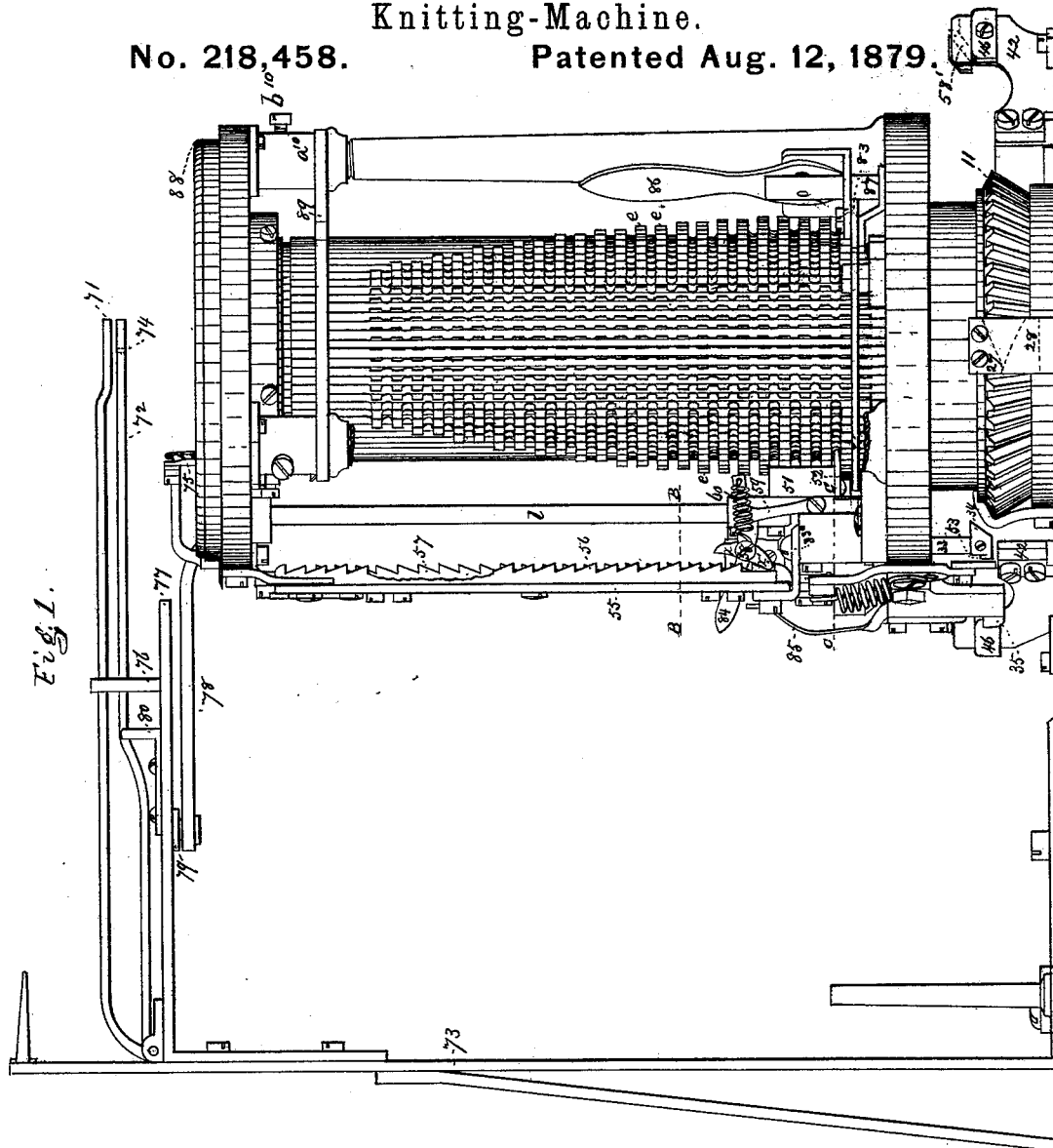


B. F. SHAW.  
Knitting-Machine.

No. 218,458.

Patented Aug. 12, 1879.



Witnesses.

L. H. Latimer.  
W. J. Pratt.

Inventor

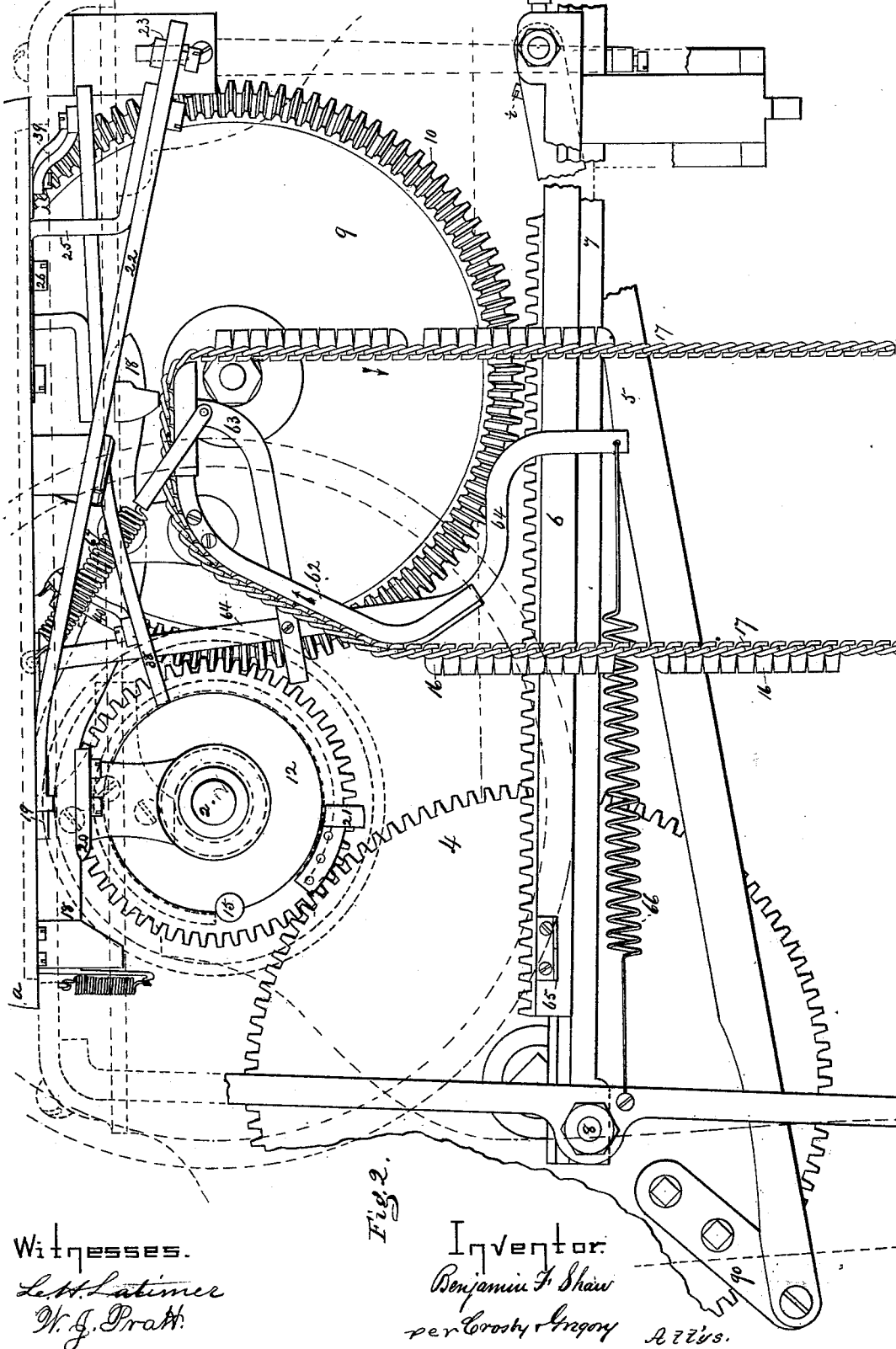
Benjamin F. Shaw

per Crosby & Gregory, Attys.

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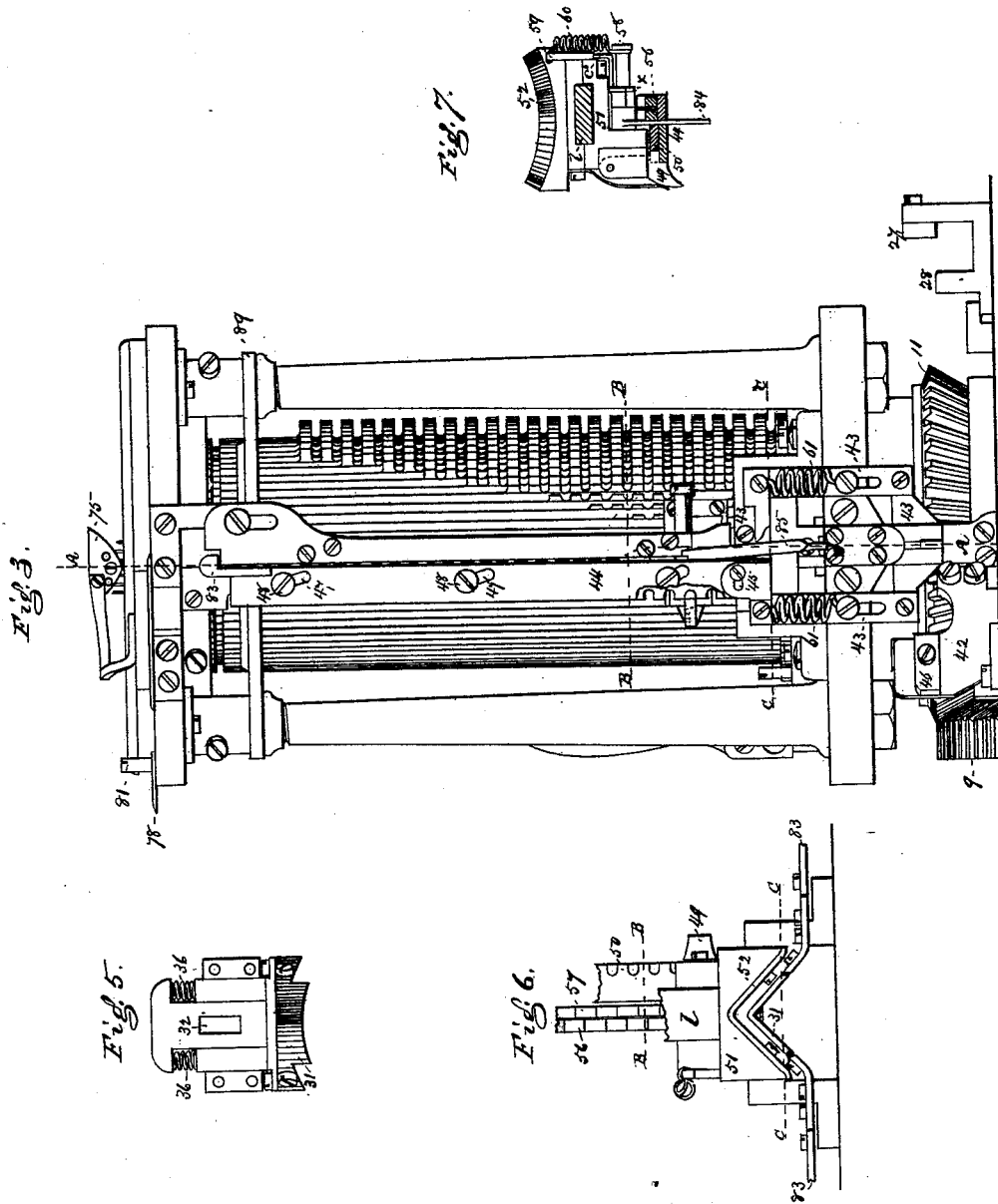
Fig. 2.

Inventor:  
*Benjamin F. Shaw*  
per *Crosby & Gregory* Attys.

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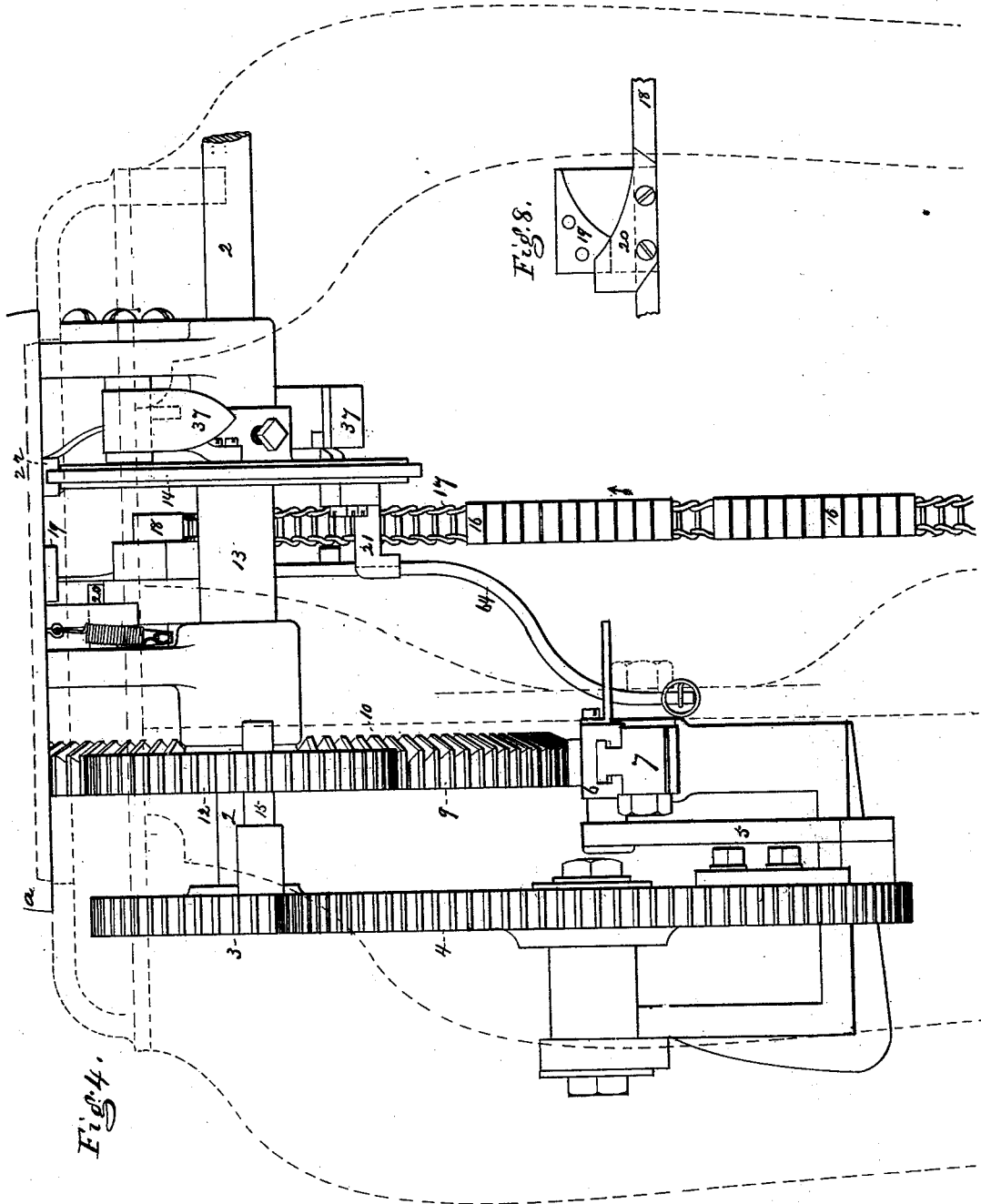
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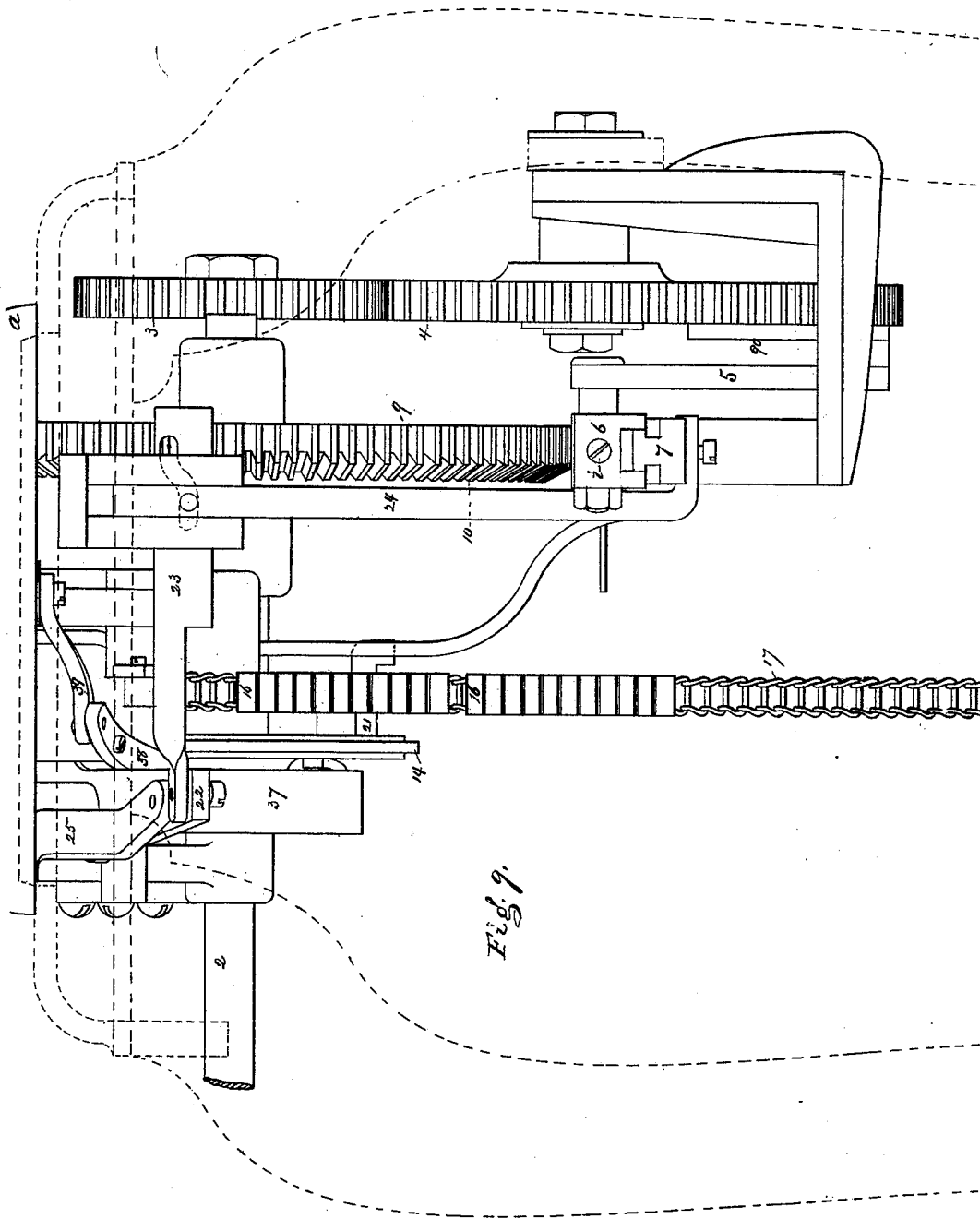
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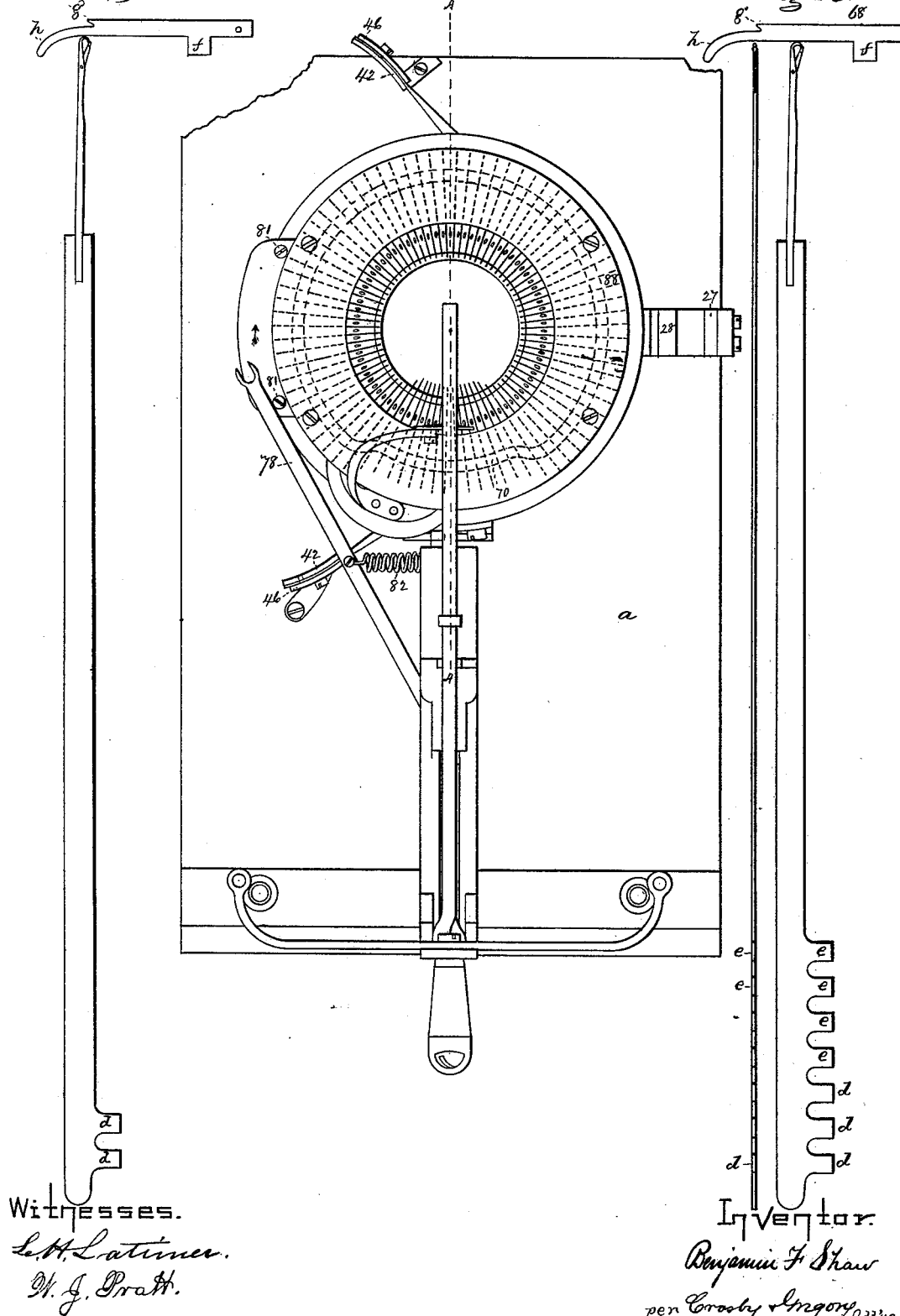
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B. F. SHAW.  
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No. 218,458.  
*Fig. 11.*

Patented Aug. 12, 1879.  
*Fig. 10.*

*Fig. 12.*

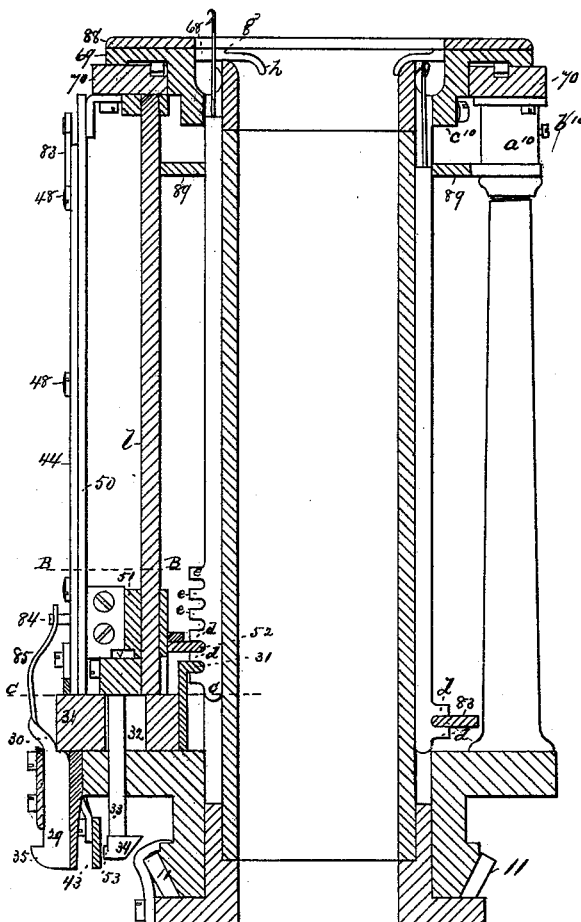


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Fig. 13.



Witnesses.  
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Inventor  
Benjamin F. Shaw  
per Crosby & Gregory Attys.

# UNITED STATES PATENT OFFICE.

BENJAMIN F. SHAW, OF CAMBRIDGE, ASSIGNOR, BY MESNE ASSIGNMENT,  
TO SHAW STOCKING COMPANY, OF LOWELL, MASSACHUSETTS.

## IMPROVEMENT IN KNITTING-MACHINES.

Specification forming part of Letters Patent No. **218,458**, dated August 12, 1879; application filed  
March 7, 1879.

*To all whom it may concern:*

Be it known that I, BENJAMIN F. SHAW, of Cambridge, in the county of Middlesex and State of Massachusetts, have invented an Improved Knitting-Machine, of which the following is a specification.

This invention relates to knitting-machines of the cylindrical class, wherein the cams for operating the knitting-needles may be made to revolve continuously about the needle-bed to operate the needles to form a circular web, or may be made to reciprocate about a portion of the needle-bed and needles to knit a flat web, or to fashion a web, as in the production of heels and toes for socks.

In this embodiment of my invention I provide the machine with two suitable needle-actuating cams, one of which, when in place, operates the entire series of needles to produce a circular web, the other one operating only the needles employed in knitting the fashioned portion of the web, or that part of the web knitted when the machine reciprocates.

The number of fashioning-needles selected for operation at each reciprocation of the machine is determined by a Jacquard pattern, and in connection with the Jacquard pattern is employed a second pattern device, to indicate the number of revolutions and of reciprocations of the machine, and consequently the lengths of the circular and the fashioned portions of the web.

The cams in the machine are so made and placed with reference to each other that the cam to move the needles for circular knitting can be put into or out of action while the machine is in full operation, thereby permitting the machine to be automatically changed from circular to fashioned work, and vice versa.

The toothed gear or wheel that directly engages and operates the cam-carrying frame is driven at times through a rack, the machine being then reciprocated for fashioned work, and at other times by a spur-gear, the machine then being rotated and knitting circular web; and the rack and the spur-gear are so arranged and combined with this toothed gear that as the teeth of one are moving from, the teeth of the other are entering between, the teeth of the

toothed gear. In this way there is no point of time during which the toothed gear is not positively engaged by either the rack or spur-gear, or both.

The engagement of the rack (moved at a varying speed by a crank) with the toothed gear is accomplished just before, at, and just after a point of time during which the rack and toothed gear move in the same direction and substantially at the same speed. In this way it will be observed that the change from rotary to reciprocatory motion, and vice versa, is effected when the machine is in full operation, and without any interruption whatever in the application of the moving power to the operation of the knitting-cams.

With the mechanism herein described for rotating and reciprocating the knitting-cams, it is impossible for the parts to become disarranged as to time or relative working position owing to momentum, inertia, or friction.

It will be observed that an ordinary clutch device wherein the shifting-sleeve is disengaged from one gear at one end of it before it is engaged with the gear at the other end of it could not be made to operate practically or successfully a machine substantially such as herein described, for, by reason of momentum, inertia, or friction, the gears alternately engaged by the shifting sleeve would slip and disarrange the harmonious action of the parts with reference to the production of the fashioned portion of the web.

In the machine herein described the cams are arranged to operate several needles at once instead of a single needle.

If the machine were arranged to operate one needle at a time, then the cam, having a pitch sufficient to operate the needle the required distance, would have to be placed with reference to the butts of the needles, so that its base would be included between the butts of adjacent needles, this being necessary to complete the stitch, and consequently it would be impossible to knit a web of sufficient closeness any size for an ordinary stocking fabric on a machine where straight needles reciprocated in a cylindrical path.

To enable needles operated one by one to be placed sufficiently close in a cylinder to pro-



duce a practical stocking-web, it would be necessary to operate such needles through long levers or arms interposed between the needles and cams, the cams in such case engaging the outer ends of the radial levers, such levers being separated at such ends far enough to permit the base of the cam to be included between the ends of adjacent levers. Such a construction of a machine employing, as do practically operating cylindrical machines, from one hundred to two hundred and fifty needles would necessitate the extension of the radial levers—say, in a two-hundred-needle machine—about five feet from the needle-cylinder, and unless the machine were operated very slowly the downward draft of the needle upon the yarn would be so rapid as to break loops.

In this machine the changes in selecting a greater or less number of needles, for widening or narrowing, are made at the end and beginning of the crank-strokes, when the movement of the cam-carrying frame is substantially at its slowest speed.

In this machine the reciprocations are uniform in length, carrying the needle-operating cams clear beyond the greatest number of needles used in fashioning, while the length of each row of stitches is determined by the Jacquard. Were the length of the rows of stitches governed by the length of the reciprocations, rather than by the Jacquard, the length of the reciprocations would have to be varied in order to produce fashioned work.

If the machine were to knit with one needle, or a stitch-hook, at a time, the reciprocations would have to vary in length in order to narrow, and when the reciprocations vary in length the mechanisms for producing the reciprocations are necessarily more complex than when the reciprocations are uniform.

Figure 1 represents, in front elevation, the upper portion of a knitting-machine embodying my invention; Fig. 2 being a view of the front of the machine below the bed; Fig. 3, a left-hand end view above the bed, and Fig. 4 a like view below the bed. Figs. 5, 6, 7, and 8 represent details of cams to be referred to; Fig. 9, right-hand end of machine, under the bed; Fig. 10, a top view; Figs. 11 and 12, details of needle-slides and web-holders; and Fig. 13, a vertical section on line A A, Fig. 3.

The frame of the machine is of suitable shape to properly support the working parts, the knitting devices and needle-cylinder being placed, as herein shown, above a bed-plate, *a*, and the devices for reciprocating or rotating the cam-carrying frame and other parts about the needle-bed are placed below the plate.

The main shaft 2, driven in any proper way, has fixed at its end a pinion, 3, geared with a crank-bearing pinion, 4, of twice its size, and connected by a rod, 5, with the rack-bar or equivalent 6, adapted to be reciprocated upon a movable guideway, 7, to impart to the cam-carrying frame its rotary reciprocating move-

ments, this rod being preferably adjustably connected with the rack-bar, in this instance, by means of screws *i*. This guideway, in this instance, is pivoted at 8, to be moved or raised and lowered to engage the rack with, or to disengage it from, the teeth of the toothed gear 9, provided with bevel and straight teeth, the bevel-teeth 10 engaging the teeth of the bevel-ring 11, connected with, or forming part of, the frame that carries and moves the needle-actuating cams and web-holders.

The toothed gear 9 is the same in size as the crank-gear 4, and ring 11 the same in size as the pinion 3, in order that the actuating parts of the machine may always be in the same defined position with relation to each other when the change from rotary to rotary-reciprocating motion, or vice versa, is effected.

When the stocking is first commenced (if begun at the top of the leg, the needles then knitting a circular web) the cam-carrying frame is revolved continuously through the pinion 3 and a spur-gear, 12, attached to a sleeve, 13, provided with a cammed disk, 14, loose on shaft 2, but connected with pinion 3 through a pin, 15. This pin-connection permits the spur-gear 12 and its sleeve and disk to be moved longitudinally upon the shaft 2, to disengage it from, or to engage it with, the toothed gear 9, that operates the ring 11.

When it is desired to knit upon but a portion of the needles to form heels or toes, the cam-carrying frame is then to be given a rotary reciprocating motion. At the proper time to produce this change of motion a projection or suitable pin, 16, on a pattern-chain or equivalent, 17, (see Fig. 2,) lifts one end of the shifting-lever 18, thereby depressing its other end, provided with two oppositely-inclined cams, 19 20. (See Figs. 2 and 4, and detail Fig. 8.) This change of position of the lever brings the cam 19 in position to be struck by the cam-projection or stud 21 upon the cam-disk 14, thereby moving the disk, sleeve, and spur-gear 12 toward the pinion 3 and out of engagement with the toothed gear 9. This cam-disk is suitably connected with a lever, 22, the lever, in this instance, being forked and embracing the edge of the disk. The lever is connected at its forward end with a cam-bar, 23, suitably shaped to operate a lifting-bar, 24, on which rests the guideway 7. As the disk is moved laterally, as described, the lifting-bar, through the lever 22, lifts the guideway, and engages the rack with the teeth of the toothed gear, this engagement of the rack with the toothed gear and the disengagement of the spur-gear 12 from the toothed gear 9 being simultaneous; or, in other words, the teeth of the rack commence to engage the teeth of the toothed gear as the teeth of the spur-gear commence their movement for disengagement, thus preventing the slipping of a single tooth, which would disarrange the operation of the machine and render it worthless.

The spur-gear 12 is moved with a regular speed with relation to the speed of the main shaft; but the rack-bar, being actuated by a crank, is moved at a varying speed, sometimes faster and sometimes slower; but at a certain point of time the speed and direction of movement of the teeth of the gear 9, operated, it may be, by either the rack or the spur-gear 12, coincide, and just before, at, and just after this point the toothed gear is engaged with the rack and disengaged from the spur-gear 12, or vice versa. This change of source of motion for the toothed gear 9 during the time that the speed of the toothed gear and rack are alike, and when they are moving in the same direction, is a very essential element of this invention, and the devices employed to accomplish this result may be applied in other classes of machines wherein it is desired to produce a similar change of motion.

The operative length of the crank 90, on the crank-carrying pinion 4, will depend upon the length of the reciprocations it is desired to give the cam-carrying frame through the attached ring or gear, the length of these reciprocations depending upon the greatest number of needles employed to knit heel or toe or a flat web for shaped or fashioned work other than a plain cylindrical web.

Connected with the lever 22 is a lever, 25, pivoted at 26, and connected with a tripping device composed of two reversely-inclined cam-surfaces, 27 28. (See Fig. 3, and dotted lines Fig. 1.)

When the machine is knitting round and round the tripping device is in its outermost position, the cam 28 then resting immediately below the cam-slide 29. (Shown clearly in section in Fig. 13.) When the tripping device was first brought to this position the cam 28 acted upon the cam-slide 29, and lifted it, as shown in Fig. 13, and the cam-face 30 thereon, moved forward the circular-knitting cam 31, its horizontal portion being slotted, as at 32, to permit the passage of a rod, 33, having a foot-piece, 34, to be hereinafter described.

When the change of parts to engage the rack with the toothed gear 9 takes place, this tripping device is thrown inward through the lever 25, thereby placing the cam 27 in position to be struck by a toe, 35, at the lower end of the cam-slide 29, drawing it down and permitting the springs 36, Fig. 5, to move the cam 31 backward out of operative position.

The butt of the arrow-cam 37 ceases to control the end of lever 38 just as the disk 14 is moved toward the pinion 3, and as the disk is so moved the point of the arrow-cam is placed in such position that it, as the cam rotates, will engage the end of lever 38 at its opposite side, thereby moving the lever, and it, through its links 39 40, (see Fig. 2,) moves the wings 42 from the positions shown in Fig. 10, where they are inoperative so long as the machine knits round and round to a position nearer the ring 11 and in the path of foot 34, and of the

lower end of the unlocking-slide, composed of two parts, 43 44, connected loosely together by a pin and slot, as at 45.

When the change is to be made from reciprocating to circular knitting, the cammed portion 21 of the disk 14 meets the inclined cam 20 at the end of lever 18, (the lever not then being operated upon by the projection 16 of the chain,) and moves the disk, sleeve, and spur-gear 12 laterally, throwing the latter into engagement with the toothed gear 9 and disengaging the rack. This movement of the disk places the arrow-cam in position to operate upon the other side of the lever 38 and turn the wings outward, and at the same time the tripping-cam is thrown outward.

The part 43, beveled at its lower end in opposite directions, as the cam-carrying frame reciprocates, meets the cam portion 46 of the wing 42, and is lifted by it. The part 44 is also lifted, and it, through its inclined slots 47, fitting pins 48, is moved laterally, forcing the catch 49 from one of the notches at the edge of a bar, 50.

The catch 49 is pivoted on the block 51, that carries the cam 52, that operates the needles during the time that the cam carrying frame reciprocates, such cam moving on a guide-rod, *l*. Immediately after the catch is unlocked from the bar 50, a projection, 53, on the foot 34 enters an inclined groove or way, 58', at the inner side of the wing, (see dotted lines, Fig. 1,) and as the pin moves through or in such groove at the end of the stroke of the cam-carrying frame, and then immediately back through such groove, the rod 33 is raised, and then immediately lowered as the frame moves back. This rod 33 is connected, by means of the piece 33', with a bar, 55, provided with two series of ratchet-teeth, the one series the reverse of the other.

A pin, 58, supported by the block 51, serves to support centrally a two-ended reversible pawl, *x x'*. (See Figs. 1 and 7.) This pawl has projecting from it at one side a finger, provided with a heart-shaped cam-projection, *c'*, against which is pressed a holding-lever, 59, operated upon by a spring, 60, the holding-lever pressing upon one or the other side of the point of the heart, keeping the double-ended reversible pawl in such position that one or the other of its ends, as desired, will be held in position to engage its row of ratchet-teeth. When the end *x'* of the reversible pawl is in position to be engaged by one of the teeth of its series of teeth 57, then, as the bar 55 and the series of teeth 57 are raised, the cam and block 52 51 are also lifted the distance of one tooth. The bar 55 is now lowered, as the rod 33 is pulled down by the wing on the reverse motion of the frame, and the springs 61 then lower or pull down the unlocking-slide 43 44 as it slips from the wing, this change of position of the slide permitting the catch 49 to enter a notch next above the one just occupied by it in the bar 50.

When the machine is operated to knit round and round the cam 31 is pressed forward, it then moving the needles, and at the same time, in this embodiment of the invention, the cam 52 is also in position, engaging the needles that at some stages are operated to knit when the cam-carrying frame is reciprocated; but this cam 52, while knitting round and round, is not then considered the operative cam, for during the time that such cam is moved past the needles employed to knit the front of the stocking it does not raise such needles.

Fig. 11 shows one of the needles employed, in this instance, for knitting the front of the stocking, such needles never being operated by cam 52. This needle, Fig. 11, is shown as provided with two projections, *d*, between which the cam operates.

The Jacquard needles, or the needles to be operated in fashioning the fabric, as when the cam-carrying frame reciprocates, are provided with additional projections *e*, the arrangement of which upon the needles indicates or determines the needles that are to be lifted during the reciprocations of the cam-frame, and consequently the form or outline of the web to be produced. These projections constitute one form of Jacquard, and a most simple form, wherein the Jacquard projections are part of the needles; but these projections may be otherwise placed, and caused to determine the selection of the fashioning-needles that are interspersed in the cylinder between the plain needles for round-and-round knitting, without departing from my invention; or, in other words, these Jacquard projections may be carried otherwise than directly by the needles.

I do not desire to limit the claims hereinafter made to the exact form of Jacquard shown and described; for, instead of it, I may use any other well-known form of Jacquard adapted, in a circular-knitting machine of the kind described, to select certain of the needles for fashioning the web. The number of these projections will vary with the number of needles being used and the form desired to be given to portions of the web.

The cam 52, for operating these Jacquard needles as the cam-carrying frame reciprocates, engages between some of the additional projections *e*; but in this construction I narrow the web only to such an extent that at the narrowest portion of the web the cam 52 bears against the upper portions of, and holds in position the lower ends of, enough of the Jacquard needles to permit the cam 31, when pressed forward, to slip into operative position.

It will be observed that the cam for operating the needles when knitting round and round and the second cam for operating the Jacquard needles have their apices upon the same radial plane projected through the axis of the cylinder, and that the tripping-up device is placed in a radial line intersecting the center of the cylinder and the central needle of

the set of Jacquard needles; consequently, when the cam for knitting round and round is moved into operative position, the other cam, 52, then acts to place the projections *d d* in proper position to receive it. This change of cams, necessary to be made when the machine is changed from round-and-round to reciprocating knitting, or vice versa, is made while the machine is in motion, and in accordance with the pattern-indications 16 on a chain or equivalent pattern-surface, the change being made when the machine is moving in the direction that it turns when knitting round and round.

The pattern-chain 17, in this instance, supported on a curved rest, 62, (see Fig. 2,) is moved by a dog, 63, the point of which engages a link of the chain. This dog is connected with a lever, 64, operated in one direction by a lug, 65, on the rack 6, and in the opposite direction by a spring, 66. The dog is held up in contact with the chain by a spring, 67.

The web-holders 68, Figs. 11 and 12, are steel plates, each provided with a lug, *f*, a point, *g*, and a tail, *h*. These web-holders are fitted in radial grooves in an annular holder-bed, 69, attached by set-screws to the upper part of the needle-bed, the holder-bed being, in this instance, grooved upon its under side, to permit the lugs *f* to project far enough to be engaged by a cam, 70, at the upper end of the cam-carrying frame, such cam moving the web-holders radially. There is a web-holder to each space between the needles; and the acting surface of the cam 70, with its center in the same radial plane with the apices of the knitting-cams, is made sufficiently long to throw the holders in advance of the rising needles and hold them there until after the needles complete their descent. As the needles descend they draw the thread down over the holders, the holders being in the position with relation to the needles as shown at the left of Fig. 13, the partially-formed loops then resting back of the points *g*, the yarn connecting the series of loops last formed then being held by the points *g*, that prevent the web from rising or following the needle. The tails *h*, turned down as indicated, prevent the holders entering the web as they are moved forward. Upon the retraction of the web-holders the points *g* pass out from under the yarn just drawn over the web-holders, the yarn, as it passes the point *g*, contracting upon the tail of the holder in position to be caught by the point *g* as the web-holder is again advanced, the points holding the web, as before described.

A take-up for the yarn is necessary when the cam-carrying frame is reciprocated to operate the Jacquard needles. The take-up herein shown is composed of two fingers, 71 72, pivoted on a stand, 73. When the machine knits round and round the fingers are separated and do not take hold of the yarn, it being led through a hole, 74, to the yarn-guide

75, the upper finger being then held up by a support, 76, resting on arm 77; but when the machine knits with a reciprocating motion the fingers at the commencement of each reciprocation are closed upon the yarn through the action of a crotch-bar, 78, attached to a carriage, 79, provided with a rest, 80, which, as the carriage 79 is moved, operates upon the curved portion of the lower finger, 72, and lifts the fingers, causing them to close upon and take up the slack of the yarn. This carriage is moved alternately by one and then by the other of two pins, 81, attached to the top of the cam-carrying frame, such pins engaging the notch at the end of lever 78. This lever is held in contact with the frame by a spring, 82.

Looking at Fig. 10, (supposing the frame to be moving in the direction of the arrow at the left,) the side of the lever 78 rests against one of the pins 81, and so long as the frame moves in a circular direction the pin will not engage the crotch; but when the frame is reversed, that one of the two pins which leads engages the crotch, carries it backward, and operates the carriage 79 and take-up. The crotch-lever 78 is carried by the pin past the central line, A A, Fig. 10, and then the spring 82, changed as to its position and expanded, draws the crotch-lever and carriage forward and lowers the take-up, thereby freeing the thread. In this position the crotch-bar will be engaged by the other pin as the cam-carrying frame is moved in the opposite direction, and it will be again moved to the position shown in Fig. 10.

It will be understood that the pins will pass beyond the end of the crotch-lever at each reciprocation of the frame before the reverse movement takes place.

The thread is delivered to the needles by the thread-guide 75, the needles rising and falling with relation to such guide-opening as in ordinary knitting-frames. When knitting round and round, the cam 31 is, as before described, considered as the knitting-cam, it engaging all the needles and operating them as usual for circular work, the needles left down by the cam being held down until again lifted by the cam through the action of a guide, 83, extending around the cylinder in each direction from the cam 31. Supposing the stocking to have been commenced at the top of the leg, the pattern-chain will be properly set at the time the knitting is commenced to govern the length of the uniform cylindrical portion of the web for the leg. In this instance two courses are knit to each of the links of the chain.

When the plain links indicating the length of the leg portion have passed the operative point of lever 18, then the first of a series of projections, 16, placed on the chain to indicate the time at which the machine is to be reciprocated to fashion the web, meets and operates the lever, as before described, causing the reciprocating rack to operate the machine,

bringing the wings and tripping device into proper position at the proper time, as before described, to throw out of operation the cam 31, and to operate the unlocking device and rod 33 and bar 55, with its double set of ratchets, so as to enable the Jacquard cam to come into operation to produce the form indicated by the Jacquard pattern. The machine continues to reciprocate so long as the projections 16 continue to engage the lever, there being one back-and-forth movement of the cam-carrying frame for each projection. The number of projections is varied to correspond with the length of time it is desired to operate the frame with a reciprocating motion; and the number of projections on the chain is, in this instance, one-half in number of the Jacquard projections *e e*, arranged upon or in connection with the needles having the greatest number of such projections, the three bottom projections, *d*, on the Jacquard needles not being operated by the Jacquard cam.

At the completion of each stroke of the cam-carrying frame the Jacquard cam is lifted one notch, so that it may operate, during each of its successive strokes, fewer and fewer needles, until the web is narrowed or fashioned as indicated by the Jacquard pattern, that indicates the number of needles to be operated at each stroke of the cam-carrying frame.

When the cam 52 operates a number of needles corresponding with the narrowest portion of the web, as indicated by the Jacquard pattern, the machine, as constructed in this instance, owing to the absence of projections 16 on the chain, resumes round-and-round knitting for four courses, (but the pattern may be altered to give more courses,) the Jacquard cam moving in the same path that it did when the narrowest portion of the web was being knitted.

At the last downward movement of the unlocking device 43 44, and just before the cam 52 was locked preparatory to operating the least number of needles, a hook, 83, on the part 44 engaged an arm, 84, connected with the two-ended pawl *x x'*, and, pulling down such arm, reversed the position of the pawl, putting it in position to permit the portion *x* of the pawl, upon resuming the reciprocating knitting, to be engaged by the series of ratchet-teeth 56, adapted to move the cam 52 downward during the widening operation of the Jacquard needles, which is to succeed the narrowing operation. This cam is lowered a notch at the beginning of each stroke by the devices before employed to raise it, except that the series of ratchet-teeth 56 operate instead of the series 57. The cam in this way is made to automatically operate a gradually-increasing number of needles, corresponding with the Jacquard pattern, for the shaping of the web, until the widest portion of the fashioned portion is being knitted, when the round-and-round knitting is again resumed, the mo-

tion of the parts being changed by the absence of a projection, 16, upon the chain. This narrowing and widening operation produces a protruding fashioned portion suitable for the heel of a sock. The circular courses between the narrowing and widening may be omitted, if desired, by making the series of projections 16 continuous rather than broken, as shown in Fig. 2.

When the tripper, after the widening operation, operates the cam slide 29 to throw the cam 31 into position for the resumption of round-and-round knitting, a stem, 85, on the cam-slide meets the arm 84, and again reverses the two-ended pawl, placing it in proper position to cause the cam 52 to narrow the web when reciprocating knitting is again resumed. The round-and-round knitting then progresses for a certain distance, indicated by the pattern-chain, far enough to form the cylindrical foot-part, and then the narrowing and widening are again repeated to form a protuberance or fashioned portion, as before described, suitable for the formation of a toe, the web being preferably fashioned by the introduction of two round-and-round courses immediately following the narrowing operation. After the completion of the toe the machine is automatically caused to resume round-and-round knitting for the leg portion of another sock, this operation producing a web with protuberances or fashioned portions projecting from but one of its sides, suitable for heels and toes, these protuberances being separated by cylindrical portions of proper or suitable lengths for the legs and feet. The toe is finished by severing the web on that line of stitches connecting the widened portion of the toe and the foot part with the leg part, and then the widened portion of the toe, so severed, is brought up and united, in any usual way, with the top of the foot part just severed from the leg of the stocking with which these parts were connected.

The stocking, in this instance, has its line of closure across the upper portion of the toe, and is such a stocking as is described in Patent No. 64,154, granted to me April 23, 1867.

By this machine the stocking may be knitted and cast off singly, or be made in the connected form described.

If desired, the stocking may be commenced at the toe, and to do this the narrowed portion will be first knitted upon the needles and then the widened portion. At the completion of the widening operation, the loops composing the last widened row are held on the needles which formed such loops, leaving an equal number of loops on the opposite edge of the web, but not held by needles, such loops being those first knitted.

Now the machine is stopped and the needles then unoccupied by loops (substantially one-half the number of needles in the machine) are then lifted together, or *en masse*, by means of levers 86, pivoted on stands 87, and connected with, and so as to operate or lift a portion of, the guide 83, corresponding in length with

the space occupied by the needles to be lifted. These vacant loops are then placed upon such needles, the needles are returned to their positions, and round-and-round knitting is begun for the production of the foot, the machine continuing automatically to form the foot, the heel, and the leg, when the yarn is broken and the work cast off.

In a machine constructed substantially as above described, and employing web-holders, as set forth, the work may be set up without first placing upon the needles portions of a fabric already formed, as is commonly done in knitting-factories, and without winding yarn about needles, as practiced in some cases, and without the use of a so-called "setting-up device," employing hooks.

When starting the work, the latches being open, it is only necessary to place the yarn in the yarn-guide, so that it will be taken by the needles. Upon the first revolution of the machine the yarn is drawn down over the longest portions of the web-holders, upon the second revolution of the machine the partially-formed loops are held from rising by the points *g* of the web-holders, and on the third revolution of the machine the second row of partially-formed loops is held by the points *g*, and so on, so that the knitting proceeds without any unravelling. The web-holders are held in place by a top plate, 88. The ring 89 serves to hold the needles in position in their grooves. The holder-bed 69 and the top of the needle-bed, which latter serves as the knocking-over bar, are made adjustable, so that the loop formed may be longer or shorter. The web-holders, acting substantially as described, render unnecessary the employment of friction-rolls, or equivalent mechanism, usually employed to produce the necessary tension on and take-up of the slack of the web, and these web-holders, so acting, are specially beneficial in connection with a machine for the production of a fashioned web, as described.

If desired, the machine may be made to produce what is known as a "square heel." To do this in the machine the chain 17 would be provided with a continued series of projections, 16, sufficient in number to produce a parallelogrammic flap of the desired size. Then, upon the first reversal of motion the machine would be stopped, and the two-ended dog would be placed by hand so as to escape the ratchet-teeth, and then the machine would thereafter operate a fixed number of the Jacquard needles until the flap is of the length indicated by the chain. The double-ended pawl will then be replaced by hand and the Jacquard cam lowered one notch, when circular knitting is resumed for the foot. The web so produced is left with an opening at each side. The bottom of the foot portion then joined to the bottom of the heel is to be separated from it, and the raw and selvage edges remain to be united, as will be readily understood, by hand.

In an earlier machine using stitch-hooks the

reciprocations were varied to govern the length of each row of stitches, and a stocking-web was knitted having introduced at opposite sides, at certain intervals, a series of rows of loops, each row gradually decreasing in length. Such portions of the web were intended to serve for heel and toe portions; but such a machine did not produce a protuberance consisting of a narrowed portion united to a complementary widened portion for the production of an ample and symmetrical heel and toe, such as is produced by this machine; and I am unaware of any machine to produce a web such as is produced by this, my improved machine, prior to the date of the patent heretofore granted to me and herein cited. This machine has been constructed in accordance with the idea that the heel and the toe of a stocking are substantially the same in form, and that it is only necessary to construct a set of appliances for the mechanical knitting of the one to have what is required for knitting the other. This involves, of course, the production of the heels and toes upon the same side of the tube.

The invention herein described might be embodied in a machine wherein the needle-bed revolved and the cam-carrying frame remained stationary.

I do not herein broadly claim the web-holders and the devices for operating them, for such web-holders form the subject-matter of another application for Letters Patent filed May 2, 1877.

I claim—

1. In a knitting-machine provided with a cylindrically-arranged series of reciprocating needles to produce tubular fabric, the combination, with the needles, of a cam to operate them for cylindrical or round-and-round knitting, and a second cam to operate certain of them to shape the fabric for heels and toes, substantially as specified.

2. A cylindrical bed, a circular series of independently-acting needles, and a cam to move the entire series of needles for round-and-round knitting, in combination with a Jacquard to determine the selection of needles, and a second cam to operate the needles indicated by the Jacquard when the machine reciprocates to form heels or toes, substantially as set forth.

3. A cylindrical needle-bed and independently-acting needles, a cam to operate the needles to knit round and round, a Jacquard to indicate and a cam to operate needles to produce a fashioned web, in combination with a pattern device and with mechanism to rotate or reciprocate the cams according to the requirements of the pattern, substantially as described.

4. A cylindrical bed, a series of independently-acting needles, a cam-carrying frame, a Jacquard to indicate and a cam to operate the needles indicated by the Jacquard, in combination with a reciprocating rack and a crank to operate it, the rack being adapted to recip-

rocate the cam-carrying frame about that part of the bed holding the fashioning-needles, to move the frame at a decreased speed at the end and beginning of each stroke, and to retain its positive engagement with the cam-carrying frame during the time that the frame is reciprocated, substantially as specified.

5. The combination, with a cam-carrying frame in a knitting-machine, of a reciprocating rack and a revolving spur-gear adapted to be alternately thrown into or out of operation, to impart to the needle-actuating mechanism either a rotary or a rotary reciprocating motion, substantially as described.

6. A toothed gear, in combination with a rack and a spur-wheel, each adapted to be alternately engaged with or disengaged from the toothed gear, and with mechanism to effect the engagement of the rack with the toothed gear while the spur-wheel is being disengaged therefrom, and of the spur-wheel with the toothed gear when the rack is being disengaged, to insure the positive operation of the toothed gear by either the rack or spur-wheel, substantially as described.

7. The combination, with the needles, of two cams, with their centers arranged in the same radial plane, whereby one of them is adapted to be thrown out of operative position when the fashioning-needles are to be operated, and into operative position when the machine is moved to knit round and round, substantially as specified.

8. A series of needles provided with a series of pattern-indicating projections, arranged to indicate the shape or figure to be knitted, in combination with a cam to progressively engage the series of projections, substantially as described.

9. The movable guideway and rack and crank, and toothed gear to be engaged by the rack, in combination with the lifting bar or device and mechanism to move the rack into engagement with the toothed gear, while the rack and toothed gear move in the same direction and at substantially the same speed, substantially as described.

10. The combination, with the wings, of the unlocking-slide, ratchet-bars, two-ended pawl and cam, and catch, to operate the cam and then hold it, substantially as described.

11. The ratchet-bars and rod, in combination with the wings, to move the rod and ratchet-bars, substantially as described.

12. The combination, with a needle-bed and two cams, of plain and Jacquard needles, constructed and adapted to operate substantially as described.

13. A needle provided with projections to be operated upon by one cam for round-and-round knitting, and with other projections to be operated upon by a different cam to give form or figure to the web, substantially as specified.

14. The combination, with the needles, of a guide to lift the needles to receive loops, substantially as described.

15. The movable tripping device, in combination with, and adapted to throw into and out of operation, the cam for round-and-round knitting, substantially as described.

16. The gear 3 and annular spur-gear, connected together as described, and the sleeve and disk and cam portion 21, in combination with a double cam-lever and pattern-chain, to move the spur-gear and sleeve laterally at the

times and for the purposes substantially as described.

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

BENJAMIN F. SHAW.

Witnesses:

GEO. W. GREGORY,

W. J. PRATT.