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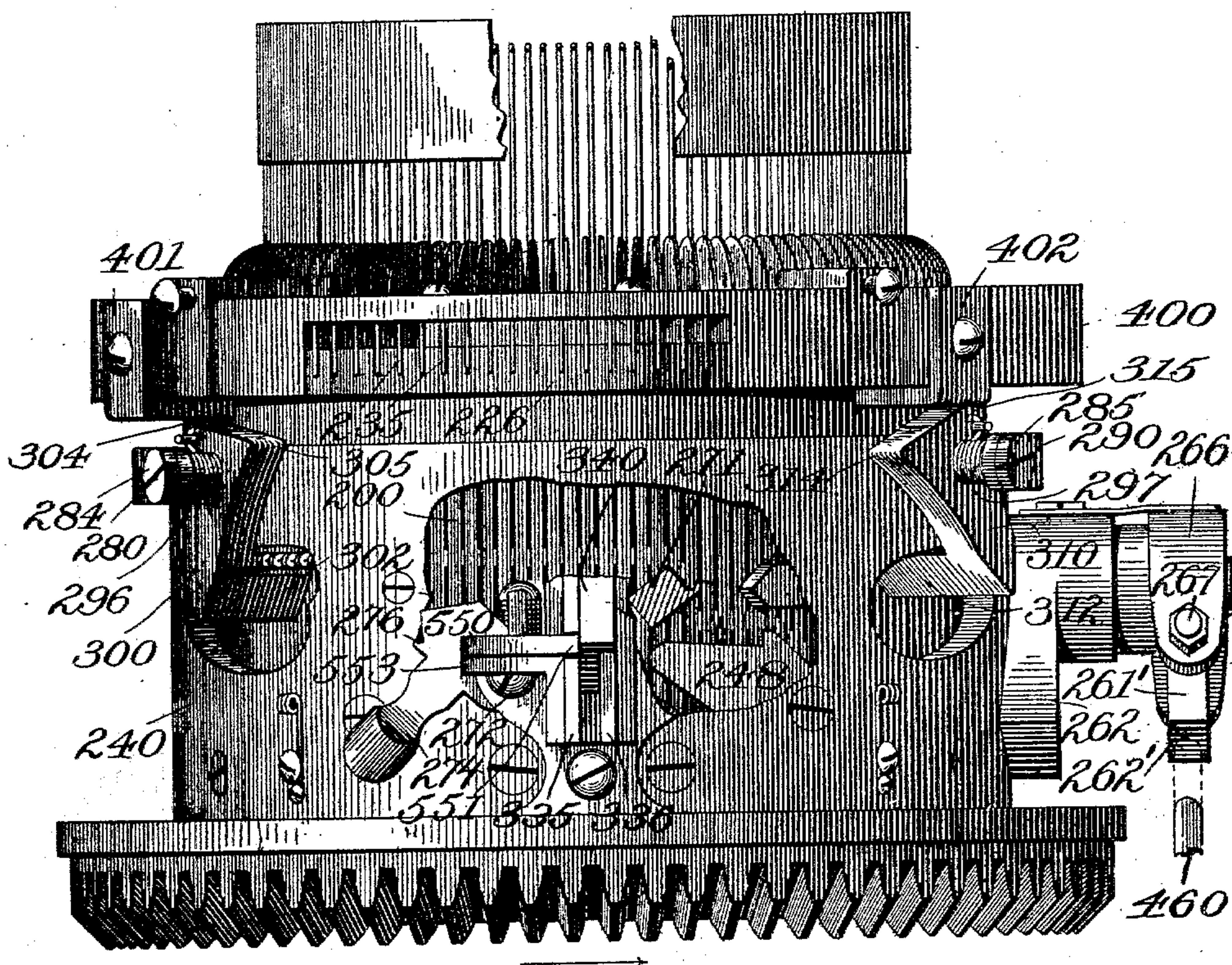
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J. A. BURLEIGH.  
NARROWING AND WIDENING MECHANISM FOR CIRCULAR KNITTING  
MACHINES.

No. 596,933.

Patented Jan. 4, 1898.

*Fig. 1.*



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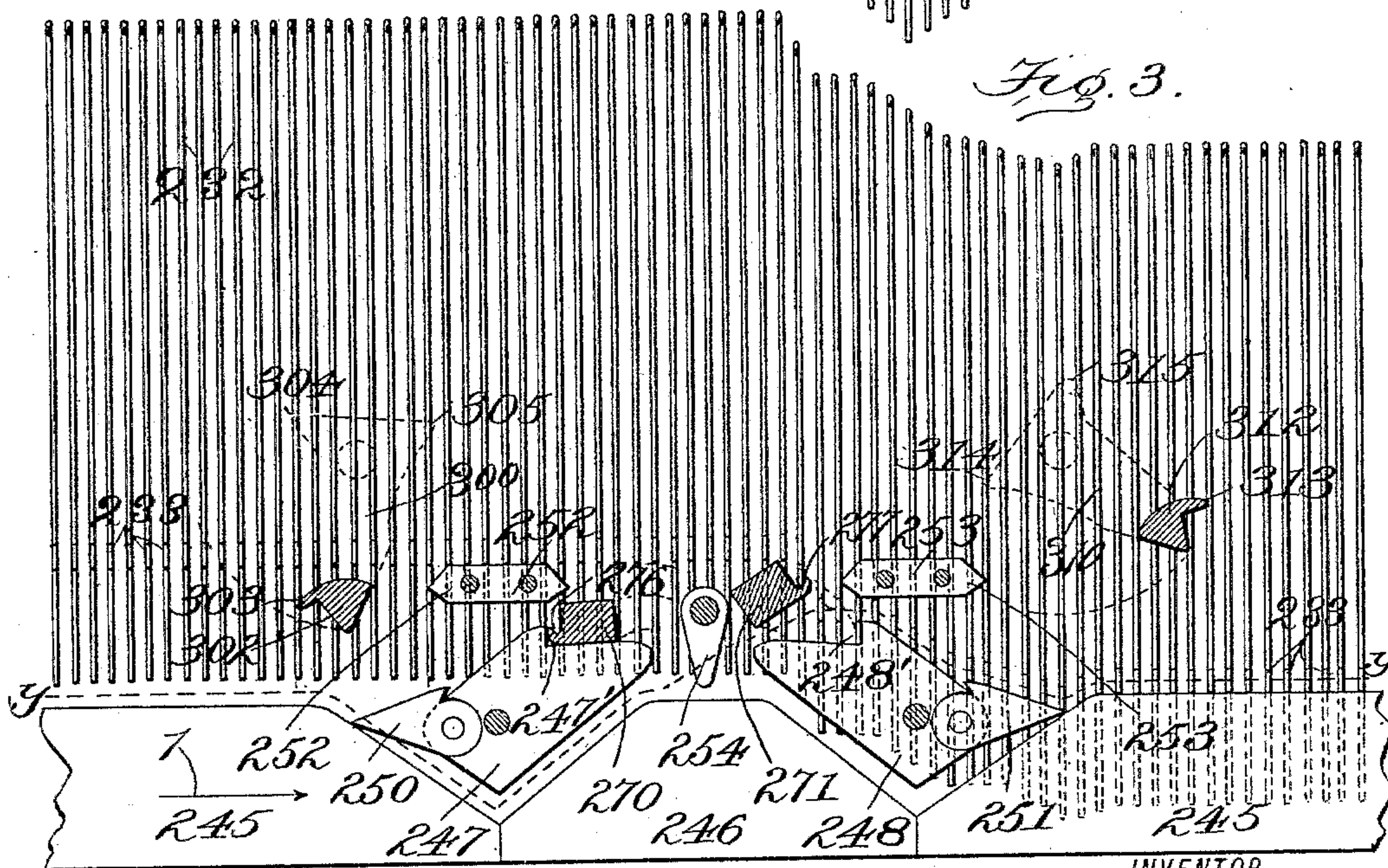
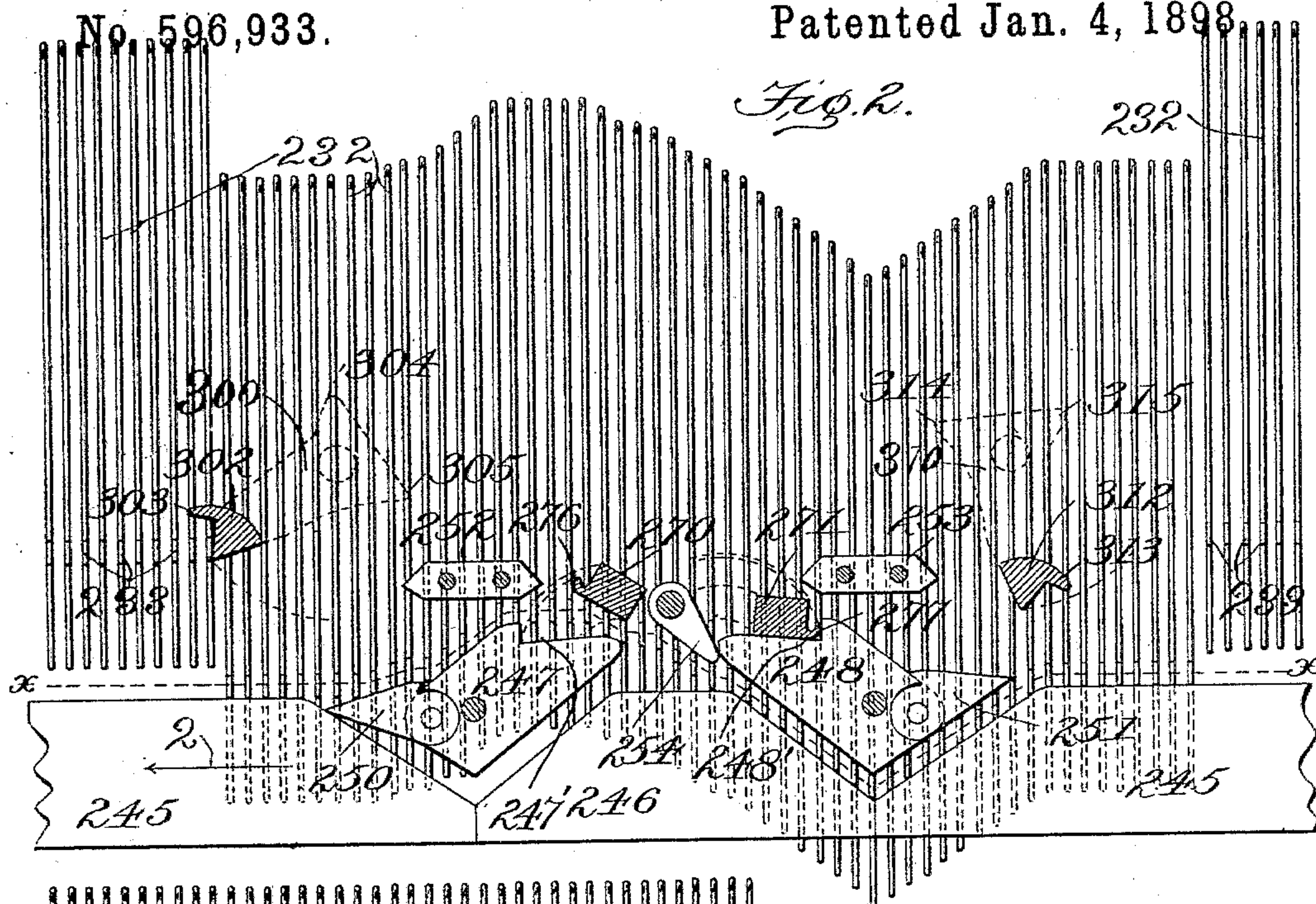


5 Sheets—Sheet 2.

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No. 596,933.

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(No Model.)

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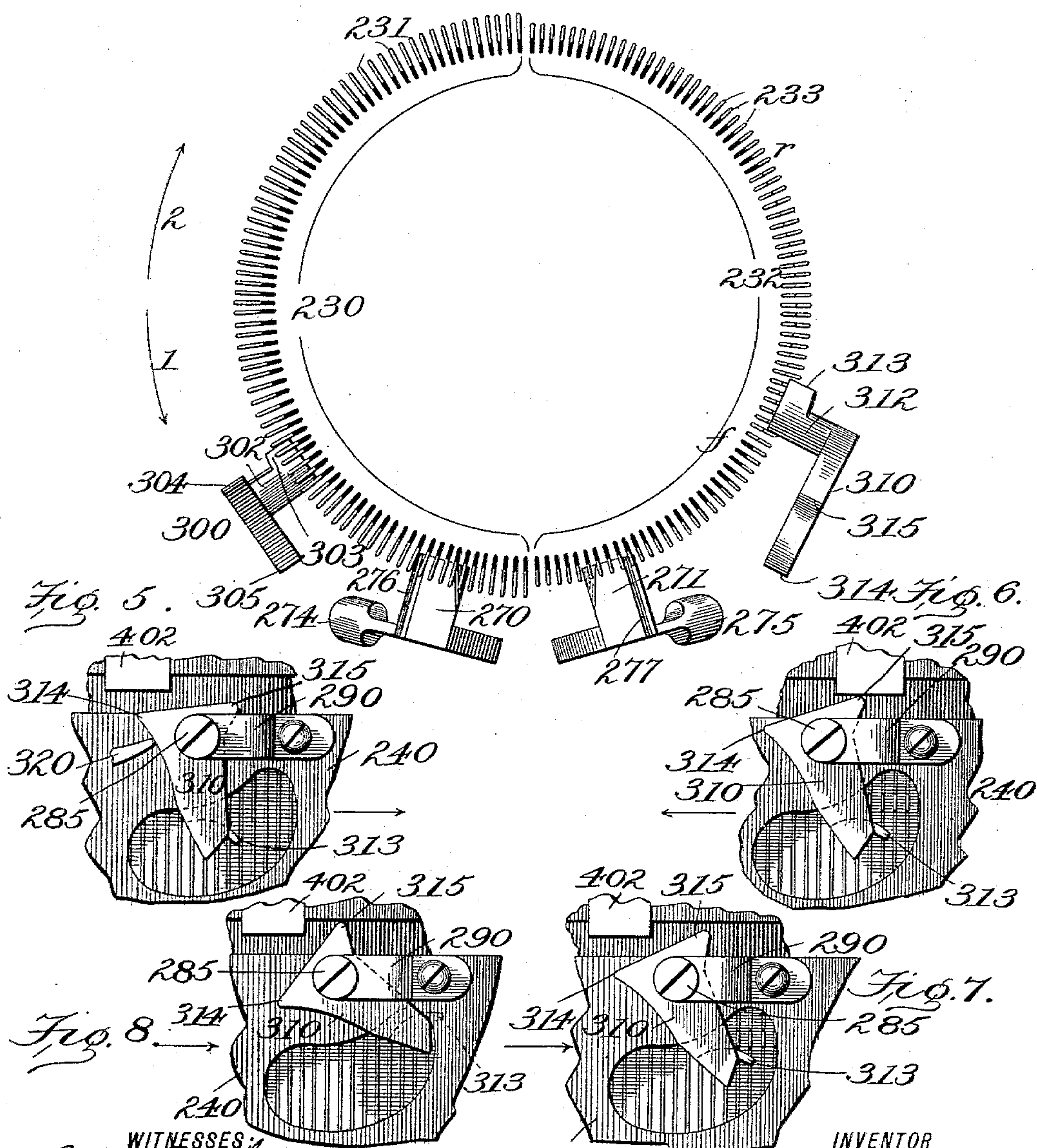
J. A. BURLEIGH.

NARROWING AND WIDENING MECHANISM FOR CIRCULAR KNITTING  
MACHINES.

No. 596,933.

Patented Jan. 4, 1898.

Fig. 4.



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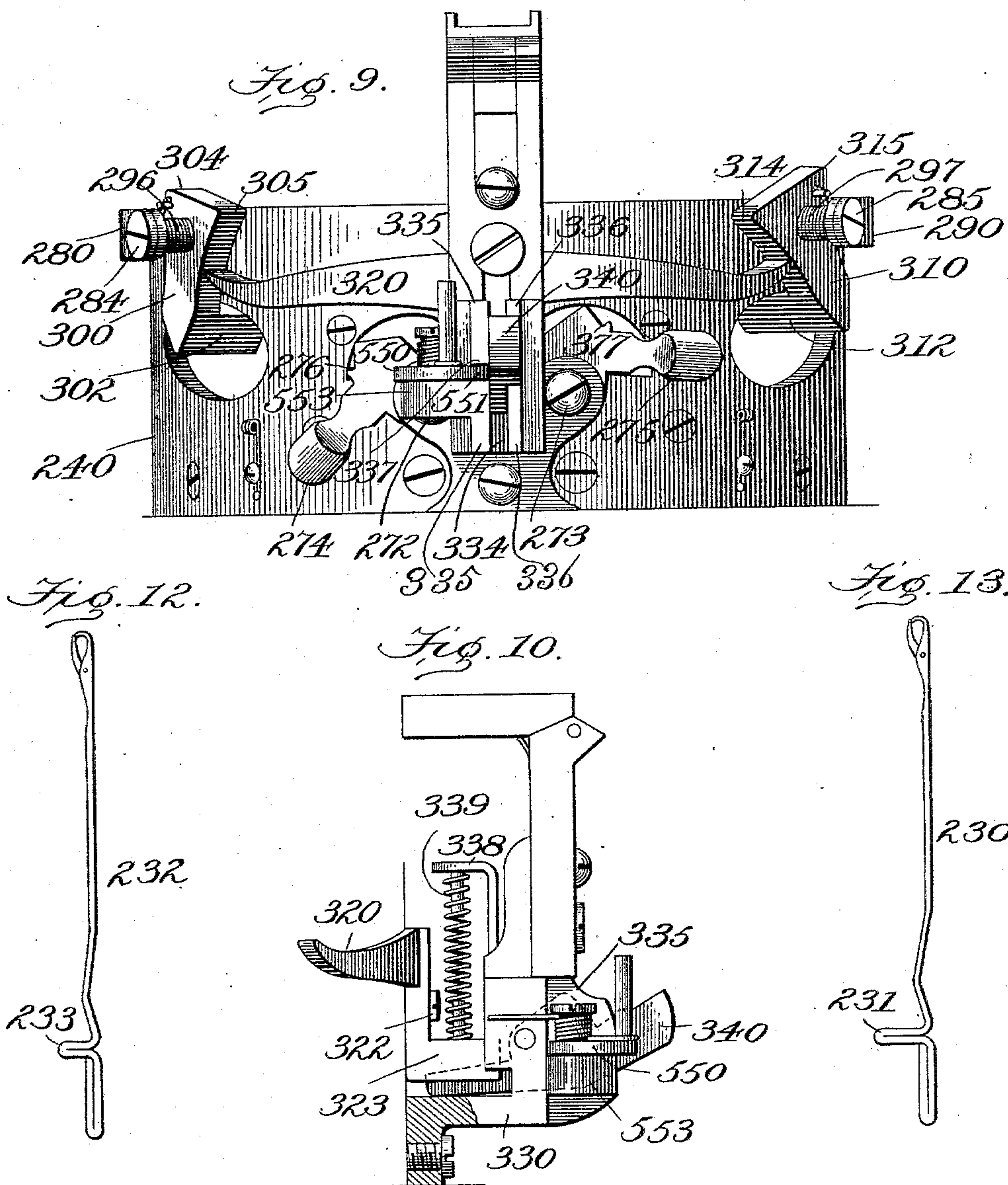
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J. A. BURLEIGH.  
NARROWING AND WIDENING MECHANISM FOR CIRCULAR KNITTING  
MACHINES.

No. 596,933.

Patented Jan. 4, 1898.



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(No Model.)

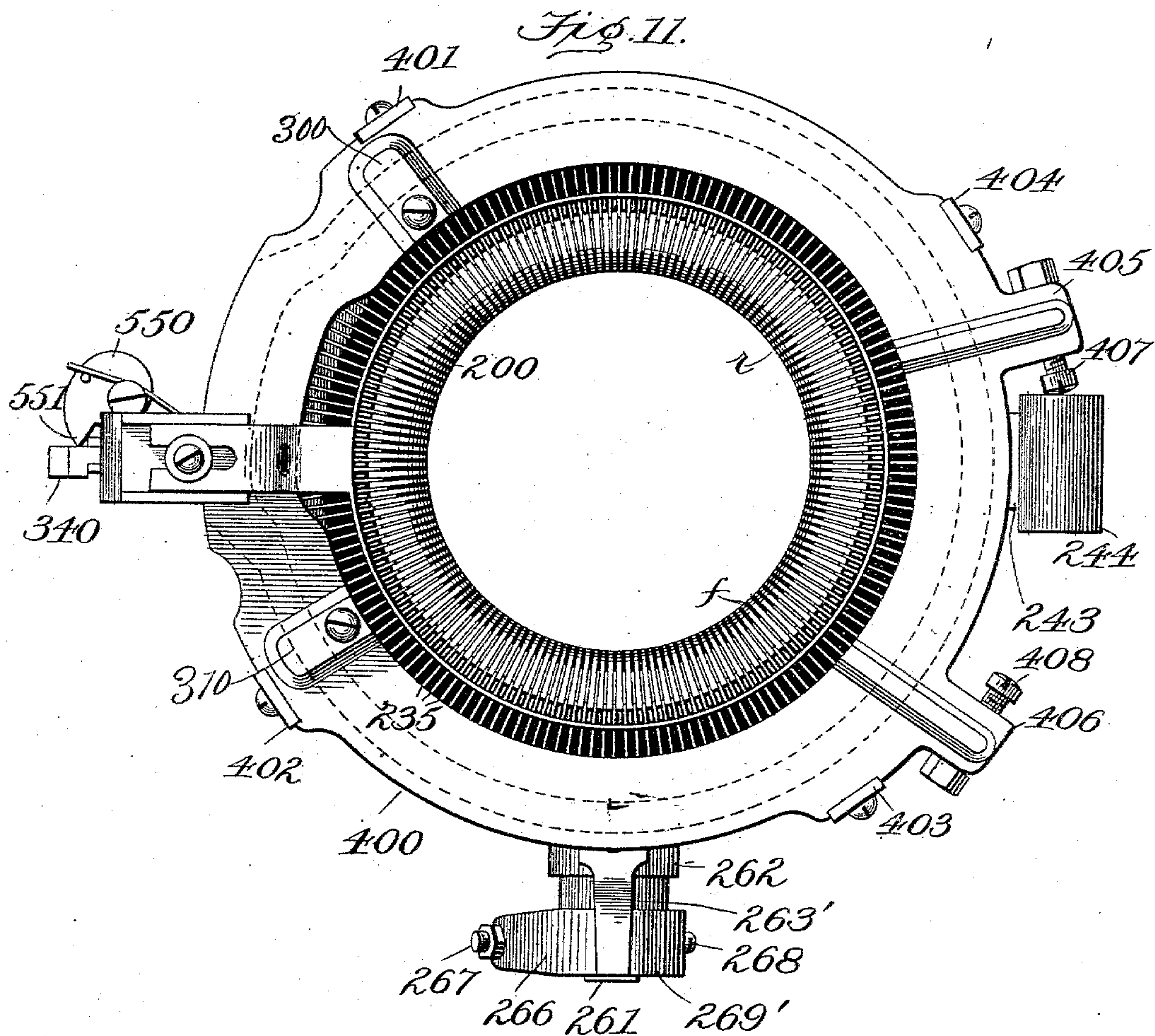
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J. A. BURLEIGH.

NARROWING AND WIDENING MECHANISM FOR CIRCULAR KNITTING MACHINES.

No. 596,933.

Patented Jan. 4, 1898.



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# UNITED STATES PATENT OFFICE.

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## NARROWING AND WIDENING MECHANISM FOR CIRCULAR-KNITTING MACHINES.

SPECIFICATION forming part of Letters Patent No. 596,933, dated January 4, 1898.

Application filed February 8, 1896. Serial No. 578,547. (No model.) Patented in England February 6, 1896, No. 2,756.

*To all whom it may concern:*

Be it known that I, JOSEPH A. BURLEIGH, a citizen of the United States of America, residing at Laconia, in the county of Belknap, in the State of New Hampshire, have invented certain new and useful Improvements in Narrowing and Widening Mechanisms for Circular-Knitting Machines, (for which I have obtained a patent in Great Britain, No. 2,756, dated February 6, 1896,) of which the following is a specification.

This invention is herein illustrated as applied to a circular-knitting machine for the knitting of stockings and socks in which the knitting is performed by a circular series of needles which are moved up and down in vertical grooves in the needle-cylinder under the action of the cams on the cam-cylinder, which encircles the needle-cylinder, the knitting of the tubular portion of the work constituting the leg and foot being performed in continuous circular courses by all the needles under a continuous rotary motion of the cam-cylinder, and the pouch-knitting for the formation of the heel and toe being performed in arc-shaped courses by a part of the needles under a reciprocatory motion of the cam-cylinder. When the work has been completed in the knitting of a stocking to a point where the pouch-knitting begins for the formation of the heel and toe, a number of the needles, usually one-half of the circular series, are at once thrown into inoperative position out of reach of the knitting-cams and out of the path of the yarn and at the same time the motion of the cam-cylinder is changed from a continuous rotary to a reciprocatory movement. Then the knitting operation continues on the needles remaining in action, about one-half of the circular series, and a needle at each end of the active series is thrown into inoperative position at alternate reciprocating strokes of the cam-cylinder, so that each successive knit course is shorter by one stitch than its preceding course, one stitch being dropped at one end of the course and the fabric being thus gradually tapered until the narrowest point of the pouch is reached, this being known as the "narrowing" operation. The cam-cylinder continues

to reciprocate, and the needles which were thrown into inoperative position on alternate reciprocating strokes of the cam-cylinder are likewise brought back into action and the successive knit courses are longer by one or more stitches than its preceding course, one or more stitches being added at one end of the course and the fabric being thus gradually broadened until the heel or toe is completed, this operation being known as "widening."

The example herein given is a circular-knitting machine in which during the widening operation two needles at each end of the inoperative series of needles are pulled down at once into active position and both utilized in the current knitting course and one of said needles thrown back into inoperative position in the next succeeding course and again pulled down into operative position with the next adjoining needle and utilized in knitting the succeeding course. This operation prevents a taut drawing of the yarn, as is the case when a single needle is pulled down, and it also multiplies the stitches at the joints of the heel and joints of the toe, so as to produce close work at these points. To accomplish this down-drawing of two needles at once and the restoration of one needle thereof to be drawn down with the next adjoining needle, it is necessary that the lifting-cam be free to operate to lift out of action one of the down-drawn needles while the throwing-down cams are in operative position.

The principal object of the invention in its application to the class of machines described is to provide for the moving of two needles simultaneously into active position, a simple and reliable mechanism which can be operated rapidly without breakage of the needles.

The general objects are to provide means for holding a needle-engaging cam out of engagement with the needles during its return or inactive movement and to conveniently locate such means.

Figure 1 of the accompanying drawings represents a side elevation of a knitting-head embodying this invention, a portion of the cam-cylinder being broken out to show the cams



therein and a portion of the guard-ring being broken out. Fig. 2 is a diagram representing a series of the short stud-needles used in pouch-knitting and the cams for operating them during the widening operation when the cam-cylinder is moving toward the left, the view being taken just inside the cam-cylinder with the cams detached and looking toward the center. Fig. 3 is a similar diagram representing the same parts when the cam-cylinder is moving toward the right. Fig. 4 represents a plan of the circular series of needles and of the widening and narrowing cams in connection therewith, the left half of said series being long butt-needles which are used only in continuous circular knitting, the right half thereof having short butts which are used in continuous circular knitting and also in pouch-knitting, about one-fourth the circular series represented in outline at the right being those which are always in action during knitting, while the others (indicated in solid black) are more or less out of action. Fig. 5 represents an elevation of a fragment of the needle and cam cylinders, showing the right widening-cam and a fragment of the T-shaped slide engaging said cam and holding it in its lowest position. Fig. 6 represents a similar fragment showing the left widening-cam held in its second position by contact with the projection on the sinker-ring, the cam-hook being out of operative position and below the studs of the needles. Fig. 7 represents a similar fragment of the cam and needle cylinders, showing the pivoted right widening-cam in the third position which it assumes when its cam-hook rides in contact with the studs of the passing needles. Fig. 8 represents a similar fragment of the cam and needle cylinders, showing said widening-cam in operative position ready to engage the studs of two needles at the right for bringing them into operative position. Fig. 9 represents an elevation of a portion of the needle-cylinder, showing the mechanism for releasing the widening-cams. Fig. 10 represents a side elevation of said mechanism detached. Fig. 11 represents a plan view of the knitting-head. Fig. 12 represents a side elevation of one of the short butt-needles. Fig. 13 represents a side elevation of one of the long butt-needles.

The same reference-numerals indicate the corresponding parts in all the figures.

A knitting-head is mounted on a bed-plate supported on the frame of the machine. This knitting-head may be of any suitable construction. As shown, it is similar in its general features to that illustrated and described in my Patent No. 537,802, dated April 16, 1895, and it comprises a needle-cylinder, as 200, an annular sinker-bed 226, encircling the top of the needle-cylinder, a rotary cam-cylinder, as 240, adjusted in the needle-cylinder, and a rotary sinker-cam ring, as 400, over and encircling the sinker-bed.

The needle-cylinder 200 has on its outer pe-

riphery the usual series of vertical grooves in which the knitting-needles are disposed in a circular series in the usual manner and in which said needles are adapted to reciprocate vertically. About half the needles, as 230, more or less, have elongated studs 231 and are disposed in a semicircular series, and the other semicircular series is composed of needles, as 232, which are provided with shorter studs 233. A spiral spring-band rests in the circumferential groove and serves to clamp all the needles in the vertical grooves of the cylinder and permits them to move up and down therein. A circular series of radially-sliding sinkers 235 move in radial slots in the sinker-bed and play at their inner ends between the needles, cooperating therewith in the knitting operation.

The rotary cam-cylinder 240 is provided on its inner face at its lower end with a rib 245, which extends about three-fourths of the distance around the cylinder and serves as a shoulder or track for the studs of the needles when the latter are in lowered position, the ends of the rib being beveled. An inverted approximately V-shaped fixed cam 246 is disposed between the beveled ends of said rib or formed integral therewith, and two fixed side cams 247 and 248 are disposed just above the beveled ends of said ribs and the inclined ends of the V-shaped cam. These fixed side cams are provided with recesses 247' and 248'. Two pivoted latching-cams 250 and 251 are adapted to bridge the spaces between the lower ends of the fixed side cams 247 and 248 and the beveled ends of said rib. Disposed, respectively, over the fixed cams 247 and 248 are two small fixed cams 252 and 253. An automatic switch-cam 254 depends from a stud on the inner face of the cam-cylinder and is adapted to oscillate freely between the adjacent ends of the two side cams 247 and 248. The cams described in this paragraph constitute the ordinary stitch or knitting cams for raising or lowering the needles in forming the loops of the stitches. Ordinarily the moving parts of the machine are so arranged that in the continuous rotary motion of the cam-cylinder 240 for the production of circular fabric the movement is "against the sun" in the direction of the arrow 1 in Figs. 3 and 4. Then the course of the studs of all the needles is from right to left of Fig. 3 on the line *y y* thereof—to wit, off the right end of the rib 245, over the latch-cam 251, over the side cam 248, between it and the small fixed cam 253; thence under the lifting-cam 271, which is held up by the continuous circular series of the studs of passing needles, the lifting-cam 270 being in position of rest, as shown; thence against the automatic switch-cam 254, which is swung by the needles toward the left; thence downward by the guiding action of said switch-cam between the fixed side cam 247 and the inverted-V-shaped cam 246; thence upward on the other beveled end of the rib 245 and under the latch-



cam 250 onto the top of said rib. The needles are thus raised and lowered in an ordinary manner, and during said raising and lowering they cooperate with a corresponding number of radial sliding sinkers 255 and form the connected loops which constitute the fabric.

The foregoing description corresponds with that form of knitting-head which is illustrated and described in my patent heretofore referred to.

The present invention relates to that part of the mechanism for the narrowing and widening operation and may be embodied in a knitting-head such as that just described or any knitting-head for which it is adapted.

Before the pouch-knitting to form a heel or toe, as the case may be, is begun the needles 230, having the long studs 231, comprising one-half of the circular series of needles, more or less, are moved into inoperative position by any suitable switch device—such, for instance, as that numbered 260 in the patent referred to.

The narrowing mechanism may be of any suitable construction. When constructed as herein shown, it comprises two narrowing-cams 270 and 271, similar in general construction to those in the patent referred to, for raising single needles to effect the narrowing operation. These cams are attached to shanks, which are pivoted on studs 272 and 273 on the outer face of the cam-cylinder, and play in slots in said cylinder. These narrowing-cams rest normally in the recesses 247' and 248' in the fixed cams 247 and 248. Their shanks are provided with weighted arms, as 274, which tend to hold the cams in said recesses and yet permit them to swing freely under the action of the needles. The cam 270 is adapted by a lip 276 or otherwise to engage the stud of a needle, and the cam 271 is adapted by a lip 277 or otherwise to engage the stud of a needle. When either cam rests in its recess, its lip is in position to engage a needle-stud. When a stud of a needle strikes one of these cams, the cam is swung on its pivot under the influence of the needle, and the lip of the cam acting in turn on the stud elevates the needle out of its knitting-path into inoperative position. As the cam swings up it leaves the ordinary knitting-path free for the passage of the studs of the succeeding needles, and the studs thereof, passing under the lifting-cam thus raised, serve to hold it in elevated position until the working portion of the current stroke of the cam-cylinder is completed. Thus no separate mechanism is required for holding the lifting-cams in inoperative position. In my patent referred to these lifting or narrowing cams are engaged by a mechanism for holding them out of operative position when the widening-cams are operative, and they are provided with teeth, which adapt them to be engaged by said mechanism. In this invention such teeth are omitted and the lifting-cams are al-

ways free to gravitate into operative position except as they are engaged by the studs of the needles.

The needle-engaging widening-cams for bringing into action during the widening operation the needles which were thrown out in narrowing are in the machine shown adapted to engage the studs of two or more needles at once. Two small brackets 280 and 290 are attached to the outer face of the rotary cam-cylinder at the upper edge thereof. The widening-cam 300 at the left in the drawings comprises a dependent oscillatory arm, which is pivoted near its upper end on a pivot 284, projecting through the bracket 280. This arm is provided at its lower end with a fixed stud 302, preferably integral with said arm, which stud extends through and plays in a slot in the wall of the cam-cylinder. The inner end of this stud is provided with a fixed hook 303, which projects toward the left and is adapted to engage the studs of two needles at once. The upper surface of the stud is rounded to adapt it to slide smoothly under the studs of the needles when in position in contact therewith. The upper end of the oscillating arm is somewhat broadened above its pivot, forming lateral ears 304 and 305. A torsional spring 296 on the pivot 284 tends to swing the cam 300 in upward direction toward the left. The arm, stud, and hook are rigidly united and are preferably formed in one piece of metal.

The cam 310 is of a construction similar to the cam 300, excepting that the hook extends in the opposite direction. This cam 310 comprises a dependent oscillatory arm, which is pivoted near its upper end on a pivot 285, projecting through the bracket 290, an inwardly-projecting stud 312 at the lower end of said arm, and extending through a slot in the wall of the cam-cylinder. The inner end of this stud is provided with a fixed hook 313, which projects toward the right and is adapted to engage the studs of two needles at once at the other end of the elevated series of needles.

The cam 310 is somewhat broadened at its upper end, forming lateral ears 314 and 315. A torsional spring 297 on the pivot 285 tends to swing the cam 310 in upward direction toward the right.

A T-shaped slide 320, having a vertical slot in its shank or body, is adapted to move vertically on a fixed stud 322 on the outer face of the cam-cylinder midway between the widening-cams 300 and 310. Its shank has an outwardly-projecting toe 323. The outer ends of the top of this T-shaped slide are adapted to engage at once the ear 305 of the cam 300 and the ear 314 of the cam 310. A fixed bracket 330 is attached to the cam-cylinder and extends radially outward and then vertically upward in front of the body or shank of the T-shaped slide. This bracket 330 is provided with a vertical slot 334, extending from its bottom to a point about midway of its height, and on its outer face on the



opposite side of said slot with vertical cheeks 335 and 336, the left cheek 335 having a notch 337 in its outer edge. A spiral spring 339 tends to move the T-shaped slide downward and hold it in its lowermost position. As shown, this spring extends between a lug 338 on the inner face of said bracket and the toe 323 of said slide. A lever 340 is pivoted on said bracket and adapted to swing in the slot therein and between the cheeks 335 and 336. The inner end of this lever engages said T-shaped slide. When the outer end of said lever is depressed, said slide is raised and its T-shaped head engages the widening-cams to swing said cams into vertical position, in which case their hooks for engaging the needles are in their lowest position, somewhat below the studs of the needles. A spring-actuated latch 550, having a nose 551, is pivoted on a lug 553, attached to the cheek 335, and when the outer end of the lever 340 is depressed said latch shuts over said lever into the notch 337 on the cheek 335 and locks said lever in depressed position until the latch is actuated to release it.

The mechanism for actuating the lever 340, which controls the T-shaped slide, and the mechanism for actuating the latch for releasing said lever automatically may be of any suitable construction—such, for instance, as that shown in my Patent No. 537,802.

A flanged sinker-cam ring 400 is adapted to rotate on the flange 226 on the needle-cylinder and operates to throw in and out a certain number of the radial sliding sinkers. This sinker-cam ring is held on the flange 226 by means of flanged lugs 401, 402, 403, and 404, attached to the flange of the cam-ring and projecting inward under the flange on the bed-plate 226. Two radial lugs 405 and 406 are disposed apart from each other in the usual manner on the cam-ring and have adjustable screws 407 and 408. When the cam-ring is disposed on the needle-cylinder, the boss 244 on the cam-cylinder is between the adjusting-screws 407 and 408, and during the rotation of the cam-cylinder said boss engages one of said screws and causes the cam-ring to rotate with it, and during the reciprocation of the cam-cylinder said boss engages said screws alternately and causes the cam-ring to reciprocate, said ring remaining stationary while the boss passes from one screw to the other.

Two projections are disposed on the under side of the sinker-ring 400 and adapted to engage the tops of the widening-cams, being disposed slightly nearer together than said cams, so that when one projection engages one of the widening-cams the other projection releases the other widening-cam. These projections may be of any suitable construction, and preferably they comprise two of the flanged lugs 401 and 402, which hold the sinker-ring in position on the sinker-bed attached to the needle-cylinder. In the widening operation these projections serve to hold the needle-engaging widening-cams alternately out

of engagement with the needles during the return or back stroke thereof in each direction, respectively, and thereby prevent each of said cams from striking on its back stroke the stud of the needle at either end of the row of raised needles and also prevent said cams on their back strokes from dragging around in contact with the studs of the raised needles. These widening-cams assume four different positions in the narrowing and widening operations of the machine, as herein illustrated, to wit: In the first position they are engaged by the T-shaped slide 320 and held in inoperative position, as shown in Fig. 5, during the narrowing operation for the formation of the first part of the pouch. In the second position during the widening operation either is engaged and held on its back stroke in inoperative position by engagement of one of the lugs 401 or 402, respectively, on the sinker-ring, as shown in Fig. 6, while the other is free to act. In the third position either is released from the lug and its hooked stud is in contact with the under side of the series of studs of the elevated needles. In the fourth position either is free from the T-shaped slide and from the lugs and from the studs of the needles and is swung under the action of its torsional spring upward into operative position, as shown in Fig. 8, in which case the hook of the cam is in the same horizontal plane as the studs of the elevated needles. Its upward movement in assuming this position is arrested at the proper point by contact of its shank with the upper end of the slots in the cam-cylinder.

The operation: In the knitting of the tubular fabric in continuous circular courses by continuous rotary motion of the cam-cylinder in the direction of the arrow 1 in Fig. 4 the studs of all the needles take the course from right to left on line *y y* of Fig. 3, all said needles being then in position for operation instead of a portion thereof being out of operative position, as represented in said figure. In such knitting of the tubular fabric the narrowing-cam 271 is in elevated position, riding on the continuous circle of needle-studs, which constitutes a circular track around the needles. The narrowing-cam 270 rests in the recess 247'. The widening-cam 300 is held by the clip 401 in the inoperative position shown in said Fig. 3, corresponding to the position of widening-cam 310 in Fig. 6, and the widening-cam 310 is in the position shown in Figs. 3 and 8; but both said widening-cams are inoperative, because they are not required, and the studs of the needles are below and out of the way of said cams. When a pouch is to be knit to form a heel or toe, the needles of the semicircular series of long-stud needles 230 are moved out of active position by the means hereinbefore described or otherwise. The motion of the cam-cylinder is changed from a continuous rotary to a reciprocatory movement, as described in my prior patent, or otherwise, and



the T-shaped slide is made to engage both the widening-cams, as indicated in Fig. 5, and hold them in inoperative position. When the lifting-cam 271 passes the right-hand end 5 of the short-stud series of needles, it falls into operative position in the recess 248', the path of the needle-studs being broken by the elevation of the long-stud needles, and the cam-cylinder, before reversing, carries the lifting-cam 270 beyond the right-hand end of the short-stud series of needles. When the cylinder is reversed, the lifting-cam 270 engages the short-stud needle at the right-hand end of the short-stud series and lifts it out of 15 operative position, and the remaining short-stud needles pass under and hold up said cam 270 until all have passed under it, and then it falls again into the recess 247'. As the cylinder continues to reciprocate the cams 270 and 271 act alternately upon opposite ends of the short-stud series of needles, raising one needle at a time at each stroke in each direction until the required number of needles are raised out of action, and the knitting of 25 the gradually-tapered portion for the heel or toe pouch, as the case may be, is completed. The heel is half knit when the narrowing is completed, and it may be assumed that at this point the cam-cylinder is moving in the direction of the arrow 1 of Fig. 4 against the sun. The mechanism which holds the T-shaped slide 320 in elevated position and the widening-cams in their first and inoperative position is released automatically by 35 suitable mechanism, such as that described in my patent heretofore cited. Then the spring 339 retracts said T-shaped slide and releases said cams. When the widening-cams 300 and 310 are thus released by the T-shaped slide 320, the left cam 300 swings up a short distance under the action of its torsional pivot-spring 296 until it is arrested by contact of its ear 304 with the projection or lug 401 on the sinker-ring 400. This lug holds 45 the cam 300 in its second position, and consequently its hooked stud 302 for engaging the needles below the plane of and out of contact with the studs of the raised needles, and at the same time the right cam 310, which is 50 in a position beyond the lug 402 on said sinker-ring, is swung upward under the action of its torsional pivot-spring into third position, as shown in Fig. 7, and its hooked stud 312 then rests against the under side of the studs of the raised needles and is free to spring upward into operative position as soon as it passes one end of this series of studs. The cam-cylinder then continues to rotate in the direction of the arrow 1 against the sun for 60 the distance of a half-rotation, and during this movement the lug 401 continues to hold the left widening-cam 300 in the second position. Then the cam-cylinder reverses and moves in the direction of the arrow 2 of Fig. 4, which is "with the sun," and during the time that the cam-cylinder moves in this reverse direction through an arc equal to the distance between the studs 407 and 408 the sinker-ring stands still and the boss 244 on the bracket 243 moves out of contact with the 70 lug 407 and into contact with the lug 408. During this part of the back stroke of the cam-cylinder while the sinker-cam ring is stationary the left widening-cam 300 passes to the left of and out from under the lug 401 75 and the right widening-cam 310 passes from the right of the lug 402 under said projection or lug and is swung thereby from third to second position. The left widening-cam 300, which was held by the lug 401, when released 80 therefrom flies up under the action of its pivot-spring into contact with the studs of the raised needles at the rear, assuming the third position. The cam-cylinder continues on its back stroke, arrow 2, and the left cam 85 300 rides under the studs of the needles until it passes the rear end of the series of raised needles at or above the point *r* of Fig. 4. It is then released from contact with the studs of said needles and swings up under the action 90 of its pivot-spring into the fourth or operative position, where its hook is in the plane of the studs of the raised needles. The cylinder still continues on its back stroke, and when the left cam 300 reaches the front end 95 of the series of raised needles at or about the point *f* of Fig. 4 its hook grasps two of said needles, as shown in Fig. 2, and draws them down into operative position, then releases their studs, flies back into third position, and 100 moves in contact with the studs of the succeeding elevated needles at the front, as illustrated in Fig. 4. During this back stroke of the cam-cylinder the left lifting-cam 270, which coöperates with the right widening-cam 310, 105 rests in the recess 247' until it reaches the rear end of the depressed series of needles at or about the point *r* of Fig. 4, and there coming in contact with the stud of the last needle at that end of said series lifts said needle out of 110 operative position, then rides over the studs of the succeeding depressed needles, as shown in Fig. 2, and on passing the last of said series at the front, at or above the point *f*, falls of its own weight back into the recess 247' 115 into operative position again. The cylinder 240 continues its back stroke, arrow 2, until the boss 244 is again at the right. During the back stroke the studs of the operating-needles pass from left to right on line *x x* of Fig. 2. 120 Then the cam-cylinder reverses and makes a forward stroke in the direction of the arrow 1 against the sun, and the sinker-ring, as before, remains stationary, while the boss 244 passes from contact with the lug 408 into contact with the lug 407, and during this dwell 125 the right widening-cam 310 is released from contact with the lug 402 and the left cam 300 is again engaged by the lug 401. The right widening-cam 310 when so released springs 130 at first into second position under the studs of the raised needles 230, and then it passes off the front end of said series at or about the point *f* and springs up under the tension



of its pivot-spring into operative position, as shown in Figs. 3 and 4. The cylinder continues on its forward stroke against the sun in the direction of the arrow 1, and the narrowing-cam 271 engages and lifts a needle at one end of the series of depressed needles, as shown at the left in Fig. 3 and at or about the point *f* in Fig. 4, and thence rides on the studs of the succeeding depressed needles. The right widening-cam 310 comes in contact with and pulls down two needles at one end of the series of raised needles, as shown at the right of Fig. 3 and at or about the point *r* of Fig. 4. During this forward stroke the studs of the needles engaged in knitting pass from right to left on line *y y* of Fig. 3. The backward and forward strokes are repeated until all the short-stud needles which were raised in narrowing are finally restored to operative position, two needles being brought into operative position at once at each end of the series of elevated needles, one of said needles being raised on the next stroke and again brought down with the next adjoining needle on the succeeding stroke thereafter.

It is obvious that the order of knitting may be changed as desired and according to the pattern-chain used. For instance, the knitting of a stocking may be begun at the toe in reciprocating courses after a start of a few circular courses has been made.

The construction and arrangement of the parts may be altered without a departure from the scope of this invention.

I claim as my invention—

1. In a knitting-machine, the combination with a cam-cylinder, of a needle-engaging cam, and means for moving and holding said cam out of engagement with the needles during its return or inactive movement.

2. In a knitting-machine, the combination with a cam-cylinder, of a needle-engaging cam, a sinker-cam ring, and means carried by said cam-ring for holding said cam out of engagement with the needles during its return movement.

3. In a knitting-machine, the combination of a cam-cylinder, of a needle-engaging cam, a sinker-cam ring, and a cam carried by said cam-ring for holding said needle-engaging cam out of engagement with the needles during its return movement.

4. In a knitting-machine, the combination of a cam-cylinder, two needle-engaging cams, and means for moving and holding said cams out of engagement with the needles during the return movement of each.

5. In a knitting-machine, the combination of a cam-cylinder, two needle-engaging cams, a sinker-cam ring, and means carried by the cam-ring for alternately holding said cams out of engagement with the needles during the return movement of each.

6. In a knitting-machine, the combination of a cam-cylinder, two needle-engaging cams, a sinker-cam ring, and two cams carried by said cam-ring for alternately holding said

needle-engaging cams out of engagement with the needles during the return movement of each.

7. In a knitting-machine, the combination of a needle-cylinder for the needles, a cam-cylinder, stitch-cams disposed in the cam-cylinder, narrowing-cams for moving individual needles out of operative position, widening-cams for bringing said needles back into operative position, and means operating alternately for holding said widening-cams out of engagement with the needles during the return movement of each.

8. In a knitting-machine, the combination of a needle-cylinder for the needles, a cam-cylinder, stitch-cams disposed in the cam-cylinder, narrowing-cams for moving individual needles out of operative position, widening-cams for bringing said needles back into operative position, a sinker-cam ring, and means carried by said cam-ring operating alternately for holding said widening-cams out of engagement with the needles during the return movement of each.

9. In a knitting-machine, the combination of a needle-cylinder for the needles, a cam-cylinder, stitch-cams disposed in said cam-cylinder, narrowing-cams for moving individual needles out of operative position, widening-cams for bringing said needles back into operative position, a sinker-cam ring, and cams carried by said cam-ring for holding said widening-cams out of engagement with the needles during the return movement of each.

10. In a knitting-machine, the combination of free narrowing-cams, widening-cams constructed and arranged to throw in two needles at once, and means for holding said widening-cams out of engagement with the needles during the return movement of each.

11. In a knitting-machine, the combination of a cam-cylinder, free narrowing-cams, widening-cams, a sinker-cam ring, and means carried by said cam-ring for holding said widening-cams out of engagement with the needles during the return movement of each.

12. In a knitting-machine, the combination of a cam-cylinder, free narrowing-cams, widening-cams, a sinker-cam ring, and cams carried by said cam-ring for holding said widening-cams out of engagement with the needles during the return movement of each.

13. The combination of a needle-cylinder, a cam-cylinder, needles disposed in the needle-cylinder, stitch-cams disposed in the cam-cylinder, narrowing-cams for moving individual needles out of operative position, spring-tensioned widening-cams pivoted exteriorly of the cam-cylinder and provided with studs extending through slots in the cam-cylinder and having oppositely-faced fixed hooks for returning the needles to operative position, and means for engaging and releasing said widening-cams respectively on each reversal of the needle-cylinder.

14. The combination of a needle-cylinder,



a cam-cylinder, needles disposed in the needle-cylinder, stitch-cams disposed in the cam-cylinder, narrowing-cams for moving individual needles out of operative position, 5 spring-tensioned widening-cams pivoted exteriorly of the cam-cylinder and provided with studs extending through slots in the cam-cylinder, and having oppositely-faced fixed hooks each adapted to engage two needles at 10 once for returning the needles to operative position, and means for engaging and releasing said widening-cams respectively on each reversal of the needle-cylinder.

15 15. The combination of a needle-cylinder, a cam-cylinder, needles disposed in the needle-cylinder, stitch-cams disposed in the cam-cylinder, narrowing-cams for moving individual needles out of operative position, spring-tensioned widening-cams pivoted exteriorly of the cam-cylinder and provided with 20 studs extending through slots in the cam-cylinder and having oppositely-faced fixed hooks for returning the needles to operative position, and means for engaging and releasing 25 said widening-cams respectively on each reversal of the needle-cylinder, said cam-studs having rounded upper surfaces adapted to ride in contact with the studs of the needles.

30 16. The combination of a needle-cylinder, a cam-cylinder, needles disposed in the needle-cylinder, stitch-cams disposed in the cam-cylinder, narrowing-cams for moving individual needles out of operative position, spring-tensioned widening-cams consisting of 35 arms pivoted exteriorly of the cam-cylinder, having rigid studs projecting through slots in said cylinder and provided with rigid hooks for engaging the studs of the needles for restoring them to operative position, means for 40 holding said widening-cams in inoperative position during the continuous rotation of the cam-cylinder, and separate means for individually holding the widening-cams in in-

operative position at different times during the reciprocation of the cam-cylinder. 45

17. The combination of a needle-cylinder, a cam-cylinder, means for operating one of said cylinders, needles disposed in the needle-cylinder, stitch-cams disposed in the cam-cylinder, narrowing-cams for moving individual needles into inoperative position, 50 spring-tensioned widening-cams consisting of independently-swinging arms provided with fixed studs at their lower ends adapted to project through slots in the cam-cylinder and 55 having fixed hooks for engaging the needles, a movable sinker-ring disposed on the cam-cylinder and adapted to remain stationary during an arc of movement of the cam-cylinder, and provided with projections adapted 60 to engage said widening-cams alternately at each reversal of the cam-cylinder.

18. The combination of a needle-cylinder, a cam-cylinder, needles disposed in the needle-cylinder, stitch-cams disposed in the cam-cylinder, narrowing-cams for moving individual needles into inoperative position, spring-tensioned widening-cams consisting of 65 independently-swinging arms provided with fixed studs at their lower ends adapted to project through slots in the cam-cylinder and 70 having fixed hooks for engaging the needles, a movable sinker-ring disposed in the cam-cylinder and adapted to remain stationary during an arc of movement of the cam-cylinder, and provided with projections adapted 75 to engage said widening-cams alternately at each reversal of the cam-cylinder, and a slide adapted to engage said widening-cams simultaneously for holding them both in inoperative position. 80

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Witnesses:

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