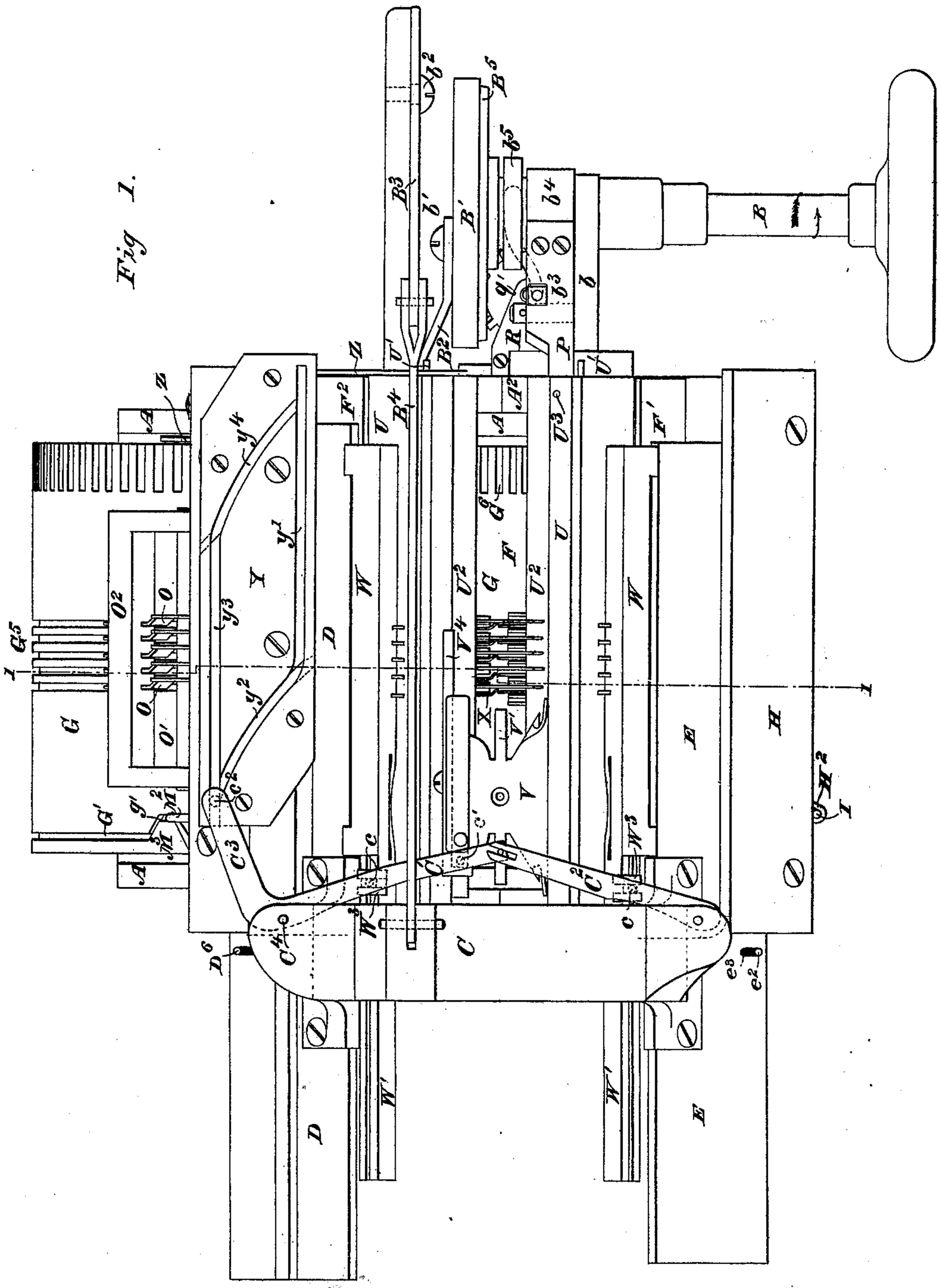
14 Sheets—Sheet 1.

J. NELSON.
Knitting-Machine.

No. 214,308. **Patented April 15, 1879.**

Fig 1.



WITNESSES

Wm A. Skinkle
F. Stich

INVENTOR

John Nelson.

By his Attorneys,

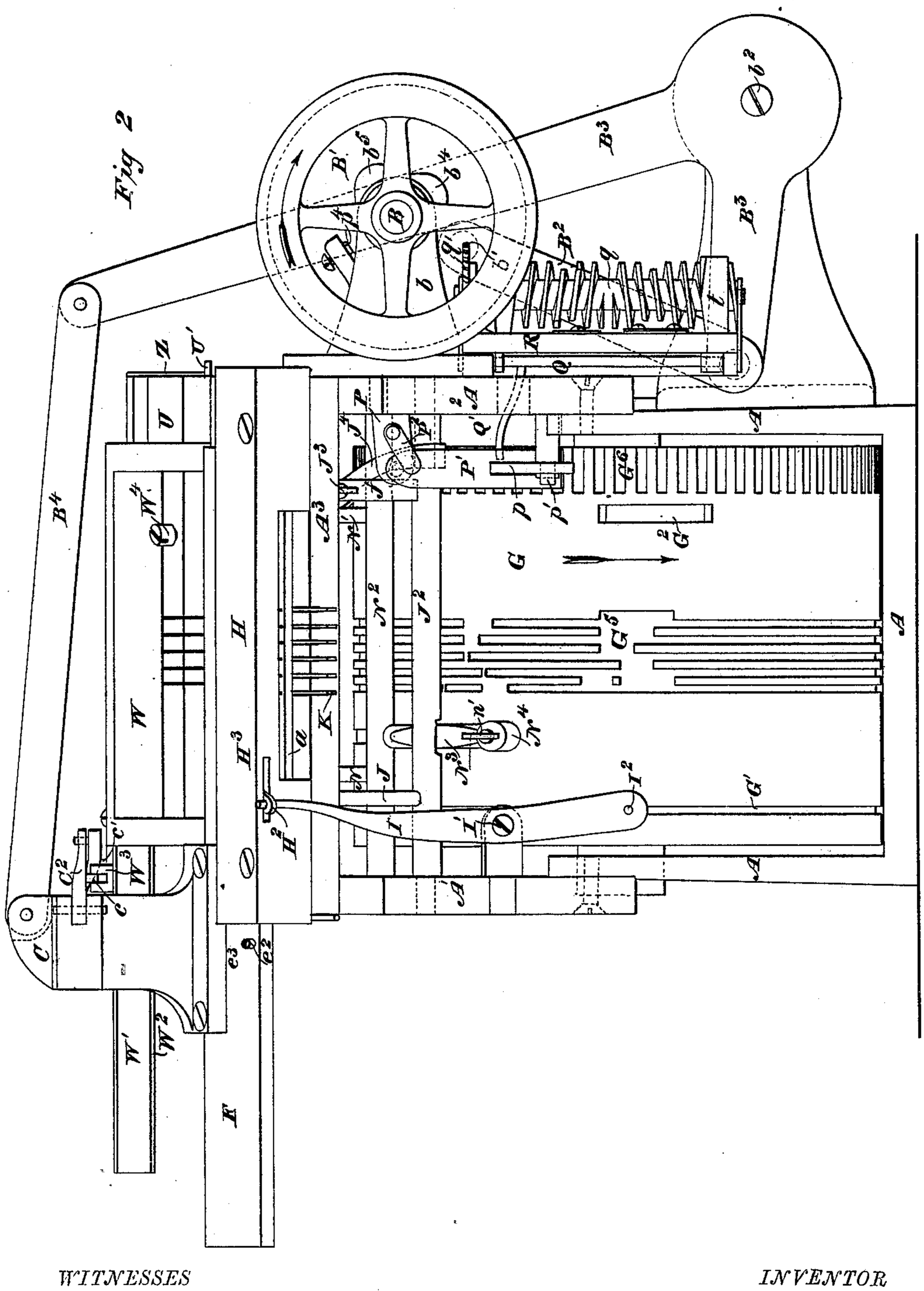
Baldwin, Hopkins & Peyton

14 Sheets—Sheet 2.

J. NELSON.
Knitting-Machine.

No. 214,308. **Patented April 15, 1879.**

Fig 2



WITNESSES

Wm A Skinkle

F. Stich

INVENTOR

John Nelson

By his Attorneys.

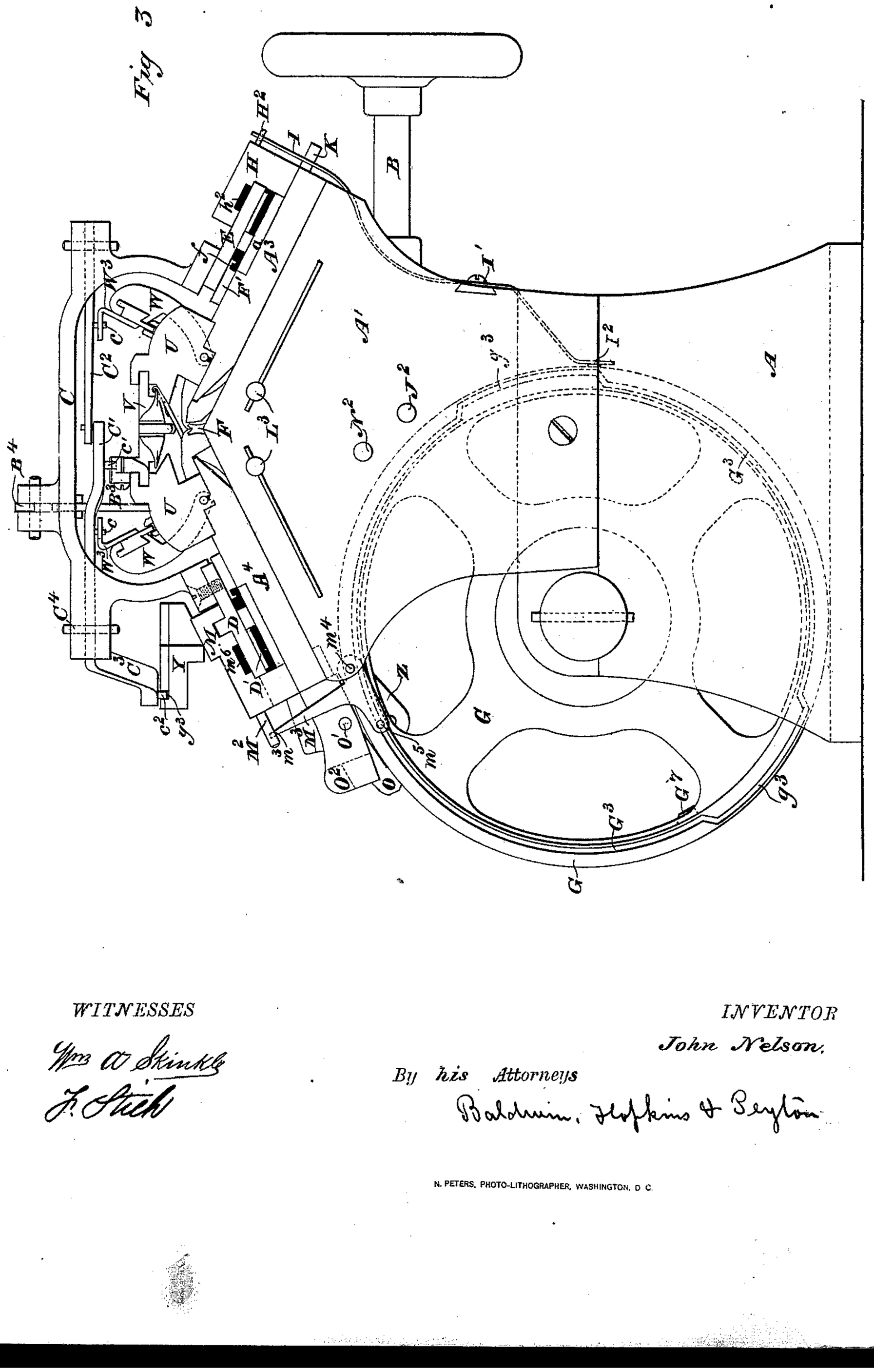
Baldwin, Hopkins & Peyton

14 Sheets—Sheet 3.

J. NELSON.
Knitting-Machine.

No. 214,308. **Patented April 15, 1879.**

Fig 3



WITNESSES

Wm A Skinkle
F. Stich

INVENTOR

John Nelson.

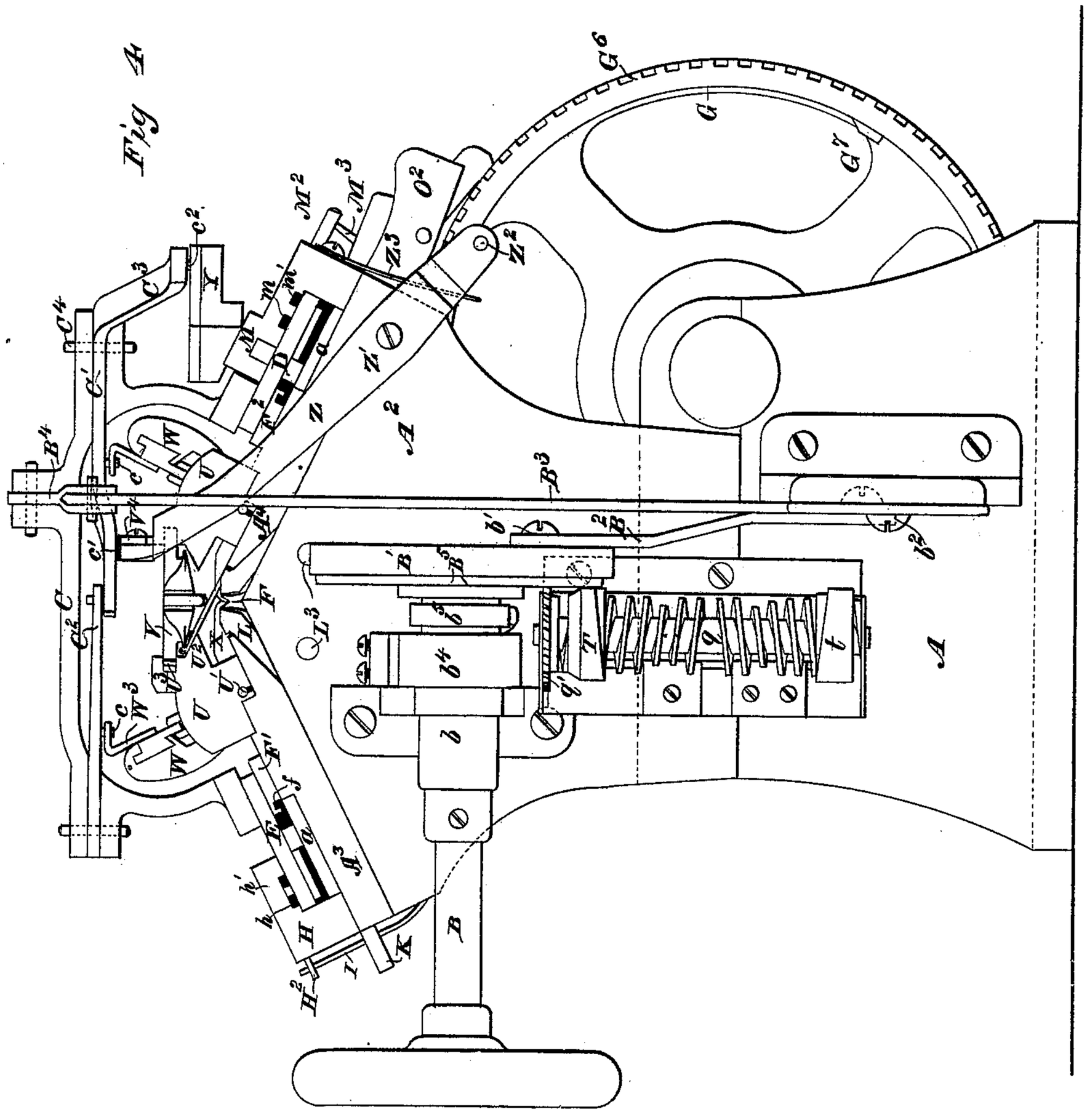
By his Attorneys

Baldwin, Hopkins & Peyton

14 Sheets—Sheet 4.

J. NELSON.
Knitting-Machine.

No. 214,308. **Patented April 15, 1879.**



WITNESSES

Wm A Skinkle
F. Stuck

INVENTOR

John Nelson.

By his Attorneys.

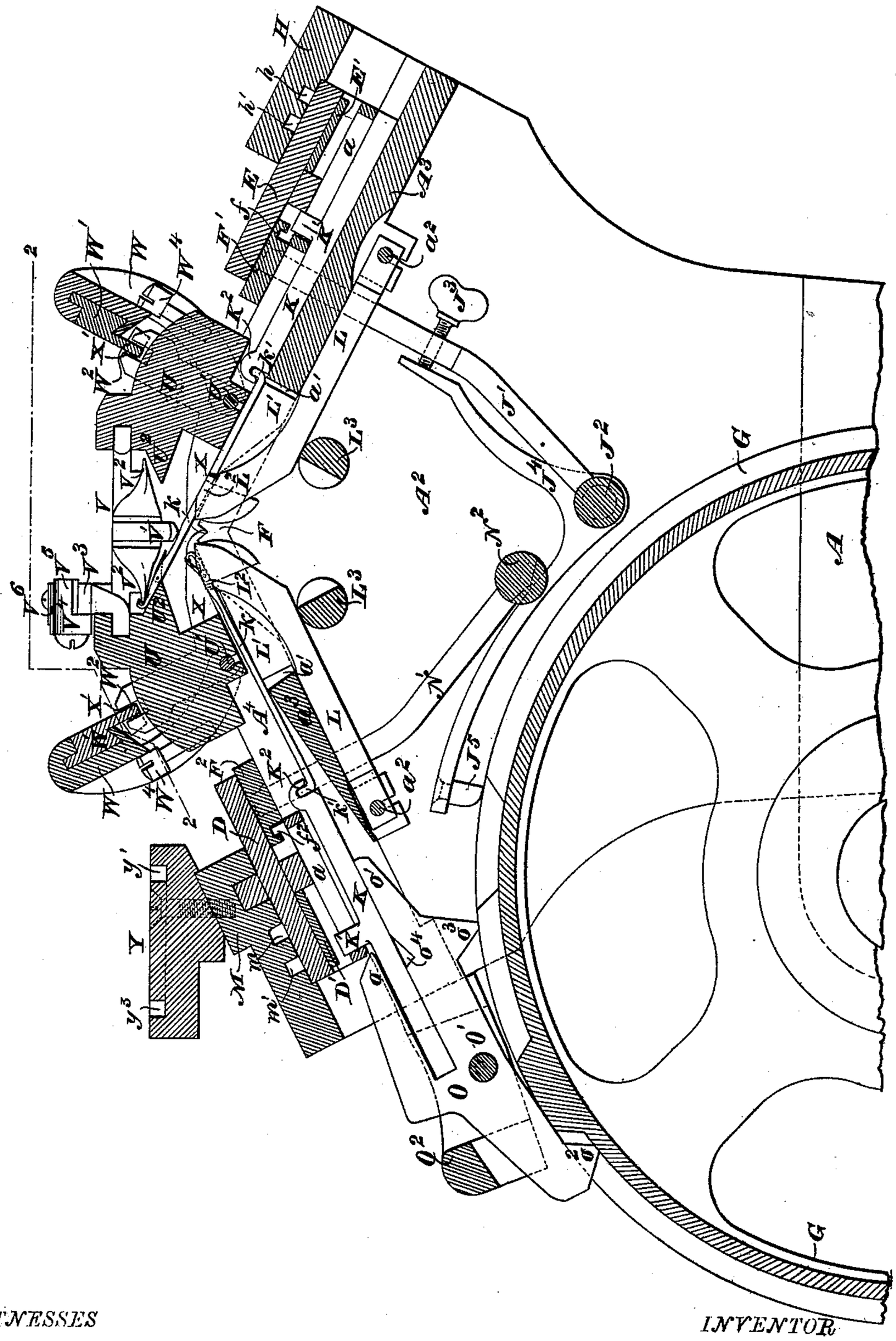
Baldwin, Hopkins & Peyton

14 Sheets—Sheet 5.

J. NELSON.
Knitting-Machine.

No. 214,308. Patented April 15, 1879.

Fig 5.



WITNESSES

Wm A Skinkle
F. Smith

INVENTOR

John Nelson.

By his Attorneys

Baldwin, Hopkins & Peyton

14 Sheets—Sheet 6.

J. NELSON.
Knitting-Machine.

No. 214,308. Patented April 15, 1879.

Fig 6.

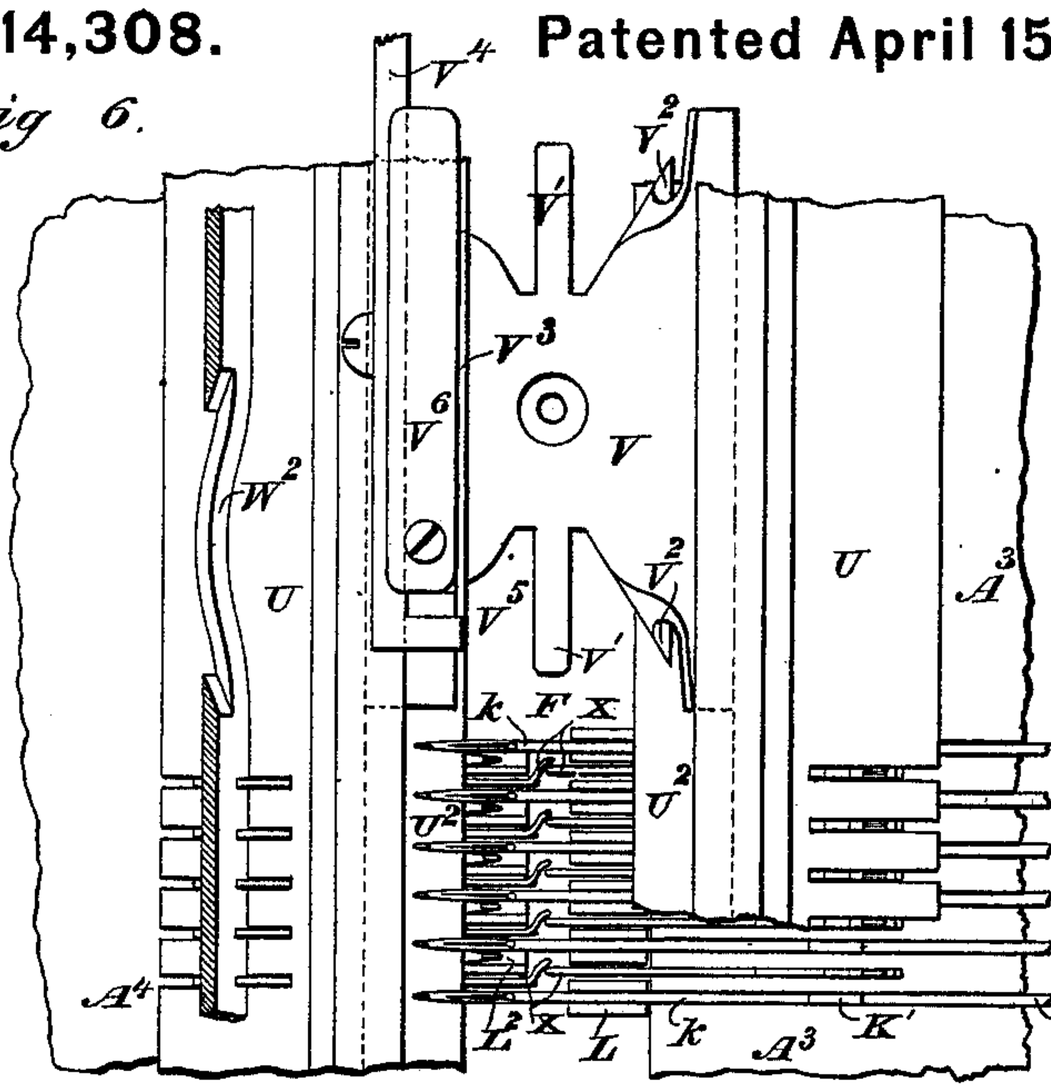


Fig 7.

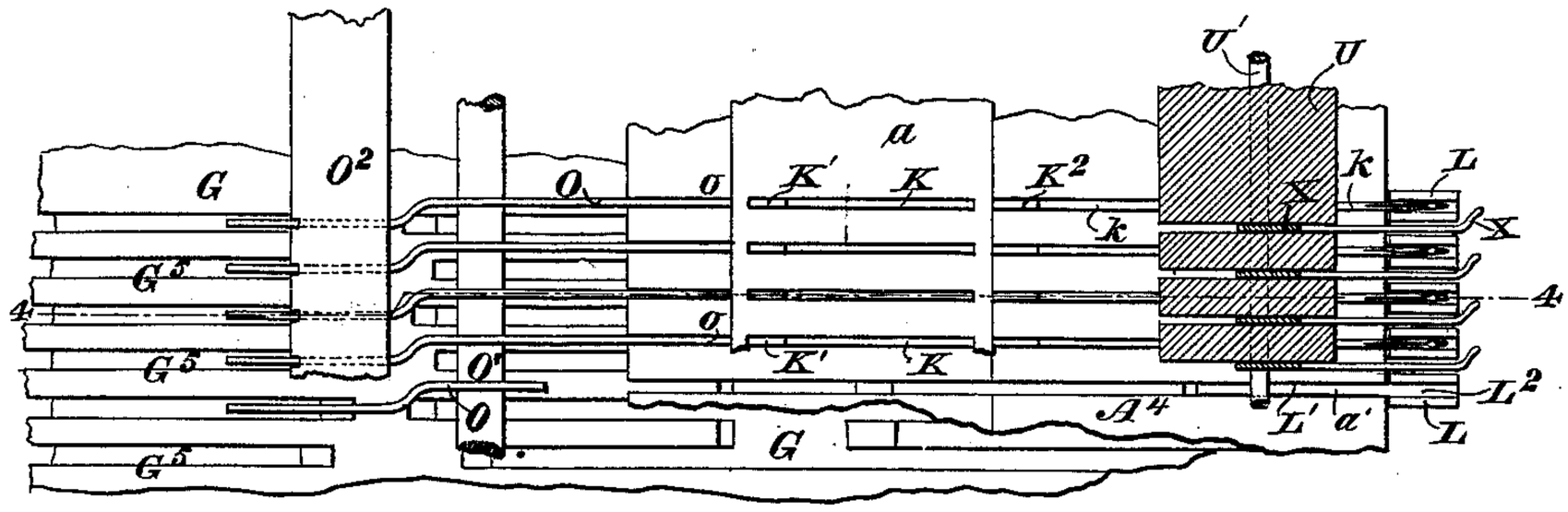
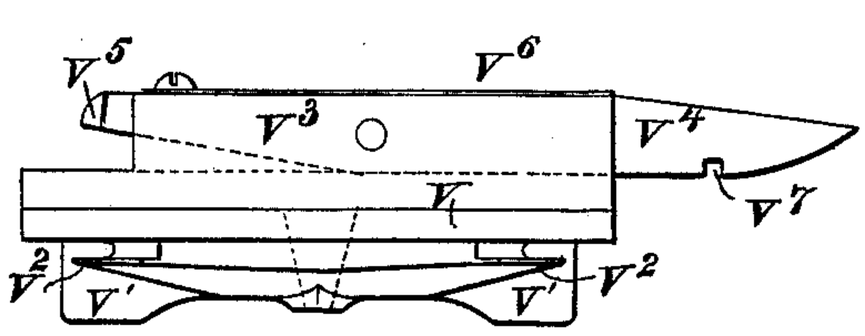
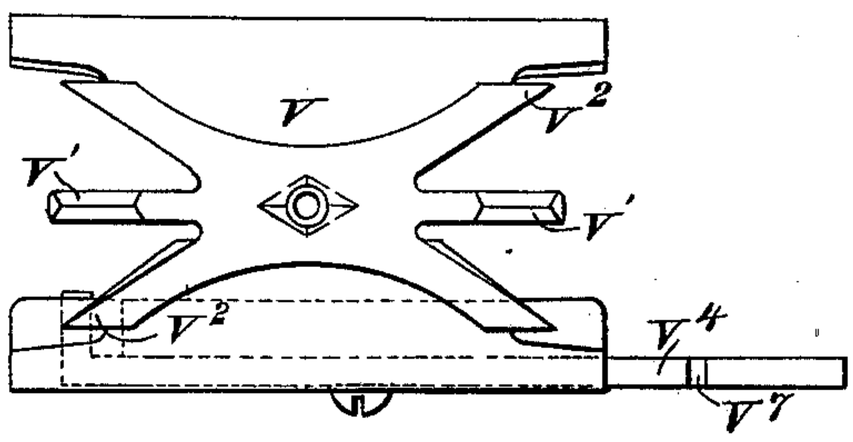


Fig 8.

Fig 9





WITNESSES

Wm a Skinkle
F. Stieh

INVENTOR

John Nelson.

By his Attorneys.

Baldwin, Hopkins & Peyton

14 Sheets—Sheet 7.

J. NELSON.
Knitting-Machine.

No. 214,308. Patented April 15, 1879.

Fig 12.

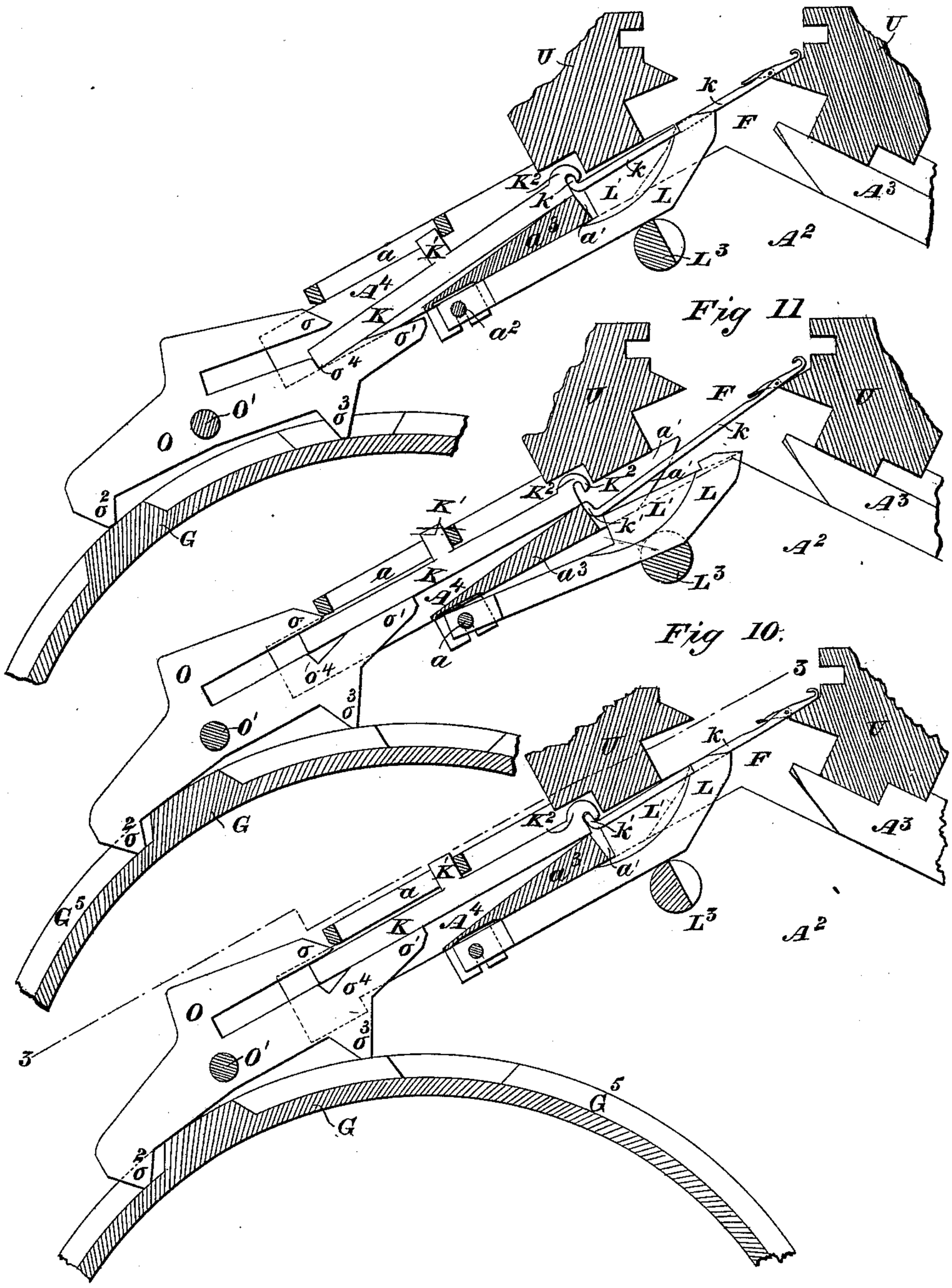


Fig 11

Fig 10.

WITNESSES

Wm A Skinkle
F. Smith

INVENTOR

John Nelson

By his Attorneys.

Baldwin, Hopkins & Peyton

14 Sheets—Sheet 8.

J. NELSON.
Knitting-Machine.

No. 214,308. Patented April 15, 1879.

Fig 13

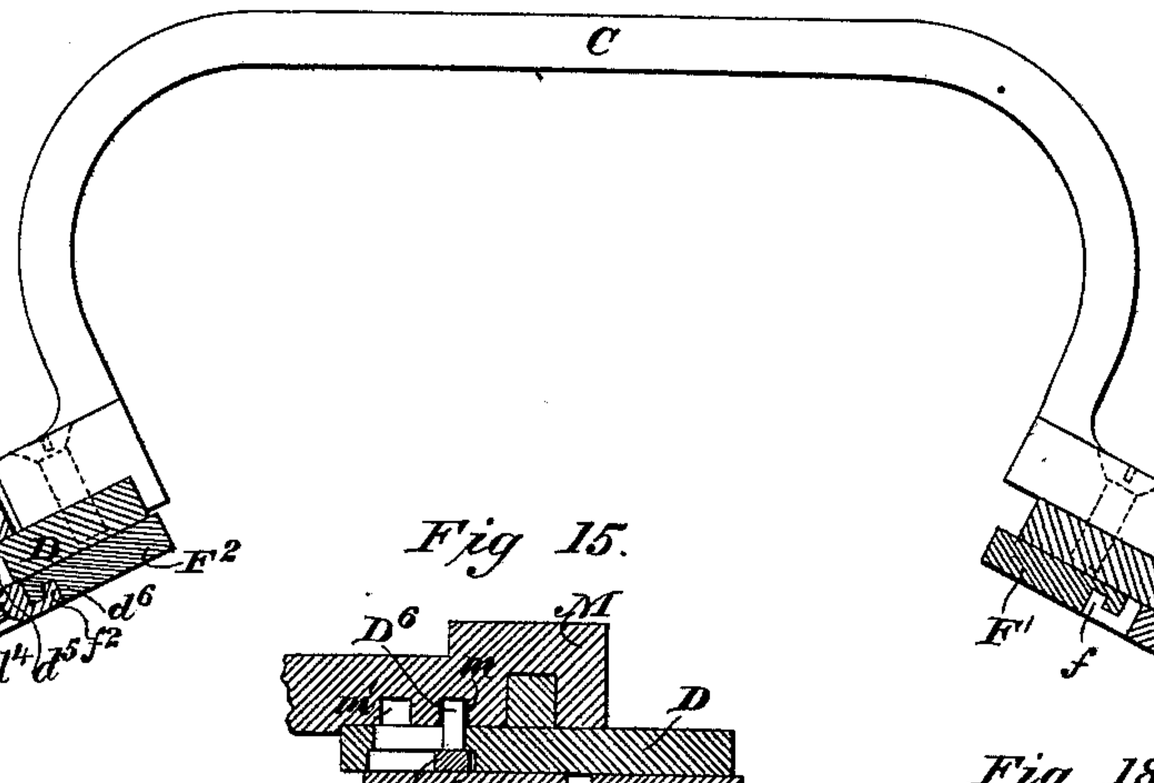


Fig 14.

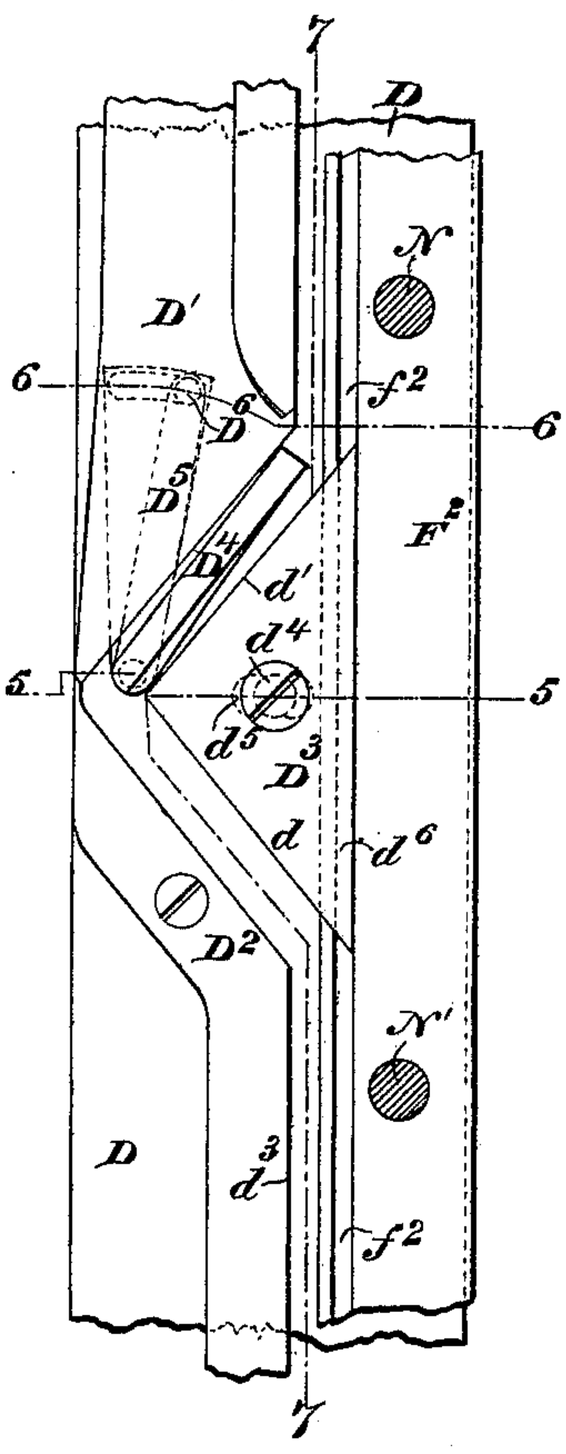


Fig 15.

Fig 16.

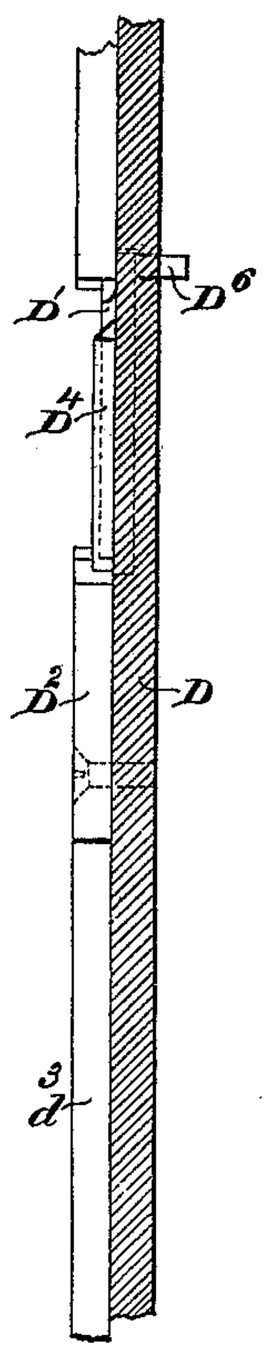


Fig 17.

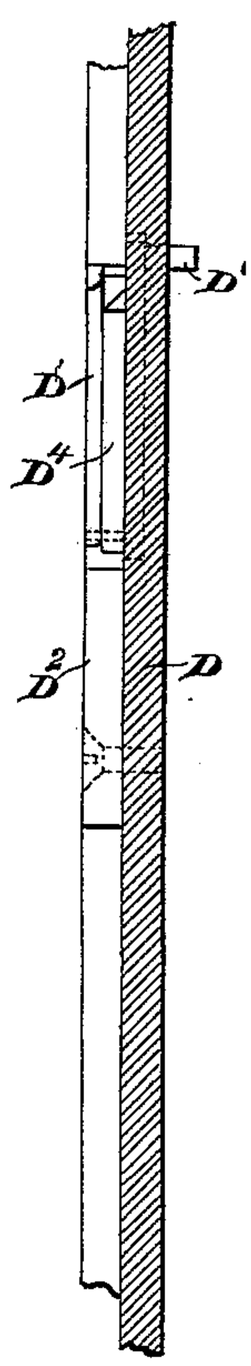
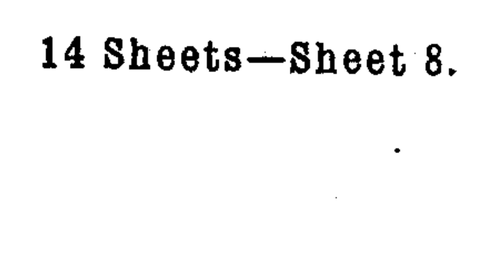
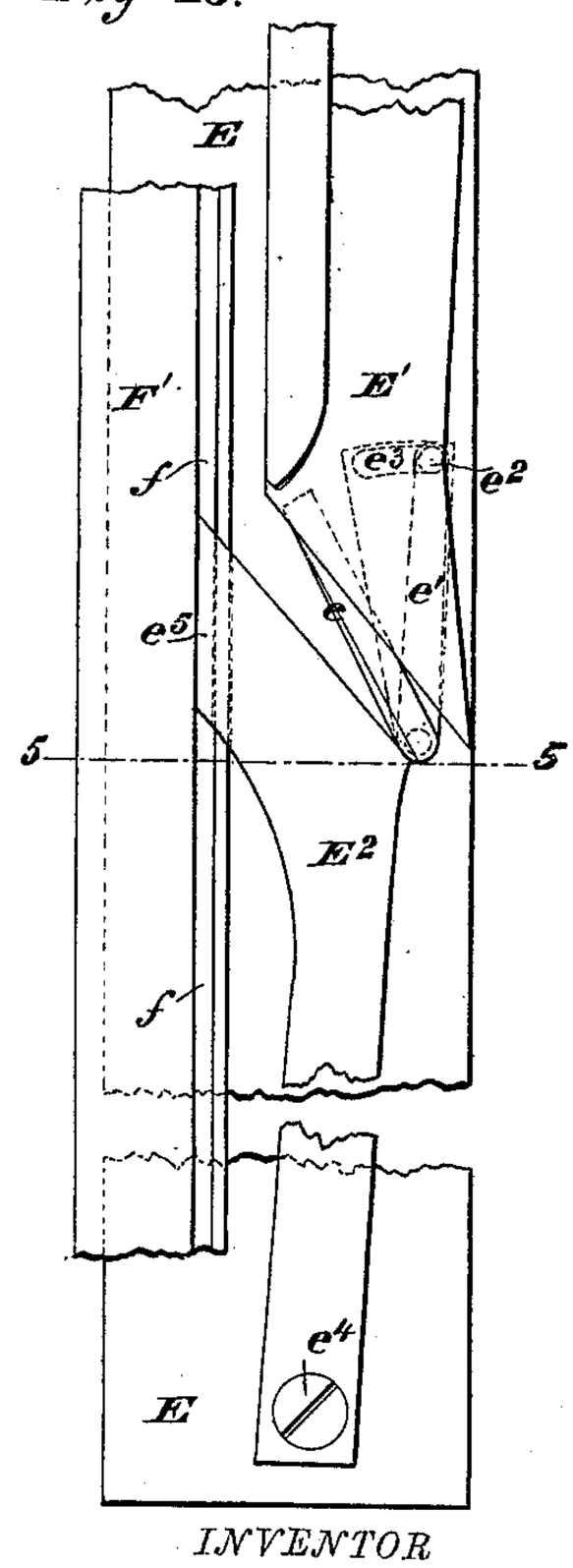


Fig 18.





WITNESSES

Wm A Skinkle

F. Stieb

INVENTOR

John Nelson.

By his Attorneys.

Baldwin, Hopkins & Peyton

14 Sheets—Sheet 9.

J. NELSON.
Knitting-Machine.

No. 214,308. Patented April 15, 1879.

Fig 19.

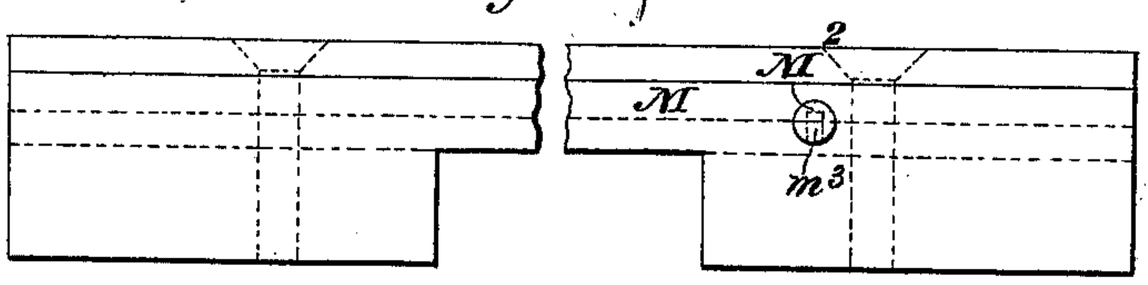


Fig 21

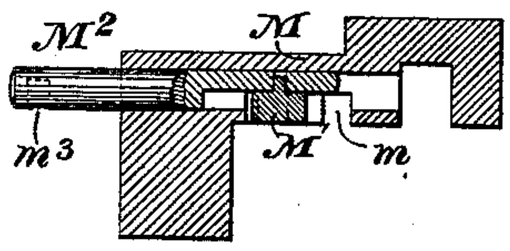


Fig 20.

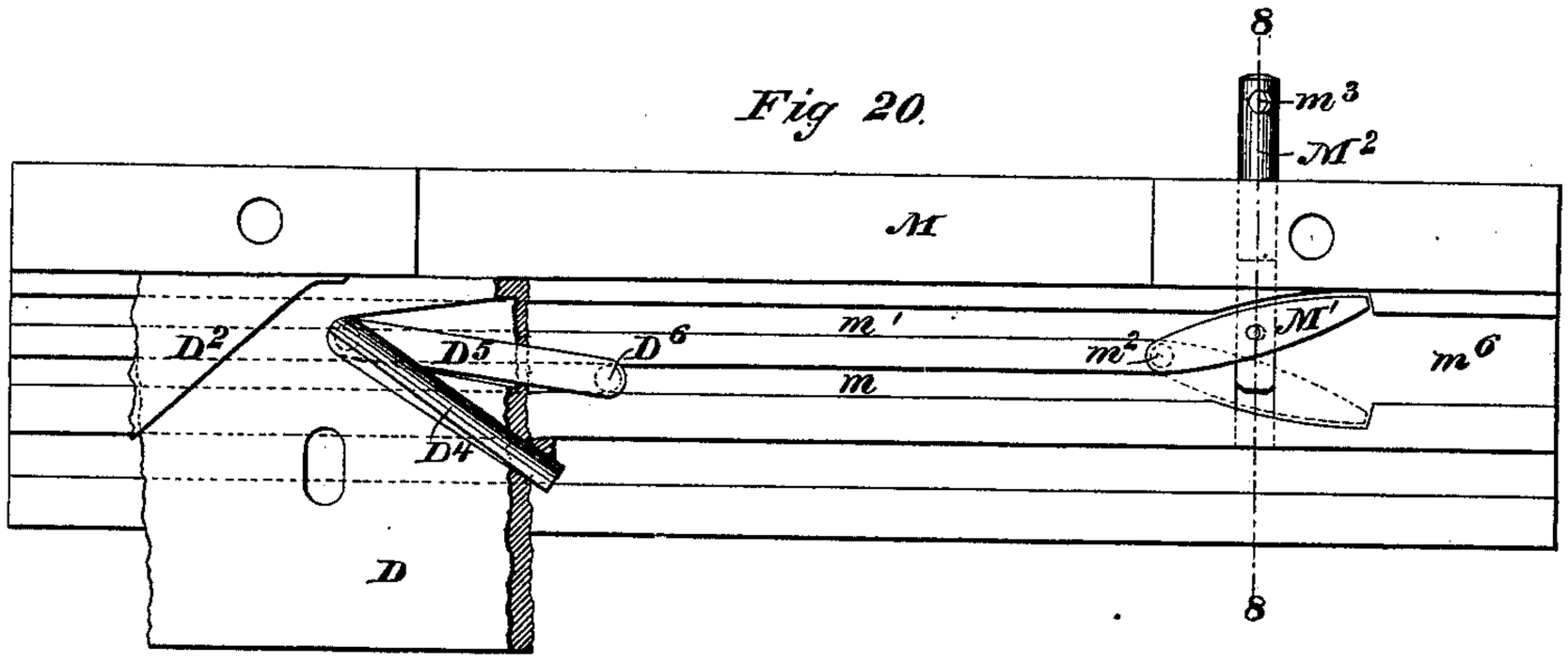


Fig 22.

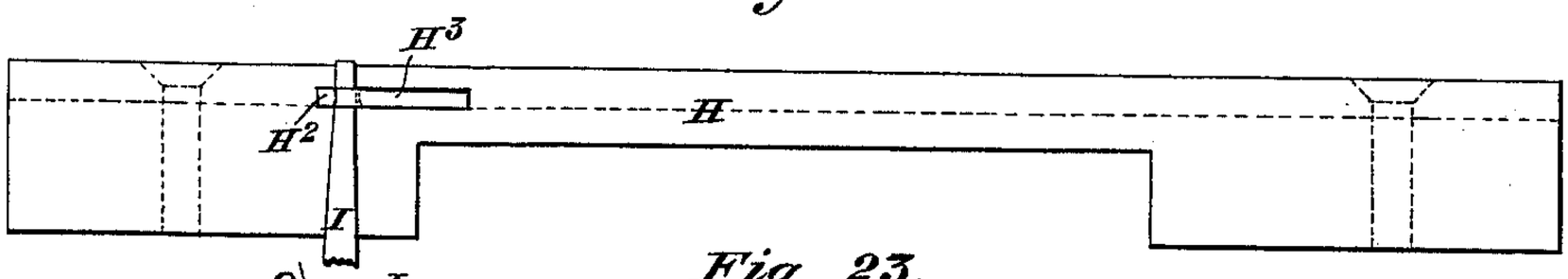


Fig 23.

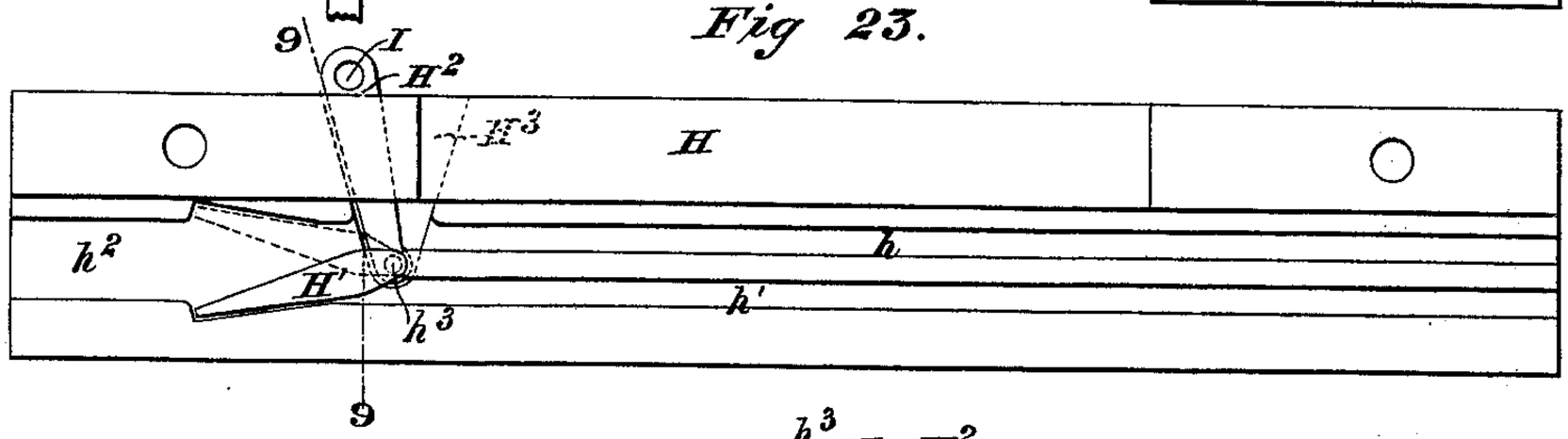
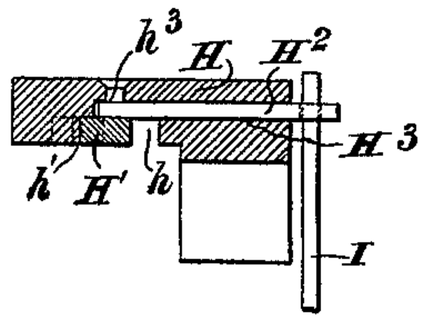


Fig 24.



WITNESSES

Wm A Skinkle

F. Fish

INVENTOR

John Nelson.

By his Attorneys.

Baldwin, Hopkins & Peyton.

14 Sheets—Sheet 10.

J. NELSON.
Knitting-Machine.

No. 214,308. **Patented April 15, 1879.**

Fig 25.

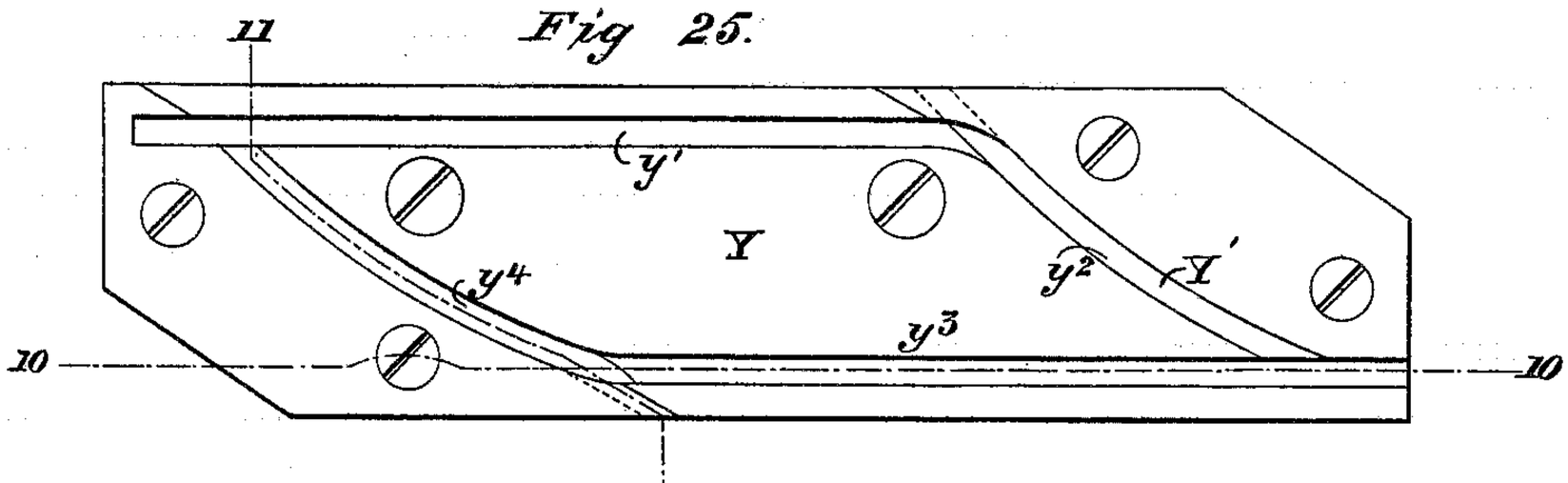


Fig 26

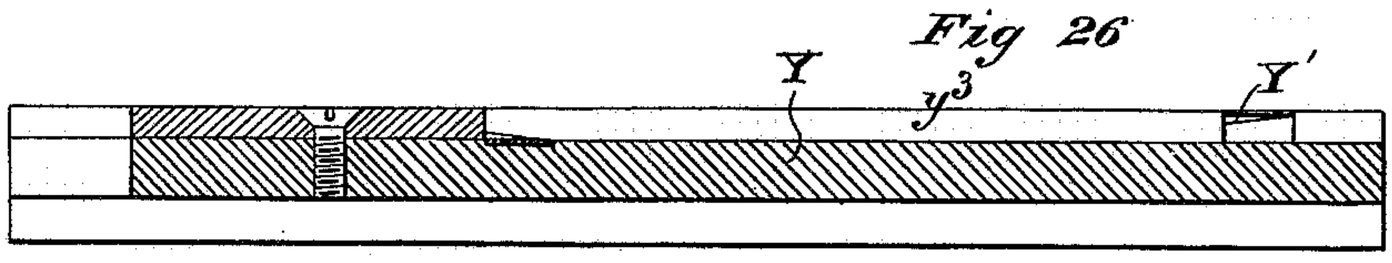


Fig 27.

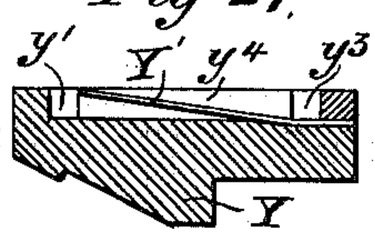


Fig 29

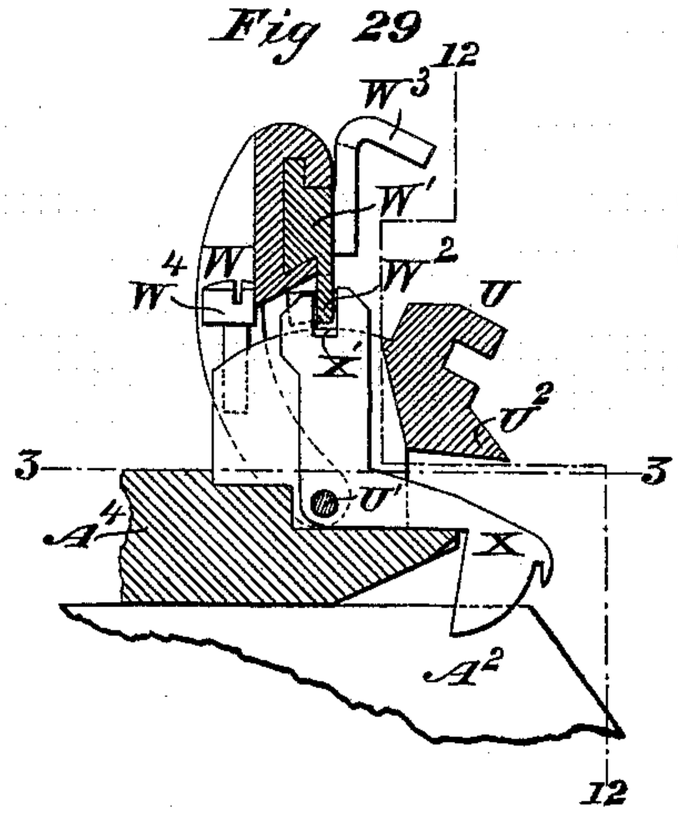


Fig 28.

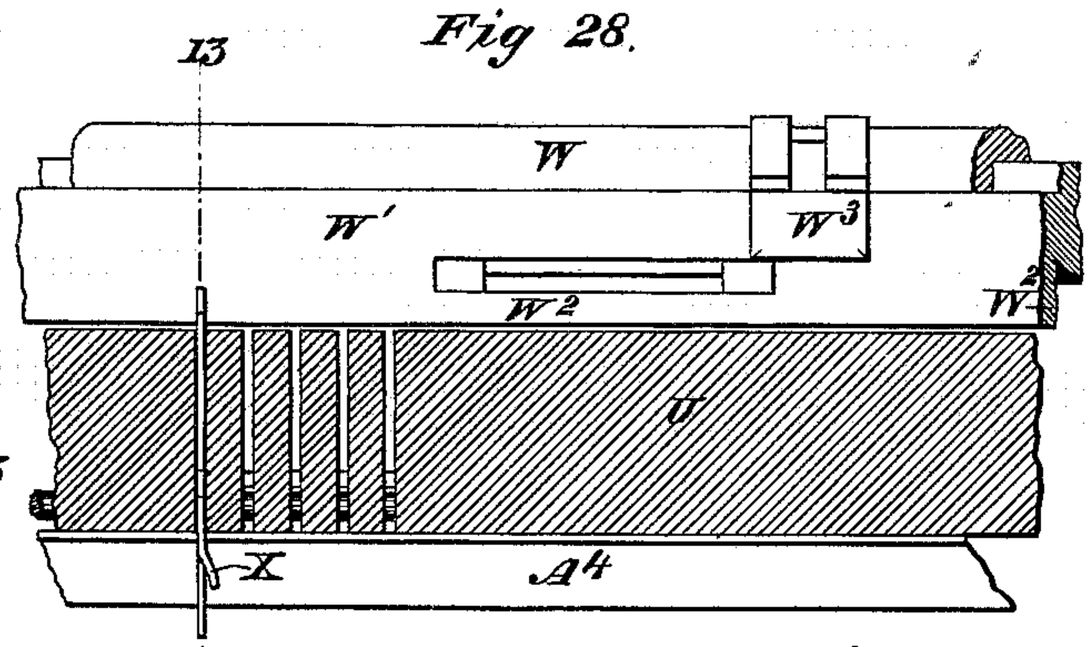


Fig 30.

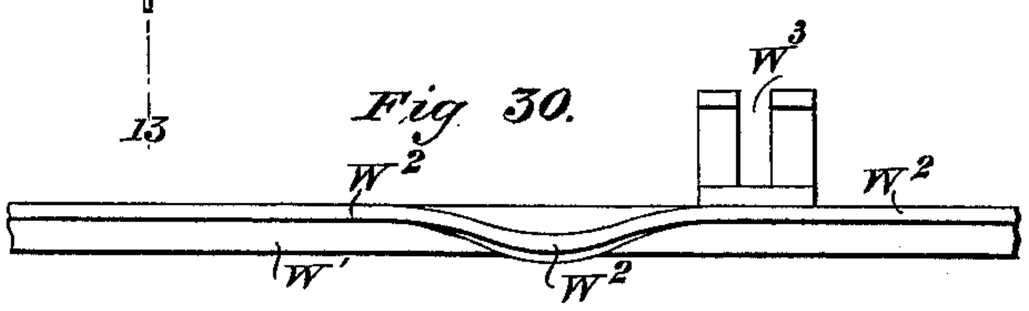
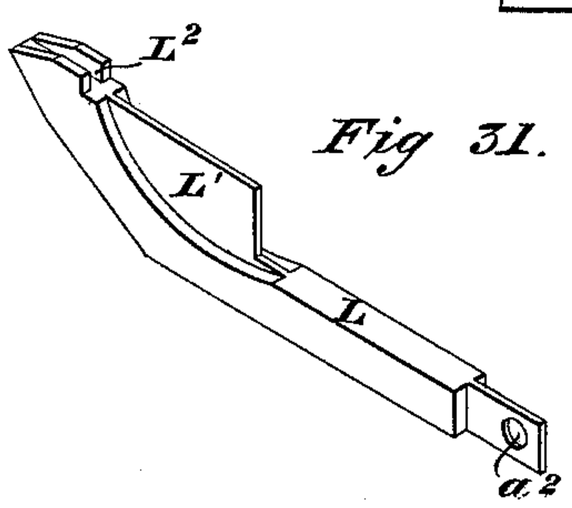


Fig 31.



WITNESSES

Wm A Skinkle
F. Stich

INVENTOR

John Nelson.

By his Attorneys

Baldwin Hopkins & Peyton

14 Sheets—Sheet 11.

J. NELSON.
Knitting-Machine.

No. 214,308. **Patented April 15, 1879.**

Fig 33.

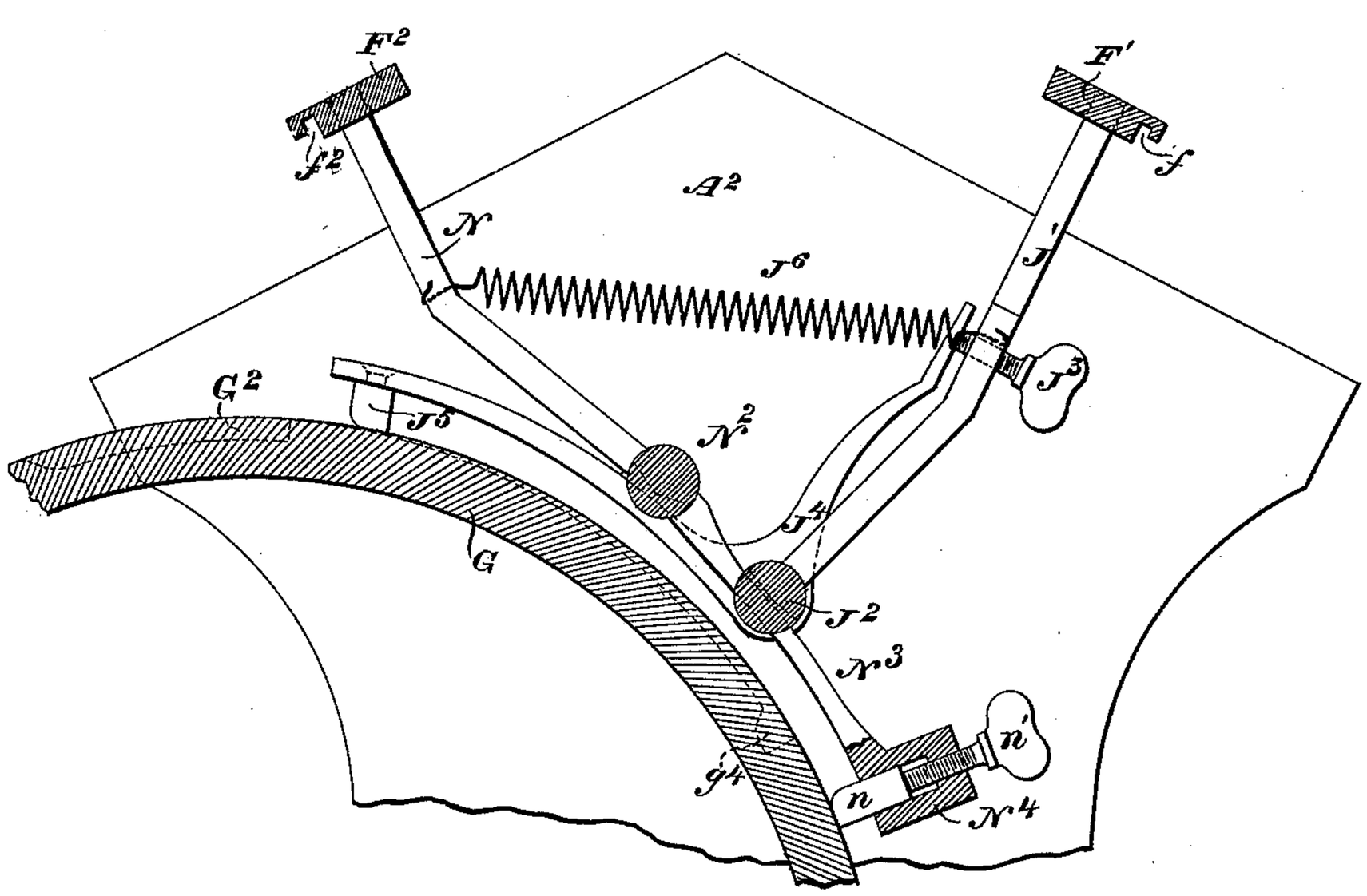
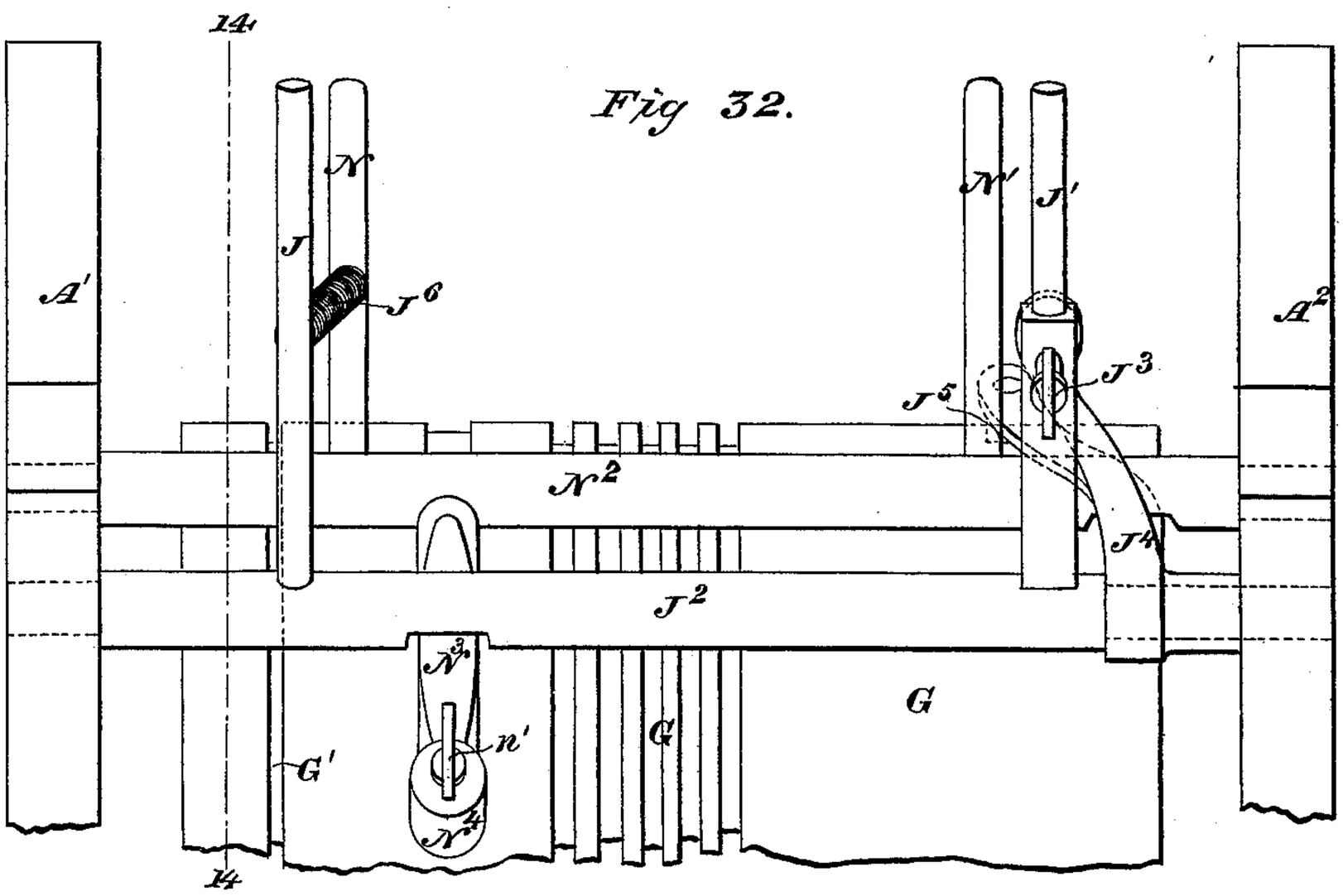


Fig 32.



WITNESSES

Wm a Skinkle
F. Stich

INVENTOR

John Nelson,

By his Attorneys.

Baldwin, Hopkins & Peyton

14 Sheets—Sheet 12.

J. NELSON.
Knitting-Machine.

No. 214,308. Patented April 15, 1879.

Fig 34.

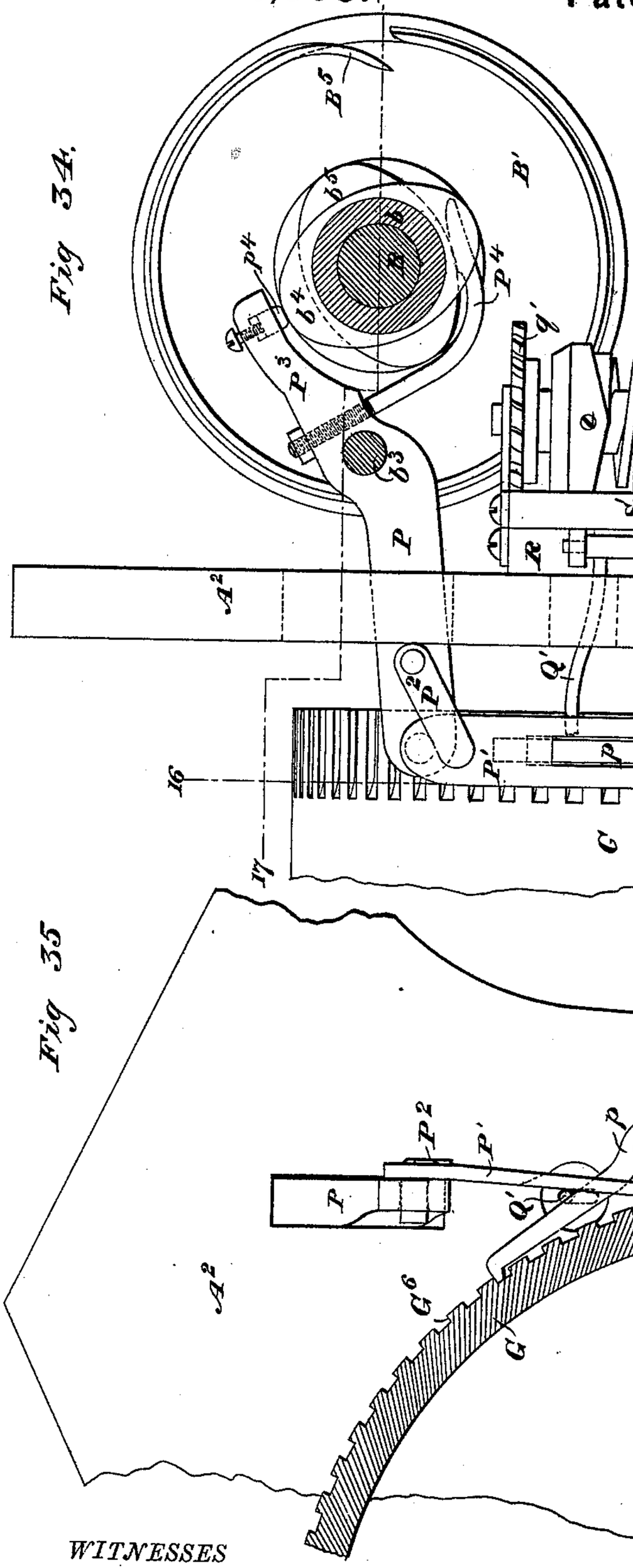
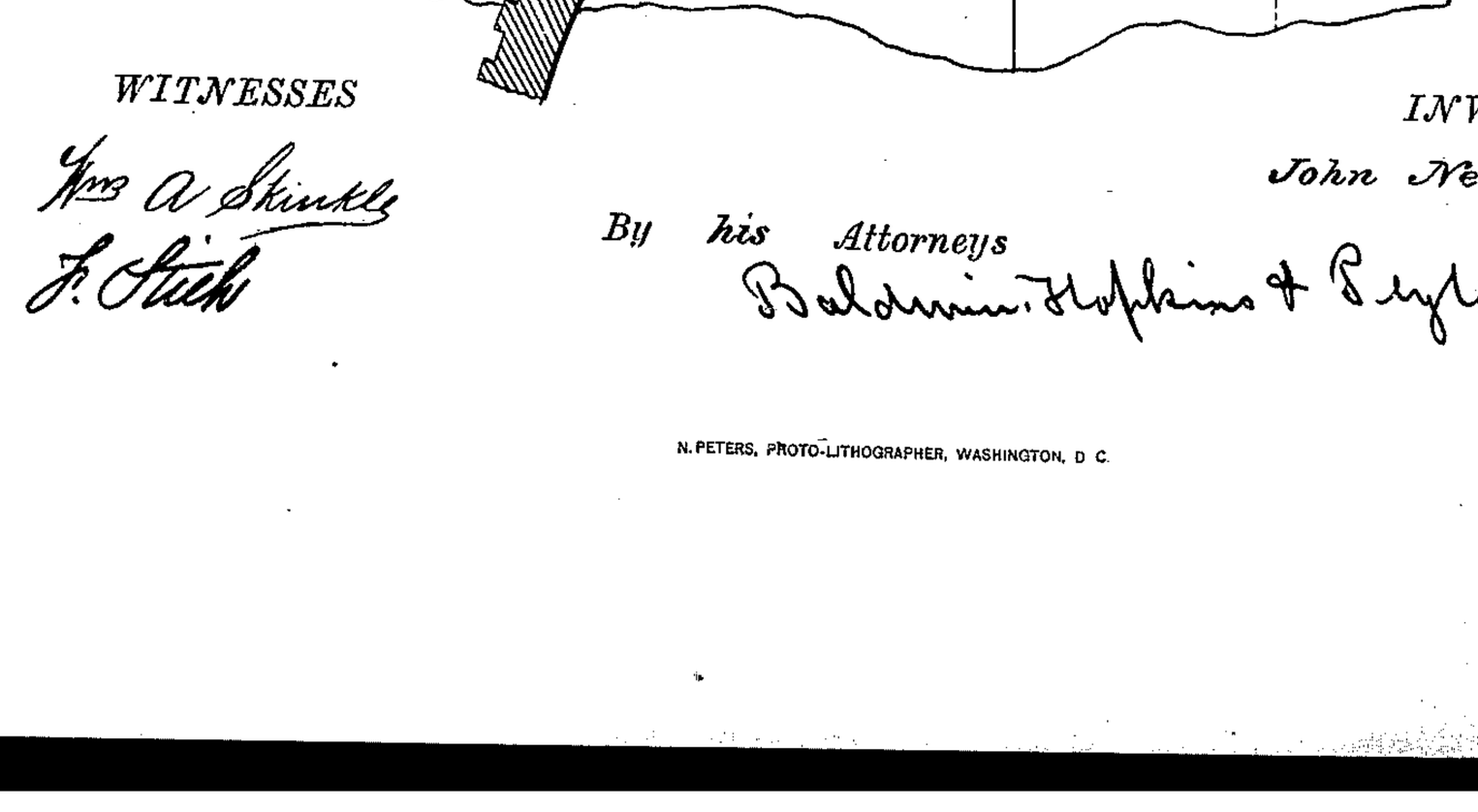


Fig 35



WITNESSES

Wm A Skinkle
F. Stich

INVENTOR

John Nelson

By his Attorneys

Baldwin, Hopkins & Peyton

14 Sheets—Sheet 13.

J. NELSON.
Knitting-Machine.

No. 214,308. Patented April 15, 1879.

Fig 37

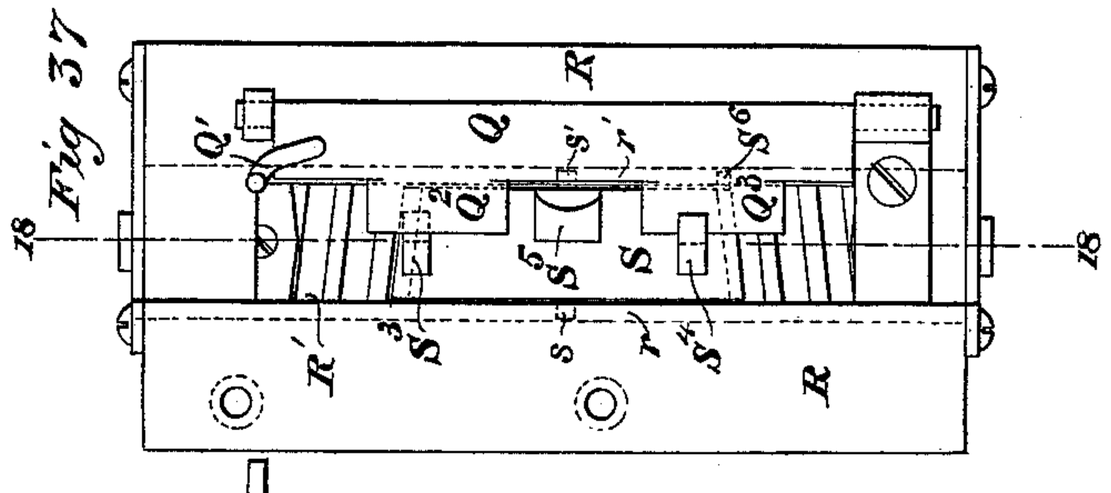


Fig 41

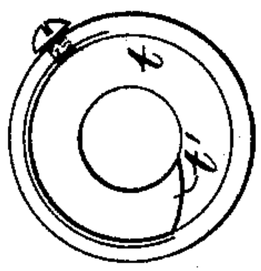


Fig 42.

Fig 38.

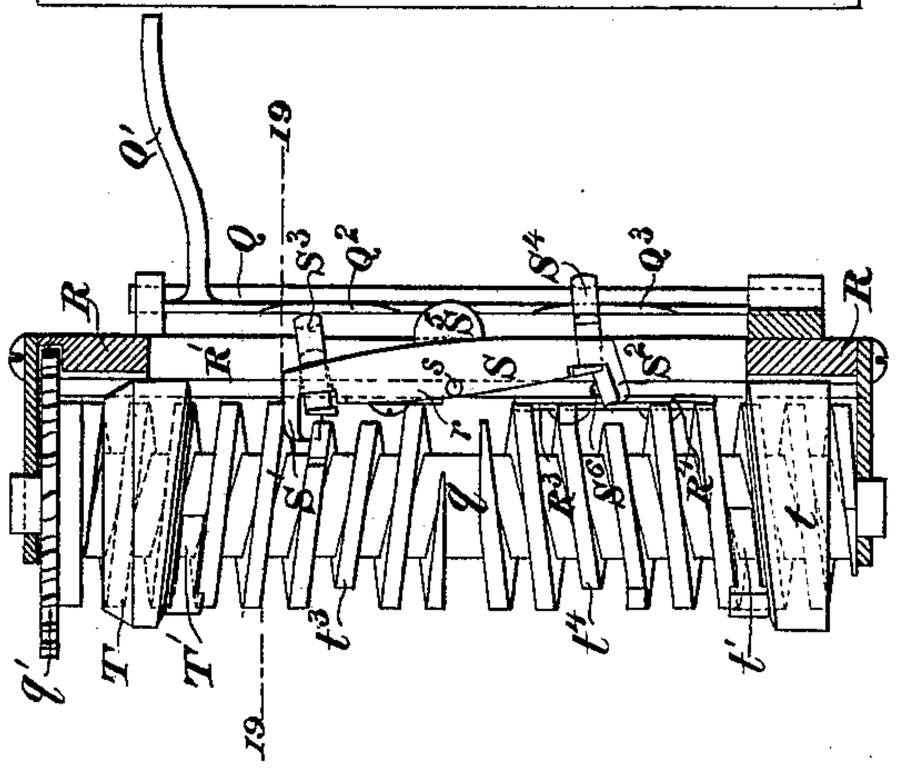


Fig 36.

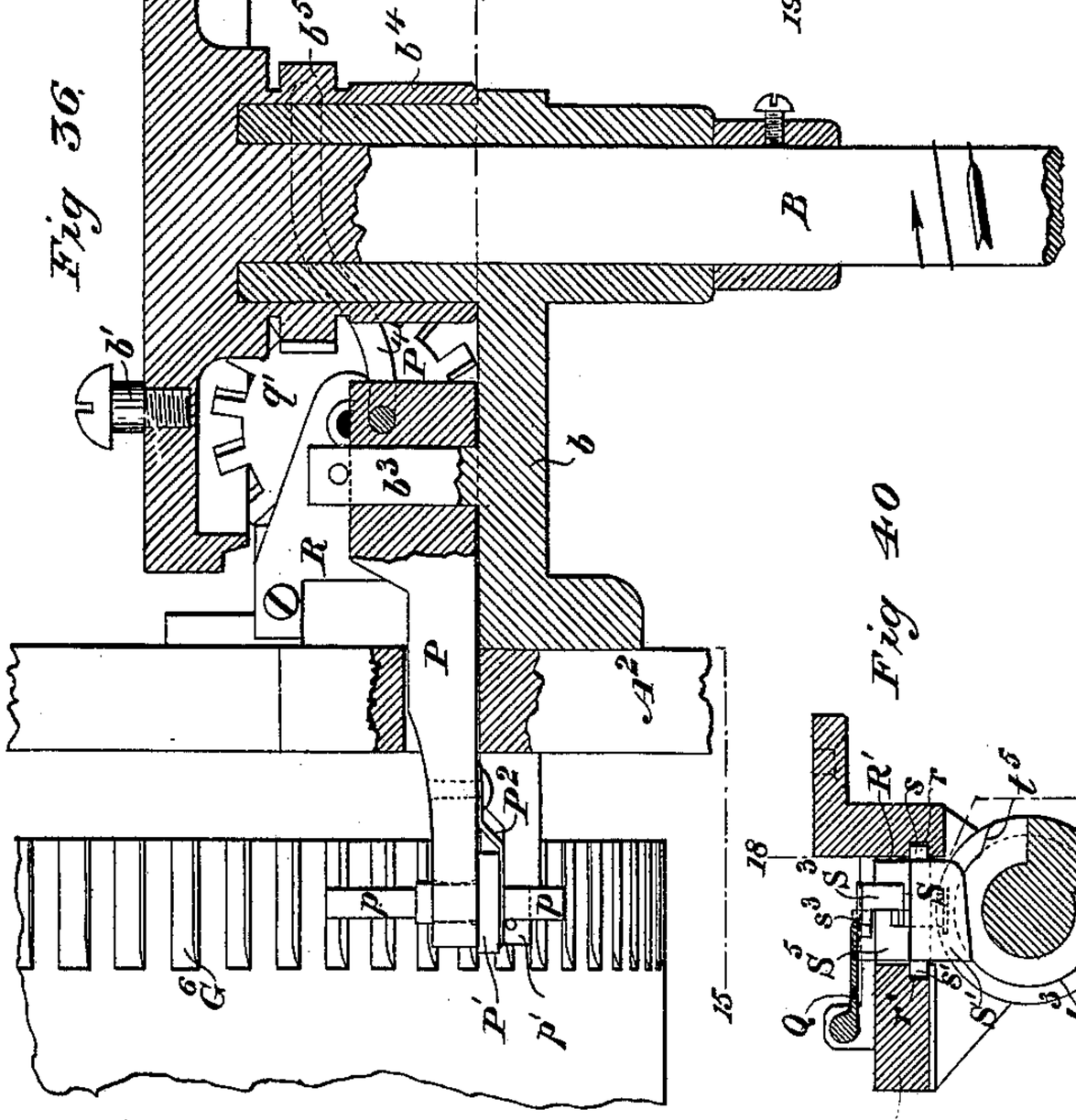
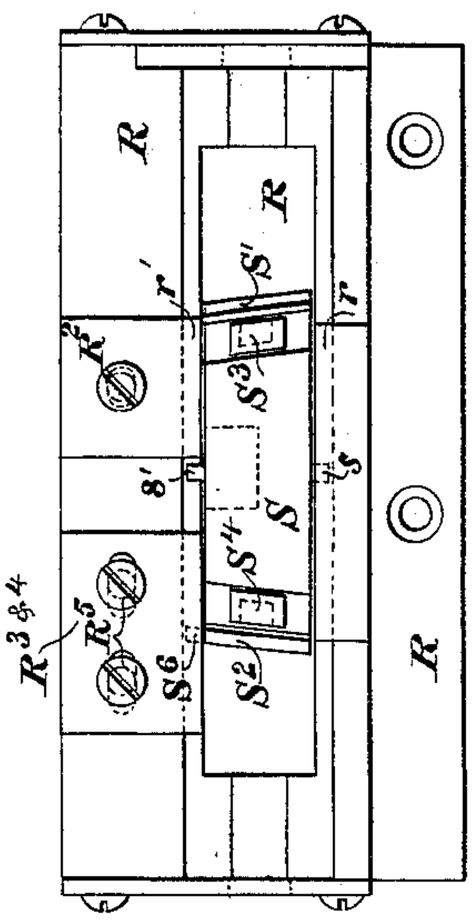


Fig 40

Fig 39



WITNESSES

Wm A Skinkle

F Stich

INVENTOR

John Nelson

By his Attorneys.

Baldwin, Hopkins & Peyton

14 Sheets—Sheet 14.

J. NELSON.

Knitting-Machine.

No. 214,308. Patented April 15, 1879.

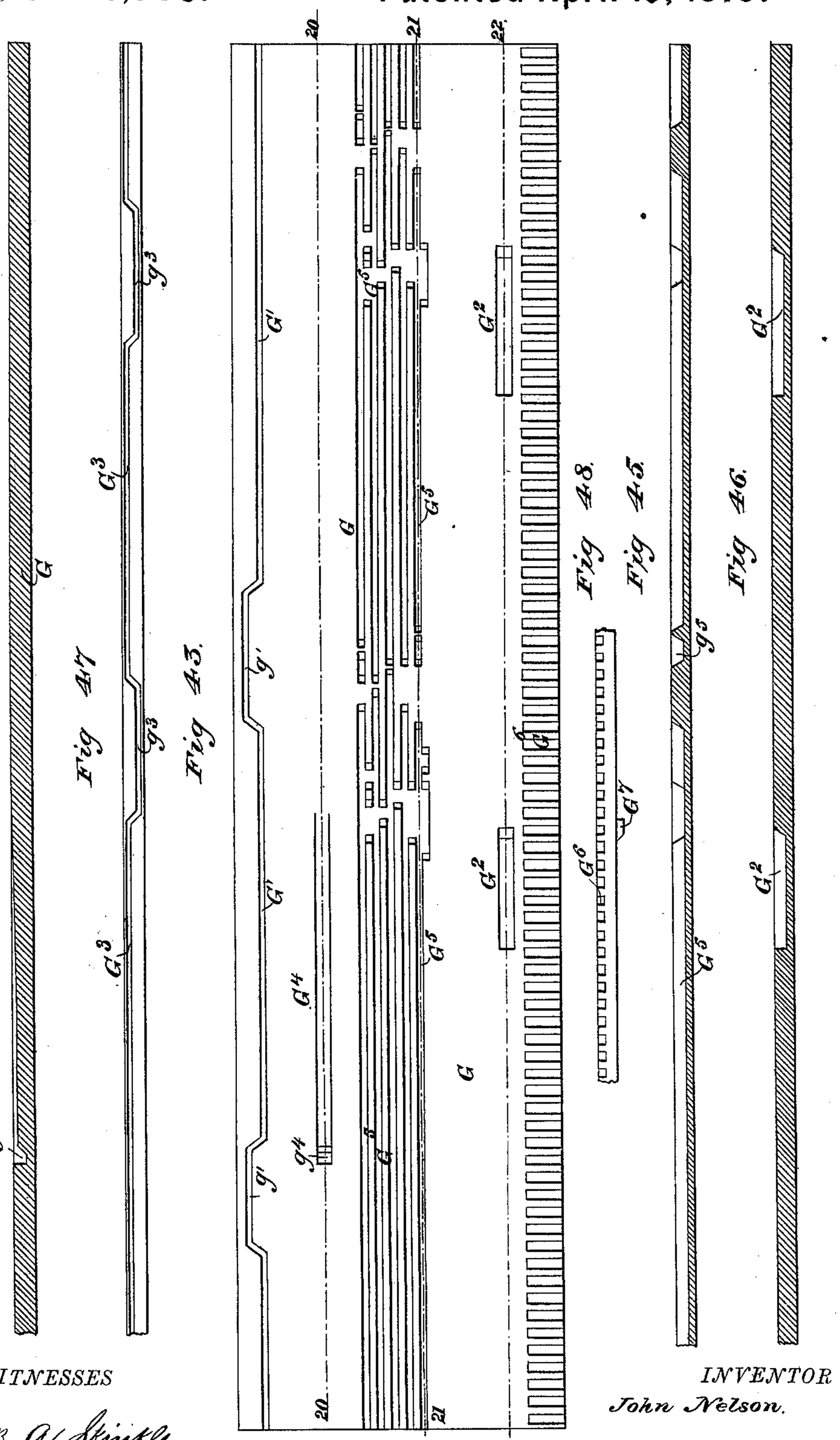


Fig 44.

Fig 47.

Fig 43.

Fig 48.

Fig 45.

Fig 46.

WITNESSES

Wm A Skinkle

F. Stich

INVENTOR

John Nelson.

By his Attorneys.

Baldwin, Hopkins & Peyton

UNITED STATES PATENT OFFICE.

JOHN NELSON, OF ROCKFORD, ILLINOIS.

IMPROVEMENT IN KNITTING-MACHINES.

Specification forming part of Letters Patent No. **214,308**, dated April 15, 1879; application filed December 13, 1876.

To all whom it may concern:

Be it known that I, JOHN NELSON, of Rockford, in the county of Winnebago and State of Illinois, have invented certain new and useful Improvements in Knitting-Machines, of which the following is a specification.

My invention relates to knitting-machines of that class known as "straight-row" knitting-machines.

Its objects are so to organize said mechanism as to render it capable of automatically and completely knitting an entire sock of a uniform or parti-colored yarn, of the same or different sizes of yarn, and of increased thickness wherever required.

The subject-matter claimed will hereinafter specifically be designated.

The accompanying drawings represent all my improvements as embodied in one machine in the best way now known to me. It is obvious, however, that some of said improvements may be made and used without the others, and in machines varying in their organization from the one herein described. It is also obvious that the details of construction of some of the parts may be varied in various well-known ways without departing from the principle of the invention herein claimed.

Figure 1 represents a plan or top view of so much of my improved machine as is necessary to illustrate the subject-matter herein claimed; Fig. 2, a front elevation. Fig. 3 is a view, in elevation, of what I call the "left end" of the machine; and Fig. 4, a similar view of the right end.

That end of the machine on the right of a person facing the machine, as in Fig. 2, I call the "right end" of the machine; the other the "left end."

Fig. 5 represents a section on the line 1 1 of Fig. 1. Fig. 6 represents a plan or top view of the central portion of the machine, partly in section, on the line 2 2 of Fig. 5, and on an enlarged scale, showing the relation of the front and back needles, one set being pushed up and the other set being pushed down. Fig. 7 is a similar view of some of the back needles and their needle jacks and levers, with the covering-plates removed and partly in section, on the line 3 3 of Fig. 10. Fig. 8 is a side view of the yarn-carrier, seen from the front; Fig. 9, a bottom-plan view thereof. Fig. 10 is a vertical transverse section on the line 4 4 of Fig. 7 through the center of one of the back-needle grooves, showing the relative position of the parts when the needle is pushed up and in working order. Fig. 11 is a similar section, with the needle-supports lowered to admit of the removal of the needles. Fig. 12 is a similar section, showing the needle-jack locked in its advanced position to hold the needle when not working. Fig. 13 is a vertical transverse section through the needle-cam slides on the line 5 5 of Figs. 14 and 18. Fig. 14 is a bottom-plan view of a portion of the rear cam-slide or needle-actuator, showing the cam in its working position when knitting circular work; Fig. 15, a vertical cross-section thereof on the line 6 6 of Fig. 14. Fig. 16 is a vertical longitudinal section through the needle-cam slide on the line 7 7 of Fig. 14, showing the spring-cam in its ordinary working position. Fig. 17 is a similar section, showing the spring-cam as raised or in position for working the needles by the movement of the slide each way when the front needles are not working. Fig. 18 is a bottom-plan view of the front cam-slide or needle-actuator in its working position. Fig. 19 is a back view of the back channel-plate; Fig. 20, a bottom-plan view of the same. Fig. 21 is a vertical transverse section therethrough on the line 8 8 of Fig. 20. Fig. 22 is a front view of the front channel-plate. Fig. 23 is a bottom-plan view of the same; Fig. 24, a vertical transverse section therethrough on the line 9 9 of Fig. 23. Fig. 25 is a plan or top view of the top guide-cam or channel-plate for actuating the yarn-carrier and presser-hook-actuating cams. Fig. 26 is a vertical longitudinal section therethrough on the line 10 10 of Fig. 25; Fig. 27, a vertical transverse section therethrough on the line 11 11 of Fig. 25. Fig. 28 represents a view, partly in section, on the line 12 12 of Fig. 29, of the central presser-hooks of the back needles; Fig. 29, a vertical transverse section therethrough on the line 13 13 of Fig. 28. Fig. 30 is a bottom-plan view of one of the hook-cams, both being alike in contour. Fig. 31 is a view, in perspective, of one of the swinging beds or hinged needle-supports detached. Fig. 32 is a front view, showing the details of the tension arms or levers which

regulate the tightness of the stitches. Fig. 33 is a vertical transverse section therethrough on the line 14 14 of Fig. 32. Fig. 34 is a front view of the pattern-drum-actuating mechanism, partly in section, on the line 15 15 of Fig. 36. Fig. 35 is a vertical transverse section through the same on the line 16 16 of Fig. 34. Fig. 36 is a plan view of the same, partly in section, on the line 17 17 of Fig. 34. Fig. 37 is a view from the inner side of the mechanism which controls the intermittent movement of the pattern-cylinder, showing it detached from the main frame. Fig. 38 is a vertical longitudinal section of the same on the line 18 18, Figs. 37 and 40. Fig. 39 is a view from the outer side of the same, with the screw removed in order to show the parts which lie under it more clearly. Fig. 40 is a horizontal section therethrough on the line 19 19 of Fig. 38. Fig. 41 is a plan view of one of the reversing-rings, that are located on each end of the screw; Fig. 42, a side view of the same. Fig. 43 is a side view of the periphery of the pattern-drum laid out on a flat surface. Fig. 44 is a vertical longitudinal section of the same on the line 20 20 of Fig. 43, showing the groove or cam which actuates or governs the back tension. Fig. 45 is a similar section on the line 21 21 of Fig. 43, showing the groove or cam which controls the action of one of the back-needle jacks. Fig. 46 is a similar section on the line 22 22 of Fig. 43, showing the groove or cam which actuates or controls the front tension-levers. Fig. 47 is a view of the left edge of the rim of the pattern-drum, showing the cam or groove which governs the movement of the back set of needles, causing them to knit either once or twice, as required, at each reciprocation of the sliding needle-cams; and Fig. 48 is a view of the right edge of the pattern-drum, showing the lug or wiper which is instrumental in stopping the yarn-carrier at the proper time in order to throw off the completed stocking.

The mechanism is mounted upon a suitable frame, consisting of a rigid base or main frame, A, carrying two side plates, A^1 A^2, which rest upon ledges on the outer sides of the main frame, and are held securely thereto by screws. A shaft, B, driven from any suitable prime mover, is mounted in a bracket-bearing, *b*, projecting from the side plate A^2, and carries a crank-wheel, B^1, the wrist-pin b^1 of which is connected, by a pitman, B^2, to an elbow-lever, B^3, rocking in a vertical plane on a pivot, b^2. The long arm of this lever is pin-jointed to a link, B^4, which is pivoted to a yoke or saddle, C, which rides upon and is securely fastened to the needle-cam slides D and E, connecting them together and imparting to them a positive movement, thereby causing them to reciprocate in parallel planes on their respective needle-beds on opposite sides of a vertical longitudinal slot or opening, F, through which the knit fabric descends.

Each set of needles is arranged parallel with this slot and works over it in an inclined path, each needle moving independently of the others in its respective slot in the needle-bed, being protruded and retracted successively by means of a stud, K^1, projecting from its jack K, acted upon by a cam on the under side of a cam-slide.

In working the heel or toe of a sock by this machine, it is necessary to throw one set of needles out of operation, by preference the front set, or the one farthest from the pattern-cam G. This I do by so constructing that part E^1 of the cam-slide E which pushes up the needles that it shall usually lie out of contact with the shank of the needle-jacks, and making it in the form of a spring, or otherwise giving it a yielding motion which will bring it within range of the shank on the jack when required. I do this automatically by means of an oscillating wedge, *e*, pivoted underneath the cam-plate E, and intermediate between it and the movable cam E^1. (See Fig. 18.) When the wedge is between the spring-cam and the cam-plate, the inclined edge of the former is pushed down until it almost touches the needle-bed, and when in this position it comes in contact with the jack-shanks, which move up the inclined edge as the cam-plate advances. On the return movement of the cam-slide the jack-shanks come in contact with the inclined edge of the pivoted plate E^2, and are moved back to their former position.

When it is desired to stop the needles, or throw them out of action, the wedge is moved from between the cam-plate and the spring-cam, when the latter rises and lies close up against the bottom of the cam-plate, passing above the tops of the shanks of the jacks without touching them.

The wedge *e* consists of one leg of a V-shaped lever or bell-crank, the other leg, e^1, oscillating in a recess in the cam-plate, as shown by dotted lines, Fig. 18, carrying at its outer extremity a stud or pin, e^2, which projects up through and vibrates in a slot, e^3, in the cam-plate E. That part of the pin e^2 which projects through the plate traverses one or the other of two grooves in the under side of the channel-plate H, Figs. 22, 23, and 24. While the wedge is over the spring-cam E^1, and the latter pressed down in such position as to act on the needle-jacks, the pin e^2 traverses the outer groove, *h*, and the gate or shifter H^1 remains in the position shown in Fig. 23 by full lines; but when it is desired to stop the action of the needles the gate is shifted to the position shown by the dotted lines, which closes the groove *h* and shifts the pin into the groove h^1, which action causes the wedge to move from over the spring-cam E^1, allowing it to spring up and ride over the shanks of the jacks. This change should only take place when the cam-slide has reached the limit of its stroke to the left and the pin has passed beyond the gate and lies in the wide groove h^2 at the left end of the channel-plate.

The gate or shifter forms one leg of a bell-

crank or L-shaped lever, which oscillates on a pivot, h^3. The other leg, H^2, lies in a recess above the top of the grooves to permit the pin e^2 to pass freely under it, and extends through and vibrates in a slot, H^3, of the channel-plate. The outer end, which projects a short distance beyond the front side of the channel-plate, is perforated, and has the upper end of the lever I projecting through it. This lever is pivoted at I^1, (see Figs. 2 and 3,) and has at its extreme lower end an inwardly-projecting stud, I^2, which runs in the groove G^1 of the pattern-drum G. The peculiar shape of this groove is best shown in Fig. 43.

So long as the machine is knitting circular work the stud I^2 traverses the straight part G^1 of the groove; but while the toe or heel of a sock is being formed, and it is desired that the front set of needles shall remain inoperative, the stud will be shifted and run in one or the other of the parts g^1 of the groove, thereby shifting the lever I, which, through the medium of the gate H^1, causes the stud e^2 to change its path from the channel h to the channel h^1, thereby moving the wedge e from over the spring-cam E^1, allowing it to spring up and pass over the shanks of the needle-jacks, as before described.

In order to knit tighter or looser, I shorten or lengthen the retracting movement of the needles, to accomplish which object that part E^2 of the cam-slide E which retracts the front needles is pivoted at one end on the cam-plate at e^4, to admit of the necessary lateral play or oscillation, which movement is effected by means of a laterally-moving bar, F^1, lying on the needle-bed, and provided with a longitudinal groove, f, on its under side, and in which a corresponding ledge or flange on the movable bar E^2 traverses. (See Figs. 3, 4, 5, 18, 32, and 33.) This laterally-moving shifter-bar F^1 is mounted upon oscillating arms J J^1, pivoted beneath and passing through slots in the needle-bed, and connected by the rock-shaft J^2, so as to form a rigid frame, thus compelling both ends of the bar to move correspondently. (See Figs. 32 and 33.)

A set-screw, J^3, passing through the arm J^1 of the tension-frame, bears against one leg of a bell-crank lever, J^4, mounted loosely on the rock shaft J^2, between the arm J^1 and the inside of the side plate A^2. The other end of this lever extends inward and upward nearly to the vertical center of the periphery of the pattern-drum G, and carries at its end a steel shoe or lug, J^5, which rides upon the periphery of the pattern-drum, and is held firmly thereto by the tension of the spring J^6, which connects the front and back tension frames, drawing them toward each other, and acting against the pattern-cam G.

Any adjustment of the tension of the stitches formed by the front row of needles may be obtained by means of the set-screw J^3, which, when screwed against the opposing arm of the lever J^4, forces the tension-frame, the bar F^1, and the needle-retracting cam E^2 away from the center of the machine, thereby increasing the length of stroke of needles, and causing a looser stitch to be made.

It is necessary during the knitting of the toe or heel of a stocking that the tension mechanism of the front needles should cease to operate entirely, in order to accomplish which depressions G^2 G^2 are formed in the face of the pattern-drum G, (see Figs. 43 and 46,) in the path of the shoe J^5, and into which the shoe is pressed by the spring, thereby permitting of the whole tension mechanism being drawn toward the center of the machine, and preventing any possibility of the needles being moved by the retracting-cam E^2.

The shoe J^5 might, if preferred, be provided with friction-rollers. This mode of construction permits of the lateral adjustment of the retracting-cam E^2 with a single screw; but it is obvious that this construction might be varied in various ways, and still operate with good effect.

Instead of making the needle-bed A^3, as usual, with grooves, in which the needle-bars slide, cut through and through, I construct the bottom portion thereof in the usual manner—that is, with grooves cut through and through—and superimpose upon it a steel plate, a, slotted transversely, so as to form a grating, in the slots of which the shanks K^1 of the needle slides or jacks K traverse. This grating thus acts as a means of holding the needle slides or jacks down in their grooves, guiding them accurately, forming a positive stop to limit their extreme range of movement, and, by its superior durability, preventing the wear and inaccurate working or the breakage of parts, and has in practice been found of great utility.

A hook, K^2, opening downward on the front end of the needle slide or jack, interlocks with a corresponding hook, k', on the back end of the needle k, (see Fig. 5,) so that in their ordinary working position the parts are securely interlocked; but the needle can readily be detached by bearing down upon its back end. To do this with more facility a slot, a^1, is formed on the under side of the needle-bed A^3, extending from its upper edge, or that nearest the center of the machine, to a point directly beneath the hook k' of the needle when the needle is in its most advanced potition, which slot is ordinarily closed by the web L^1 on the swinging bed or pivoted support L. The same operation can be effected in like manner with respect to the front set of needles. When it is desired to remove a needle these swinging supports can be lowered a sufficient distance to permit the needle-hook k' to fall below and entirely clear of the hook K^2 of its jack when the needle is in its advanced position. The needle can then be withdrawn.

Fig. 31 shows a view, in perspective, of one of my improved needle-supports, which is, by preference, made of steel, and is provided at its forward end with a groove, L^2, in which the front end of the needle works. It is piv-

oted at its outer end, beneath the needle-bed, on a pivot, a^2, while it is supported and held up in position at its inner end by a rocking eccentric-shaft, L^3. When in working position, as shown in Fig. 5, the top of the web L^1 lies in the same plane with the bottom of the needle-groove in the bed-plates, forming a continuation of said bottom; but when it is desired to move one or more needles the eccentric-shaft L^3 is rotated until its flat surface is presented to the bottom of the support L, which will fall by its own gravity, leaving the needle unsupported, so that if it be advanced to its limit of motion its rear end can be depressed and detached from the hook on the needle-jack. The position assumed by the parts when the needle is to be taken out is very clearly shown in Fig. 11. This figure represents one of the back needles; but the operation of detaching the needles from the jacks is precisely similar in both sets.

I have found this device of great utility in practice, as by this mode of construction I am enabled to shorten or diminish the width of the ordinary cast-iron needle-bed and substitute for it a series of independent supports of hardened steel at a point where the wear is greatest, and where any wear or breakage can readily be compensated. Moreover, this construction obviates the difficulties attendant upon the tempering of the steel-plate intersected by transverse slots, which, in practice, has been found hard to overcome.

The cam-slide D, which operates the back set of needles, or that nearest the pattern-cylinder, differs somewhat in construction from that which operates the other set, though its general outline is similar.

This difference in construction arises from the fact that in the organization of my machine it is only necessary for the front set of needles to knit one stitch for each reciprocation of the cam-slide E at any time, while during a portion of the operation they are entirely unemployed.

In the back set or pattern side the needles, while knitting circular work, make but one stitch for each reciprocation of the cam-slide D; but while the toe or heel is being formed, and the front set of needles is thrown out of action, it is necessary that they should make two stitches for each reciprocation of the cam-slide. All the needles of this set are never thrown altogether out of action, as in the front set, and the mechanism through which the action of each individual needle is controlled is of an entirely different character to that of the front set, as will be hereinafter fully set forth.

In the back cam-slide, D, there are two advancing-cams, D^1 and D^2, and a double-inclined retracting-cam, D^3. The cam D^1 consists of a steel spring or plate, and is moved at proper intervals away from the plate D by a wedge, D^4, in precisely the same manner that the spring-cam E^1 is moved by the wedge *e*, as before described.

When the back needles are knitting one stitch for each reciprocation of the cams, the wedge D^4 is in the position shown in Figs. 14, 15, and 16, and the cam lies close up to the bottom of the cam-plate D, riding over the shanks of the needle-jacks which are moved up by the inclined edge of the fixed cam D^2, and retracted on the return stroke of the cam-slide by the edge *d* of the retracting-cam D^3.

When the toe or heel is being formed, and it is desired that the needles should make two stitches for each reciprocation of the cam-slide, the wedge D^4 is moved between the spring-cam and the plate D, and the former is pressed down to the position shown in Fig. 17. This change only occurs when the cam-slide is at the extreme limit of its stroke, and when the shanks of the needle-jacks are lying along the longitudinal edge d^3 of the fixed cam D^2, with the needles in their most advanced position.

On the return stroke of the cam-slide the needles are retracted by the inclined edge *d* of the retracting-cam D^3, but are again immediately advanced by the edge of the spring-cam D^1. On the next advance stroke of the cam-slide the needles are first retracted by the edge d^1 of the cam D^3, and then advanced by the edge of the cam D^2, thus making a stitch at each stroke or movement of the cam-slide, or two stitches for each reciprocation.

The mechanism employed in depressing the spring cam D^1 is very similar to that used for the cam E^1. The leg D^5 of the wedge-lever vibrates on a pivot, and carries at its extremity a pin, D^6, which extends through and moves in a slot in the plate. This pin traverses one or the other of the grooves *m* m^1 in the channel-plate M, (Figs. 19, 20, 21,) and is shifted from one groove to the other by the gate M^1, pivoted at m^2. This gate is connected to an endwise-moving rod, M^2, by a stud which projects from its upper surface and works in a slightly-elongated hole in the rod. At the outer extremity of the rod is a hole, m^3, into which one end of the lever M^3 projects. This lever is pivoted at m^4 (see Fig. 3) between the inner side of the frame-plate A^1 and the left end of the pattern-drum G, and carries at its lower end a stud, m^5, which projects into and traverses the cam-groove G^3 in the end of the pattern-drum. (See Figs. 3 and 47.)

While the needles are knitting circular work, or one stitch for each reciprocation of the cam-slide, the stud m^5 traverses the straight part G^3 of the groove in the pattern-drum, (see Fig. 47,) the rod M^2 is drawn out, and the gate M^1 is in the position shown in Figs. 20, 21 in full lines, causing the stud D^6 to reciprocate in the channel *m*, with the wedge D^4 in the position shown in Figs. 14 and 16; but when the proper time arrives to change the needles from single to double action, the stud m^5 is drawn into one of the parts g^3 of the groove, which moves the lever M^3 and pushes in the bar M^2, causing the gate to shift to the position shown by dotted lines. At the instant this change takes place the pin D^6 is standing in

the enlarged part m^6 of the groove outside of the gate, which in shifting closes the channel m and switches the pin into the channel m^1, thereby forcing the wedge between the cam D^1 and the plate D, as shown by Fig. 17.

The triangular block or double retracting-cam D^3 (which serves the same purpose as the pivoted cam E^2) lies on top of the needle-bed, and between it and the plate D, being moved by the latter through the stud d^4, which projects up into the recess d^5 in the bottom of the plate.

In order to change the tension of the stitches knit by the back needles, I move the retracting-cam D^3 toward or away from the center of the machine, which is accomplished by a somewhat similar method to that employed in regulating the tension of the front needles.

The recess d^5, into which the stud d^4 projects, is elongated to permit the cam to be moved transversely without effecting its reciprocal motion. An upwardly-projecting ledge or flange, d^6, on the long side of the cam D^3 fits into and traverses a corresponding groove, f^2, on the under side of a laterally-moving bar, F^2, which is constructed precisely like the bar F^1. This connection allows a free reciprocating movement of the cam D^3, connects it to the bar F^2, so that they will move laterally together, and also serves to keep the cam from twisting or getting out of its true position.

The bar F^2 is mounted upon two arms, N N^1, which oscillate through apertures in the needle-bed A^4, and are connected by a rock-shaft, N^2, which works in suitable bearings in the side plates A^1 and A^2, thus forming a tension-frame like that for the front set of needles. (See Figs. 32 and 33.) An arm, N^3, extending outward and downward from the rock-shaft, carries at its end a steel shoe, n, which rides upon the periphery of the pattern-drum, and is held thereto by the action of the spring J^6, which connects the front and back tension-frames. A boss, N^4, on the end of the arm has a recess in its under side, in which the shoe n is carried with sufficient endwise movement to allow of any desired adjustment of the tension by a thumb-screw, n', which passes through the top of the boss and bears on the upper end of the shoe. The cam formed in the face of the pattern-drum, in the path traversed by the shoe n, is best shown in Figs. 43 and 44.

At the moment the completed stocking is to be cast off and a new one commenced it is desired that the tension mechanism should cease to operate entirely, and to this end the shoe drops into the deep recess g^4 of the groove G^4, from which, however, it rises at the next movement of the pattern-drum, and rides up the long incline of the groove G^4.

The gradual enlargement of the foot of the stocking from toe to heel is accomplished by knitting tight or small stitches at the toe, and gradually loosening or enlarging them as the heel is approached.

While the shoe n is upon the lower part of the cam G^4 the stroke of the needle is short, and a close fabric is knit by them; but as the shoe rides up the cam the retracting-stroke of the needles is gradually lengthened, thereby producing larger or looser stitches, and a consequent increase in the size of the fabric.

While knitting certain parts of the sock, more particularly the toe and heel, it is necessary, in order to form the gored seams required to produce the proper shape of these parts, that one or more of the back needles should be thrown out of action while the others continue working, which end I attain as follows: Certain portions of the needle slides or jacks on the flanks of the set next to the pattern-cylinder reciprocate in slots or guideways in rocking levers O, mounted on a shaft O^1, parallel with and back of the needle-bed A^4, which is slotted through and through, except the cone-shaped section a^3, which is the only continuous part of the needle-bed, and is all that holds its various sections together. The ends o o^1 of the lever play vertically through a portion of these slots, by and in which they are guided and supported. (See Figs. 5, 7, 10, 11, and 12.) Projections o^2 o^3 on the ends of the levers O bear on the pattern-cylinder and control their movements.

I have employed a lever having a single lug bearing on the pattern-cylinder with a spring to hold it down to its work, but found that this construction did not admit of such rapid work as I desired, although it would do good work at a certain speed. I have, therefore, devised a mode of operating the rocking levers positively, which permits the machine to run at any speed required. To this end I form a projection on each lever, on each side of its fulcrum, which projections o^2 o^3 bear upon the pattern-cylinder, and thus hold the lever positively to its work. To do this it is essential that the two projections should lie in different vertical planes parallel with the face of the lever. While one projection rides upon the periphery of the pattern-cylinder, the opposite projection may run in grooves G^5 therein, there being no time when both projections run loosely in the grooves of the cylinder. (See Figs. 5, 7, 10, 11, and 12.) The bottom part, o^1, of the slot or guideway in the lever, in which the needle slide or jack moves, has a notch or recess, o^4, formed in it about midway of its length, and near the point o of the upper member of the lever, which member forms the top wall of the slot.

By this mode of construction the lever can only oscillate when the needle is at the upper end of its stroke, and when so operated it bears positively upon the needle slide or jack K, and depresses its back end into the notch above described, thus positively locking the needle in this position until again thrown into operation by the pattern-cam. (See Fig. 12.) When in this position it will be noticed that the stud K^1 on the top of the needle-jack, upon which the cams on the needle-slides D act, is depressed below the surface of the grating a, so as to be entirely out of reach of the cams,

and is thus automatically thrown out of connection with them. By this means the breakage of the needle by the yarn-carrier striking them is prevented, as well as the accidental dropping back of the needle.

Thus it will be seen that by my invention the needle is uniformly supported while working throughout its entire length, and is not lifted when the rear end of the jack is depressed; while to remove the needle the swinging bed or supports L is lowered and out of the way, as described, for the front set of needles, and shown in Fig. 11, so that the needle can be depressed at its back end, releasing it from its connection with the hook on the jack, and allowing it to be withdrawn, thus combining the advantages of a continuous bearing, when working, with means for readily removing or replacing the needles.

Another feature of the organization of my machine is that those needles on the rear or pattern-cylinder side of the machine which are thrown out of operation in narrowing the fabric remain locked at the extreme limit of their upward movement, instead of being retracted out of the way, as is the case in the front set.

It has been proposed to fill the eyelet-holes, usually formed in narrowing the fabric when reversing the knitting in the central portion of it, by partially protruding the outside needles, next to the last one being knit, and throwing a loop of yarn around it on the reverse motion. I have found, in practice, this plan to be attended by the disadvantage of a tendency to break the needle, and of not leaving the fabric smooth; but I have obviated this objection by causing the last needle in knitting to advance the full length of its stroke, and remain locked in that position, with a loop of yarn around it, until the next course, when it retracts and goes on knitting like the others.

The oscillating-levers, which carry the needle slides or jacks, as above described, are steadily supported and guided by means of a comb-frame, O^2, between the teeth of which the studs at work on the pattern vibrate. (See Figs. 1 and 5.)

The pattern cam or cylinder G revolves on a shaft mounted in suitable bearings in the frame A, and has a step-by-step movement imparted to it in the following manner: A lever, P, vibrating on a stud, b^3, which projects from the bracket b, is operated by two cams or eccentrics, b^4 b^5, on the annular hub of the crank-disk B^1. One end of this lever projects through and vibrates in a slot in the side of the main frame, and has suspended from its end a loosely-pivoted pawl, P^1, which engages with the teeth of the ratchet G^6 on the pattern-drum, and as the lever vibrates gives the drum its intermittent motion.

A spring, P^2, on the side of the lever presses against the front of the pawl and serves to keep it into engagement with the ratchet. It has been found, when doing rapid work, that the momentum imparted to the drum by the pawl P^1 will sometimes carry it further forward than one step, which is very objectionable; and in order to obviate this difficulty I provide a stop-pawl, p, pivoted at p^1, and working through a slot in the actuating-pawl P^1. (See Figs. 34 and 35.) The shape and relative positions of the two pawls are such that when the actuating-pawl rises, the bottom of the slot, as shown by dotted lines, strikes against the bottom of the pawl p and lifts its upper end out of engagement with the ratchet, holding it out until part of the downward stroke is accomplished, when it is allowed to fall back on the drum; and in order to secure its engagement with the ratchet, the end of the pawl P^1 strikes a toe, p^2, on the lower end of the stop-pawl, forcing it down and the upper end of the pawl into the teeth of the ratchet.

By this arrangement it is impossible for the drum to move a greater distance than one tooth for each reciprocation of the actuating-pawl. The upper end of the lever P is divided into two branches, the upper one, P^3, riding above the actuating-cam b^4, while the lower branch, P^4, lies against the under side of the retracting-cam b^5. The two cams are so shaped that both forks of the lever are always pressed against them, any wear being compensated for by moving the steel block p^4, which is held down by set-screws, thus imparting to the lever a positive motion.

During some portions of the work it is desirable to stop this step-by-step motion of the pattern-cylinder, as in plain knitting. By stopping the movement of the pattern-cylinder I am enabled very materially to diminish the size of the pattern-cylinder required in case the cylinder should rotate continuously. To attain this end I mount a peculiarly-constructed right-and-left screw, q, (shown in Figs. 34, 37, 38, and 40.) upon a frame, R, and impart an intermittently-rotating movement to it by means of a toothed wheel, q', upon its upper end, actuated by a cam, B^5, on the inner face of the crank-wheel B^1, which cam acts upon the teeth once during each revolution of the driving-shaft B.

A plate, Q, pivoted vertically upon the inner side of the frame R, carries at its upper end an arm, Q^1, which projects through an opening in the main frame, and stands between the pattern-cylinder and its actuating-pawl P^1, holding the latter out of contact with the ratchet when it is desired that the drum should remain stationary. (See Figs. 34 to 42.)

A block or traveler, S, reciprocates in a slot, R^1, of the frame, and rocks upon its projecting pins s s^1, which traverse grooves r r' in the frame in each side of the slot. At the ends of this traveler are lugs S^1 S^2, which alternately traverse between the threads of the right and left screws, being cut at proper angles to fit therein, and through which the traveler acquires its reciprocating movement, the lug S^1 being engaged with the left-hand screw while the traveler is on its upward move, (see Fig. 38,) but is thrown out of contact therewith by the inclined plane or cam T' on the collar T at the

upper end of the screw, while at the same instant the lug S^2 on the other end of the traveler is thrown into engagement with the right-hand screw, and the traveler moves downwardly until the lug S^2 rides upon the inclined plane t^1, when its movement is again reversed.

The threads of the right and left screws are partially cut away at intervals, as shown at t^3 and t^4, Figs. 34, 38, and 40. At each end of the traveler, just inside of the lugs, are loose pieces S^3 and S^4, which project through it and have a slight endwise motion therethrough, limited by their flanges on either side of said traveler, which is recessed on its side next the screw to permit the flanges to sink until their outer surfaces are flush with the surface of the traveler. One of these pieces, when in action, rides with one end bearing upon the surface of the screw, and the other against the under side of the plate Q, while the other piece, through the rocking of the traveler, is moved entirely out of reach of the screw and straddles the plate Q with the groove like s^3, Fig. 40. So long as the piece S^3 rides upon the cut-away portion of the screw, the plate Q remains in the position shown in the drawings, allowing the pawl to engage with the ratchet; but as soon as it rides upon the incline t^5, Fig. 40, it is pushed away from the center of the screw, crowding out the plate, and moving the arm Q^1 until it pushes the pawl out of engagement with the ratchet, where it holds it until the plate Q is again released by the pin S^4 riding upon a cut-away portion of the other screw on the return movement of the traveler.

The reversal of the movement of the traveler takes place only when plain knitting is being done and when the pattern-drum is not at work.

The plate Q has two extensions, Q^2 Q^3, which extend partly over the loose pieces S^3 S^4, and are acted upon by them. While the loose piece S^3 is riding against the inner side of the extension Q^2 the piece S^4 partly straddles the extension Q^3, as before described; but when the traveler reaches the upper end of its movement, the position of the pieces is changed by the reversal and rocking of the traveler, and on the downward movement the piece S^4 is the one which rides between the screw and plate, while the piece S^3 will straddle the projection Q^2. This change or reversal of the position of the pieces can only be effected when they have both passed the ends of the extensions and while the pattern-drum is stationary.

If some provision were not made for keeping the plate in its outward position when the loose pieces pass from under the extensions, as they do just before changing positions, the actuating-pawl would be forced by its spring into engagement with the ratchet, and the pattern-drum would be moved at an improper time; but to obviate this difficulty the lug S^5 in the middle of the traveler will have passed fairly under the extension before the active loose piece leaves it, and holds it in its proper position until, on the return movement of the traveler, the other loose piece is under its extension, and in position to act upon it.

The dropping of the plate by the lugs riding upon the cut-away portions of the screw-threads, and the consequent releasing of the actuating-pawl, can only be effected while the lug S^5 is crossing the space between the two extensions, as its top lies in the same plane with the top of the working loose piece when the latter is riding upon the full part of the screw-thread.

The groove r, through which the fulcrum-pin s of the traveler moves, is formed in the frame itself, (see Fig. 40,) while the groove r', traversed by the pin s^1, is formed by a longitudinal depression in the frame, covered by the plate R^2. On the side of the lug S^2 is a pin or stud, S^6, which moves either above or below the plates R^3 R^4, maintaining the traveler in the position to which it has been rocked, thereby insuring the proper engagement of the lugs S^1 S^2 with the screw-threads. When the traveler is moving upward, as shown in the drawings, this pin rides under the plates in the groove r'; but when it has reached the limit of its upward movement and is about to be rocked by the cam T^1, the pin will have passed the upper end of the locking-plates, leaving the traveler free to rock, which it does, changing the pin from a plane beneath the plates to one above them. In the downward movement it rides outside of the plates, holding the lug S^2 down to its work between the screw-threads until the limit of its downward motion is reached, when a reversal similar to that just described takes place.

By adjusting the collars T t at the upper and lower ends of these screw-threads, respectively, the traverse of the traveler S is shortened or lengthened, thereby diminishing or increasing the length of plain knitting; consequently by adjusting one or the other of these collars I am enabled to vary the length of the leg without changing the length of the foot, or vice versa.

In order to permit of the adjustment of the length of movement of the traveler, and still have the pin S^6 work effectively during the entire traverse, the locking-plate is composed of two parts, R^3 R^4, secured to the frame by two screws, R^5, which pass through slots in both plates. For any change in the movement of the traveler a similar change should be made in these plates.

If the collar T is moved upward and the movement in this direction lengthened, the outer plate, R^3, should be moved up a corresponding distance, while, should the collar t be moved and the downward movement of the traveler lengthened, the under plate, R^4, should be moved correspondingly.

Mounted upon and securely fastened to the front and back needle-beds at a point near their inner edges, or those nearest the center of the machine, are two longitudinal bars or guide-pieces, U, of a peculiar shape, (see sections in Figs. 5, 10, 11, 12, 28, and 29,) which

serve to guide the yarn-carrier V, to support the point of the needle when it is projected across the opening F in its most advanced position, to guide and support the presser-hooks X, to carry the swinging frames W, which carry and guide the presser-hook cams W^2 in their reciprocating movements, and to hold the needles and their jacks down to their work at all times.

The base upon which each guide-piece rests on its needle-bed consists of two parts, lying in different planes, the lower part being just far enough above the bottom of the needle-groove to form a box-guide, in which there is only sufficient room to allow the needle to reciprocate freely, while it has no chance to move either sidewise or vertically out of its proper course. The upper part of the base lies in a plane elevated far enough above the lower part to permit the hook K^2 on the end of the needle-jack to run freely under it. (See front needle-jack in Fig. 5, and rear jacks in Figs. 10, 11, and 12.)

In the case of the front set of needles this arrangement is only made to allow the jack to advance its full stroke; but in the arrangement of the back set of needles this upper part of the base of the guide, in addition to this, performs the important function of holding the upper or hook end of the jack down to the bottom of the needle-groove, and into engagement with the hook on the end of the needle, while its other end is lowered and locked by the rocking lever O, and the shank of the jack is depressed below the surface of the grating *a* on the needle-bed, (see Fig. 12,) thus preventing any chance of the jack accidentally rising and becoming disengaged from the hook on the needle by this operation.

Alternating with the needles are a series of hooks, similar in general features and functions to those shown in Letters Patent No. 170,468, granted November 30, 1875, to Burson and Nelson; but the arrangement and operation of these hooks, relatively to the other parts of the machine, differs somewhat from that shown in the patent aforesaid.

In the accompanying drawings these hooks are shown as forming parts of elbow-levers X, rocking on pivots U^1, which extend the entire length of the guide-bars. These levers rock in and are guided by slots in the guide-bars, (see Figs. 28 and 29, which illustrate the back presser-hooks,) and have in their upper ends, which extend a short distance above the surface of the guide-bar U, slots X′, through which the actuating-cam W^2 glides. This cam is formed on a downward projection of the bar W^1, (see Fig. 30,) which reciprocates in suitable bearings in the swinging guides W, and is actuated by a pin which rides between the arms of the slotted hook W^3 on the face of the bar W^1, and receives its motion from the saddle C, as will be hereinafter more fully explained.

The hooks X normally lie as shown in Figs. 5 and 29, and are held down in this position by the cam W^2 while its straight parts are moving through the slot X′; but they are raised and lowered when the curve W^2 (shown in Fig. 30) is passing through them, and again held down by the straight part following said curve.

The swinging guides W are supported by curved arms, which extend into recesses near each end of the guide-bars U, and are pivoted on the pin U^1, that the levers X rock upon, thus permitting any adjustment of the position of the hooks without altering the relative positions of the cams and elbow-levers.

The swinging guides bear back against and are adjusted by the eccentrically-shaped heads of the pins W^4, which fit rather tightly in holes in the stationary guide-bars U, and are grooved across the heads like screws, to enable them to be turned by a screw-driver. By this device the swinging guides can be moved toward or away from the center of the machine, as desired, and by so doing the presser-hooks are raised or lowered to any desired position. In addition to its other functions, the guide-bar U, on which the yarn-carrier slides, acts as a support to the needles during the upper portion of their stroke, thus insuring their working in a uniform plane, and supporting them securely against the pressure of the usual shoe on the yarn-carrier.

The yarn-carrier V, sliding in grooves in the guide-bars U, carries at either end pressure-shoes V^1, which ride over and bear down upon the needles when in their advanced position, (see Fig. 5,) holding them firmly down to the supporting-ledge U^2, while the horns V^2 on the under side of the carrier pass through the hooks on the ends of the needles, and throw back any of the latches which may have become accidentally closed. As soon as the horn has passed entirely through the hook of a needle the latter commences its retracting movement, and by the time the hole in the carrier (through which the yarn is fed) passes over the needle the pivot of the needle-latch will be directly under the hole, and the yarn which is being fed through will lie upon the upper surface of the needle before it is seized by the hook.

The yarn-carrier is actuated by a pin, c^1, which projects from the under side of a lever pivoted to the saddle C, and rides in the space between the end of the upright flange V^3 on the side of the carrier and the lug V^5, which projects sidewise from the end of the rocking lever V^4, which is pivoted on the outer side of the upright flange, as shown. This lever is held in the position shown in the drawings by the spring V^6, secured to the top of the flange.

The tail of the lever V^4 projects a short distance beyond the end of the carrier, and has a notch, V^7, on its under side, about midway between the end of the carrier and the end of the lever, with an incline extending from the notch to the top and end of the lever, the notch and incline being for a purpose which will be hereinafter more fully explained.

It is necessary in the organization of this machine that the yarn-carrier should travel in advance of the presser-hook cams, while these travel slightly in advance of the needle-cam slides, and this involves a reversal of their relative positions at the end of each stroke. These ends I attain by actuating the presser-hook cams W^2 by means of pins *c*, which project downwardly from the under side of the levers C^1 C^2 and ride in the slotted hooks W^3 on the face of the cam-bars W^1, and by actuating the yarn-carrier by means of the pin c^1, projecting from the under side of the lever C^1 and riding between the end of the upright flange on the yarn-carrier and the end of the lever V^4, pivoted thereto. The levers C^1 C^2 are pivoted at the outer ends of the reciprocating saddle C, (which connects and actuates the needle-cam slides D E,) and are pin-jointed at the center, to enable them to be controlled and acted upon simultaneously by the leg C^3 of the lever C^1. This leg C^3 projects downward and away from the saddle, as shown in Figs. 1, 3, and 4, and carries at its lower extremity a stud, c^2, which projects from the under side of the lever and traverses the grooves in the top of the channel-plate or top cam-plate, Y, the details of which are fully shown in Figs. 25, 26, and 27. While the saddle is advancing in its outward movement and the yarn-carrier is over the needles, the stud on the end of the lever C^3 will traverse the straight groove y^1 in the plate Y; but when the yarn-carrier has passed over all the needles, and the saddle is nearing the end of its outward movement, the stud will run into the groove y^2, which lies at an angle to the groove y^1, passing over and depressing a spring-latch, Y^1, which lies in the groove, and springs up behind the stud as soon as it has passed into the groove y^3, thereby preventing it from re-entering the groove y^2 on its return movement. This change in the path of the stud from the groove y^1 to y^3 causes the lever by which it was carried to vibrate on its pivots C^4, thereby vibrating the levers C^1 and C^2, and through them causing the yarn-carrier and presser-hook cams W^1 to reverse their relative positions with respect to each other and the needle-cams. On the return movement of these parts the stud will traverse the straight groove y^3 until the yarn-carrier has reached the end of its movement, when it passes through the angular groove y^4, corresponding in every particular to the groove y^2, which causes a reversal of the relative positions of the parts similar to that just described.

I find it desirable to stop the reciprocation of the yarn-carrier at one end of the stroke every time the sock is finished, in order to throw off the finished sock preparatory to the commencement of a new one. This object I effect by disconnecting the yarn-carrier from its actuating-pin c^1 automatically, as follows: A lever, Z, pivoted at Z^1 on the side plate A^2 of the frame, extends to a point just beyond the back of the frame, where it is bent nearly to a right angle, and extends in toward the pattern-drum, near the side of which it is again bent, and extends a short distance at the same angle, and in a plane parallel with the main portion of the lever Z. This section of the lever carries a stud, Z^2, which projects from its inner side and rides upon the inner surface of the pattern-cylinder, being held there by the action of the spring Z^3.

The upper end of the lever Z, in its normal condition, lies with its upper horizontal edge flush with the top surface of the guide-bar U, along which surface the lever V^4 on the yarn-carrier slides until the notch V^7 in its under side lies directly over the end of the lever Z. When the sock being knit is completed and ready to be thrown off, the yarn-carrier travels as usual on its outward course; but while it is on the return movement the pin Z^2 on the lever Z rides upon a cam or wiper, G^7, on the inner surface of the pattern-cylinder, which, after vibrating the lever and elevating its upper end above the surface of the guide-bar U, holds it in such a position that as the yarn-carrier approaches the end of its return stroke the incline on the under side of the lever V^4 will ride up on it until the notch V^7 falls over it, thus securely locking the yarn-carrier until it is released by the lowering of the lever Z to its original position.

The action of the incline on the tail of the lever V^4 rocks the lever and lowers its other end to such a position that the projection V^5, which before lay directly in front of the actuating-pin c^1, will be so depressed that the pin at its next reciprocation of the saddle will move over it, leaving the yarn-carrier at rest and securely locked by the lever Z, where it remains during one reciprocation of the saddle, in which the knit sock is thrown off, and the needles are left free to commence a new one. While the saddle is making this throwing off reciprocation, or rather during the return movement thereof, the pattern-cylinder is moved one step, permitting the pin Z^2 to ride off the wiper G^7 and into its original or normal position against the inner side of the cylinder, causing the lever Z to resume its former position, thereby unlocking or releasing the lever V^4 on the yarn-carrier, which resumes its former position and awaits the return of its actuating-pin c^1. When the pin nears the end of its stroke it rides over the incline on the face of the projection V^5, and into its working position between the projection and the end of the upright flange on the yarn-carrier, the lever V^4 rocking down while the pin is passing over the projection on its end.

A pin, U^3, passing through the upper flange and across the guide-groove of the yarn-carrier in the front guide-bar, U, (see Figs. 1 and 4,) serves as a stop to hold the yarn-carrier in position while the actuating-pin c^1 is passing over the projection V^5 on the end of the spring-lever. Without this stop-pin the yarn-carrier

would not offer resistance enough to enable the actuating-pin c^1 to depress the projection on the end of the spring rocking lever V^4.

Yarns of different size or colors are supplied to the needles by shifting yarn-carriers constructed and operated substantially as shown in an application for Letters Patent filed by me December 18, 1875, and consequently need not be described in detail here.

The operation of the machine is as follows: The yarn-carrier is supplied with yarns of the desired size and color, and the yarn of which the toe of the sock is to be composed is automatically fed through a distributing-eye, which is done by the first movement of the machine, as explained in my application above mentioned. Before the yarn-carrier moves, however, both sets of needles are simultaneously thrown up, instead of one set being thrown up at a time, as usual, and as the yarn-carrier passes over the needles the yarn is seized by them, and also by the depresser-hooks, those on the back side being bent sidewise, as shown in Fig. 7, in order to catch the yarn the first time. Both sets of needles now retire with the yarn engaged, and the hooks hold the yarn down to the needles, as in the Burson and Nelson patent aforesaid, the front set of needles remaining quiescent, while the knitting proceeds with the back set.

Owing to this peculiar method of commencing the formation of the fabric, I am enabled to drop off the finished sock as soon as completed, and to start anew without the necessity of having a formed fabric to which to attach the new stitches. I am also enabled to prevent leaving an open slit across the toe, which would otherwise occur.

The front set of needles being thrown out of action, as above described, the back set continue to knit back and forth on the toe of the sock, commencing at a point about the line of the back of the toes in the human foot and knitting first the top of the toe of the sock, narrowing as the knitting progresses, and knitting the bottom of the toe part, widening from the toe backward until a point is reached opposite to that at which the knitting began. The front set of needles is then thrown into action, but so as to knit one way only, and, in fact, they never knit but in this one way, while at the same time the action of the back set of needles is changed so as to cause them to knit but one way only, and that way the reverse of the front set, the result of which is the production of a tube, forming the foot part of the sock up to the point where the heel part commences, the sock being gradually widened up to this point by gradually increasing the looseness of the stitches. The front set of needles is again thrown out of action, as in forming the toe; the action of the back set of needles is changed so as to cause them to work both ways; the old thread is cut off, a heavier one substituted, and the heel is formed, more or less of the outer needles being thrown out of action, as required, to round the heel. When the heel is completed the heavier yarn is cut off, another one is substituted; the action of the back set of needles is changed so as to cause them to knit one way only; the front set of needles is thrown into action, and the knitting progresses as before, and continues until the sock is finished. These various changes are produced in their required order by variations in the cams on the pattern-cylinder, as will readily be understood by skillful operators from the foregoing description.

In knitting with different-colored yarns the yarn is changed automatically as often as desired without interrupting the operation of the knitting in the manner described in my application of December 18, 1875, above mentioned. As soon as the sock is finished the yarn-carrier is stopped, the finished sock dropped from the needles, both sets of needles are thrown up, and the formation of a new sock commences, as hereinbefore described.

The result of this operation is the production of a sock such as described in Letters Patent No. 156,838, granted November 17, 1874, to Burson and Nelson.

The advantages of my improvements will be so obvious to those skilled in the art, from the foregoing description, as to need no further elucidation.

It is obvious that by slight modifications of the organization of mechanism above described I can adapt the machine to the knitting of mittens, caps, and other articles of different shapes.

What I claim as my invention, and desire to secure by Letters Patent, is—

1. The combination, substantially as hereinbefore set forth, with the needle-beds and the guide-pieces mounted thereon, of the needles and the yarn-carrier provided with the presser-shoe and latch-opener, whereby the needles are properly guided and are pressed down and held upon the said guide-pieces in the path of the latch-opener.

2. The combination, substantially as hereinbefore set forth, with the yarn-carrier provided with a spring-hook, the guide-pieces for supporting the same, the saddle, and mechanism for imparting thereto a reciprocating movement, of a pattern-cam, a tripping-lever actuated thereby, and a detachable mechanism by means of which the yarn-carrier is connected to the saddle.

3. The combination, substantially as hereinbefore set forth, with the needle-beds and the guide-pieces mounted thereon, of the yarn-carrier guided between the latter and over the opening between the beds, the needles arranged to work across said opening, the presser-hooks interposed between the needles, and mechanism for imparting to said yarn-carrier, needles, and presser-hooks their appropriate movements.

4. The combination, substantially as herein-

before set forth, with the yarn-carrier, the needles, the presser-hooks, and the needle and presser-hook operating cams, of the crank-wheel, its pitman, and the necessary connecting mechanism, whereby the proper movements are communicated to the several parts mentioned from a single crank.

5. The combination, substantially as hereinbefore set forth, with the yarn-carrier and the needle and presser-hook operating cams, of the saddle which connects the two needle-operating cams, the levers for operating the yarn-carrier and presser-hook cams, the top cam-plate for actuating said levers and the necessary supporting, connecting, and operating mechanisms, whereby the proper reciprocating movement is communicated to the saddle and the yarn-carrier, the presser-hook and needle-operating cams are caused successively to follow each other to the end of the stroke, to reverse their relative positions, and again to follow each other on the back stroke, for the purposes specified.

6. The combination, substantially as hereinbefore set forth, with the needle-bed, the needles, and their jacks, of the rocking levers in which the jacks traverse and mechanism for controlling such rocking levers.

7. The combination, substantially as hereinbefore set forth, with the needle-bed, the needles, and the needle-jacks interlocking therewith, of the rocking levers in which the needle-jacks slide, provided with the notches o^4 in the guideways thereof, the swinging supports for the needles, and mechanism for raising and lowering the same.

8. The combination, substantially as hereinbefore set forth, with the needle-bed, the needles, and the needle-jacks, of the rocking-levers for carrying the said needle-jacks, provided with the notches in the guideways thereof, the pattern-drum, and mechanism for rotating the same, whereby any desired needle may be thrown out of operation while at the upper end of its stroke and be positively locked in that position.

9. The combination, substantially as hereinbefore set forth, with the needle-bed, the needles, and the needle-jacks, of the rocking levers for carrying the jacks, the pattern-drum provided with independent cam-grooves for each of the said rocking levers, and mechanism for rotating said pattern-drum, whereby, in the operation of narrowing, the proper needles are successively thrown out of action and are positively locked while at the upper end of their stroke.

10. The combination, substantially as hereinbefore set forth, with the guide-pieces U U, the presser-hooks working therethrough, and the cams and slides for operating the same, of the frames for supporting and guiding the said cams and slides and mechanism for adjusting such frames, whereby the said presser-hooks may be raised or lowered.

11. The combination, substantially as hereinbefore set forth, with the guide-pieces U U, the presser-hooks working therethrough, and the cams and slides for operating the same, of the frames for supporting and guiding the said cams and slides pivoted to the guide-pieces U U, and the eccentrics for adjusting the said frames, whereby the presser-hooks may be raised and lowered to adjust them to tight or loose knitting.

12. The combination, substantially as hereinbefore set forth, with the needle-depressing cam E^2, the front set of needles, and the pattern-drum, of the shifter-bar F^1, the rocking frame for supporting the same, and the adjustable lever connection between said rocking frame and the pattern-drum, whereby the said depressing-cam is automatically shifted and the machine thereby caused to knit a tight or loose fabric.

13. The combination, substantially as hereinbefore set forth, with the needle-bed A^4, the back set of needles, their operating-jacks, and the pattern-drum, of the cam-slide D, provided with the fixed cam D^2, the movable cam D^3, shifter-bar F^2, and connecting mechanism intermediate the pattern-drum and said shifter-bar.

14. The combination, substantially as hereinbefore set forth, with the cam-slide E, the flexible or spring cam E^1, mounted thereon, and the pattern-drum, of a pivoted lifting-wedge interposed between such cam and the cam-slide, and connecting mechanism intermediate the pattern-drum and the lifting-wedge, whereby the said cam is adjusted toward or from its carrying-slide, and the needles are automatically thrown into and out of operation at the proper times.

15. The combination, substantially as hereinbefore set forth, with the pattern-drum, its operating-pawl, and cams for actuating the same, of a right and left screw and mechanism for rotating the same, and intermediate devices between said screw and the operating-pawl, whereby said pawl is removed from engagement with the pattern-drum, and is caused to engage therewith at predetermined periods, according to pattern.

16. The combination, substantially as hereinbefore set forth, with the pawl for operating the pattern-drum, the right and left screw, and mechanism for rotating the same, of the rocking frame provided with a projecting arm for engagement with the said pawl, and intermediate devices between said rocking frame and the right and left screw.

In testimony whereof, I have hereunto subscribed my name.

JOHN NELSON.

Witnesses:
E. C. DAVIDSON,
H. T. EARNEST.