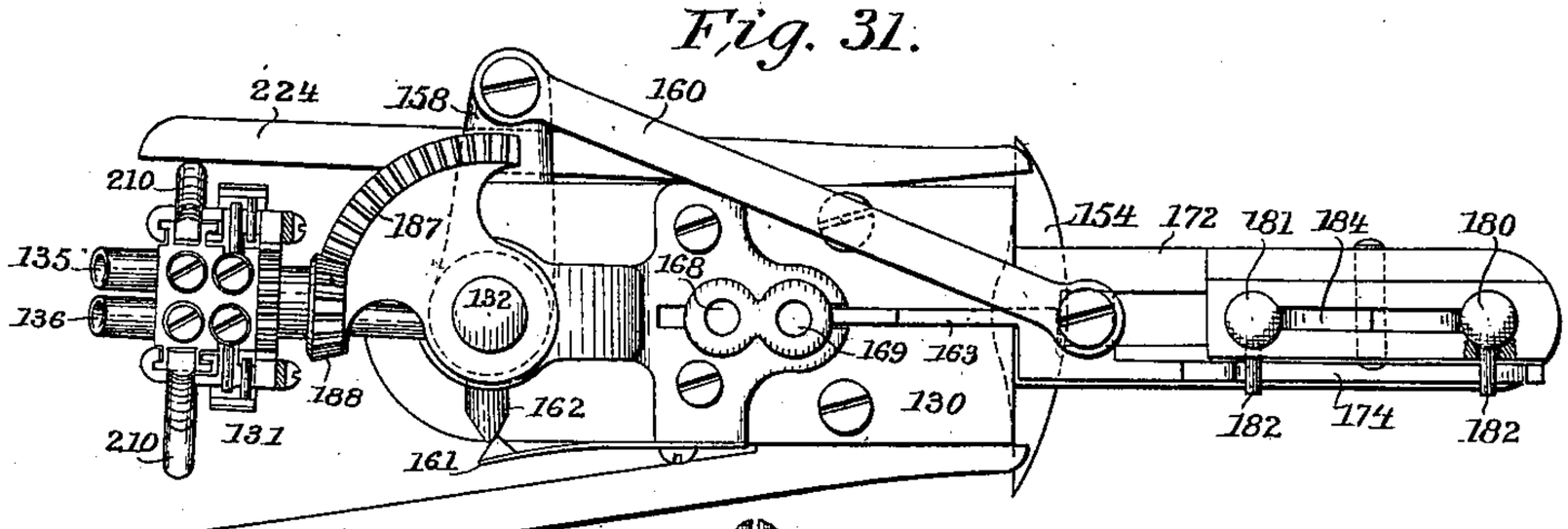
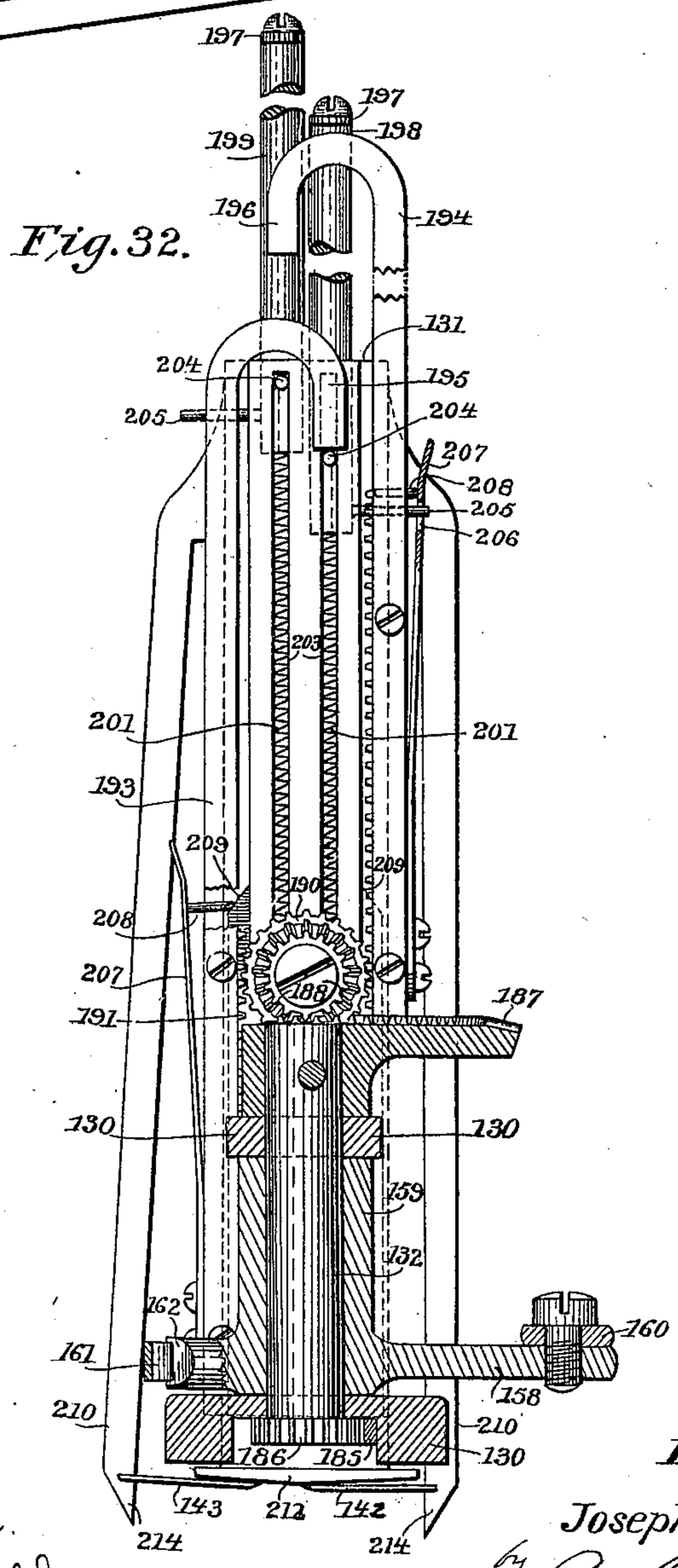


Fig. 32.



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(Application filed June 21, 1895.)

(No Model.)

8 Sheets—Sheet 8.

Fig. 35.

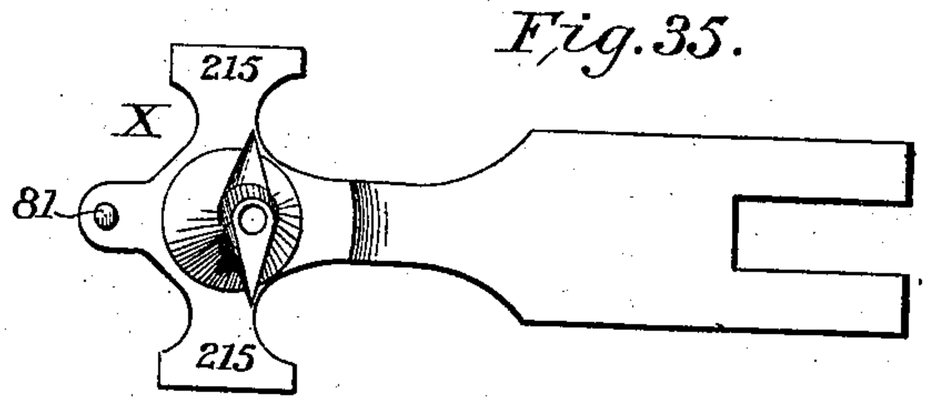


Fig. 38.

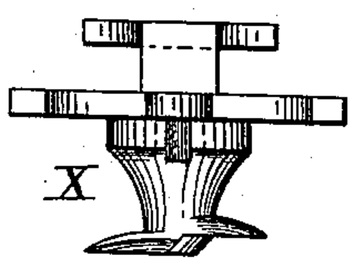


Fig. 36.

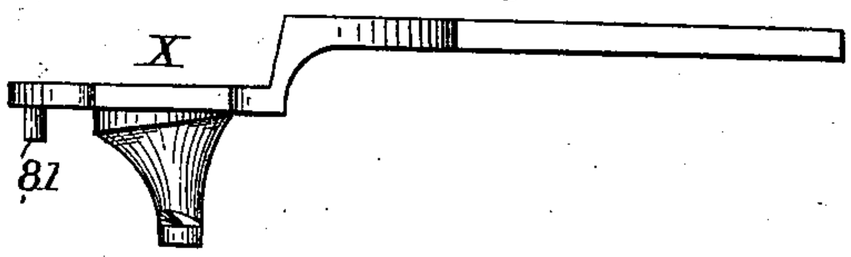


Fig. 37.

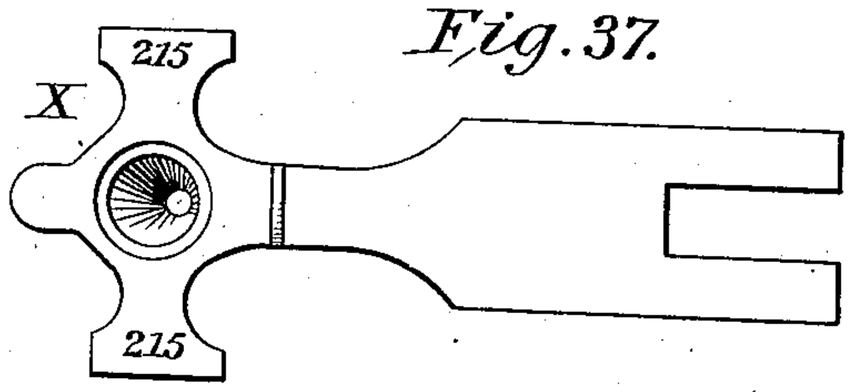
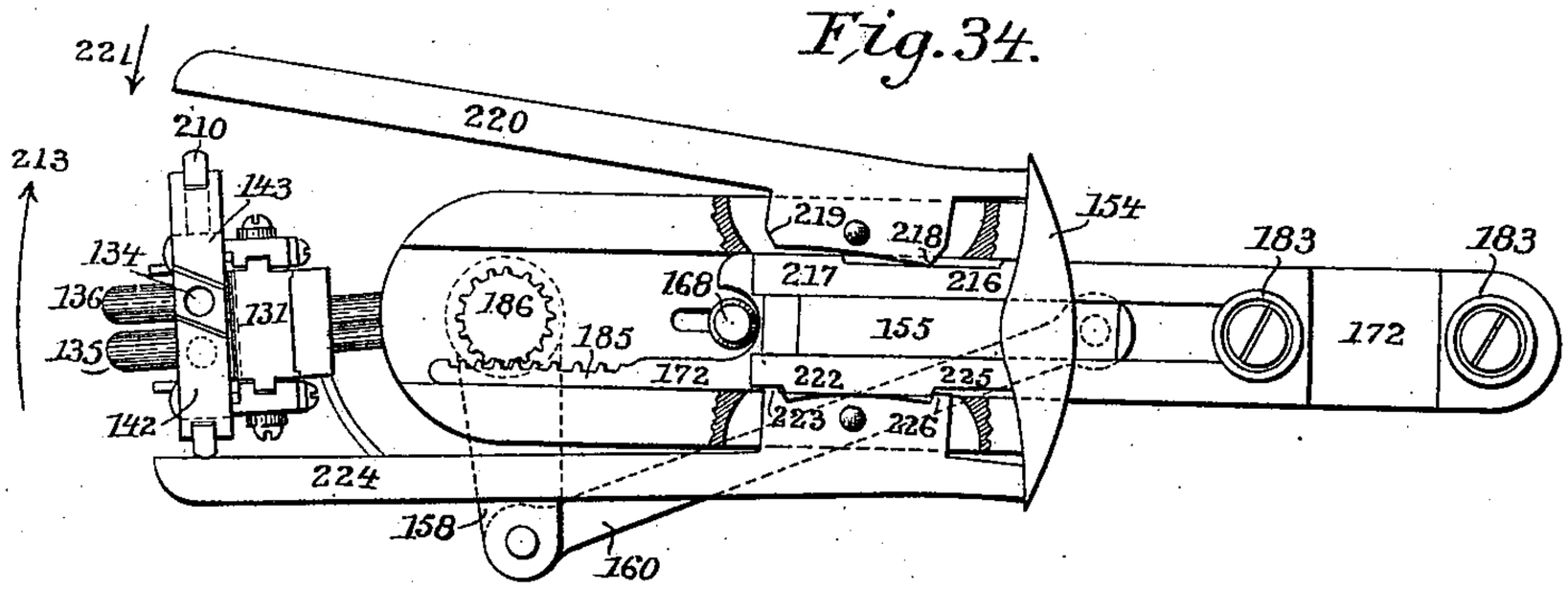


Fig. 33.

Fig. 34.



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Inventor
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UNITED STATES PATENT OFFICE.

JOSEPH A. RICARD, OF MANCHESTER, NEW HAMPSHIRE.

KNITTING-MACHINE.

SPECIFICATION forming part of Letters Patent No. 656,216, dated August 21, 1900.

Application filed June 21, 1895. Serial No. 553,518. (No model.)

To all whom it may concern:

Be it known that I, JOSEPH A. RICARD, of Manchester, in the county of Hillsborough and State of New Hampshire, have invented certain new and useful Improvements in Knitting-Machines, of which the following is a specification, reference being had to the accompanying drawings, wherein—

Figure 1 is a view of a stocking as made upon the improved machine. Fig. 2 is a view of the finished stocking. Fig. 3 is a side view of the machine. Fig. 4 is a plan view of the machine. Fig. 5 is a vertical cross-section of the head of the machine. Figs. 6 and 7 are detail views showing the connection between the frame of the machine and the sliding post of the rib-forming mechanism, Fig. 6 being a horizontal section in the plane indicated by the line 6 6 in Fig. 3. Figs. 8 and 9 are detail views showing the connection between the sleeve and sliding post of the rib-forming mechanism, Fig. 9 being a horizontal section in the plane indicated by the line 9 9 in Fig. 3. Figs. 10 and 11 are detail views of the controlling devices which operate the mechanism for discontinuing the feed of the yarn to the needles and the mechanism for controlling the length of the stitches. Figs. 12, 13, and 14 are detail views of the controlling devices which move the rib-knitting cams into and out of action. Figs. 15 and 16 are detail views of the mechanism which moves the rib-knitting cams into and out of action. Fig. 17 is a side view of the rib-knitting cams. Fig. 18 is a cross-section on the line 18 18 in Fig. 17. Fig. 19 is a detail view of the rib-elevating cam-block. Fig. 20 is a detail plan view of the cams which operate the yarn-breaker. Fig. 21 is an under side view, and Fig. 22 is a vertical section, of the mechanism which governs the length of stitch and of the mechanism which discontinues the feed of the yarn to the needles. Fig. 23 is a view of an intermediate yarn-guide shifter which connects the mechanism shown in Figs. 21 and 22 with the leading-in yarn-guide. Figs. 24, 25, and 26 are detail views of the controlling devices which govern the movements of the yarn-changer. Fig. 27 is a side view of the yarn-changer. Fig. 28 is a front view thereof. Fig. 29 is a cross-section on the line 29 29 in Fig. 27, some of the parts being removed. Fig. 30 is a detail vertical section of a portion of the yarn-changer. Fig. 31 is a plan view of the yarn-changer. Fig. 32 is a sectional view of the yarn-changer on the line 32 32 in Fig. 27. Fig. 33 is a vertical longitudinal section of the yarn-changer. Fig. 34 is a bottom view of the yarn-changer. Fig. 35 is a bottom view, Fig. 36 a side view, Fig. 37 a plan view, and Fig. 38 an end view, of the leading-in yarn-guide. Figs. 39, 40, 41, and 42 are detail views of a modified means for freeing the rib-needles from loops. Fig. 5 is drawn to a standard scale, as indicated. Figs. 6 to 18, inclusive, and Figs. 20, 23, 24, 25, 26, 39, 40, 41, and 42 are drawn to the standard scale. Fig. 3 is drawn to a scale one-half of that of the standard. Fig. 4 is drawn to a scale two-thirds of that of the standard. Figs. 27, 28, 31, 33, and 34 are drawn to a scale one and one-half times that of the standard. Figs. 19, 21, 22, 32, 35, 36, 37, and 38 are drawn to a scale twice that of the standard. Fig. 30 is drawn to a scale two and two-thirds times that of the standard. Fig. 29 is drawn to a scale four times that of the standard.

The present invention relates more particularly to machines for knitting stockings of the kind known as "whole-stocking" machines.

Heretofore numerous circular-knitting machines have been made which automatically knit the entire stocking in a continuous operation, the stocking so knit having a seamless foot with seamless heel and toe and a leg, the only incomplete portion of the stocking being an opening above the toe, which is subsequently closed by seaming or looping. Such prior machines have also heretofore been so organized as to automatically knit a plurality or succession of stockings of this character without stopping the machine and without additional attention on the part of the attendant of the machine. As an example of such prior machines I refer to Letters Patent of the United States No. 507,560, granted to me October 31, 1893. Such prior machines have ordinarily been equipped with a single set of needles only, and consequently have been adapted to produce plain knitting only, the only alterations in the knitting being due to loosening or tightening the stitches or to feeding in additional or different yarns. The

only "fashioning" which has been ordinarily attempted has been by tightening and loosening the stitches, and this is an insufficient expedient, especially in ladies' and misses' stockings. In circular whole-stocking knitting-machines as ordinarily constructed the same number of needles is in operation in knitting the calf portion of the leg as in knitting the ankle or the portion of the foot which is knit in circular courses, so that, except for knitting more loosely, the leg is no fuller than the foot or ankle. It is obviously desirable to use a greater number of needles in knitting the leg than in knitting the ankle and foot. This has heretofore been done by knitting the stockings with ribbed legs and plain feet, using more needles in producing the leg than in producing the foot, thus giving greater fullness to the calf of the leg of the stocking, and the ribbed legs are handsomer in appearance, warmer, and more durable. The usual practice, however, in making such ribbed-leg stockings has been to knit the leg on one machine and then transfer it to another machine, on which the foot is knit, or vice versa, and this practice has been almost universally employed. The only machines heretofore designed of which I have knowledge wherein a plain foot with seamless heel and toe has been knit upon the same machine as a ribbed leg knit with a greater number of needles have been constructed in substantial accordance with Letters Patent No. 149,813, granted April 14, 1874, to Calvin R. Tuttle. The machine of this patent, it is to be noted, is a hand-machine, and the rib-needle carrier, with its additional needles, is brought by hand into operative position relatively to the plain-needle carrier when the rib is to be formed, thus increasing the number of needles in use, and is then moved manually out of the way, so that plain stitching is resumed with a smaller number of needles. Manifestly such a mechanism does not meet the requirements of the present state of the art. The present state of the art imperatively requires that the entire knitting operation should be wholly automatic, that the machine should be power-driven, and that the time of knitting a single stocking should be reduced to minimum.

Now the primary object of the present invention is to automatically change from plain knitting to rib-knitting with an increased number of needles and from rib-knitting to plain knitting again with the fewer needles without any interruption in the operation of the machine. More specifically, the primary object of the present invention is to provide a wholly-automatic machine with plain and rib needles which will automatically knit one after the other without cessation (as long as yarn and oil are supplied) stockings, such as are shown in Fig. 1 of the accompanying drawings, which have plain feet and ribbed legs of greater fullness than the feet, owing to the greater number of needles employed in knitting them. In other words, a machine provided with the present improvements performs the following operations, reference being made to Fig. 1: The knitting begins at the toe. An initial margin consisting of a few circular courses is first knit, as shown at *a*, with the plain needles alone, during which operation the stitches are tight. Then with loose stitches the seamless toe *b* is knit. As is usual, the machine reciprocates during the formation of the toe and a heavier yarn is used than in knitting the foot and leg, or instead an additional splicing-yarn may be employed. The stitches are then tightened and the plain foot *c* is knit in circular courses until the heel is reached. The seamless heel *d* is then knit with loose stitches in reciprocating courses, a thicker yarn or an additional splicing-yarn being then employed. Then with tight stitches the plain ankle *e* is knit in circular courses. Then with loose stitches (looser than for the toe and heel) the ribbed leg *f* is knit in circular courses, the rib-needles for the first time coming into action, proper provisions being made to prevent defective union between the plain and ribbed work. Then the plain welt *g* is knit in circular courses upon the plain needles only, the rib-needles being out of action, but still retaining their loops. Then both sets of needles resume action and a few circular ribbed courses are knit. The feed of the yarn to the needles is then discontinued, the stitches are removed from the rib-needles, (and preferably, but not necessarily, from the plain needles also,) the yarn is severed from the completely-knit stocking, the rib-needles are rendered inactive, the feed of the yarn is again resumed, and the knitting of the next stocking commencing with the plain needles alone at the initial margin begins. This entire operation is wholly automatic. The stocking thus made is structurally completed, except that the initial circular margin *a* is raveled down to the courses *h i*, and the portions *h i* of this course are then seamed or looped together, thus completing the stocking, as shown in Fig. 2.

During the entire operation of the machine the rib-needle carrier maintains its proper position in the machine, and the change to ribbed from plain work is accomplished by a simple automatic movement of the throw-out or main knitting rib-cam, which brings the rib-needles into action, and the change to the ordinary plain work from the ribbed is accomplished by a simple automatic movement of said main knitting rib-cam, which takes the rib-needles out of action, together with the operation of mechanism which casts off the stitches or loops from the rib-needles. Aside from this operation of the main knitting rib-cam the rib-needles, their cams, and carrier remain in their appropriate operative place in the machine without any shifting movement whatsoever during the entire operation of the plain needles, including the for-

mation of the seamless heel and toe, as well as the plain foot, ankle, and initial margin.

The primary improvements therefore consist in the permanent application of the rib mechanism to the machine and the means for changing from plain to rib knitting, and vice versa. In addition the invention comprises other and important features of improvement, such as improved means for enabling the completed stockings to be removed from the machine from time to time, improved means for severing the yarn after one stocking is completed and before the next one is begun, improved means for controlling the tightening and loosening of the stitches at the appropriate times, means for preventing the catching of the yarn beneath the ends of the latches of the needles during the reciprocation of the machine when widening and narrowing in the formation of the seamless heels and toes, and an improved yarn-changer for changing the yarns as may be required, and particularly in knitting the heel and toe.

In order that the present improvements may be fully understood, I have selected for illustration in the accompanying drawings their application to a machine having the same general structural characteristics as the machine set forth in my aforesaid Patent No. 507,560, because I consider such application of the present improvements the best mode for applying the principles thereof. Aside from the additional features which have special reference to the new improvements the general construction and mode of operation of the here-illustrated machine is the same as in said Patent No. 507,560 and need not (it is thought) be here minutely described. Hence the parts of the machine which are identical with those of the machine of said Patent No. 507,560 will be described only with sufficient fullness to enable the present improvements to be clearly understood. One general difference in operation should, however, be here pointed out and borne in mind. The machine of said Patent No. 507,560 as therein described was so organized as to knit the top of the leg first and the toe last, whereas the machine as hereinafter set forth begins at the toe and ends at the top of the leg.

The machine selected for illustration is one of that class wherein the needle and sinker beds or carriers remain stationary and the knitting and sinker cams rotate or reciprocate in accordance with the work to be performed. To make the cams stationary and rotate the needle and sinker beds or carriers, as is frequently done, would be an obvious equivalent.

Referring first to Fig. 3, A is the framework of the machine, B the stationary bed-plate, and C is the rotating and reciprocating cam-plate.

Referring now to Fig. 5, Sheet 3, (and comparing it with Fig. 3 of my said Patent No. 507,560,) D is the step-by-step-rotating time-wheel. E is the grooved bed or carrier for the plain needles *j j*. *k* is the knitting-cam groove, which actuates the plain needles. *l l* are the needle shifters or jacks, which lower those needles out of action which remain inoperative during the formation of the heel and toe, which lower the needles out of action in narrowing, and which restore the needles in widening and in bringing them again into action. *m m* are the sinkers or web-holders. F is the sinker comb ring or carrier. G is the sinker cam-ring, and *n* is the stitch-regulating ring, (see Fig. 4,) which operates the throw-out needle-cam, so as to vary the looseness or tightness of the stitches, all of which parts are identical in construction and mode of operation with the corresponding parts in my aforesaid Patent No. 507,560, except in those respects which are hereinafter particularly named and in some structural particulars which are immaterial as far as the mode of operation is concerned and which will be evident on making a comparison. Each needle of both sets is an ordinary knitting-needle of the usual construction with a single solid shank at its hooked end.

The mechanism for rotating and reciprocating the cam-plate C and for automatically changing from one motion to the other is not shown, nor is the mechanism for bringing the time-wheel into action and actuating it step by step, because they are identical with the corresponding mechanism of said Patent No. 507,560.

The time-wheel D contains some additional cam-grooves for automatically effecting the required new movements, and there are some slight changes in the selection of particular grooves for particular purposes, as will be hereinafter more particularly set forth. Also, since the present machine is organized so as to knit the stocking in reverse order as compared with the machine of said Patent No. 507,560, the cam rises, which effect the same movements as in said patent, are arranged correspondingly; but, since this change in arrangement falls exclusively within the province of the mechanic, no particular description thereof is deemed to be here necessary.

The mechanism as thus far referred to in its operation (owing to intervening instrumentalities substantially identical with that shown in the said Patent No. 507,560) knits the initial margin, then throws out of action the instep-needles, then knits the seamless toe, then knits the foot, then knits the seamless heel, (more needles being used in knitting the heel than in knitting the toe,) and then knits the ankle.

The rib mechanism.—The rib-needles *o* are arranged below the plain needles at an angle approaching the vertical, and they are located and reciprocate in grooves in the rib-needle carrier H, which is a segment of a cone. The rib-needle carrier H is secured (as by a screw-joint, as shown in Fig. 3) to the upper end of a sleeve I, which is con-

nected by a telescopic joint to a post J, which rests upon a cross-bar *p*, constituting a portion of the framework A. The post J slides within the sleeve I, said post J having a longitudinal slot *q*, (see Figs. 3, 8, and 9,) with which engages a stud *r* on the sleeve I, so that there can be no relative rotation between the sleeve I and post J. The post J is prevented from rotation by a stud *s* thereon, (see Figs. 6 and 7,) which enters an open slot *t* in the cross-bar *p*. In this way the rib-needle carrier H is prevented from rotating.

Mounted upon the rotary cam-plate C is a bracket having standards K and cross-bar L. (See Figs. 3, 4, and 15.) Secured to a sleeve *u* on the cross-bar L by a set-screw *v* or otherwise is a depending vertical spindle M, having its central axis coincident with the axis of rotation of the machine, said spindle partaking of the rotation of the cam-plate. At its lower end this spindle carries a circular plate N, which is located between the upper end of the sleeve I and an annular shoulder *w* on the rib-needle carrier H. (See Fig. 5.) In this manner the rib-needle carrier is maintained in proper vertical position with reference to the plain needles.

Fitting upon the spindle M and within the rib-needle carrier H is the rib-needle cam plug or carrier O, which is constrained to partake of the rotation of the spindle M, by reason of a stud *x* on the spindle (see Fig. 5) entering a notch on the cam-carrier. The proper vertical position of the spindle M in the sleeve *u* is determined by a sleeve P, surrounding the spindle and located between the rib-cam carrier O and the said sleeve *u*, as shown in Fig. 5.

Any convenient means may be used for securing the proper register between the rib-knitting cams and the plain-knitting cams—as, for example, by a registering collar Q, which is splined both to the spindle M and to the sleeve *u*, as shown in Figs. 3 and 4.

The rib-knitting cams are shown in detail in Figs. 17, 18, and 19. The throw-out rib-cam R is vertically movable. When said cam R is moved up, as shown in Fig. 17, the rib-needles are in action, and when moved down, as shown in Fig. 5, the rib-needles are out of action. Said throw-out rib-cam slides up and down in a recess *y* in the rib-cam carrier and in addition has studs *z z*, entering a longitudinal slot 50 in the rib-cam carrier. Said throw-out cam is raised and lowered by a vertically-sliding rod S, which slides vertically in a channel 51 in the rib-cam carrier and has a wing 52, which enters a recess 53 in the throw-out rib-cam R between the studs *z z*, said wing 52 traveling in the slot 50. At its upper end the rod S is secured, as by a set-screw 54, (see Figs. 5 and 16,) to a collar T, which slides up and down upon the sleeve P.

For raising and lowering the collar T, and hence the throw-out rib-cam R, the collar has a cross-groove 55, with which engages a crank-pin 56 on a rotary shaft U, said shaft extending horizontally and being journaled in a sleeve 57, formed upon one of the standards K. (See Figs. 3, 4, 15, and 16.) The crank-pin 56 is preferably not attached directly to the shaft U, but is carried by a sliding cap 58, which slides upon and is feathered to the inner end of the shaft U. The cap 58 is normally held, with the pin 56, in engagement with the groove 55 in collar T by a spring 59. The purpose of this arrangement is to enable the crank-pin 56 and collar T to be readily engaged and disengaged in putting the machine together and taking it apart.

To raise and lower the throw-out rib-cam R, the shaft U is rotated at the proper moments a half-revolution at a time, so that the crank-pin either occupies its highest or its lowest position. At its outer end the shaft U has a beveled pinion 60, which meshes with a beveled annular rack 61 on a star-wheel V, (see Fig. 4,) which is mounted on a vertical axis 62 on the rotary cam-plate C, so that it turns horizontally. The star-wheel V has a plurality of radial and horizontally-projecting arms 63 63. The star-wheel is given a step-by-step rotation from time to time when required by means of the arms 63 63 thereon striking in succession tappet-pins 64 65, which are at the proper instants projected upwardly into the path of said arms 63 as said arms are carried around by the rotation of the cam-plate C. As shown in Fig. 14, both of the tappet-pins 64 65 are normally below the plane of the star-wheel, so that the knitting progresses without any alteration. When, however, the tappet-pin 64 is elevated into the path of the outermost arm 63 of the star-wheel, as shown in dotted lines in Fig. 12, the star-wheel is rotated a sufficient distance to rotate the shaft U a half-rotation, and thereby the throw-out rib-cam is elevated, thus bringing the rib-needles into action, and at the same time the next arm 63 on the star-wheel is brought to its outermost position. When, then, the tappet-pin 65 is elevated into the path of the then outermost arm 63 of the star-wheel, the shaft U is given another half-rotation, thus depressing the throw-out rib-cam, taking the rib-needles out of action, and bringing the next arm 63 of the star-wheel into the outermost position. It is thus evident that the action and inaction of the rib-needles is controlled by the elevation and depression of the tappet-pins 64 and 65. The operation of these tappet-pins at the proper instants is effected by the time-wheel D. For this purpose the time-wheel is provided on its periphery with two cam-grooves 66 and 67, and to accommodate these grooves the time-wheel has a depending flange 68 on its rim. This flange 68 and the cam-grooves 66 and 67 are new, not being in the time-wheel of my said Patent No. 507,560. The upper end of the tappet 64 (see Figs. 12, 13, and 14) extends through an aperture in a ring W, and its lower end is secured to (or is part of) an arm 69, which is secured by a set-screw 70 to a rod 71. Said

rod 71 extends through an aperture in the bed-plate B and beneath said bed-plate has a wing 72, with a pin 73, which is located within the lower cam-groove 66 of the time-wheel D. To still further hold the rod 71 in position and to facilitate putting it in place and taking it out in case of need, a bracket 74 is provided fastened beneath the bed-plate B, which has a channel 75, open at one side for the rod 71, and a stop 76, against which the wing 72 abuts during the operation of the machine. To remove the rod 71, release the set-screw 70, and the rod 71 can then be turned, so as to swing its wing 72 away from the stop 76 and its pin 73 out of the cam-groove 66, and then the rod 71 can drop down and away from the machine.

The tappet-pin 65 is mounied exactly like the pin 64, except that its controlling-pin 77 is located within the upper cam-groove 67 on the time-wheel D, as indicated in Fig. 14.

The mechanism has now been sufficiently described to enable the rib-knitting operation to be understood. At the appropriate time when a sufficient length of the ankle has been knit plain by the action of the plain needles *j j* the step-by-step moving time-wheel D brings one of its cams of the lower cam-groove 66 (the cam 78, see Fig. 3) into contact with the pin 73, thus elevating the tappet 64 into the path of the outermost arm 63 of the star-wheel. Hence when by the rotation of the cam-plate C the star-wheel passes the tappet 64 its outermost arm 63 encounters the tappet 64, whereby the star-wheel is rotated partially, and the throw-out rib-cam R is thereby raised, thus bringing the rib needles into action. As soon as this is done the cam 78 passes from beneath the pin 73, and the tappet 64 drops down out of the way. The rib-needles being thus brought into action, they take the yarn for one round or course of stiches only, just enough to cast the loops upon the hooks of all of the rib-needles, and then the rib-needles are thrown out of action by the depression of the throw-out rib-cam R. This is accomplished by the cam 79 in the upper groove 67 of the time-wheel D (see Fig. 3) coming into contact with pin 77, thus elevating tappet-pin 65 into the plane of the star-wheel, whereby the then outermost arm 63 is struck, thus rotating shaft U a half-rotation, depressing the rib-cam R, and rendering the rib-needles inactive. Pin 65 then drops down out of the way. A few rounds or courses of stitches are then knit with the plain needles alone, the rib-needles in the meanwhile retaining the loops cast thereupon. One, two, three, or more courses may thus be knit. In the machine from which the annexed drawings were made three such courses are knit. The object of knitting these few plain courses with the loops cast onto the rib-needles before proceeding with the knitting of the ribbed work is to prevent the occurrence of holes in the fabric, which would otherwise show at the juncture between the plain and ribbed portions. The mode of operation here described prevents the occurrence of such holes. As soon as these few plain courses have been knit the next cam 80 (see Fig. 3) in the lower cam-groove 66 comes in contact with pin 73, thus elevating the tappet-pin 64 and again bringing the rib-needles into action. Tappet-pin 64 then drops down out of the way. With both sets of needles in action the ribbed leg is formed. In this connection it is to be noted that the proportion of rib-needles to plain needles may be varied in accordance with the style of ribbed fabric desired.

In case a welt is to be knit, as is usually desired but not essential, an appropriate cam in the upper cam-groove 67 elevates the tappet-pin 65, and thereby the rib-needles are rendered inactive, still retaining, however, their loops. The plain needles then knit alone until the desired length of welt is knit, and owing to the employment of the sinkers or web-holders *m m* any length of welt can be knit. Then by the action of an appropriate cam in the lower cam-groove 66 the rib-needles are again brought into action and the welt is tied to the fabric by knitting a few ribbed courses.

Freeing the fabric.—The stocking being now completed, it is necessary to free the fabric from the rib-needles at least, and preferably from both sets of needles, before beginning the next stocking. This is done, as are all of the other operations, entirely automatically. The mechanism illustrated in Figs. 4, 10, 11, 21, 22, and 23 for freeing the fabric operates to free the loops from both sets of needles by casting off the stitches or loops from both sets of needles, and this is effected by a relative movement of separation between the yarn-guide and the knitting-cams. As shown, this relative movement is effected by moving the leading-in yarn-guide away from the needles, so that the needles will not take the yarn, sufficient revolutions of the cam-ring then taking place to cast off the loops from both sets of needles. As soon as this is done the yarn is severed, the rib-needles are thrown out of action by the appropriate movement of tappet-pin 65, the leading-in yarn-guide is restored to its operative position, and the knitting of the next stocking by the plain needles alone is begun.

The leading-in yarn-guide X is shown in detail in Figs. 35 to 38, and it is capable of sliding radially and horizontally to and from the needles. It is guided for this purpose in suitable ways 801, formed by the yarn-changer Y, as shown in Figs. 27 and 33, and it rotates with the cam-plate C. As shown in Figs. 32 and 33, the base 130 of the yarn-changer has a recessed channel in its under side, in which the yarn-guide is held and slides just beneath the rack-bar 172 and pinion 186. The yarn-guide X has a coupling-pin 81, which engages an aperture 82 in a cross-arm 83 of a yarn-guide shifter 84, which is shown

in detail in Fig. 23. This yarn-guide shifter moves parallel with the leading-in yarn-guide and is slidingly connected with the cam-plate C by means of the slots 85 and pins 86, Figs. 4 and 23. At its forward end the yarn-guide shifter has a hook 87, which is just above the plane of the upper surface of an intermittently-rotating horizontal disk 88 and in the path of pins 89 thereupon. When in the rotation of said disk 88 (in the direction of arrow 900) one of said pins comes in contact with the hook 87 and the yarn-guide shifter is thereby moved in such direction as to move the leading-in yarn-guide X away from the needles, the yarn is no longer fed to the needles. Consequently as the knitting-cams thereafter continue to operate the loops on both sets of needles are cast off.

The intermittent step-by-step rotation of the disk 88 is effected by the time-wheel D. As shown in Figs. 10 and 11, there is a slide 90, having a pin 91 entering the next to innermost groove 92 of the time-wheel. This slide 90 is mounted to slide in a radial groove, Fig. 11, in the stationary bed-plate B, just above the time-wheel D, in the same manner as the slides are mounted, as shown in Fig. 11 of my said Patent No. 507,560. (In fact, this slide 90 corresponds with the slide x of said patent, except that a similar view of the bed-plate of the present machine would show it a little nearer the slide g^3 than is the case in Fig. 11 of said patent. This change in position is, however, a matter of convenience in construction only and immaterial as far as the mode of operation is concerned.) The cams in said cam-groove 92 of the time-wheel serve to move the slide 90 in and out at the proper instants. As shown in Fig. 10, slide 90 extends out beyond the time-wheel D and has a depending wing 93, with an inclined slot 94. Riding in this inclined slot is a pin 95 on a vertically-sliding rod 96, which extends upwardly through an aperture in the bed-plate B. A pin 97 near the upper end of the rod 96 enters a peripheral groove 98 in a roller 99, which turns and slides upon a pillar 100, that constitutes also one of the supports for the ring W. Now it is evident that when the slide 90 occupies its outermost position the roller 99 is at its lowest and normal position, and when the slide 90 is drawn in the roller 99 occupies its highest and operative position. When the roller 99 thus occupies its highest and operative position, its upper rim 101 is in the path of a cam-shaped arm 102, which rotates with the cam-plate C. (See Figs. 4 and 21.) The cam shape of this arm 102 is clearly indicated in Fig. 21, wherein the dotted line 103 is concentric with the main axis of the machine. The arm 102 is rigidly secured to the outer end of a slide 104, which slides radially within a housing 105, which is fastened to the rotary cam-plate C. The slide 104 is pushed inwardly by its cam-arm 102 encountering the rim 101 of the roller 99, and when freed from said roller it is pushed out again by the spring 106. The slide 104 carries a pawl 107, which coöperates with a ratchet-wheel 108, fast to an arbor 109, journaled in the housing 105, said arbor carrying the pin-disk 88. A detent 110 prevents backward movement of the ratchet, said detent being held in contact with the ratchet by said spring 106, acting through an intermediate plunger 111. Hence by the reciprocation of the slide 104 the pin-disk 88 is given an intermittent step-by-step rotation. The proper movements of the slide 104 are controlled by the cams in the groove 92 in the time-wheel, and these cams are so disposed that while the time-wheel executes a complete rotation during the knitting of each stocking the pin-disk 88 rotates through one hundred and twenty degrees only during the same period, so that there are three of the pins 89 thereupon, and one of the pins 89 encounters the hook 87 on the yarn-guide shifter just as the stocking is completed. As soon as the fabric is cast off from the needles the pin 89 passes away from the hook 87, a spring 112 restores the yarn-guide shifter and the leading-in yarn-guide to their normal positions, and since in the meanwhile the rib-needles have been rendered inoperative the knitting of the next stocking with the plain needles alone begins.

Yarn-severer.—After a stocking has been completed and the feed of the yarn is discontinued it is desirable that the yarn should be broken or severed, so that the completed stockings may be independent of each other and to prevent the yarn winding around the post J and sleeve I. Accordingly means are provided for breaking the yarn just after the feed thereof to the needles has been discontinued by the movement of the leading-in yarn-guide away from the needles and while the fabric is being cast off. This mechanism is shown best in Figs. 5, 17, and 20. The yarn severer or breaker consists of two jaws, the fixed jaw 113 being secured to the upper side of the rib-cam carrier O, and the vertically-movable jaw 114 is beneath the fixed jaw 113 and is carried on the upper end of a vertically-movable rod 115, which extends through a vertical aperture in the carrier O and below the same and through and below the plate N. Said movable jaw is moved downwardly and away from the fixed jaw by a spring 116. (See Fig. 5.) Said rod 115 rotates with the carrier O, and it is elevated by means of a cam 117 on the upper face of the stationary sleeve I, Fig. 20. During the entire operation of the machine the movable jaw rises and falls with each revolution of the cam-plate C. When, then, the work is being cast off, the yarn is brought between the two jaws, which thereupon clamp the same, and it is broken off between the jaws and the work during the further revolution of the machine.

Removing completed stockings.—The stockings as they are knit are fed down, around, and outside of the rib-needle carrier H, the

sleeve I, and post J, and when the stockings are completed they fall down upon the cross-bar (see Fig. 3) and upon each other, still surrounding the post J. From time to time the stockings are removed by simply lifting the post J, which slides within the sleeve I, and withdrawing the stockings. Several dozen pair of stockings can accumulate before there is any necessity for their removal.

Preventing the yarn catching.—Owing to the presence of the rib-needles it is necessary that the yarn should be led into the needles by the leading-in yarn-guide X much closer to the needles than would otherwise be the case in order that the rib-needles may take the thread during the knitting of the ribbed portion of the work. As the result it frequently happened that in back-and-forth knitting when forming the heels and toes of the stockings with the plain needles alone the yarn would catch beneath the free ends of the needle-latches, thus closing the latches, hence casting off the loops and spoiling the fabric. To avoid this difficulty, the leading-in yarn-guide X is moved inwardly away from the needles when the formation of the toe begins and when the formation of the heel begins, is maintained moved away during the formation of the toe and of the heel, and is restored to its normal position just as soon as the toe is completed and again just as soon as the heel is completed. For this purpose the yarn-guide X is moved away from the needles, not far enough to prevent their taking the yarn, but just far enough to prevent the yarn catching beneath the free ends of the latches. The additional mechanism for this purpose is very simple. It consists simply in adding to the pin-disk 88 two extra pins 118 118 between adjacent pins 89 89. These pins 118 118 are nearer the axis of the disk 88 than are the pins 89 89, and consequently they do not withdraw the yarn-guide X away from the needle as far as do the pins 89. Of each pair of pins 118 118 one operates upon the hook 87 when the toe is to be knit and the other when the heel is to be knit.

Tightening and loosening the stitches.—As heretofore stated, the stitches are loose during three portions of the knitting—to wit, while knitting the toe, while knitting the heel, and while knitting the ribbed leg—being the loosest while knitting the leg, and are tight while knitting three portions—to wit, the initial margin, the foot, and the ankle. In my aforesaid patent, No. 507,560, it is described on page 2, lines 106 to 130, how the movement of a pin *m* and ring *l*, by a spring *o* and cam *n*, affects the movement of the throw-out cam for the plain needles to vary the stitch. The stitch-regulating ring *n* (shown in the present drawings, Fig. 4) corresponds to the ring *l* of said patent, and the pin 119 of the present drawings corresponds to the pin *m* of said patent. Likewise in the present instance the pin 119 and ring *n* are held by a spring 120 (shown in cross-section in Fig. 5 only) against cams, as in said patent. The cam arrangement, however, is different. Instead of there being a single cam like the cam *n* of said patent there are three sets of six cam-faces each, the three sets being exactly alike, only one set acting during the formation of a single stocking. The new cam arrangement is shown in Figs. 21 and 22. As therein shown, there is fast upon the ratchet 108 and moving intermittently therewith a cam-disk 121, having cam-faces 122 123 124 125 126 127, against which the pin 119 is held by the spring 120. When the pin 119 is against the face 122, the loose toe is being knit. When the pin 119 is against the face 123, the tight foot is being knit. When the pin 119 is against the face 124, the loose heel is being knit. When the pin is against the face 125, the tight ankle is being knit. When the pin is against the face 126, the loose ribbed leg is being knit, and when the pin is against the face 127 the tight initial margin is being knit. The cam-face 126, it will be noted, is the deepest, so that the ribbed leg is the loosest. The pin 119 slides within an aperture 128 in the housing 105. The three sets of cam-faces are necessary in the particular machine shown, because the disk 121, moving with the pin-disk 88, makes only a third of a revolution during the knitting of a complete stocking.

Sinker-cam-ring adjustment.—The sinker cam-ring G in its relation to the sinkers is the same as in my Patent No. 507,560. Owing to the wear on the sinker-cams they do not when worn move the sinkers properly with reference to the needles. In the present machine the construction is such that this wear can be taken up. To this end the sinker cam-ring G has two upwardly-projecting pins Z Z, (see Figs. 4 and 5,) which alternately abut against stops 129 129 on one of the standards K during reciprocating knitting, (only one pin and stop being in action during round-and-round knitting.) The stops 129 129 have screw-shanks, so that they are adjustable in the standards K, and hence wear on the sinker-cams can be compensated.

Yarn-changer.—The purpose of the yarn-changer in the particular machine here selected for illustration is to change the yarn on beginning and finishing the toe and the heel in order that the toe and heel may be made of more durable yarn than the rest of the stocking. The difficulty with ordinary yarn-changers is that they do not work uniformly under all contingencies and are particularly apt to fail to feed in the fresh yarn in case there is a kink or enlargement in the yarn, and they do not operate with equal facility with yarns of different textures and sizes. The object of the present invention in this respect is to provide a yarn-changer which will feed in the fresh yarn with certainty and precision under all conditions. The present yarn-changer is an improvement upon that set forth in United States

Patent No. 214,309, granted April 15, 1879, to John Nelson, and in several fundamental respects is similar thereto. Referring to the annexed drawings, Y is the yarn-changer as a whole. It is shown in Figs. 3 and 4, but is particularly illustrated in Figs. 27 to 34, inclusive. The yarn-changer has a base 130, which is secured by screws (shown in Figs. 4 and 31) to the cam-plate C, so as to rotate therewith, and a swinging head 131, which is pivotally connected to said base, said base having a spindle 132, upon which said head swings. The head 131 has two parallel vertical yarn-channels 133 and 134, the lower discharge ends of which are just above the plane of the leading-in yarn-guide X, Fig. 33. Two yarn-conveyers 135 and 136 receive the two yarns and convey the yarn into the channels 133 and 134, respectively, said yarn-conveyers entering the yarn-channels at about the middle thereof, as shown in Fig. 33. Below the discharge-mouths of the yarn-conveyers the channels are smaller than above said mouths, shoulders 137 being thus formed in the channels, as shown in Figs. 29 and 30. Sliding and guided within the upper enlarged portions of the channels 133 and 134 are plungers or carriers 138 and 139, respectively, and each carrier has a depending stem 140, with a brush 141 at its lower end, said brush preferably being a wire brush or bundle of metal threads formed by shredding the lower end of the metal stem 140. Two knives 142 and 143 are employed for severing the yarn.

The general operation is as follows: Assume that the yarn which is used in knitting the foot and leg is the main yarn and that it passes through conveyer 135 and channel 133, that the yarn which knits the toe and heel is the auxiliary yarn, and that it passes through the conveyer 136 and channel 134. During the knitting, then, of the initial margin *a* (see Fig. 1) the foot, ankle, and leg, the main yarn-channel 133 is in vertical coincidence with the leading-in yarn-guide X, as shown in Fig. 28. The main yarn passes freely through the conveyer 135, and channel 133 and leading-in thread-guide X to the needles, the corresponding brush 141 being then above the discharge-mouth of the conveyer, as shown in Fig. 30, so that the brush does not interfere with the free running of the yarn. At the same time the auxiliary yarn is clamped and held near its end between the shoulder 137 and brush 141 of the auxiliary-yarn channel 134. Being thus firmly held there is no danger of the auxiliary yarn being pulled out of its position ready to be fed in by the tension devices which are usually and ordinarily employed between the conveyer 136 and the yarn-holding bobbin. When, then, the yarn is to be changed, the head 131 of the yarn-changer swings on its axis 132 in the proper direction to swing the main-yarn channel 133 away from the leading-in yarn-guide X. The auxiliary-yarn channel 134 is thereby brought into axial and vertical alinement with the leading-in yarn-guide X. The auxiliary feed-brush 141 in the channel 134 thereupon descends, carrying down with it the auxiliary yarn, thus forcing said auxiliary yarn positively with it and through the leading-in yarn-guide X and to the needles. Thereafter the two yarns are both fed simultaneously to the needles for a few stitches until the taking of the auxiliary yarn by the needles is fully established. Then the auxiliary feed-brush rises above the union between the auxiliary conveyer 136 and channel 134, leaving a free passage for the auxiliary yarn. Then the main feed-brush in the main-yarn channel 133 descends, clamping the main yarn between it and the shoulder 137 in the main channel, and finally the main-yarn knife 142 severs the main yarn just above the leading-in yarn-guide.

A reversal of the movements of the parts puts in the main yarn and cuts out the auxiliary yarn. These movements take place automatically at the appropriate instants through the action of the time-wheel D and intervening mechanism.

Referring to Figs. 24, 25, and 26, 144 is a radially-movable slide guided in the bed-plate B and having a stud 145, which engages the innermost cam-groove 146 of the time-wheel D. This slide 144 is similar in construction and mounting to the slides of my said Patent No. 507,560, and occupies a position between slides t^2 and v^2, as shown in Fig. 11 of said patent. The slide 144 is moved radially in and out by appropriately-located cams in the cam-groove 146. Near its forward end the slide 144 has an upwardly-projecting wing 147, having an inclined slot 148. Within this slot 148 is a stud 149, on a vertically-movable tappet-pin 150. As the slide 144 moves in and out under the action of the cams in the cam-groove 146 in the time-wheel its inclined slot 148 depresses and raises the pin 150. The tappet-pin 150 is connected with a second tappet-pin 151 (see Fig. 25) by an intermediate centrally-pivoted lever 152, so that when one of the tappet-pins 150 151 is depressed the other is elevated. These two tappet-pins are located at different radial distances from the axis of the rotation of the machine. They do not rotate, since they are carried by a part secured to the stationary bed-plate. Communication between the yarn-changer Y and the tappet-pins 150 151 is effected through an opening 153 in the rotary cam-plate C, through which extends a cam-arm 154, depending from the yarn-changer. (See Figs. 24 and 33.) This cam-arm 154 is carried by a cam-slide 155. The cam-slide 155 fits and slides within the central channel of the bifurcated brush and knife slide 172, hereinafter more particularly referred to, as shown in Figs. 33 and 34, and the said brush and knife slide 172 slides within and is guided by the channel in the under side of the base 130. The inner end of the cam-slide 155 is further guided by the recess in the end

of the yarn-guide X, which recess is shown in Figs. 35 and 37. The movement of the cam-slide 155 in either direction is positively limited by a pin 156 thereupon, which slides in a slot 157 in the base 130, Fig. 33. The cam-slide 155 is moved in opposite directions by coming in contact with the tappet-pins 150 and 151. When one of said pins is depressed, it is below the plane of the cam-arm 154 and the other of said pins is in its path. When the outer tappet-pin 150 is elevated, the outer surface of the cam-arm 154 encounters the same, and thereupon the cam-slide 155 is pushed inward and remains there until the position of the tappet-pins is reversed by the action of the time-wheel, and thereupon the inner face of the cam-arm 154 encounters the inner tappet-pin 151, and thereupon the cam-slide is moved outwardly. This radial movement of the cam-slide 155 controls all of the movements of the swinging yarn-changer head 131, of the feed-brushes 141, and of the knives 142 and 143. The cam-slide 155 is connected to a crank-arm 158 on the hub 159 of the swinging head 131 by means of a link 160, pivoted at opposite ends to said crank 158 and slide 155, respectively, Fig. 31. Hence when the cam-slide 155 moves inwardly the main-yarn channel 133 is brought into operative position with reference to the yarn-guide X, and when the slide 155 is moved outwardly the auxiliary-yarn channel is brought into operative position. The swinging head 131 is retained in its two positions by a spring-detent 161, (see Fig. 31,) fastened to a part of the base 130, and coöperating with a stud 162 on the hub 159 of the swinging head. An inwardly-extending cam-bar 163 is fastened to the cam-slide 155 by a screw, as shown in Fig. 27, and has two lower dwells 164 in the same plane connected with an upper dwell 165 by two cam rises or inclines 166 167, as shown in Fig. 33. Coöperating with this cam-bar are two vertically-moving locking-pins 168 and 169, which move in vertical chambers 170 in the base 130 and are moved downward and held in contact with the cam-bar 163 by springs 171. The range of movement and location of the cam-surfaces 164, 165, 166, and 167 are such that when one of the locking-pins 168 169 is up the other is down or ready to move down. These locking-pins lock in place a bifurcated feed-brush and knife controlling radially-movable slide 172, which for brevity I will hereinafter call a "brush and knife slide," or simply a "brush-slide" or "knife-slide," depending upon its particular function which for the time being is under discussion. This bifurcated brush and knife slide 172 has a cross locking-bar 173, which coöperates with the locking-pins 168 and 169. When, as shown in Fig. 33, the pin 168 is down, it is in front of the bar 173, and the inward movement of the brush and knife slide is thereby prevented. When, however, the cam-slide 155 moves inwardly, carrying with it the cam-bar 163, the incline 166 elevates the locking-pin 168 from in front of the locking-bar 173, thereby unlocking the brush and knife slide 172, and leaving it free to move inwardly. At the same time the dwell 165 is withdrawn from beneath the locking-pin 169, which thereupon, under the action of its spring 171, rests upon the upper face of the locking-bar 173. The cam-slide 155 also carries rigidly secured to it an outwardly-extending cam-bar 174, which, as shown in Figs. 27 and 31, may be and preferably is in one with the cam-bar 163. This cam-bar has (see Figs. 27 and 33) two cam-inclines 175 and 176, connected by an intermediate lower dwell 177 and terminating in upper dwells 178 and 179. The brush and knife slide 172 carries at its outer end two vertically-movable shifting pins 180 and 181, each having a lifting stud 182, and a rotary bowl 183 at its lower end. The two shifting pins 180 and 181 are connected by an intermediate lever 184, centrally pivoted to the brush and knife slide 172, so that one of said shifting pins is elevated when the other is depressed. When, therefore, the parts are in the position shown in Fig. 33 and the cam-slide 155 and cam-bar 174 are moved inward, the outer incline 175 encounters the lifting stud 182 on the outer shifting pin 180, thereby elevating said shifting pin until the stud rides on the dwell 178, so that shifting pin 180 is thereby held elevated, and at the same time, through the lever 184, the inner shifting pin 181 is lowered, since the lower dwell 177 is then below its stud 182. This depression of the shifting pin 181 lowers its bowl 183 below the plane of the base 130 and into the plane of the stationary ring W, which has already been alluded to. This ring is indicated in Fig. 27, but is best shown in Fig. 4. It is supported above the bed-plate by pillars 100 and has its upper surface flush with that of the horizontal portion of the cam-plate C, as shown in Fig. 5. This ring is cam-shaped on both its outer and inner edges, as shown in Fig. 4, neither edge being concentric with the axis of rotation of the machine. When, therefore, the bowl 183 of shifting pin 181 is depressed into the plane of the cam-ring, which occurs when the shifting pin 181 is opposite the narrowest portion of said cam-ring, the said bowl travels along the inner cam edge of said ring W, until the widest portion of said ring is reached. This movement forces the pin 181 inwardly, and with it the brush and knife-slide 172. The inward movement of the brush and knife slide is possible because the locking-pin 168 has previously been lifted, thereby unlocking the brush and knife slide. This inward movement of the brush and knife slide permits the outer locking-pin 169 (which heretofore has been riding on the locking-bar 173) to move down under the influence of its spring 171 when the locking-bar 173 passes beneath it to a position behind the said locking-bar, thereby locking the brush and knife slide

from outward movement. Since the cam-slide 155 and its bars 163 and 174 do not partake of this radial movement of the brush and knife slide, the termination of the inward movement of the brush and knife slide leaves the parts in the position shown in Fig. 27, with the lifting stud 182 of the inner shifting pin 181 close to the cam-incline 176 and the outer shifting pin 180 in position with its lifting stud above the dwell 177, ready for movement in the reverse direction. The dwell 177 is of sufficient length to allow for the radial movement of the brush and knife slide. The mechanism whereby this inward movement of the brush and knife slide 172, (which I will now call simply the "brush-slide,") moves the brushes 141 is as follows: The brush-slide at its inner end (see Figs. 33 and 34) carries a rack 185, which meshes with a pinion 186 on the lower end of the spindle 132. Keyed to the upper end of the spindle, above the hub 159 of the swinging head 131, is a beveled rack 187, (see Fig. 31,) which meshes with a bevel-pinion 188, carried by a rotary sleeve 189, which turns upon a pivot-stud 1891 on the swinging head 131. (See Fig. 33.) The rotary sleeve 189 has a pinion 190, which intermeshes on opposite sides with two vertically extending and sliding rack-bars 191 and 192. (See Fig. 32.) These rack-bars are suitably mounted and guided upon the head 131, as shown in Fig. 29. These rack-bars 191 and 192 have secured to them, respectively, upwardly-extending arms 193 and 194, the upper ends of which are bent over to lap by each other, as shown, and to form clampers 195 and 196. One of said arms 193 and 194 is bent inwardly, so that the two clampers 195 and 196 do not conflict with each other, as shown in Fig. 27.

The brush-carriers 138 and 139 are connected, respectively, by straps 197 to rods 198 and 199, which slide vertically in channels 200 in the swinging head parallel with the yarn-channels 133 134. Within said channels 200 are coiled springs 201, which tend to elevate the rods 198 and 199 and the brush-carriers. Each channel 200 has a vertical side slot 202, Fig. 29, and an outer vertical slot 203. Each rod 198 and 199 has a depressing-stud 204, projecting out through the outer slot 203, and a coupling-stud 205, which extends out through the side slot 202.

Now in Figs. 31, 32, and 33 the parts are shown while the auxiliary thread is being fed in and before the inward movement of the brush-slide 172 begins. The inward movement of the brush-slide, acting through the rack 185, pinion 186, spindle 132, beveled rack 187, bevel-pinion 188, and pinion 190, elevates the rack-bar 191 and clamper 195 and depresses the rack-bar 192 and clamper 196. The downward movement of the rack 192 carries with it rod 198 and main-brush carrier 138, because at this time the rack 192 is coupled to the rod 198, since the side stud 205 thereof then engages an aperture 206 (see Fig. 27) in a coupling-spring 207, secured to and carried by the rack 192. The consequent downward movement of the main-yarn carrier and brush carries down the main yarn, thus feeding it to the needles. This downward movement of the main-brush carrier continues, it will be noted, during about two-thirds of a revolution of the cam-plate C, since the inward movement of the actuating-rack 185 continues until it passes the widest portion of the cam-ring W. Hence during the first portion of the downward movement of the main-brush carrier its yarn is fed to the needles and thereafter both yarns feed simultaneously to the needles during the next portion of the downward movement of the main-brush carrier. When the rack-bar 192 approaches the termination of its downward movement, its clamper 196 comes in contact with the depressing-stud 204 on the rod 199 of the auxiliary-brush carrier, and thereafter the auxiliary-brush carrier descends until its brush clamps the auxiliary yarn, which theretofore had been the working yarn, against the shoulder 137 in the auxiliary-yarn channel 134, thereby preventing the auxiliary yarn from being pulled out by the tension devices when severed. Just as the rack-bar 192 is approaching its downward limit of motion a stud 208 on its coupling-spring 207 encounters a fixed cam 209, Figs. 29 and 32, on the head 131, whereby the spring 207 is forced outward, thus uncoupling the coupling-stud 205 on the rod 198, and thereupon the rod 198 and the main-brush carrier 138 are moved upward to their highest position (see Fig. 30) by the coacting spring 201, so that thereafter the main thread has a free and unobstructed passage to the needles. At the close of this movement the clamper 196 is left holding the auxiliary-brush carrier 139 partially down, as shown in Fig. 30, with the auxiliary yarn clamped against the shoulder 137. In the meanwhile the other rack 191 has been moved upwardly, its coupling-spring couples with the rod 199 of the auxiliary-brush carrier, and the parts are in readiness to put in the auxiliary yarn and take out the main yarn when at the appropriate time the brush-rack is moved outwardly. Immediately after the auxiliary yarn has been clamped by its brush its knife 143 cuts it off. Each of the two knives 142 143 is carried at the lower end of a knife-carrier 210, which is pivoted at 211, (see Fig. 28,) near its upper end, to the swinging head 131. The edges of the knives, as shown in Fig. 34, are inclined, so that they make a shear cut, and they work along a cutting or shear plate 212 at the lower end of the head 131, which is slightly inclined both ways from the center, as shown in Fig. 32, so as to allow for the swing of the knives and to aid in the cut. The knife-blades are thin and extend horizontally beneath the shear-plate 212 and just above the leading-in yarn-guide X, as shown in Fig. 28. The operation of the knives can be best explained by reference to Fig. 34. As shown in this

figure, the auxiliary-yarn channel 134 is open, the auxiliary yarn working, and the main-yarn channel 133 is closed by its knife 142. When the yarn-changer head swings in the direction of the arrow 213 preparatory to changing from the auxiliary to the main yarn, the auxiliary-yarn knife 143 moves with the head, leaving the auxiliary-yarn channel still open. The main-yarn knife 142 does not, however, move with the head, being prevented from doing so by reason of a projection 214 on its carrier 210 abutting against a shoulder 215 on the yarn-guide X. (See Figs. 28 and 37.) Consequently during the simultaneous feed of both yarns the discharge ends of both yarn-channels are open. At the proper moment after the auxiliary yarn has been clamped as aforesaid its knife 143 is moved across the discharge-mouth of the channel 134, thereby severing the auxiliary yarn. This severing movement of the knife 143 is accomplished by the inward movement of the "knife-slide" 172, as I will here call it. Along one edge the knife-slide 172 has cam-inclines 216 217, Fig. 34, which coöperate with cam-shoulders 218 219 on a knife-operator 220, which is pivoted at 231 to the base 130. As the knife-slide 172 moves inward and approaches its limit of movement its incline 216 encounters the shoulder 218, thereby swinging the knife-operator 220 in the direction of the arrow 221, and thereupon the free end of the operator encounters the knife-carrier 210 of the auxiliary knife 143, forcing it inward and severing the thread. In the meanwhile, at the beginning of the inward movement of the knife-slide 172 a cam-incline 222 on the opposite side of the knife-slide encounters a cam-shoulder 223 on a knife-operator 224 for the main knife 142, thereby swinging the end of said operator contiguous to said knife 142 away from it, so that when the head 131 swings in the opposite direction said operator 224 will not be in the way of the carrier for said knife. The operator 224 is swung inward on the outward movement of the knife-slide 172 by reason of the cam 225 encountering shoulder 226, and at the same outward movement of the knife-slide the cam 217 encounters the shoulder 219 on the other operator 220, thereby swinging its free end outwardly.

I have described in detail the effects of moving the cam-slide 155 and the brush and knife slide 172 inwardly, and it is unnecessary to describe the effects resulting from their outward movements, since the effects are just the reverse of those just described.

While the particular shape and size of the base 130 are of no importance and constitute in themselves no part of the present invention, nevertheless said base has certain characteristics which adapt it to support and carry the operative parts. As shown in Figs. 32, 33, and 34, it is channeled on its under side at 801 to receive the pinion 186 and slides 155 and 172. It is slotted on its sides, as shown in Fig. 34, to receive the cams 218, 219, 223, and 226, said side slots communicating with the bottom channel. It is also provided with vertical apertures communicating with the bottom channel to accommodate the locking-pins 168 169, as shown in Fig. 33. It is also provided with the vertical slot 157, (see Fig. 33,) communicating with said bottom channel to accommodate the pin 156. It is also provided with a vertical aperture communicating with said bottom channel to receive the spindle 132, as shown in Fig. 33. It is curved on the inner end, as shown in Fig. 34, and is straight on its outer end, which is just above the cam 154, as shown in Figs. 27 and 31. It includes as a part fastened permanently to it by screws (see Fig. 31) a bracket, which furnishes a bearing for the spindle 132 and housings or chambers 170 for the springs 171 and pins 168 169, and which has a longitudinal channel to accommodate the cam-bar 163, all as shown in Figs. 27 and 33. Said bracket is provided with a screw-hole to receive the screw (shown in Figs. 27 and 31) to hold the spring 161 in place. The bottom part of the base 130 is also provided with holes to receive the screws 231 (shown in Fig. 31) to secure the base in place on the cam-plate C, the shanks of said screws also serving as the axes for the operators 220 224, as shown in Fig. 34. As shown in Fig. 33, the cam-slide 155 occupies a lower plane in the bottom channel 801 of the base than does the brush and knife slide 172, and the yarn-guide X also occupies a lower plane in said channel than does said brush and knife slide and the pinion 186, said yarn-guide being at all times nearer the axis of the machine than the said cam-slide. At this point also the shape of the brush and knife slide will be described, commencing at its outer end. Its outer end is semicircular, Fig. 34, and has a vertical cylindrical bore to receive the shifting pin 180 and a vertical cylindrical bore of larger diameter to receive the bowl 183. A short distance radially inward said slide has similar bores to receive the shifting pin 181 and its bowl 183. Between these inner and outer bores the said slide has a vertical slot open at the top to receive the lever 184, Figs. 31 and 33, and has horizontal apertures on each side of said slot to receive the pivot-pin for said lever, Figs. 27, 31, and 33. Said slide has adjacent to the said cylindrical bores lateral slots communicating therewith to receive the pins 182 182, Figs. 27 and 31. Immediately within the outer part containing the said bores the slide 172 is reduced to flat form of small vertical height, as shown in Figs. 27 and 33, and so continues to its inner end. From this point in said slide is bifurcated to straddle the cam-slide 155 and pins 168 and 169, except where it is equipped with the cross locking-bar 173, all as shown in Figs. 31, 33, and 34. The side edges of the slide 172 are shaped to form the cams 216, 217, 222, and 225, as shown in Fig. 34. One of the bifurcated sides of the

slide is extended inwardly beyond the other, as shown in Figs. 33 and 34, and is formed with the rack 185.

While I have called the thread from which the leg and foot are knit the "main yarn" and the thread from which the toe and heel are knit the "auxiliary yarn," this has been merely for convenience and clearness of description. Either yarn can be called the "main" yarn and either be fed through either yarn-channel by a proper arrangement of the cams in the time-wheel.

The chief instrumentalities of the yarn-changer are seen to consist of the feeding-brushes, with their carriers, the swinging head, the knives, the brush and knife slide which operates the brushes and knives, the cam-slide which swings the head, unlocks the brush and knife slide, and shifts the shifting-pins upon the brush and knife slide, the cam-ring which actuates the brush and knife slide, and the tappet-pins controlled by the time-wheel which actuate the cam-slide.

The rods 198 and 199, it will be noted, constitute, in effect, parts of the respective brush-carriers and are separate pieces only as a matter of convenience in mechanical construction.

The yarn-changer can be used for striping or for splicing—*i. e.*, putting in a reinforcing-thread—and more than two yarn-channels can be employed. As compared with the yarn-changer of the Nelson patent, No. 214,309, the present improvements consist, first, in applying the yarn-changer to a circular-knitting machine; second, in locking all of the parts from accidental movements during the operation of the machine; third, in transferring all of the actuating mechanism to a position out of the way and below the tops of the brush-carriers; fourth, in the particular construction, and, fifth, in the combination with the other parts of the machine.

Modified mechanism for freeing the fabric.—The mechanism already described for freeing the rib-needles from their loops upon the completion of the stockings operates by separating the working needles and the leading-in yarn-guide, so that the yarn is no longer fed to the needles, and hence a continuation of the knitting movements casts off the fabric and frees the loops from the plain needles as well as from the rib-needles. It is only essential, however, to the invention in its most comprehensive aspect that the fabric should be freed from the rib-needles, and hence in order that this fundamental characteristic of the invention may be clearly understood means are shown for freeing the rib-needles alone from their loops. This is done by cutting the loops while on the rib-needles. Mechanism for this purpose is shown in Figs. 39, 40, 41, and 42, Sheet 3. A knife-bracket 227 is secured to any convenient rotary part of the machine out of the range of the knitting-cams—as, for example, to the housing 105, as shown. Mounted to slide vertically within this is a knife 228, which is normally upheld by a spring 229. The blade or point of this knife is normally upheld just above the loops or stitches on the depressed rib-needles. At the appropriate instant, however, the knife is depressed, so that its blade comes in contact with the loops or stitches between the rib-needle hooks and the verge of the rib-needle carrier, and consequently during the rotation of the knife with the cam-plate C all of the loops or stitches on the rib-needles are cut, and hence the rib-needles are freed from the loops and from the fabric. The throw-out cam for the rib-needles should be moved out of action before or just when the knife is depressed and begins its work. The depression of the knife 229 at the proper moment is effected by a cam 230 on the under side of the intermittently-moving pin-disk 88, the movements of which are controlled, as heretofore shown, by the time-wheel D. By this means the fabric is freed from the rib-needles alone and the knitting of the next stocking continues on the plain needles alone. The result is to leave the contiguous stockings joined together, but they can be separated by simply pulling them apart, the fabric easily giving away at the point where the rib-stitches were cut, provided that a sufficient proportion of rib-needles to plain needles is employed. Any proportion of rib-needles to plain needles greater than one to five will enable the fabric to be readily pulled apart. When thus separated, a finished edge is left upon the portion of the fabric first knit—that is to say, in the mode of operation of this machine, as heretofore described, upon the upper end of the leg of the stocking. This method is further advantageous, since it avoids beginning the new stocking with no stitches on the plain needles.

The manner of casting off the fabric by separating the leading-in yarn-guide and the working needles can be advantageously employed in machines like that set forth in my Patent No. 507,560, where plain needles alone are used and when the toe is knit last, since it is then unnecessary to cut the stockings apart or to knit a loose course for that purpose, and because when so used a finished edge is left at the toe of the stocking, where the seaming or looping is done, and hence no raveling down is needed before or after seaming or looping. It is characteristic of the present invention that ordinary latch-needles of the usual construction, each having a single shank at its hooked end, are used for both sets of needles and that all of the plain needles are in use when a tubular web is being knit, so that when the rib-needles are also brought into section all of the plain needles previously in use still remain in action, and hence the ribbed portion of the stocking is heavier and fuller. It will be noted that the loops are freed from the rib-needles in passing from ribwork to plain work by the action of means independent of the needles themselves. It is not necessary to impart to the

needles any special movement for the purpose of freeing the stitches or loops from them.

While I have described my present improvements as embodied in a whole stocking-machine, my invention in its broadest aspects is not limited to machines for this purpose; nor need all of the improvements be used together or in the same machine, since many of them are capable of use independently of the rest.

In the subjoined claims the employment of reference letters and numerals and of the designating terms used in the preceding description is to be regarded as a matter of designation and not of limitation, since the form and construction of the several parts can be widely varied without departing from the principles of the invention. Likewise in the subjoined claims words denoting direction and motion are to be regarded as terms of designation and not of limitation, since it is obvious that relative movement is alone of importance and that the particular direction is due to the position in which the machine is placed.

As far as I am aware I am the first to provide an organized wholly-automatic knitting-machine employing ordinary knitting-needles all of the plain needles of which remain in action in knitting a web wherein the work can be changed automatically from plain to ribbed work, and vice versa, with the capacity of knitting indefinite lengths of both plain and ribbed work; also, wherein the stitches on the rib-needles can be automatically freed from both sets of needles without necessitating any other movement of the needles than their ordinary knitting movements, and the knitting can then continue with the plain needles alone without stopping the machine; also, wherein in making a whole stocking automatically with seamless heel and toe the rib-forming mechanism, although idle, remains in its coöperative relation to the plain-knitting mechanism during the formation of the heel and toe, and also wherein the initiation and discontinuance of the rib-knitting are effected solely by a movement of the throw-out knitting-cam, except that in the discontinuance the stitches on the rib-needles are likewise freed from both sets of needles, and I intend that the subjoined claims shall protect me in these several assertions of originality.

It is here to be noted that the sinkers or web-holders *m m* constitute an important part in the operation of the described machine, since when the fabric is cast off from both sets of needles they enable the knitting of the next stocking to be begun and continued automatically without attention to the machine.

The described machine does its work automatically, rapidly, and with a minimum of attention.

By the word "yarn" I mean any kind of thread.

It will be noted that the out and in movements of the different shifting parts are in each instance effected by the same set of instrumentalities or means; but to use the different sets of instrumentalities or means for moving the shifting parts in opposite directions would be within the scope of my invention.

I claim as my invention—

1. Plain needles, their carrier and cams, and rib-needles, their carrier and cams, said plain and rib needles being latch-needles of the usual construction, each having a single shank at its hooked end, in combination with means for automatically bringing said rib-needles into and out of action, all of the plain needles remaining in action, and means for automatically freeing the stitches or loops on the rib-needles from both sets of needles, substantially as set forth, whereby both plain and ribbed work can be automatically produced in succession upon the same machine.

2. Plain needles, their carrier and cams, and rib-needles, their carrier and cams, said plain and rib needles being latch-needles of the usual construction, each having a single shank at its hooked end, in combination with means for automatically bringing said rib-needles into action after plain knitting has been done with the plain needles alone, all of the plain needles remaining in action, and then, after ribbed work has been knit by the conjoint action of both sets of needles, for bringing said rib-needles out of action, and means for automatically freeing the stitches or loops on the rib-needles from both sets of needles, substantially as set forth, whereby plain knitting thereafter continues with the plain needles alone.

3. Plain needles, their carrier and cams, in combination with rib-needles, their carrier and cams, provisions in virtue of which said rib-needle carrier has a fixed relation to the plain-needle carrier during the entire knitting operation of the machine, means for automatically moving the rib-needle throw-out cam in and out, whereby when said throw-out cam is in, a plain fabric is knit with the plain needles alone, and when said throw-out cam is out, a ribbed fabric is knit by the conjoint action of both the rib and all of the plain needles, and means for automatically freeing the stitches or loops on the rib-needles from both sets of needles, said plain and rib needles being latch-needles of the usual construction each having a single shank at its hooked end, substantially as set forth.

4. The plain needles, their carrier and cams, of a knitting-machine, whereby a seamless toe, heel, foot, and ankle may be knit by the plain needles alone, in combination with rib-needles, their carrier and cams, provisions in virtue of which the rib-needle carrier has a fixed relation to the plain-needle carrier during the entire knitting operation of the machine, the rib-needles being idle during the knitting of the toe, heel, foot, and ankle, and

means for automatically bringing the rib-needles into action when the leg of the stocking is to be knit so that a ribbed leg is knit by the conjoint action of the rib and all of the plain needles, and for automatically bringing the rib-needles out of action when the ribbed portion of the leg is finished, said plain and rib needles being latch-needles of the usual construction each having a single shank at its hooked end, whereby a string of indefinite length of stockings with ribbed legs and seamless heels and toes may be automatically knit, substantially as set forth.

5. Plain needles, their carrier and cams, and rib-needles, their carrier and cams, said plain and rib needles being latch-needles of the usual construction each having a single shank at its hooked end, in combination with means for automatically freeing the stitches or loops on the rib-needles from both sets of needles and discontinuing the action of the rib-needles upon the completion of the ribbed portion of the fabric, so that plain knitting with the plain needles alone may proceed without interrupting the action of the machine, substantially as set forth.

6. Plain needles, their carrier and cams; and rib-needles, their carrier and cams; in combination with means for automatically bringing said rib-needles into and out of action, the plain needles remaining in action; and means for automatically freeing the stitches or loops on the rib-needles from both sets of needles, substantially as set forth, whereby both plain and ribbed work are automatically produced in succession upon the same machine.

7. The combination of the framework A, stationary bed-plate B, the rotary cam-plate C, carrying the cams for the plain needles, the time-wheel D, the plain-needle carrier E, the plain needles *j*, *j*, the rib-needle carrier H, held from rotation by connection with the framework, the rib-needles, the spindle M, secured to the cam-plate, said spindle M, having plate N, within the carrier H, the rib-cam carrier O, secured to said spindle so as to rotate therewith, the movable throw-out cam R, the movable collar T, the rod S, connecting cam R, and collar T, the shaft U, having crank-pin engaging collar T, and pinion 60, the star-wheel V, carried by the cam-plate and having rack 61, engaging pinion 60, and tappet-arms 63, 63, the tappet-pins 64, and 65, and means connecting said tappet-pins with cam-grooves in the time-wheel, whereby said tappet-pins are projected in succession and at the proper instants into the path of said arms 63, 63, substantially as set forth.

8. Plain needles, their carrier and cams, rib-needles, their carrier and cams, and means for automatically bringing said rib-needles into and out of action, in combination with a knife for cutting the stitches or loops on said rib-needles when the same are rendered inactive, and means for automatically actuating said knife, substantially as set forth.

9. Plain needles, their carrier and cams, and rib-needles, their carrier and cams, in combination with the movable leading-in yarn-guide, the yarn-guide shifter coupled to the said yarn-guide, said shifter having a hook on its end, the rotary pin-disk having a pin in the path of said hook, the ratchet on said pin-disk, the slide 104, having pawl 107, coöperating with said ratchet, and cam-arm 102, the roller 99, movable into and out of the path of said cam-arm 102, the time-wheel, and means controlled by said time-wheel for elevating and depressing said roller 99, substantially as set forth.

10. Plain needles, their carrier and cams; sinkers or web-holders coöperating with said plain needles, and their cams; and rib-needles, their carrier and cams; in combination with means for automatically bringing said rib-needles into and out of action, the plain needles remaining in action; and means for automatically freeing the stitches or loops on the rib-needles from both sets of needles, substantially as set forth, whereby both plain and ribbed work are automatically produced in succession upon the same machine.

11. The needle-carrier H, around which the knitted fabric passes, in combination with a sliding connection between said needle-carrier and a fixed part of the machine substantially as set forth, whereby the knitted fabric can be removed from time to time.

12. The rib-needle carrier, and the framework, in combination with the sleeve I, connected with said carrier, and the post J, supported on said framework, said sleeve and post being connected by a sliding joint, substantially as set forth.

13. The plain needles, their carrier and cams, and the rib-needles, their carrier and cams, said plain needles and their cams being adapted to have a relatively-reciprocating movement during a portion of the knitting operation, and provisions in virtue of which the rib-needles may be thrown out of action, in combination with an automatically-movable leading-in yarn-guide which by a movement toward the middle of the machine during reciprocation prevents the catching of the yarn beneath the ends of the latches of the plain needles and the dropping of stitches, substantially as set forth.

14. The automatically-movable leading-in yarn-guide in combination with the yarn-guide shifter with hook 87, and the rotary pin-disk having pin 118, for moving said yarn-guide shifter, substantially as set forth.

15. The rib-needles, the stationary rib-needle carrier, the rotary rib-needle cam-block O, the rib-knitting cam R, means for automatically moving said cam, and means for casting off the stitches from the rib-needles, in combination with the rotary yarn breaker or severer comprising the jaws 113, and 114, rod 115, spring 116, and fixed cam 117, substantially as set forth.

16. The yarn-changer head having yarn-

channels, said channels having openings for the reception of the yarns, and inwardly-projecting shoulders beneath said openings, said channels being larger in diameter above than below their said respective openings, in combination with the movable feed-brushes within said channels, substantially as set forth.

17. The swinging yarn-changer head, having yarn-channels, the feed-brushes within said channels, and the brush-carriers for said brushes, in combination with springs for elevating said brush-carriers, and automatic means for depressing said brush-carriers, substantially as set forth.

18. The swinging yarn-changer head, and the cam-slide connected therewith which by its movements shifts said head, in combination with the time-wheel, and means intermediate the time-wheel and cam-slide for automatically shifting said cam-slide, substantially as set forth.

19. The combination of the swinging yarn-changer head, having crank-arm 158, and stud 162, the spring-detent 161, coöperating with said stud 162, to hold the yarn-changer head in its different positions, the cam-slide 155, having cam 154, the link 160, connecting said crank-arm and cam-slide, the connected tappet-pins 150, and 151, between which the cam 154, passes, the time-wheel D, and the slide 144, actuated by the time-wheel, and itself actuating the said tappet-pins, substantially as set forth.

20. The feed-brushes, and their carriers, and springs for elevating said brush-carriers, in combination with oppositely-sliding racks, couplers carried by said racks adapted to couple with said brush-carriers, means for uncoupling said racks and brush-carriers when said racks approach their lowermost positions, clampers carried by said racks for depressing said brush-carriers, and means for automatically moving said racks in opposite directions, substantially as set forth.

21. The yarn-changer head having yarn-channels, the feed-brushes within said channels, the brush-carriers 138, and 139, the rods 198, and 199, connected to said brush-carriers respectively, said yarn-changer head having channels 200, for said rods, said channels having slots 202, and 203, and each of said rods having studs 204, and 205, extending through said slots respectively, and springs 201, for elevating said rods, and the brush-carriers, in combination with the brush-slide 172, having rack 185, means for automatically moving said brush-slide, the spindle 132, having pinion 186, engaging said rack, and having rack 187, the pinion 188, engaging said rack 187, the pinion 190, connected with said pinion 188, the racks 191, and 192, engaging said pinion 190, on opposite sides thereof so as to move in opposite directions, the clampers 195, and 196, carried by said racks and engaging the respective studs 204, on said brush-carrier rods, the coupling-springs 207, on said racks having apertures 206, engaging said studs 205, on said brush-carrier rods, and said coupling-springs having uncoupling-studs 208, and the stationary cams 209, acting upon said studs 208, to uncouple the racks and the brush-carriers, substantially as set forth.

22. The rotary cam-plate, and the stationary cam-ring W, in combination with a yarn-changer carried by said cam-plate, and comprising a yarn-changing slide 172, having shifters coöperating alternately with the opposite cam-faces of said cam-ring, and means for actuating the shifters of said slide, substantially as set forth.

23. The yarn-changing slide 172, having connected shifting pins 180, and 181, in combination with the movable cam-bar 174, having cams 175, and 176, for shifting said pins, substantially as set forth.

24. The yarn-changing brushes and their carriers, in combination with the movable brush-slide, mechanism between said slide and brush-carriers, locking devices for locking said brush-slide in its different positions, and automatic means for unlocking said brush-slide, substantially as set forth.

25. The cam-slide 155, having operating-cam 154, and the slide 172, in combination with locking-pins 168, 169, for said slide 172, springs 171, for moving said pins in one direction, and the cam-bar 163, on slide 155, having inclines 166, 167, for elevating said pins alternately, substantially as set forth.

26. The swinging yarn-changer head having yarn-channels, in combination with the independently-moving knives for each of said channels and means controlled by a time-wheel for automatically moving said knives independently of each other, substantially as set forth.

27. The swinging yarn-changer head having yarn-channels, and the leading-in yarn-guide having stop-shoulders, in combination with the knives, one for each yarn-channel, located between said head and guide, the movable knife-carriers, said carriers having stops which encounter said shoulders in succession when said head swings in opposite directions, substantially as set forth.

28. The yarn-changer head having yarn-channels, and oppositely-beveled shear-plates at the discharge ends of said channels, in combination with the knife-carriers pivoted to said head, and having knives coöperating with said shear-plates, substantially as set forth.

29. The swinging yarn-changer head, the knives and their carriers, in combination with the knife-operators 220, and 224, and the slide 172, having cams for moving said knife-operators in opposite directions, substantially as set forth.

30. The swinging yarn-changer head having yarn-channels, the feed-brushes within said channels and their carriers, the independently-movable knives, and the carriers therefor pivoted to said head, in combination with the brush and knife slide, mechanism inter-

mediate said slide and brush and knife-carriers for moving said carriers, locking devices for said slide, movable connected shifting pins on said slide, a cam-ring acting upon said shifting pins for moving said slide to and fro, a movable cam-slide having an actuating-cam, and cam-bars for moving said shifting pins and unlocking said brush and knife slide, the time-wheel and mechanism intermediate said time-wheel and the actuating-cam on said cam-slide for moving said cam-slide, substantially as set forth.

31. The needle-carrier H, operatively connected to parts of the machine above and below it respectively, in combination with connecting means intermediate between one of said parts and said needle-carrier restraining said needle-carrier from longitudinal movement, and connecting means intermediate between the other of said parts and said needle-carrier restraining said needle-carrier from rotary movement, substantially as set forth, whereby a free passage-way around said needle-carrier for the knit fabric exists at all times.

32. Plain needles, their carrier and cams, and rib-needles, their carrier and cams, said plain and rib needles being latch-needles of the usual construction, each having a single shank at its hooked end, sinkers or web-holders coöperating with said plain needles and their cams, in combination with means for automatically bringing said rib-needles into and out of action, all of the plain needles remaining in action during the operation of the rib-needles, and means for automatically freeing the stitches or loops on the rib-needles from both sets of needles, substantially as set forth, whereby both plain and ribbed work can be automatically produced in succession upon the same machine.

33. Plain needles, their carrier and cams, sinkers or web-holders coöperating with said plain needles and their cams, rib-needles, their carrier and cams, and provisions in virtue of which the rib-needle carrier has a fixed relation to the plain-needle carrier during the entire knitting operation of the machine and an unobstructed passage-way is furnished at all times between said two carriers for the passage of the fabric, in combination with means for automatically bringing said rib-needles into action after plain knitting has been done with the plain needles alone, and then, after ribbed work has been knit by the conjoint action of both sets of needles, for bringing said rib-needles out of action, and means for automatically freeing the stitches or loops on the rib-needles from both sets of needles, substantially as set forth, whereby plain knitting thereafter continues with the plain needles alone.

34. Plain needles, their carrier and cams, in combination with rib-needles, their carrier and cams, provisions in virtue of which said rib-needle carrier has a fixed relation to the plain-needle carrier during the entire knitting operation of the machine and an unobstructed passage-way is furnished at all times between said two carriers for the passage of the fabric, means for automatically moving the rib-needle throw-out cam in and out, whereby when said throw-out cam is in, a plain fabric is knit with the plain needles alone, and when said throw-out cam is out, a ribbed fabric is knit by the conjoint action of both the rib and all of the plain needles, and means for automatically freeing the stitches or loops on the rib-needles from both sets of needles, said plain and rib needles being latch-needles of the usual construction each having a single shank at its hooked end, substantially as set forth.

35. The plain needles, their carrier and cams, the sinkers or web-holders coöperating with said plain needles, and their cams, whereby a seamless toe, heel, foot, and ankle may be knit by the plain needles alone, in combination with rib-needles, their carrier and cams, provisions in virtue of which the rib-needle carrier has a fixed relation to the plain-needle carrier during the entire knitting operation of the machine and an unobstructed passage-way is furnished at all times between said two carriers for the passage of the fabric, the rib-needles being idle during the knitting of the toe, heel, foot, and ankle, means for automatically bringing the rib-needles into action when the leg of the stocking is to be knit, so that a ribbed leg is knit by the conjoint action of the rib and all of the plain needles, and for automatically bringing the rib-needles out of action when the ribbed portion of the leg is finished, and means for automatically freeing the stitches or loops on the rib-needles from both sets of needles, said plain and rib needles being latch-needles of the usual construction each having a single shank at its hooked end, substantially as set forth.

In witness whereof I have hereunto signed my name in the presence of two subscribing witnesses.

JOSEPH A. RICARD.

Witnesses:
H. J. ODELL,
W. L. WOODWORTH.