No. 617,039. Patented Jan. 3, 1899.

J. F. NELSON.

KNITTING MACHINE.

(Application filed Dec. 29, 1897.)

(No Model.) 25 Sheets—Sheet 1.

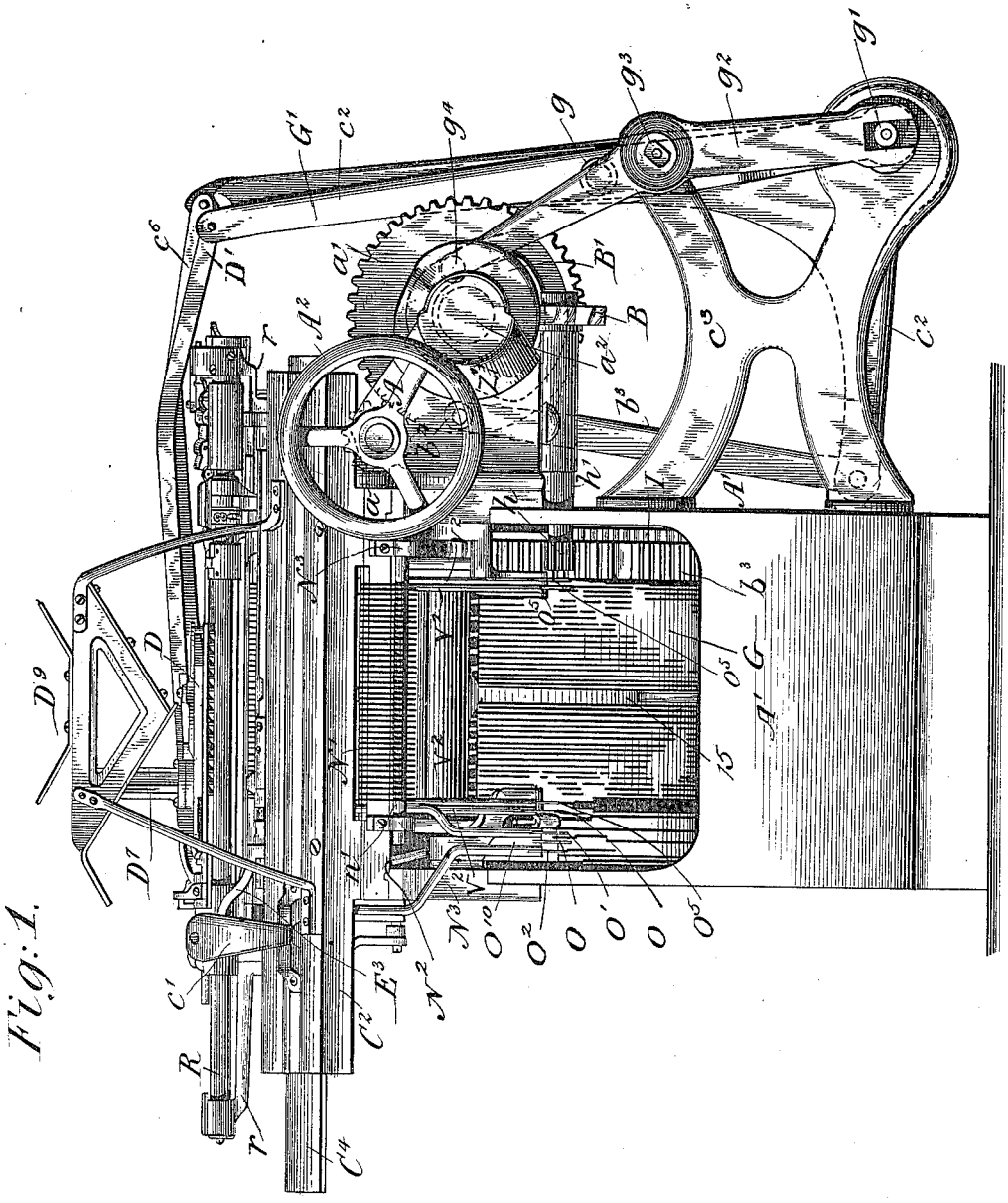


FIG. 1.

Witnesses
E. A. Bullock
Guy E. David.

Inventor
John F. Nelson,
By his Attorneys,
Baldwin Davidson & Wright

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

No. 617,039. Patented Jan. 3, 1899.

J. F. NELSON.

KNITTING MACHINE.

(Application filed Dec. 29, 1897.)

(No Model.) 25 Sheets—Sheet 2.

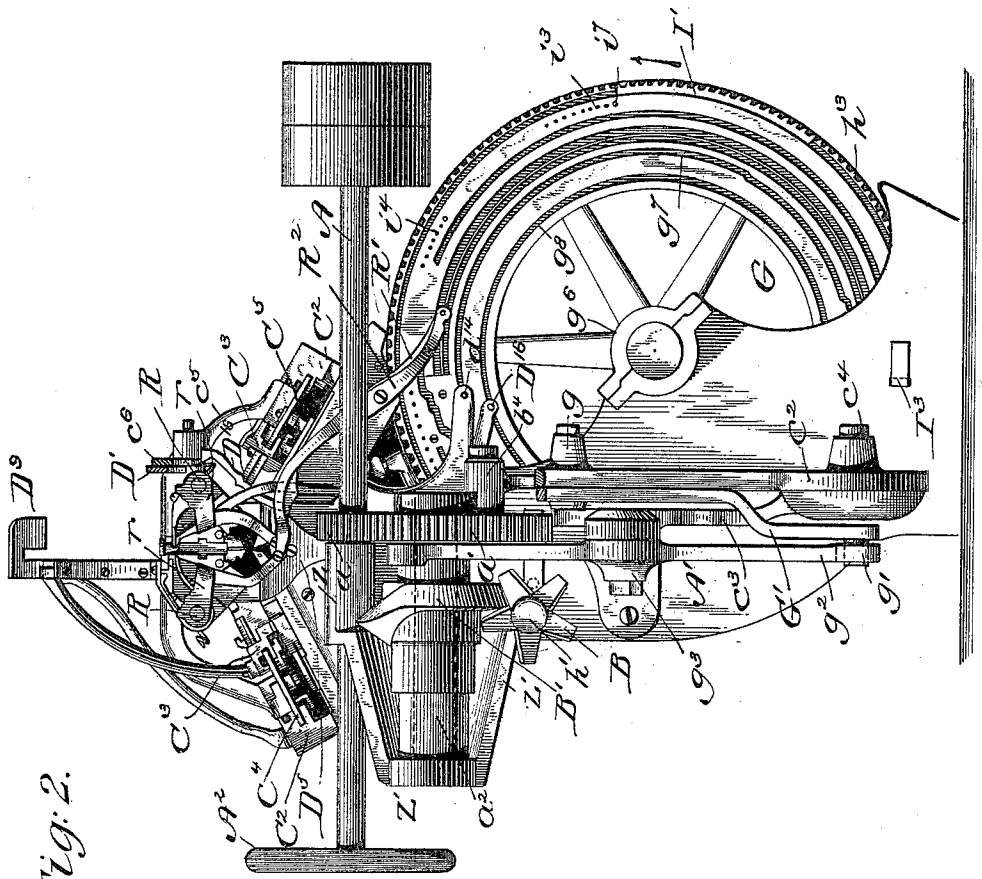


Fig. 2.

Witnesses
E. A. Bullock
Guy E. Davis.

Inventor
John F. Nelson,
By his Attorneys,
Baldwin, Davidson & Wright.

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

No. 617,039. Patented Jan. 3, 1899.

J. F. NELSON.

KNITTING MACHINE.

(Application filed Dec. 29, 1897.)

(No Model.) 25 Sheets—Sheet 3.

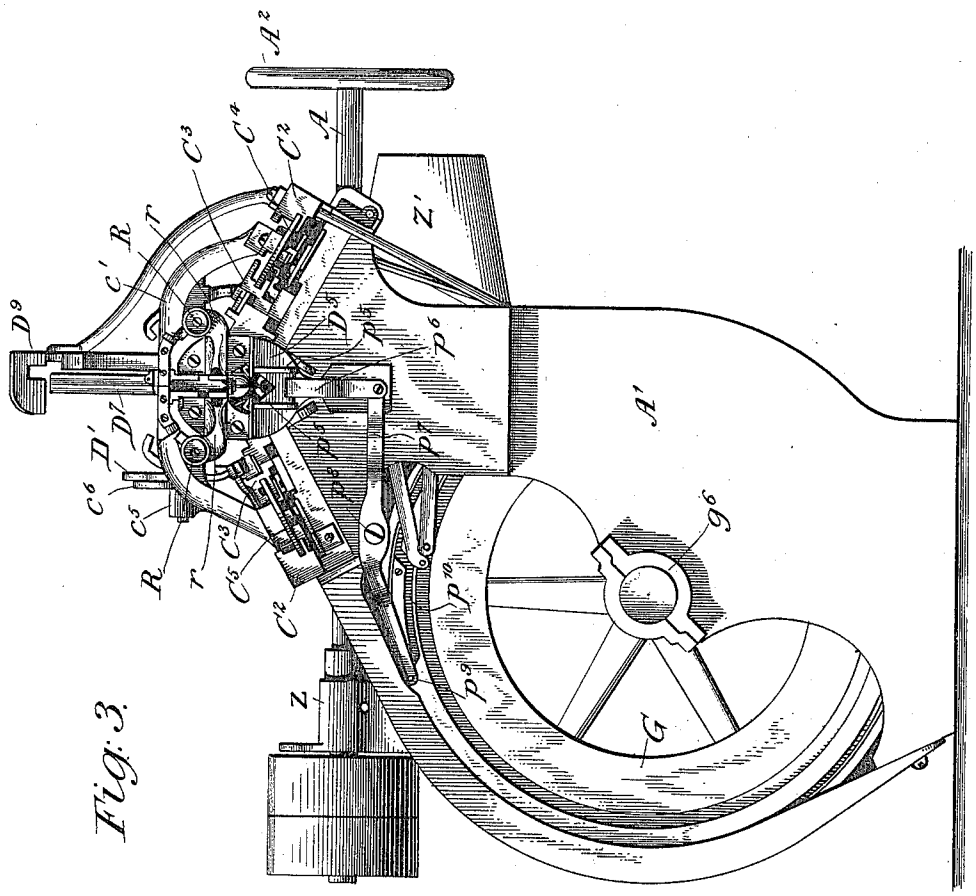


Fig. 3.

Witnesses
C. A. Bellocle.
Guy C. David.

Inventor
John F. Nelson,
By his Attorneys,
Baldwin, Davidson & Wright.

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

No. 617,039. Patented Jan. 3, 1899.

J. F. NELSON.

KNITTING MACHINE.

(Application filed Dec. 29, 1897.)

(No Model.) 25 Sheets—Sheet 4.

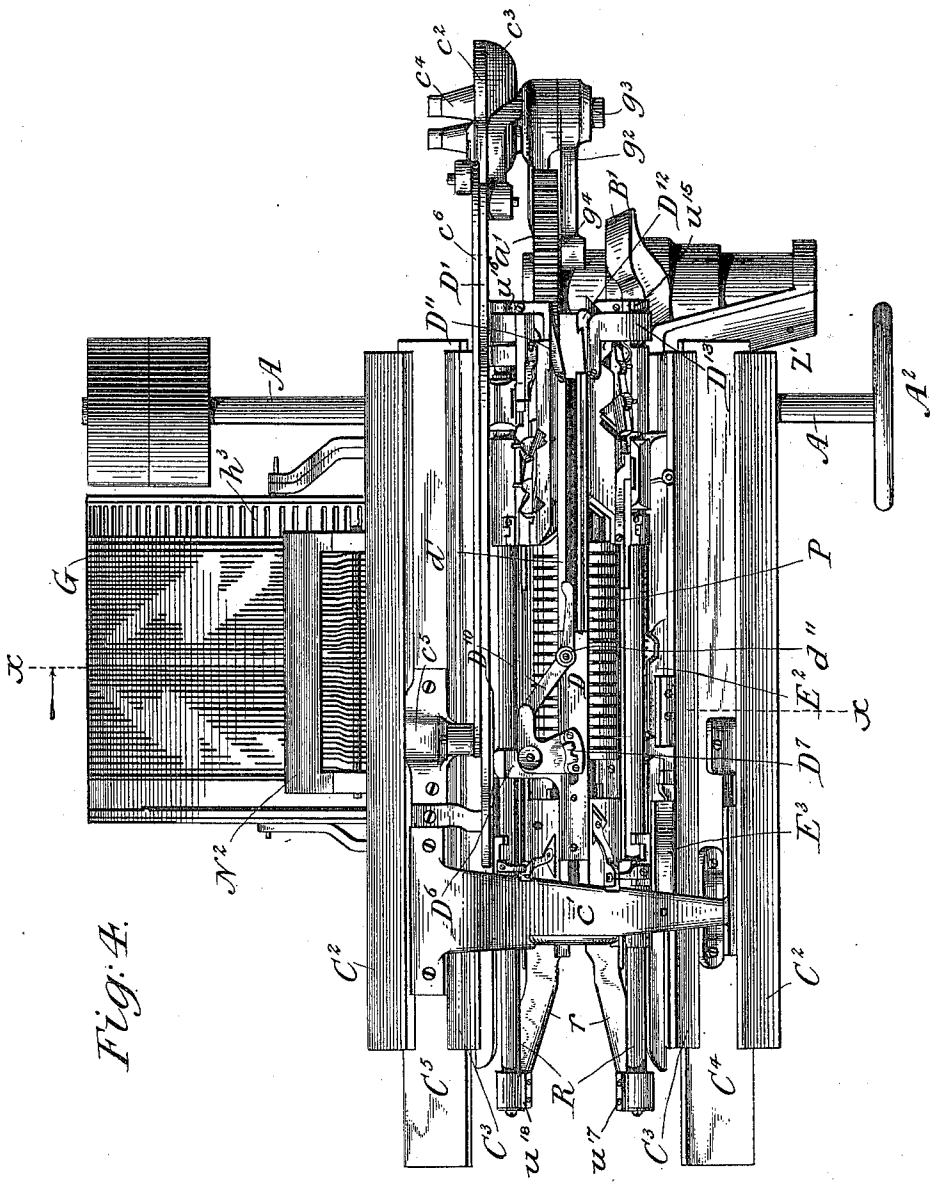


Fig. 4.

Witnesses
E. A. Bullock.
Guy E. Davis.

Inventor
John F. Nelson,
By his Attorneys,
Baldwin, Davidson & Wright.

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

No. 617,039.

Patented Jan. 3, 1899.

J. F. NELSON.

KNITTING MACHINE.

(Application filed Dec. 29, 1897.)

(No Model.)

25 Sheets—Sheet 5.

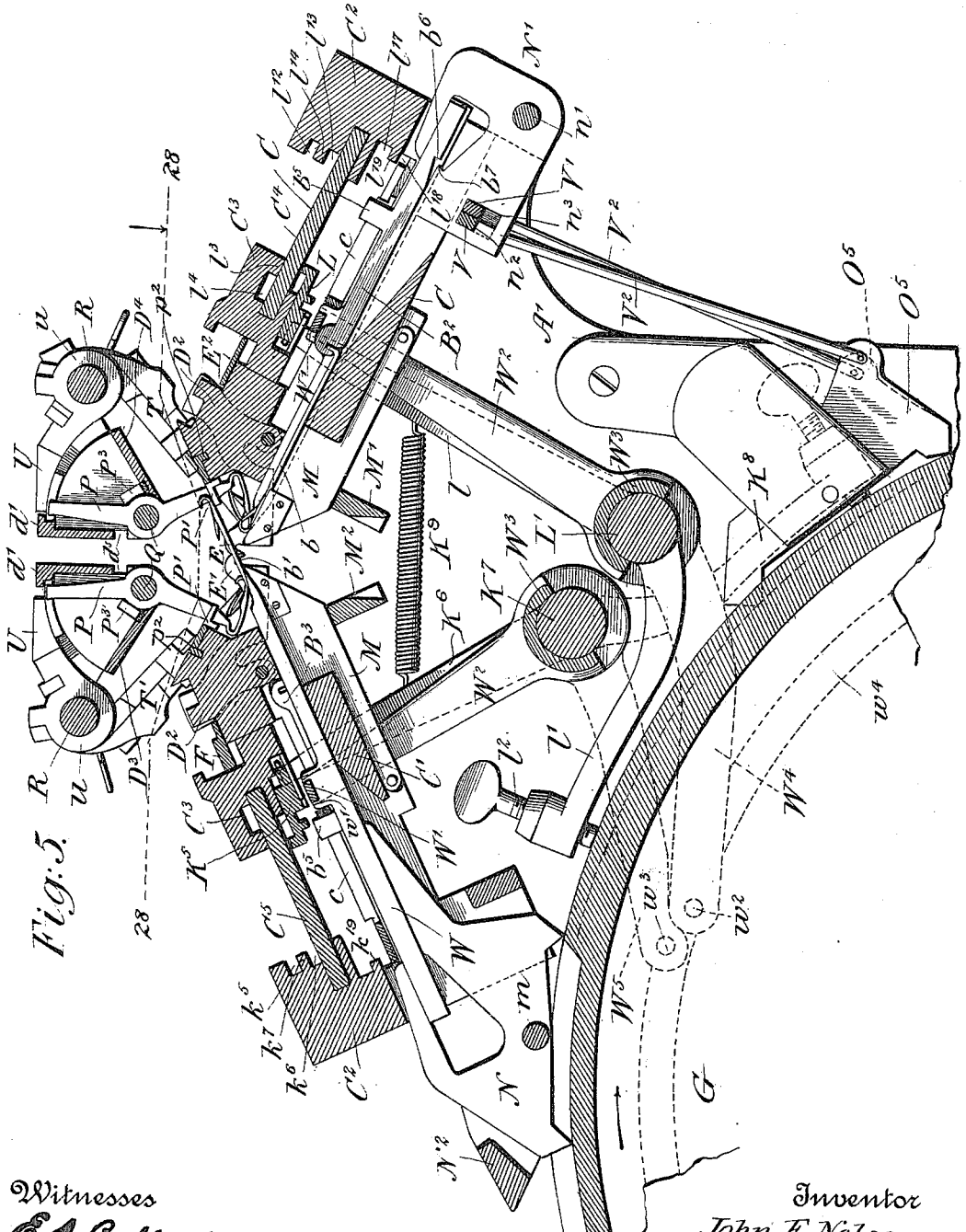


Fig. 5.

Witnesses
E. A. Ballocks
Guy E. Davis.

Inventor
John F. Nelson,
By his Attorneys,
Baldwin Davidson & Wright

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

No. 617,039. Patented Jan 3, 1899.

J. F. NELSON.

KNITTING MACHINE.

(Application filed Dec. 29, 1897.)

(No Model.) 25 Sheets—Sheet 6.

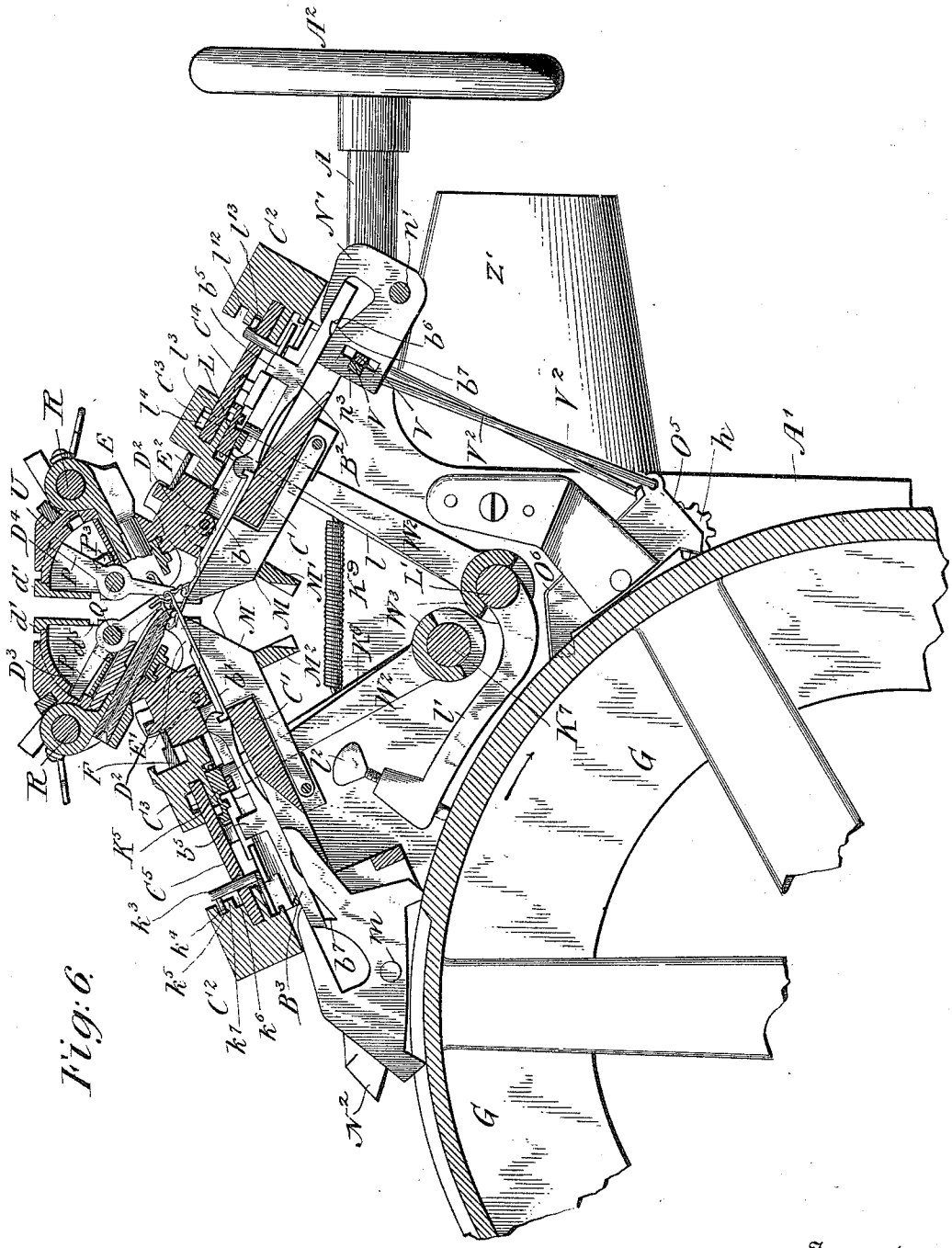


Fig. 6.

Witnesses
E. A. Balloch.
Guy E. David.

Inventor
John F. Nelson,
By his Attorneys,
Baldwin, Davidson & Wright.

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

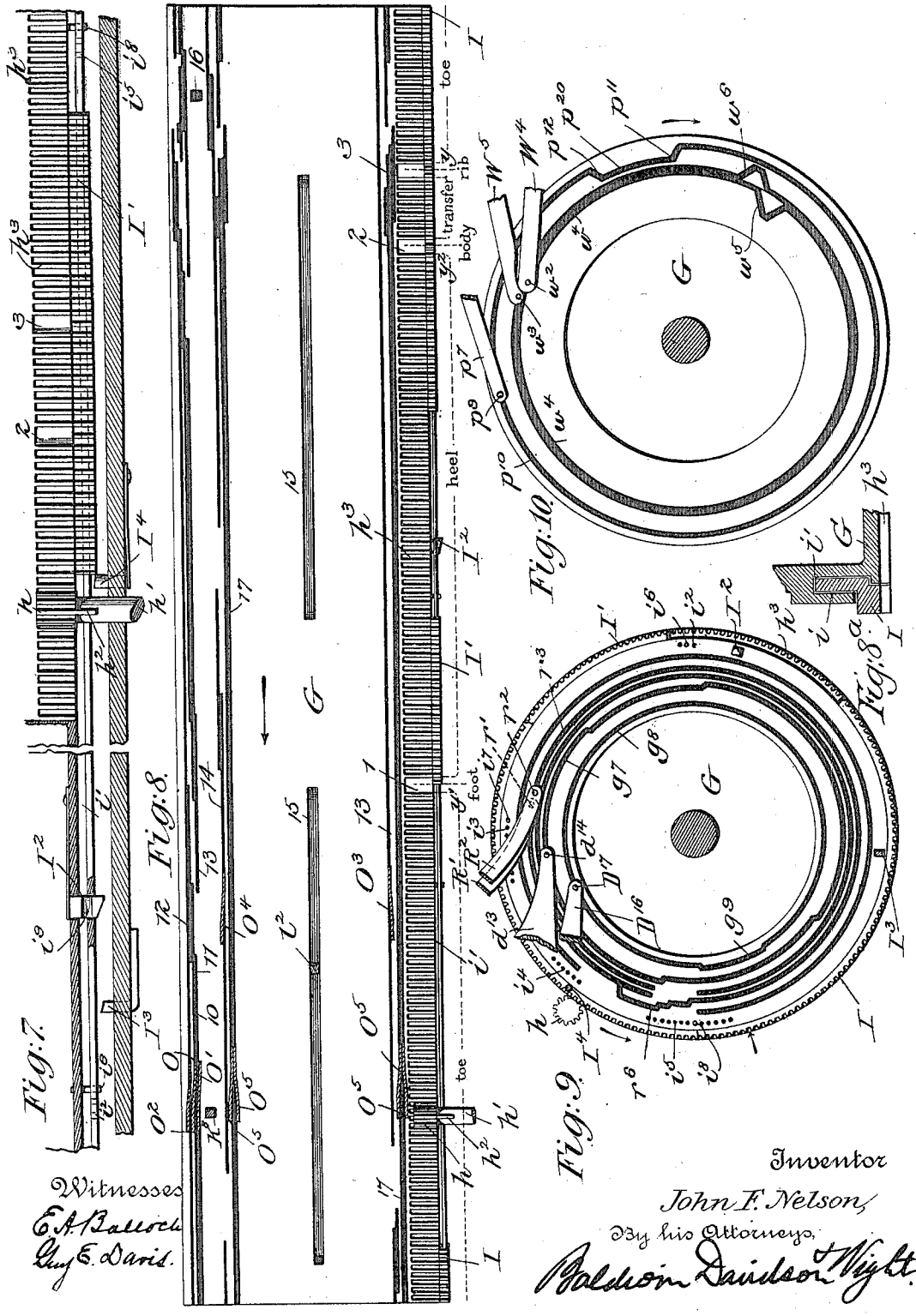
No. 617,039. Patented Jan. 3, 1899.

J. F. NELSON.

KNITTING MACHINE.

(Application filed Dec. 29, 1897.)

(No Model.) 25 Sheets—Sheet 7.



Witnesses
E. A. Bullock
Guy E. Davis.

Inventor
John F. Nelson,
By his Attorneys,
Baldwin Davidson & Wight

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

No. 617,039. Patented Jan. 3, 1899.

J. F. NELSON.

KNITTING MACHINE.

(Application filed Dec. 29, 1897.)

(No Model.) 25 Sheets—Sheet 8.

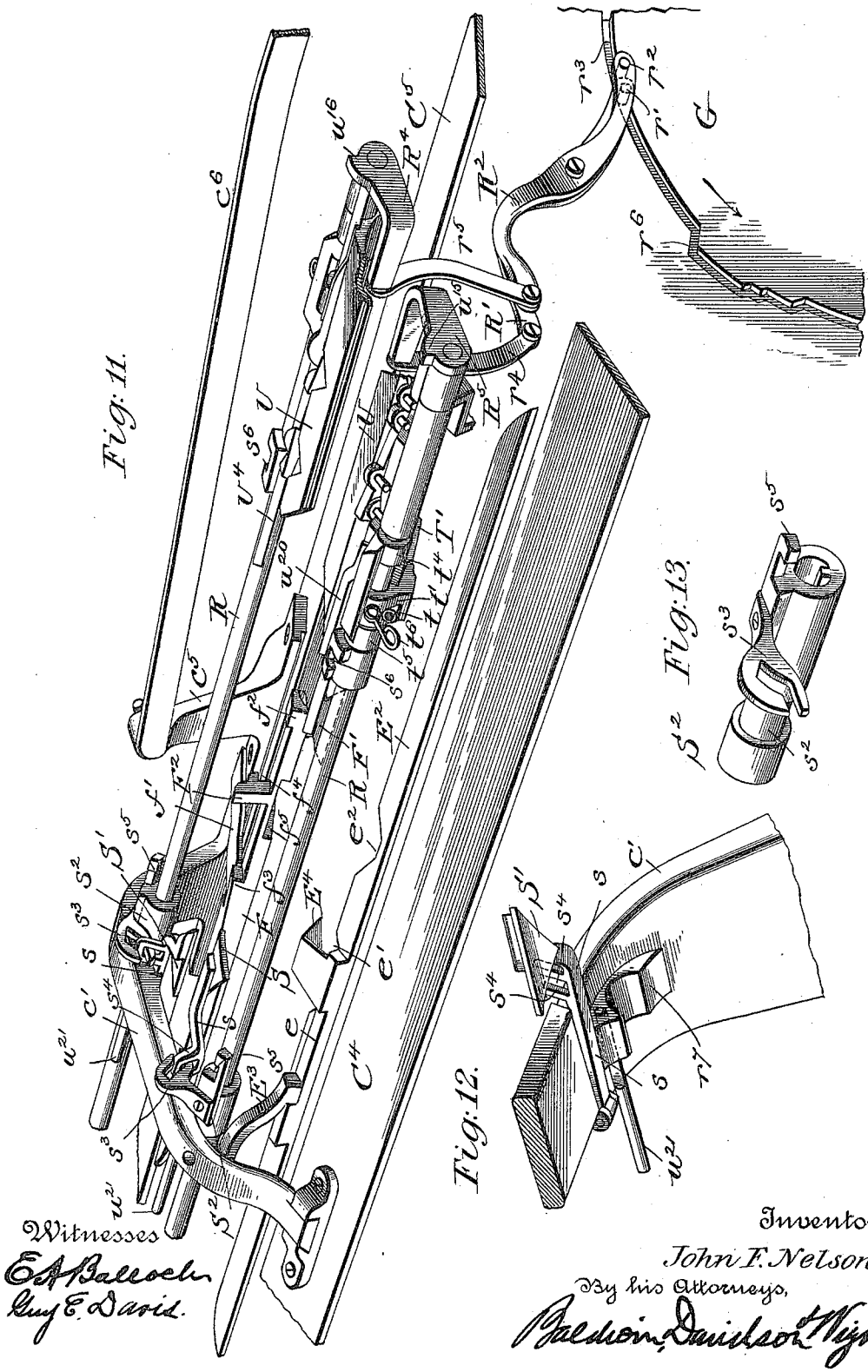


Fig. 11.

Fig. 13.

Fig. 12.

Witnesses
E. A. Balloch
Guy E. David.

Inventor
John F. Nelson,
By his Attorneys,
Baldwin, Davidson & Wright.

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

No. 617,039. Patented Jan. 3, 1899.

J. F. NELSON.

KNITTING MACHINE.

(Application filed Dec. 29, 1897.)

(No Model.) 25 Sheets—Sheet 9.

Fig. 14.

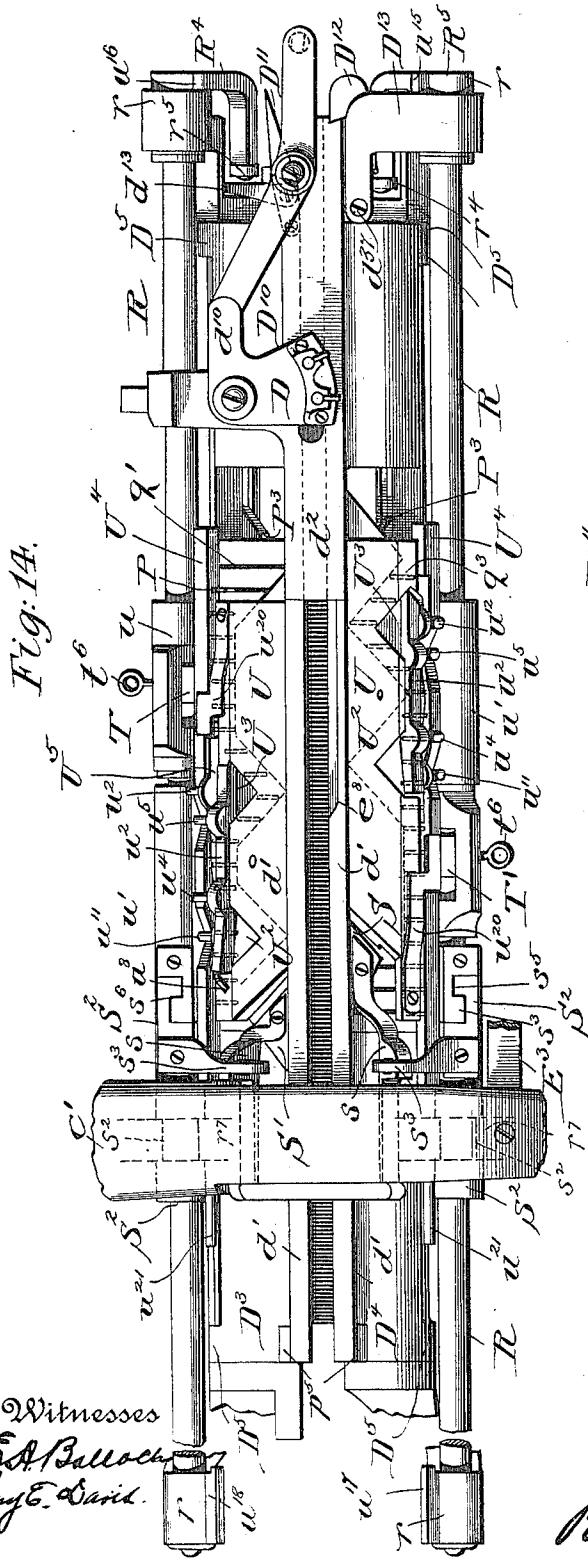


Fig. 16.

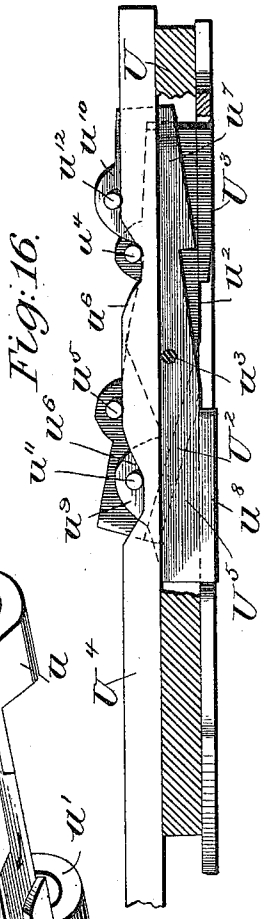
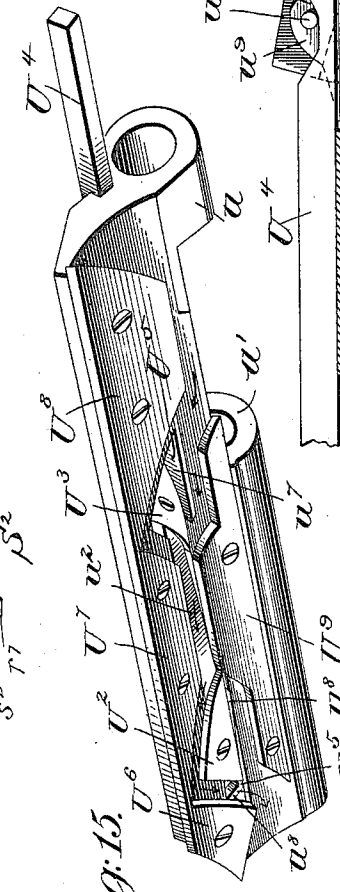


Fig. 15.



Witnesses

C. A. Ballock

Guy E. David.

Inventor

John F. Nelson,

By his Attorneys,

Baldwin, Davidson & Wright

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

No. 617,039. Patented Jan. 3, 1899.

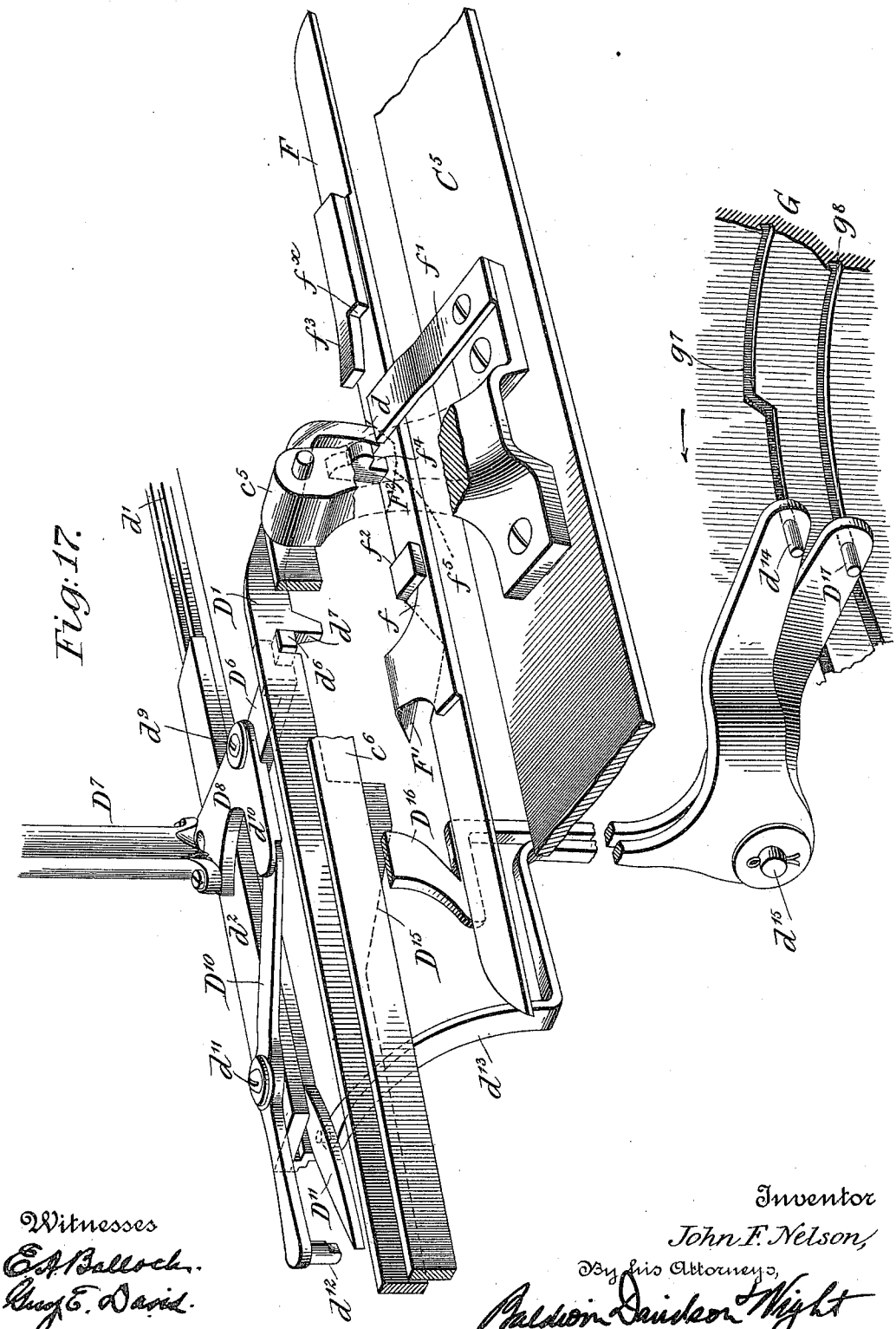
J. F. NELSON.

KNITTING MACHINE.

(Application filed Dec. 29, 1897.)

(No Model.) 25 Sheets—Sheet 10.

Fig. 17.



Witnesses
E. A. Balloch.
Geo. E. David.

Inventor
John F. Nelson,
By his Attorneys,
Baldwin Davidson & Wright

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

No. 617,039.

Patented Jan. 3, 1899.

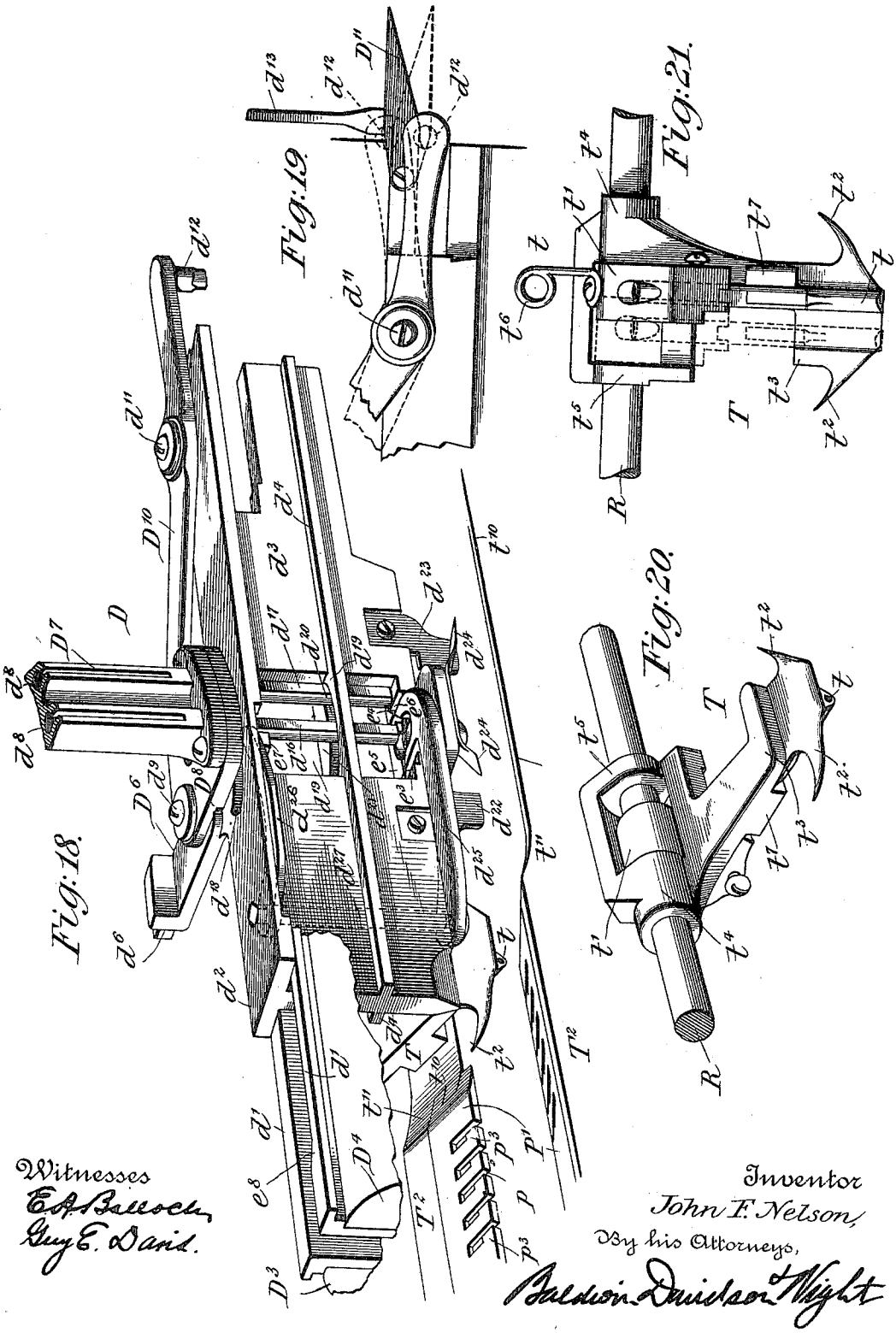
J. F. NELSON.

KNITTING MACHINE.

(Application filed Dec. 29, 1897.)

(No Model.)

25 Sheets—Sheet 11.



Witnesses
E. A. Bullock
Guy E. David.

Inventor
John F. Nelson,
By his Attorneys,
Baldwin Davidson & Wright

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

No. 617,039. Patented Jan. 3, 1899.

J. F. NELSON.

KNITTING MACHINE.

(Application filed Dec. 29, 1897.)

(No Model.) 25 Sheets—Sheet 12.

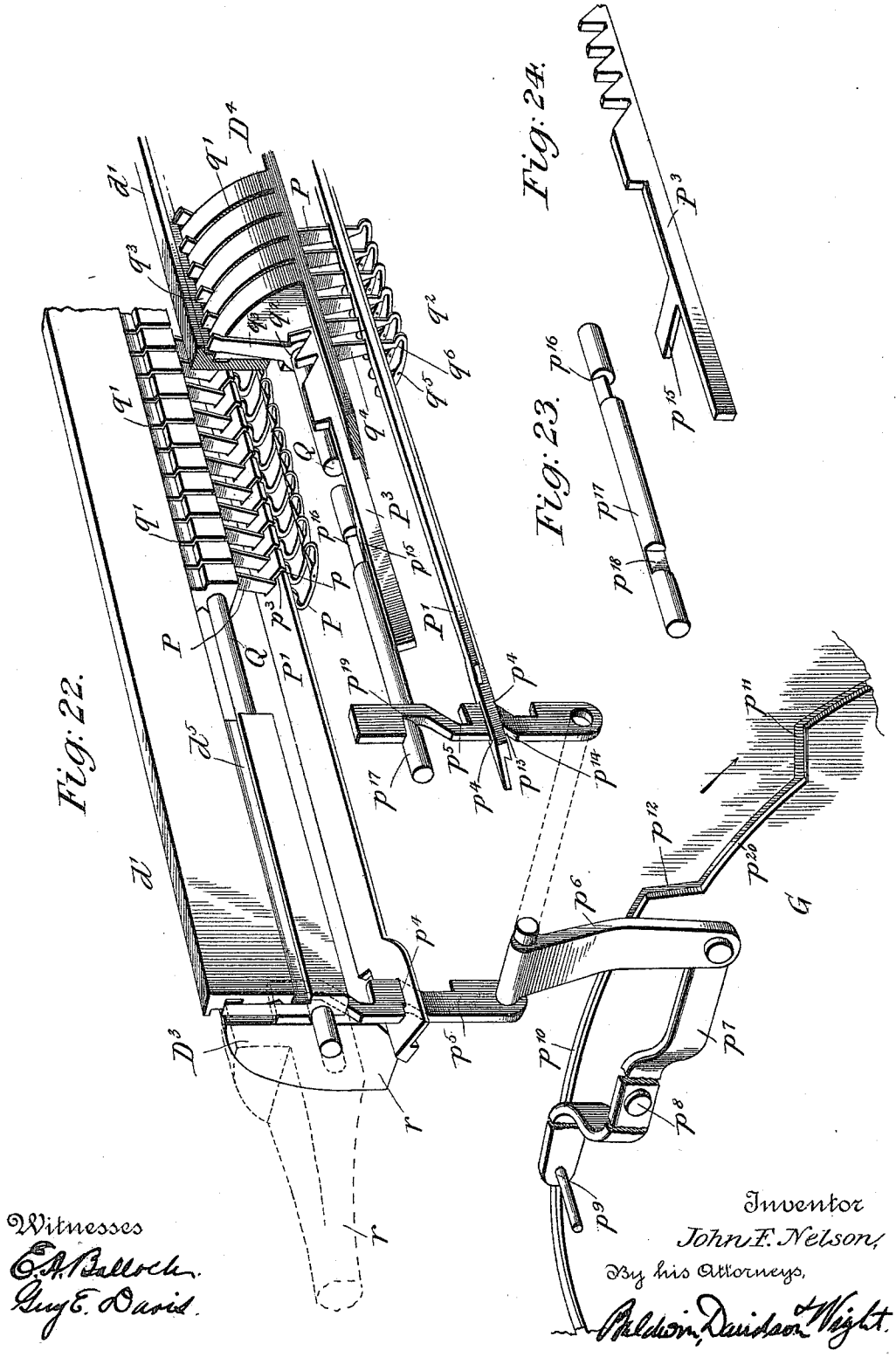


Fig. 22.

Fig. 24.

Fig. 23.

Witnesses
C. A. Ballock.
Guy E. David.

Inventor
John F. Nelson,
By his Attorneys,
Baldwin, Davidson & Wright.

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

No. 617,039. Patented Jan. 3, 1899.

J. F. NELSON.

KNITTING MACHINE.

(Application filed Dec. 29, 1897.)

(No Model.) 25 Sheets—Sheet 13.

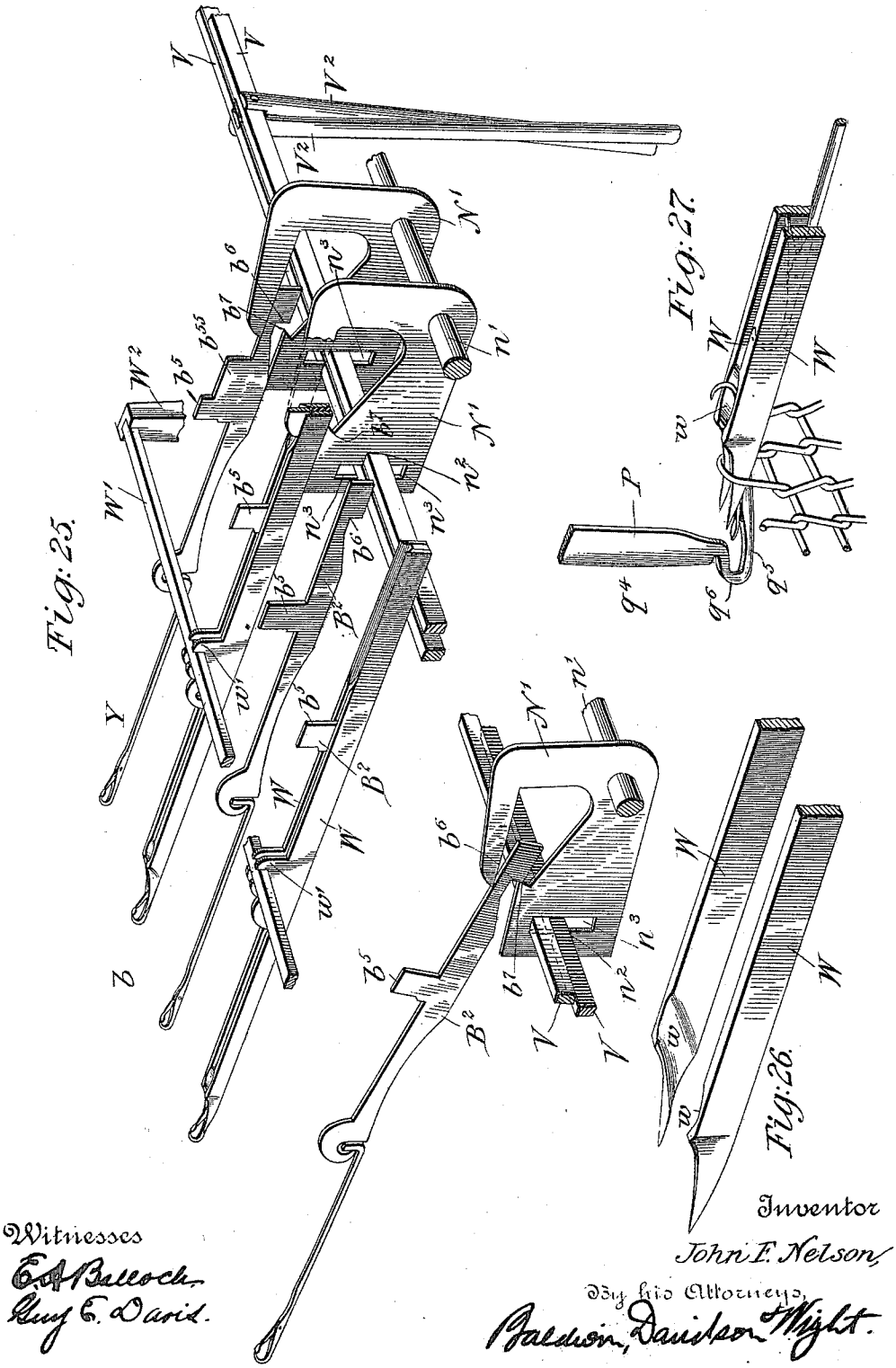


Fig. 25.

Fig. 27.

Fig. 26.

Witnesses
E. A. Bullock.
Guy E. David.

Inventor
John F. Nelson,
By his Attorneys,
Baldwin, Davidson & Wright.

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

No. 617,039. Patented Jan. 3, 1899.

J. F. NELSON.

KNITTING MACHINE.

(Application filed Dec. 29, 1897.)

(No Model.) 25 Sheets—Sheet 14.

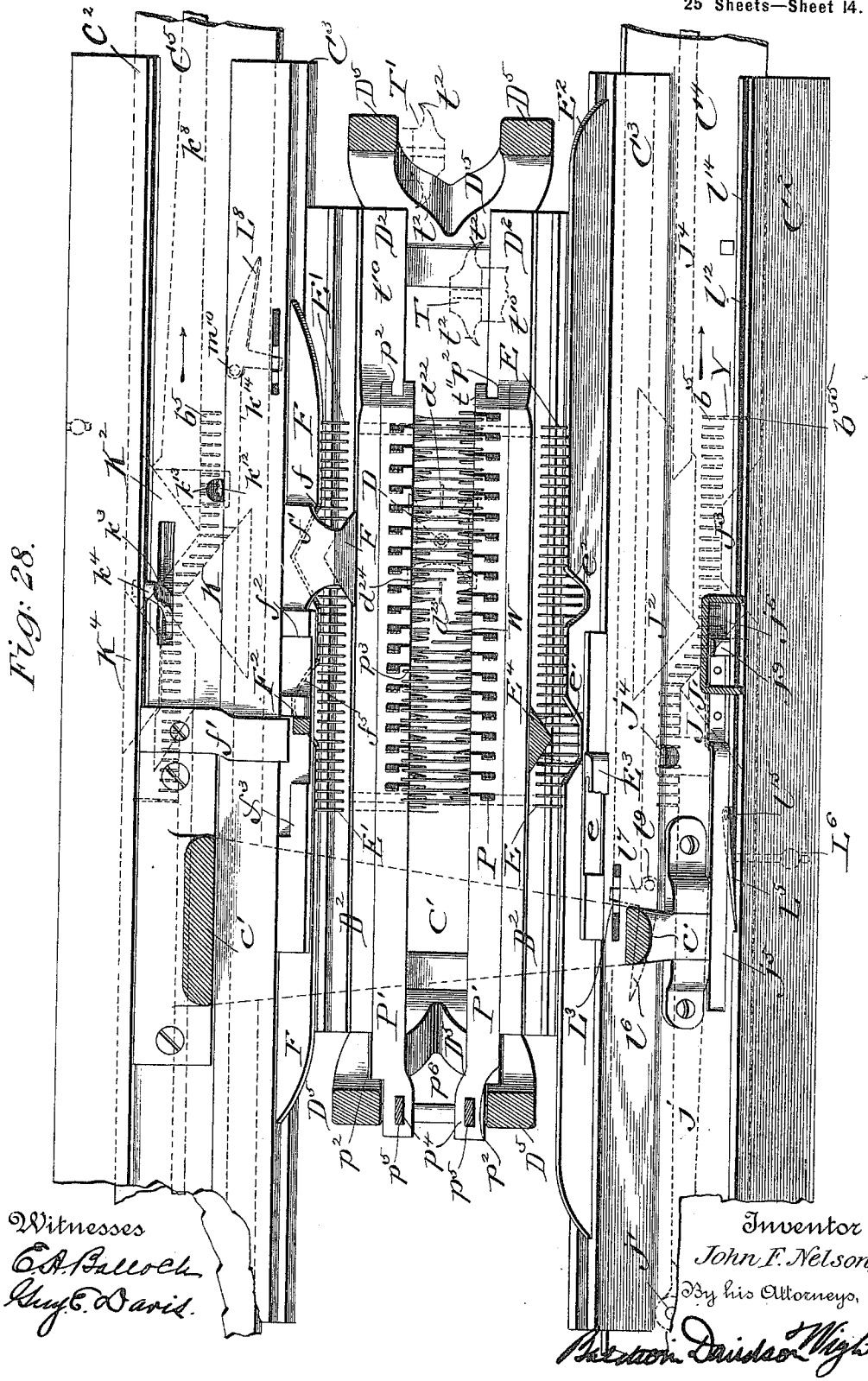


Fig. 28.

Witnesses
C. A. Bullock
Guy E. Davis.

Inventor
John F. Nelson,
By his Attorneys,
Dickerson Davidson & Wright.

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

No. 617,039. Patented Jan. 3, 1899.

J. F. NELSON.

KNITTING MACHINE.

(Application filed Dec. 29, 1897.)

(No Model.) 25 Sheets—Sheet 15.

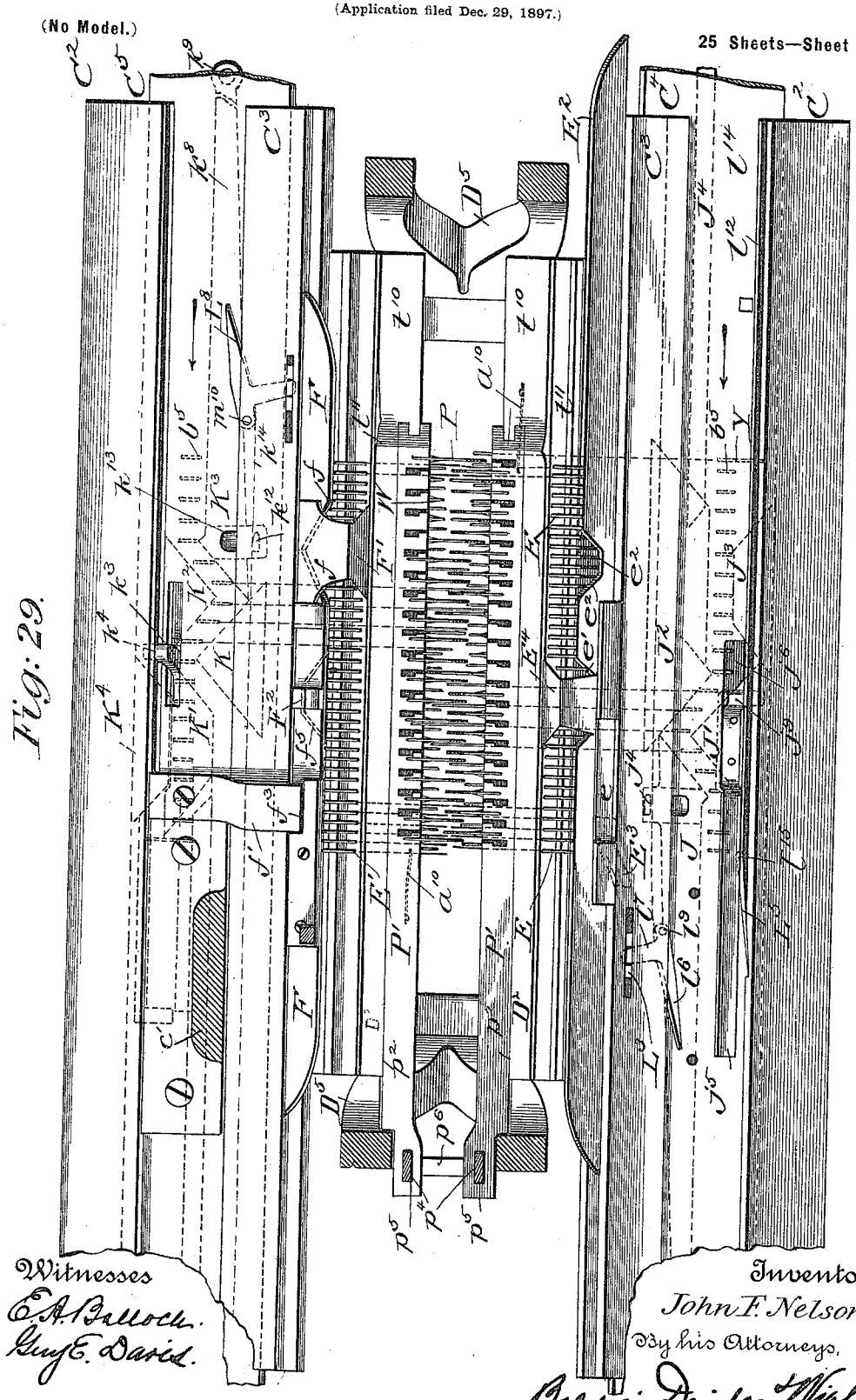


Fig. 29.

Witnesses
E. A. Bullock.
Guy E. David.

Inventor
John F. Nelson,
By his Attorneys,
Baldwin, Davidson & Wright.

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

No. 617,039. Patented Jan. 3, 1899.

J. F. NELSON.

KNITTING MACHINE.

(Application filed Dec. 29, 1897.)

(No Model.) 25 Sheets—Sheet 16.

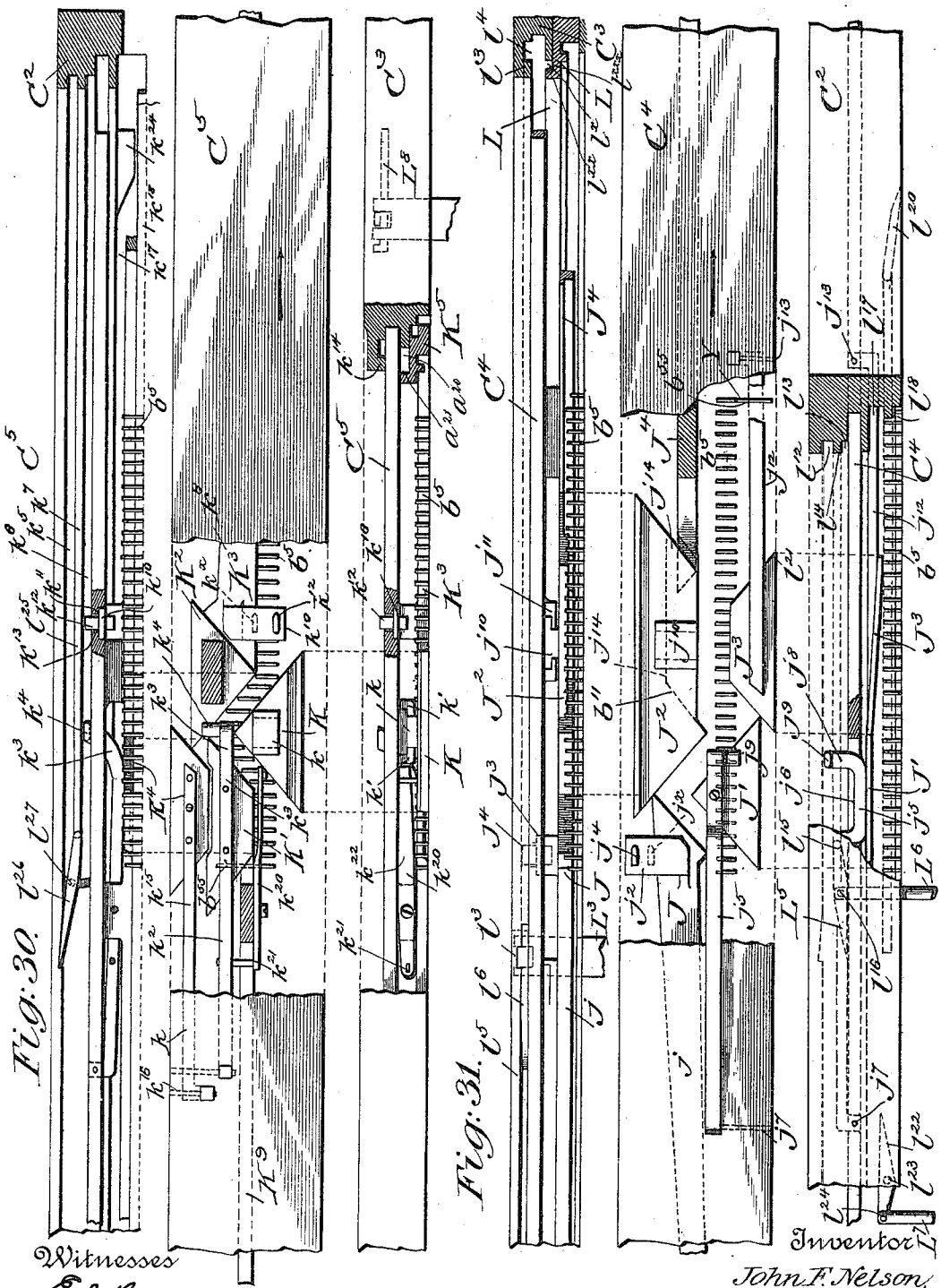


Fig. 30.

Fig. 31.

Witnesses
E. A. Bullock
Guy E. Davis.

Inventor
John F. Nelson,
By his Attorneys,
Baldwin, Davidson & Wright.

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

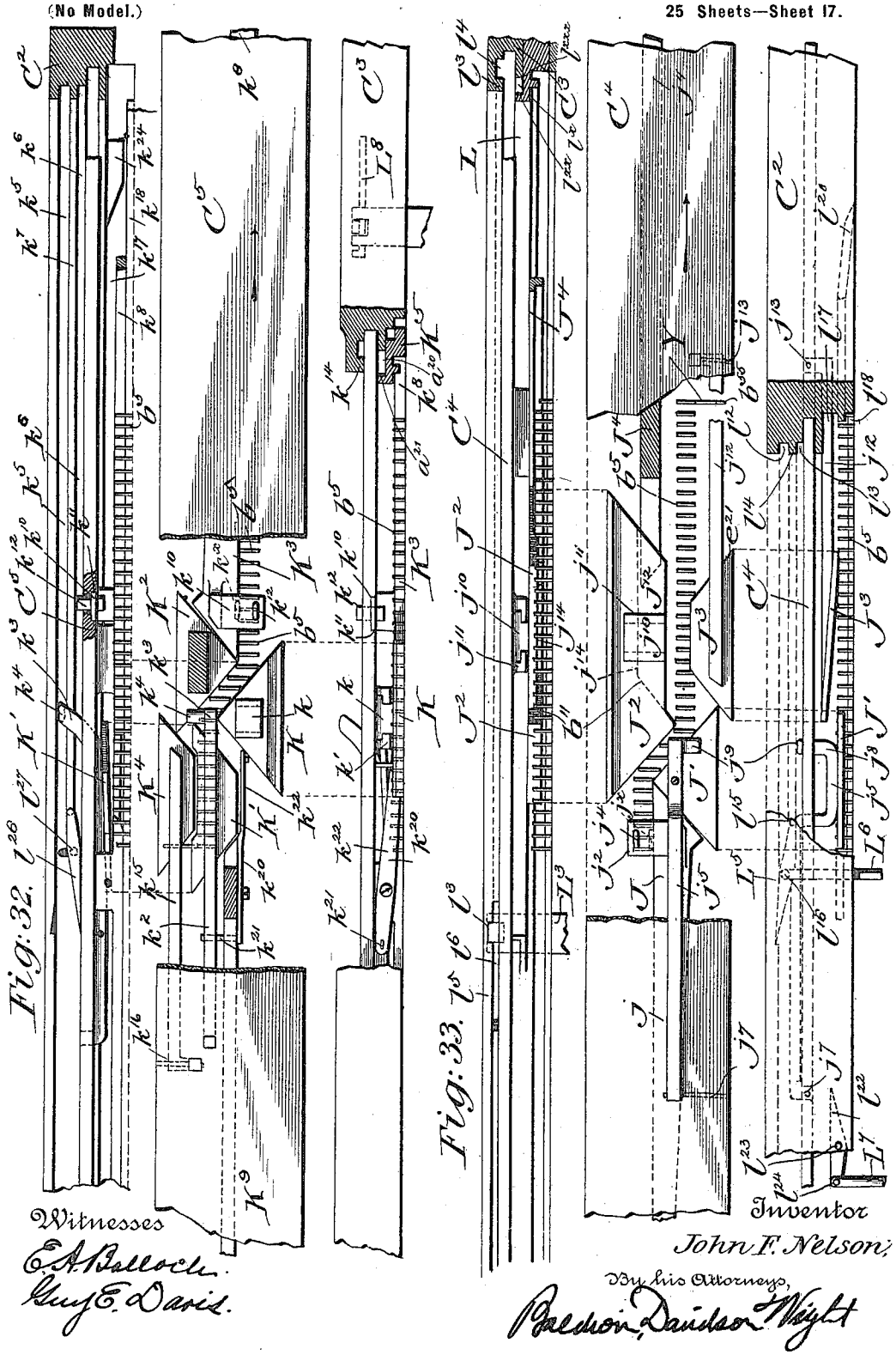
No. 617,039. Patented Jan. 3, 1899.

J. F. NELSON.

KNITTING MACHINE.

(Application filed Dec. 29, 1897.)

(No Model.) 25 Sheets—Sheet 17.



Witnesses
E. A. Bullock.
Guy E. Davis.

Inventor
John F. Nelson,
By his Attorneys,
Baldwin, Davidson & Wright

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

No. 617,039. Patented Jan. 3, 1899.

J. F. NELSON.

KNITTING MACHINE.

(Application filed Dec. 29, 1897.)

(No Model.) 25 Sheets—Sheet 18.

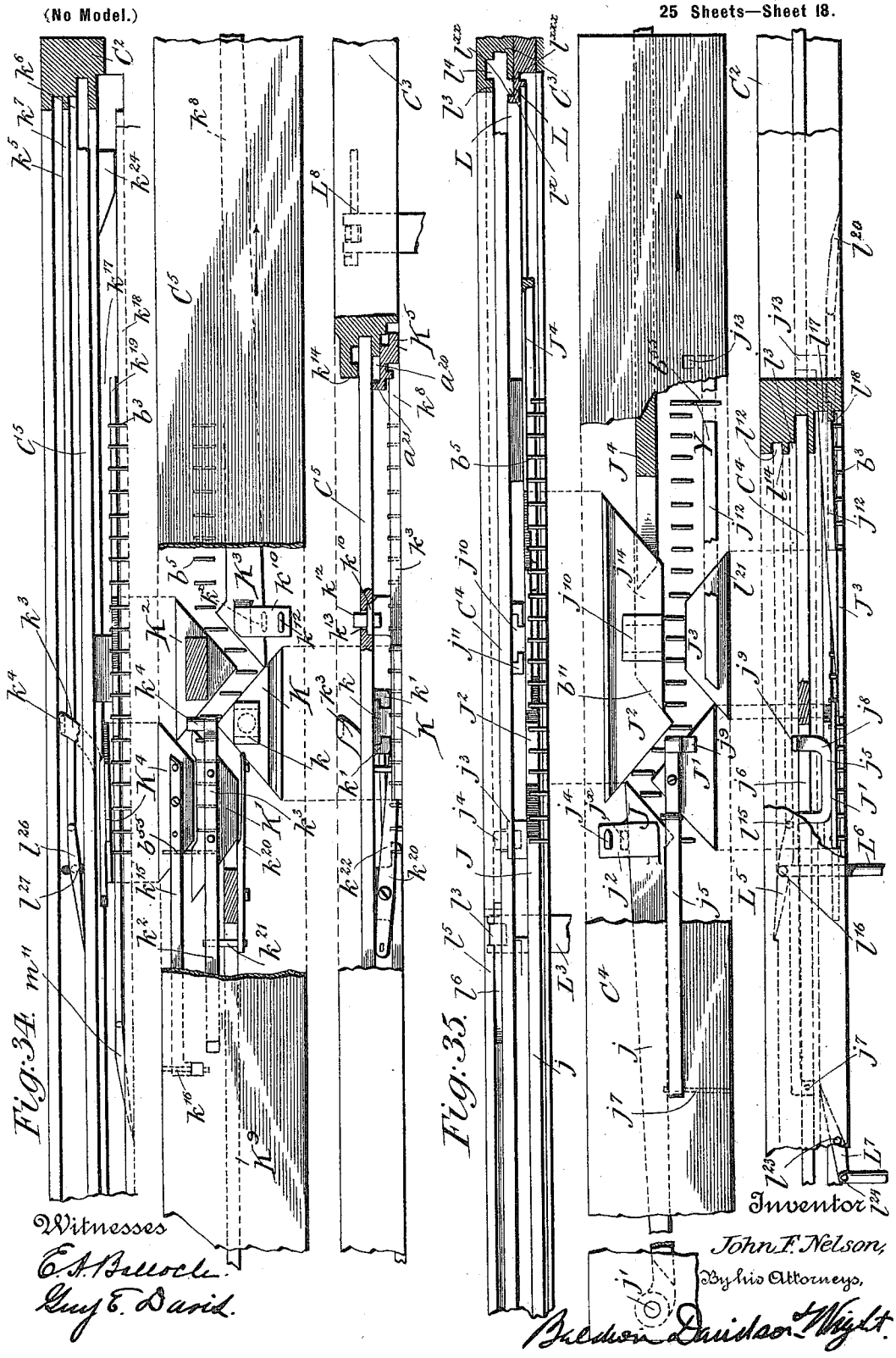


Fig. 34.

Fig. 35.

Witnesses
E. A. Bullock.
Guy E. David.

Inventor
John F. Nelson,
By his Attorneys,
Bladon Davidson & Wight.

THE NORRIS PETERS CO., PHOTO-L... D.C., WASHINGTON, D. C.

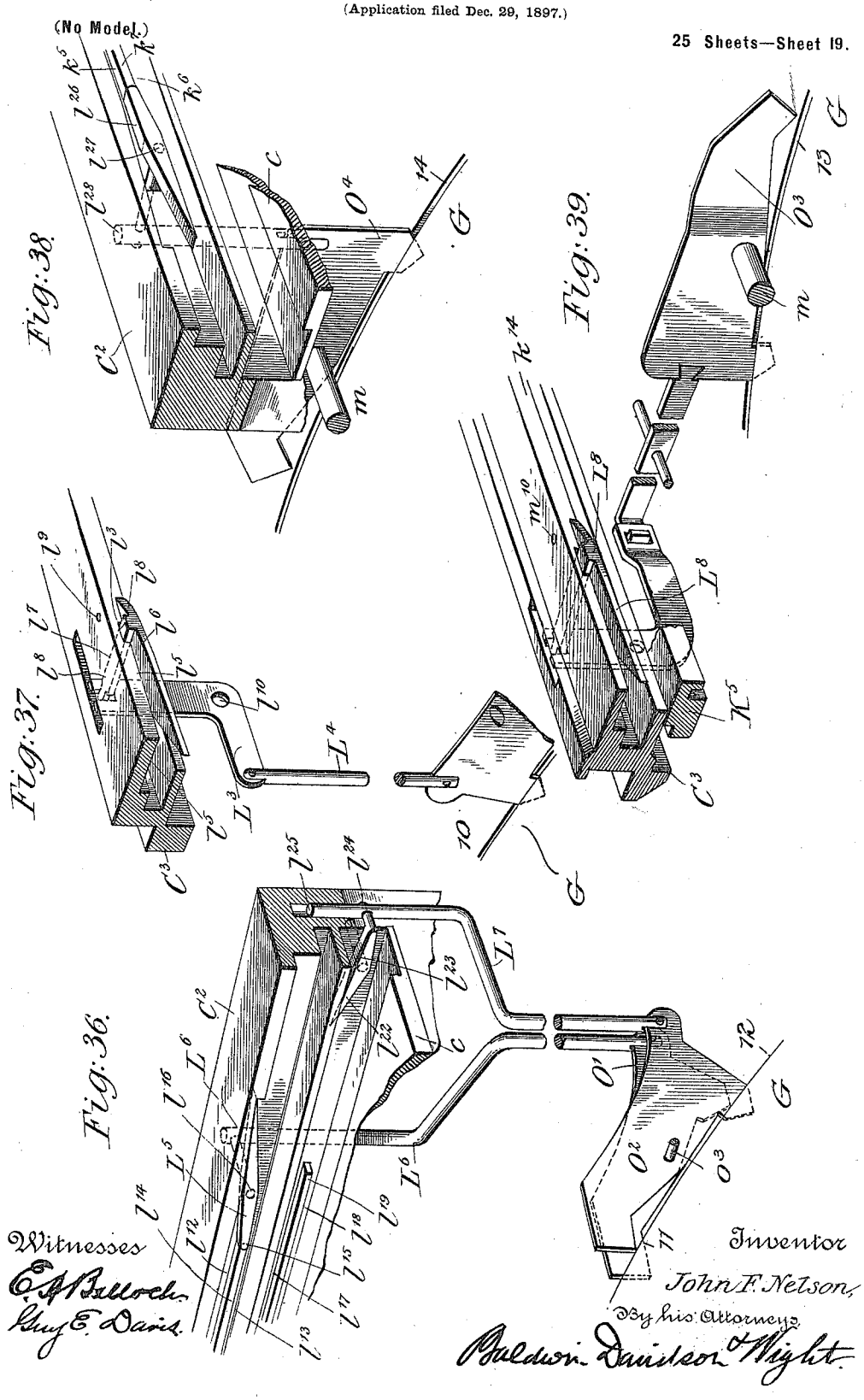
No. 617,039. Patented Jan. 3, 1899.

J. F. NELSON.

KNITTING MACHINE.

(Application filed Dec. 29, 1897.)

(No Model.) 25 Sheets—Sheet 19.



Witnesses
C. A. Bellows
Guy E. Davis.

Inventor
John F. Nelson,
By his Attorneys
Baldwin Davidson & Wright.

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

No. 617,039. Patented Jan. 3, 1899.

J. F. NELSON.

KNITTING MACHINE.

(Application filed Dec. 29, 1897.)

(No Model.) 25 Sheets—Sheet 20.

Fig. 41.

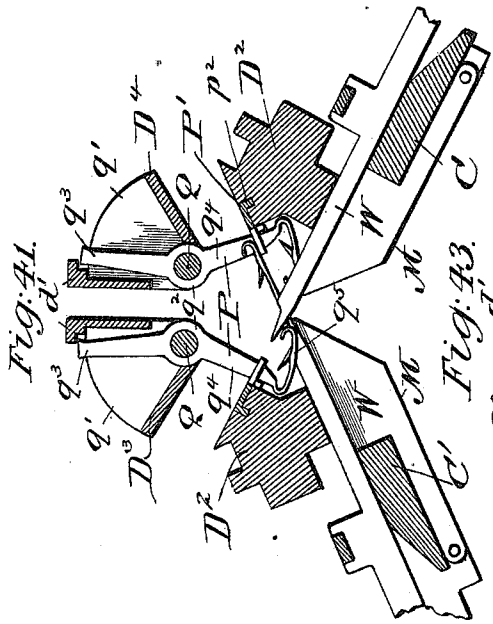


Fig. 43.

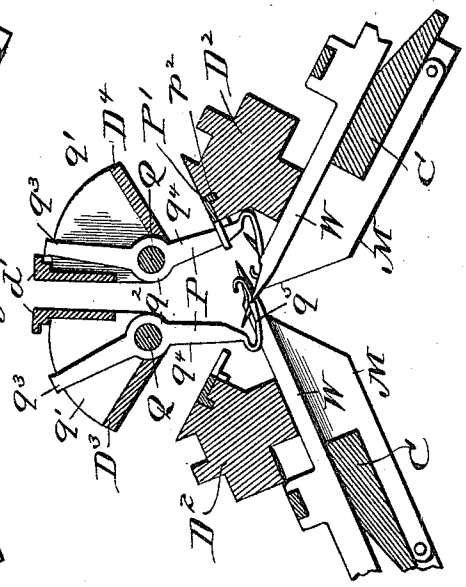


Fig. 40.

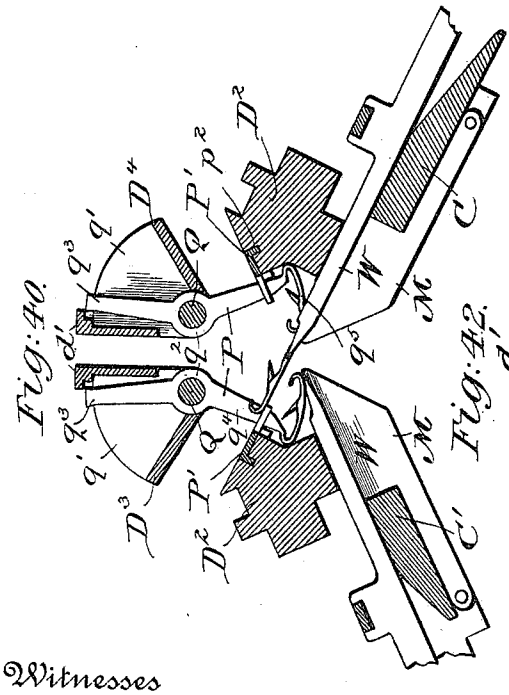
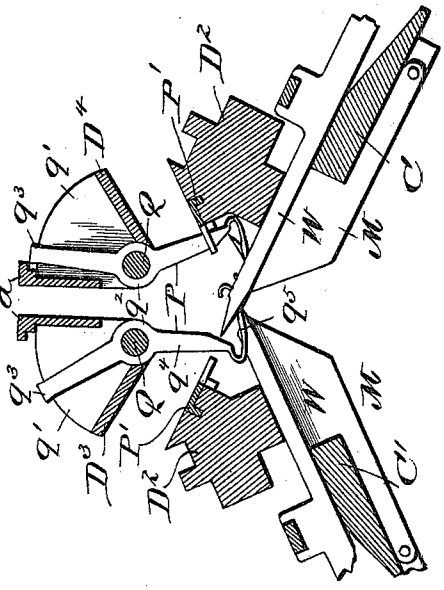


Fig. 42.



Witnesses
E. A. Bullock
Guy E. David.

Inventor
John F. Nelson,
By his Attorneys,
Baldwin Davidson & Wright

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

No. 617,039.

Patented Jan. 3, 1899.

J. F. NELSON.

KNITTING MACHINE.

(Application filed Dec. 29, 1897.)

(No Model.)

25 Sheets—Sheet 21.

Fig. 45.

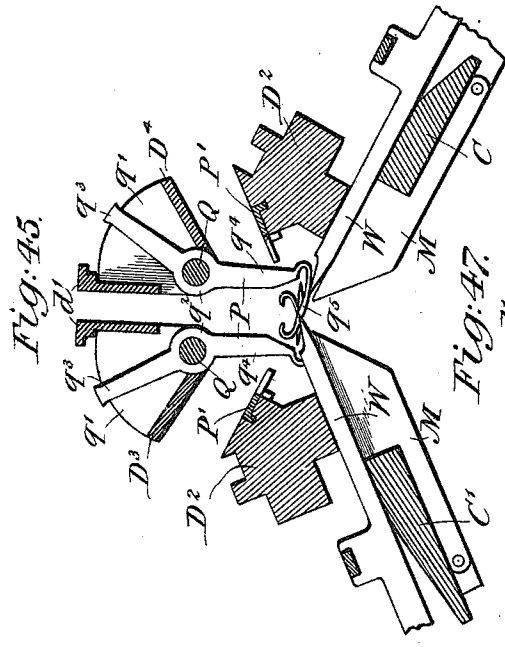


Fig. 47.

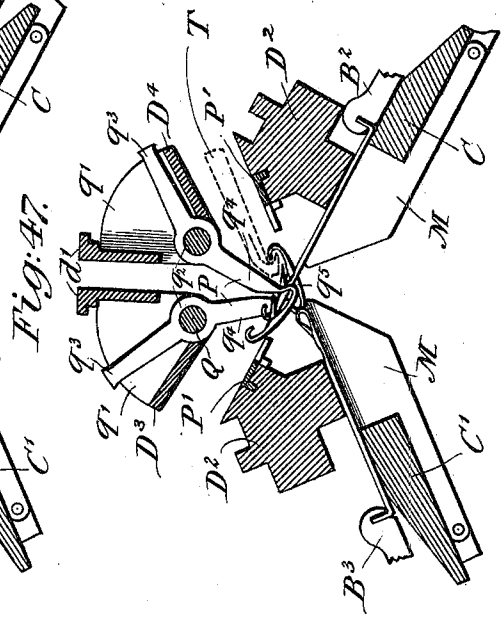


Fig. 44.

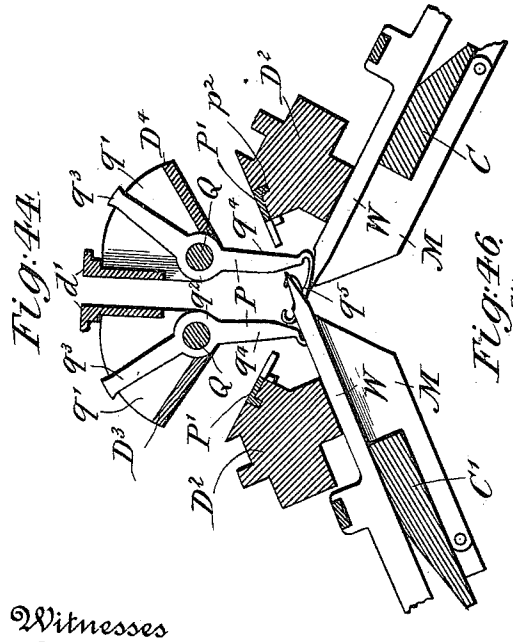
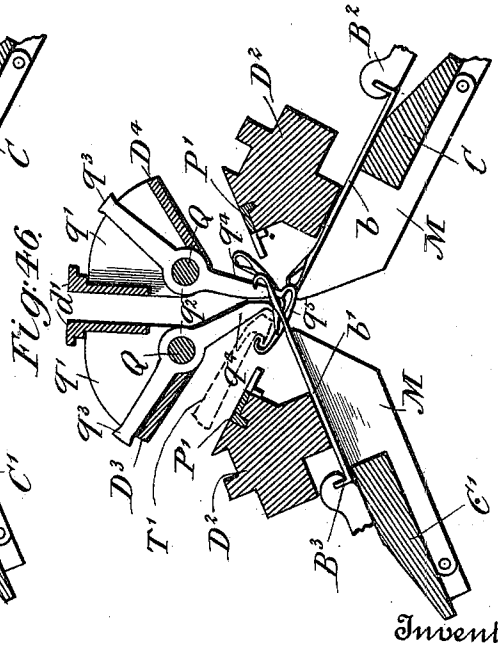


Fig. 46.



Witnesses

E. A. Bullock.

Guy E. Davis.

Inventor

John F. Nelson,

By his Attorneys,

Baldwin, Davidson & Wright.

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

No. 617,039. Patented Jan. 3, 1899.

J. F. NELSON.

KNITTING MACHINE.

(Application filed Dec. 29, 1897.)

(No Model.) 25 Sheets—Sheet 22.

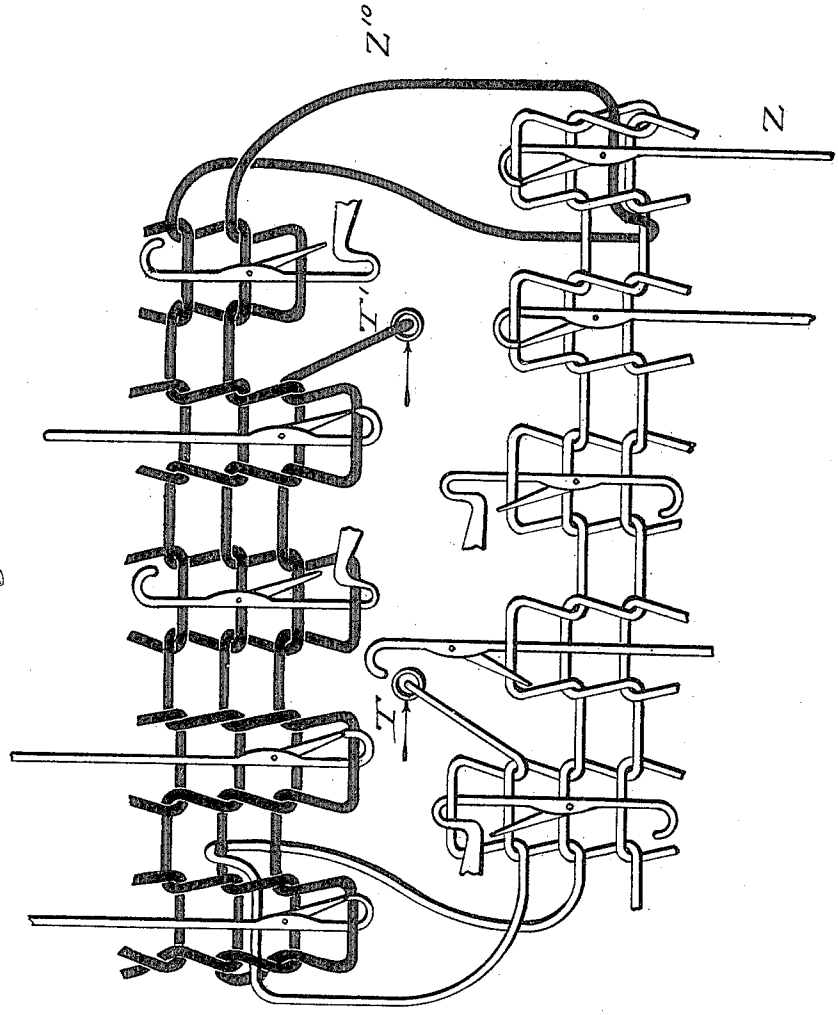


Fig: 49.

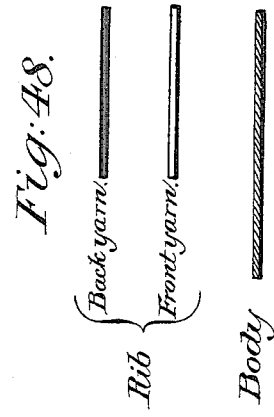


Fig: 48.

Witnesses
E. A. Bullock
Guy E. David.

Inventor
John F. Nelson,
By his Attorneys
Baldwin, Davidson & Wright

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

No. 617,039. Patented Jan. 3, 1899.

J. F. NELSON.

KNITTING MACHINE.

(Application filed Dec. 29, 1897.)

(No Model.) 25 Sheets—Sheet 23.

Fig: 51.

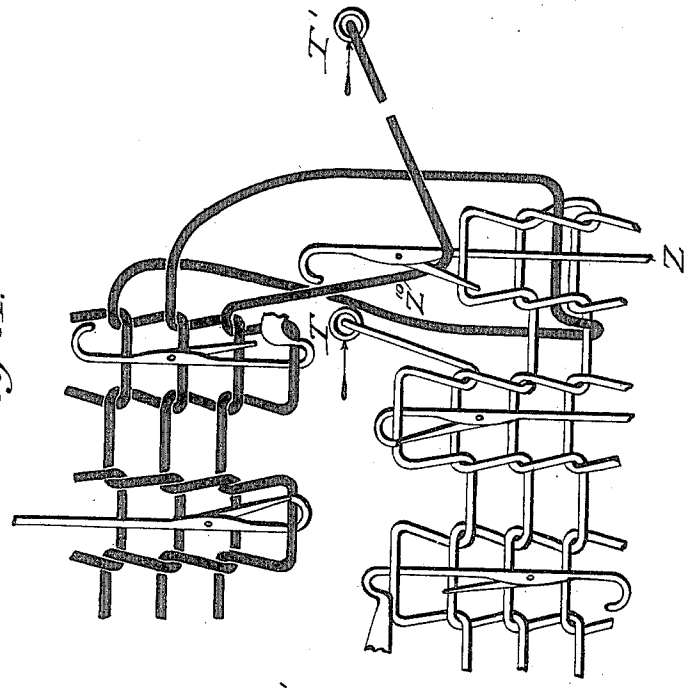
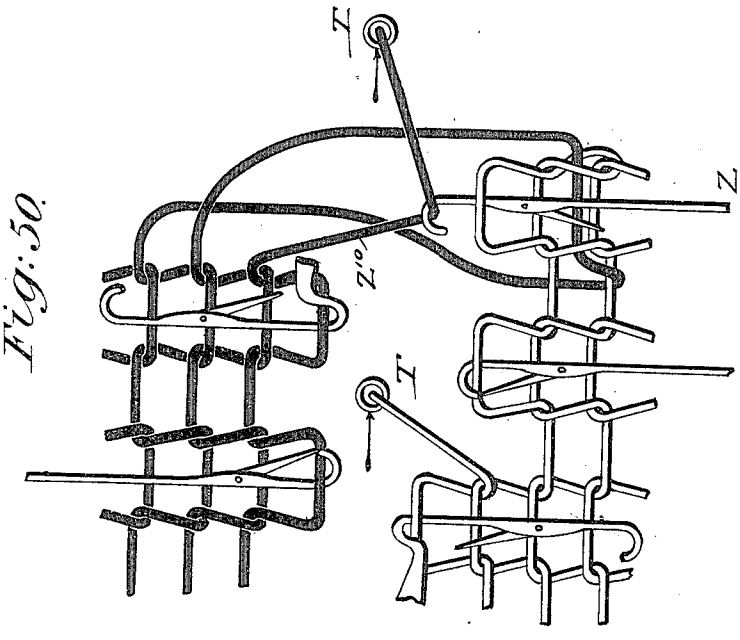


Fig: 50.



Witnesses
C. A. Bulloch
Guy E. Davis.

Inventor
John F. Nelson,
By his Attorneys,
Bakewell, Davidson & Wright

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

No. 617,039. Patented Jan. 3, 1899.

J. F. NELSON.

KNITTING MACHINE.

(Application filed Dec. 29, 1897.)

(No Model.) 25 Sheets—Sheet 24.

Fig. 53.

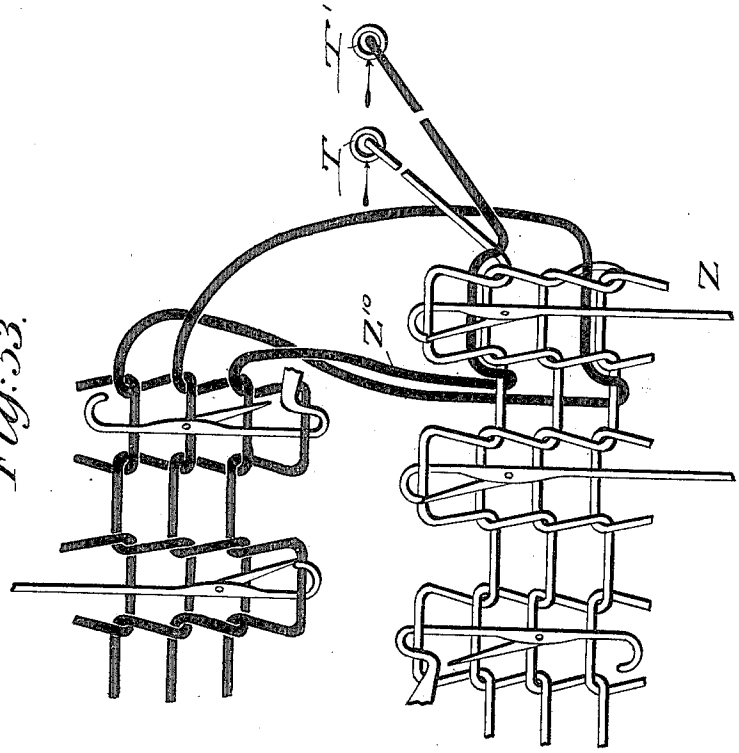
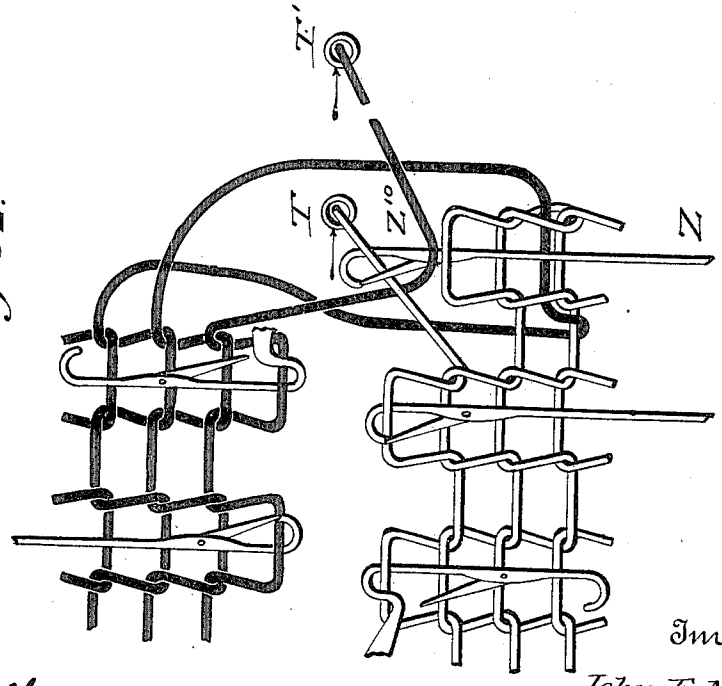


Fig. 52.



Witnesses
E. A. Bullock
Guy E. David.

Inventor
John F. Nelson,
By his Attorneys,
Baldwin, Davidson & Wright.

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

No. 617,039. Patented Jan. 3, 1899.

J. F. NELSON.

KNITTING MACHINE.

(Application filed Dec. 29, 1897.)

(No Model.) 25 Sheets—Sheet 25.

Fig. 55.

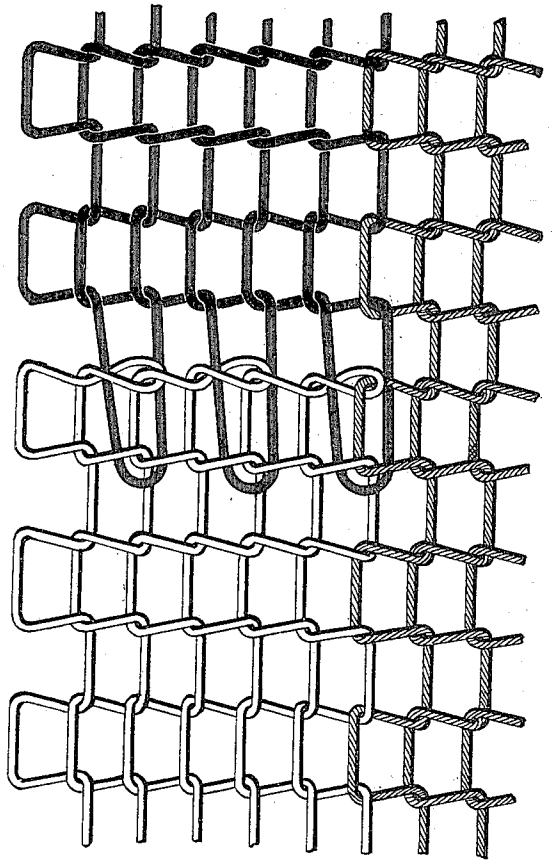
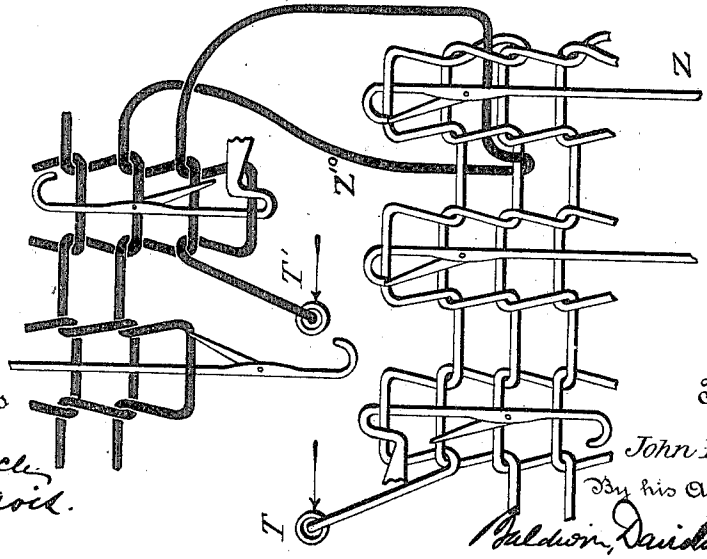


Fig. 54.



Witnesses
E. A. Bullock
Guy E. Davis.

Inventor
John F. Nelson,
By his Attorneys,
Baldwin, Davidson & Wright

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

UNITED STATES PATENT OFFICE.

JOHN F. NELSON, OF ROCKFORD, ILLINOIS.

KNITTING-MACHINE.

SPECIFICATION forming part of Letters Patent No. 617,039, dated January 3, 1899.

Application filed December 29, 1897. Serial No. 664,355. (No model.)

To all whom it may concern:

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

The primary object of my invention is to knit a finished sock with a ribbed top by one continuous operation of automatic mechanism. Heretofore, so far as I am aware, this has never been accomplished. Usually where the main portion of the sock is knit on a straight machine the ribbed top is knit on a separate machine and stitched to the sock proper by a third machine. In most circular machines for knitting this class of goods the ribbed top is knit on one machine and then transferred to another machine, which continues the knitting to complete the sock with the exception of the closing of the toe, which is done by a separate machine or by hand. It has also been proposed to knit the ribbed top and the other part of the sock on a circular machine; but this machine was not adapted to close the toe and was not automatic like mine. Never, so far as I am aware, has a straight-knitting machine been devised in which any attempt was made to knit the ribbed top and the other portion of the sock by a continuous operation of the mechanism in a single machine.

I have embodied my improvements in a parallel-row or straight knitting machine which not only knits the entire sock, including the ribbed top, by one continuous operation of automatic mechanism, but also closes the toe, thus producing a sock complete in every respect. Thus a large number of machines can, under the supervision of a single attendant, be made to each automatically knit without assistance a definite number of completed socks.

While I have stated the primary object of my invention to be the knitting of a finished sock by one continuous operation of automatic mechanism, I wish it understood that this is not the sole object of my invention, nor does my invention reside wholly in a machine entirely automatic. On the other hand, it includes many mechanisms and groups of mechanisms which are novel, useful, and efficient. The scope of my invention as I now understand it is set forth in as broad terms as I can now command, as well as in detail in the claims at the end of this specification.

In carrying out my invention in the way now best known to me I employ two parallel rows of needles operated by cams mounted on reciprocating slides and controlled by a pattern-cylinder to knit first the toe, then the foot, next the heel, and next the leg of the sock. Two additional sets of needles, called "ribbing-needles," arranged in rows parallel with those first mentioned, are employed to coöperate with some of the first-mentioned needles to form the ribbed top. The ribbing-needles are held out of opperation while the plain portion of the sock is being formed, but automatically come into action at the proper time. They are in turn automatically thrown out of operation when the rib is completed and the knitting of a new sock is begun.

The type of machine to which my improvements are shown applied is exemplified in John Nelson's patents, No. 214,308, of April 15, 1879, and No. 576,881, of February 9, 1897, and in my own patent, No. 585,589, of June 29, 1897.

In the accompanying drawings an appropriate organization of mechanism is shown for knitting socks; but instead of using all the improvements illustrated and hereinafter in detail described essential features of these improvements may be employed without the others and the mechanism may be modified in various ways without departing from the spirit of the invention herein claimed.

Figure 1 is a front elevation of a "Nelson" knitting-machine with my improvements applied. Fig. 2 shows a right-hand end elevation of the same with some of the parts broken away or removed the more clearly to illustrate other parts. Fig. 3 is a similar view of the left-hand end of the machine. Fig. 4 shows a plan thereof, the rear casing of the pattern-cylinder being omitted and some of the other parts being removed in order that some of the other mechanism may be more clearly illustrated. Figs. 5 and 6 are views, on an enlarged scale and in section, on the line $x\ x$ of Fig. 4, some of the parts being omitted and some broken away to more clearly illustrate other parts. Figs. 5 and 6 differ from

each other mainly in showing the parts in different positions. Fig. 7 is a detail view illustrating the manner of operating the pattern-cylinder. Fig. 8 is a view of the pattern-cylinder developed. This figure also illustrates the manner in which the pattern-cylinder operates upon certain devices connected therewith. Fig. 8ª is a detail view in section, showing the manner in which the segments are connected with the pattern-cylinder. Fig. 9 is a view of the right-hand end of the pattern-cylinder. Fig. 10 is a view of the opposite end thereof. Fig. 11 is a detail view in perspective, illustrating particularly the connections between the main cam-slides, portions of the ribbing mechanism, and portions of the connections between one end of the pattern-cylinder and the ribbing mechanism. Fig. 12 is a detail view in perspective of part of the ribbing mechanism. Fig. 13 is a detail view in perspective of another part thereof. Fig. 14 is a plan view of the ribbing mechanism and the main yarn-carrier. Fig. 15 is a perspective view of one of the ribbing cam-slides and the mechanism carried thereby. Fig. 16 is a detail view in section thereof. Fig. 17 is a detail view in perspective, illustrating particularly the connections between the main yarn-carrier and its operating pitman, the devices for operating the yarn-guide to change yarn, and the means for throwing the main yarn-carrier out of operation. Fig. 18 is a detail view in perspective, showing particularly the construction of the main yarn-carrier and the devices connected therewith. Fig. 19 is a detail view of the switch mechanism forming part of the devices for changing yarn. Fig 20 is a detail view in perspective of one of the yarn-guides for the ribbing-needles. Fig. 21 is a view of the under side thereof. Fig. 22 is a diagram showing in perspective particularly the arrangement of the ribbing-needles and part of the mechanism for operating them. Fig. 23 is a perspective view of one of the sliding rods shown in Fig. 22. Fig. 24 is a perspective view of a portion of one of the toothed bars shown in Fig. 22. Fig. 25 is a diagram in perspective, showing particularly the manner of mounting the needle-jacks in their supporting-levers, the manner of supporting and operating the transferring-points, and the means for moving the supporting-levers to throw the needles into and out of operation. Fig. 26 shows, on an enlarged scale, the front ends of two transferring-points. Fig. 27 shows particularly the manner in which a ribbing-needle takes a loop from a pair of transferring-points. Fig. 28 is a view, on an enlarged scale and in horizontal section, taken just below the main portion of the ribbing-needles, approximately on the line 28 28 of Fig. 5. Fig. 29 is a view similar to Fig. 28 with the parts in a different position. In Fig. 28 the cams, &c., are in the position which they occupy in making the foot or the leg of a sock, while in Fig. 29 the same parts are shown in the positions which they occupy when knitting the rib. Fig. 30 is a detail view, partly in plan and partly in section, illustrating the positions of the cams on the back slide and the switches and grooved bars which control them when knitting the "set-up" and the toe or the heel of the sock. Fig. 31 is a similar view of the cams, &c., of the front slide when knitting the toe or the heel. Fig. 32 is a view similar to Fig. 30, showing the same parts in the positions they occupy when the machine is knitting the foot or the leg of the sock. Fig. 33 shows the positions of the cams, &c., of the front slide when knitting the foot or the leg or the set-up. Figs. 34 and 35 are similar views showing the positions of the cams, &c., of the back and front slides, respectively, when knitting the rib. Figs. 36 and 37 are detail views, in perspective, showing particularly the arrangement of the switches and their operating mechanism at the left-hand end on the front side of the machine. Fig. 38 is a similar view of the switch and its operating mechanism at the left-hand end of the back side of the machine. Fig. 39 is a similar view showing the switch and its operating mechanism at the right-hand end of the back side of the machine. Figs. 40 to 47, inclusive, illustrate the operation of the ribbing-needles and the transferring-points for transferring the loops from the main knitting-needles to the ribbing-needles. Fig. 40 shows the arrangement of the parts before the ribbing-needles are operated and when the transferring-points on the front side of the machine are only partially advanced. Fig. 41 shows the front transferring-points advanced to the end of their upward stroke, the back transferring-points being partially advanced. Fig. 42 shows the front transferring-points advanced to the limit of their upward stroke and the back transferring-points halfway advanced, the back row of ribbing-needles having been moved through the transferring-points of the front row. In Fig. 43 the back transferring-points have been advanced to the end of their upward stroke and the front transferring-points have been drawn halfway down. In Fig. 44 the back transferring-points have been moved to the end of their upward stroke, the front transferring-points have been moved half-way down, and the front ribbing-needles have been moved through the back transferring-points to take loops therefrom. In Fig. 45 the front transferring-points have been drawn all the way down, thus leaving the loops on the back ribbing-needles, the back transferring-points having been drawn partially down. Fig. 46 shows particularly the manner of feeding the yarn on the back side of the machine to the main knitting-needles of the back side and the ribbing-needles of the front side. It will be observed that the yarn-guide operates behind the ribbing-needles of the back side when laying yarn in the ribbing-needles of the front side. Fig. 47 indicates the manner in which the yarn-guide on the front side of the

machine lays yarn in the ribbing-needles of the back side and the main knitting-needles of the front side. Fig. 48 indicates the three kinds of yarn used in the fabric. Figs. 49 to 55, inclusive, are diagrams illustrating the manner in which the fabric is formed, and particularly the manner in which the ribbed fabric is joined to the plain fabric and the ribbed fabric is formed into a tube by the end needles. Fig. 49 shows the two yarn-guides advancing toward the end needle at the right-hand end of the machine. Fig. 50 shows the yarn-guides advanced from the position shown in Fig. 49, the back yarn having been grasped by the end needle. Fig. 51 shows the two yarn-guides still farther advanced to the right, the end needle having been farther advanced and the back yarn having been caught by the open latch thereof. In Fig. 52 the yarn-guides are still farther advanced to the right and the end needle has been advanced and grasped the front yarn, the latch being closed. In Fig. 53 the end needle has been retracted and then advanced, forming a loop with the front yarn and interlocking it with a loop of the back yarn. Fig. 54 illustrates particularly the manner in which the back yarn is carried from the front side of the fabric and joined on again to the fabric on the back side. Fig. 55 shows the manner in which the ribbed work joins the body and the manner in which the ribbing on the back side of the fabric joins that on the front side thereof.

The driving-shaft A, extending transversely across the machine, is mounted in suitable bearings z in the main frame A', which may be of any suitable construction. A hand-wheel A^2 is secured to the front end of the driving-shaft, and at its rear end the driving-shaft is provided with fast and loose pulleys, as usual. A pinion a on the driving-shaft meshes with a main actuating gear-wheel a', secured to a sleeve mounted on a stud-shaft a^2, secured to a bracket Z'. The gear-wheel a' is connected with a cam-wheel or irregular snail-gear B', which gears with a star-pinion B for operating the pattern-cylinder G, as will be hereinafter explained.

A front needle-bed C and a rear needle-bed C' are each slotted and provided with a slotted plate c, which constitute guides for the front and back rows of main knitting-needles b and b' as well as for their jacks B^2 B^3. The two beds are inclined, as heretofore, and each is provided with a lower longitudinal grooved guide-bar or channel-plate C^2 and an upper longitudinal grooved guide-bar or channel-plate C^3. A front main cam-slide C^4 and a back main cam-slide C^5, rigidly connected by a yoke c', reciprocate longitudinally in the guide-grooves in the front and back guide-bars. These main cam-slides carry cams for actuating the two rows of main knitting-needles and are reciprocated by the mechanism next to be described.

An elbow-lever c^2, pivotally mounted on the main frame-bracket c^3 by a stud c^4, is connected at the upper end of its longer arm with a bracket c^5 on the back main cam-slide C^5 by means of a pitman or link c^6. The other end or shorter arm of the elbow-lever is linked by a connecting-rod b^3 with a wrist-pin b^4 on the gear-wheel a'. The result of this organization is that the main cam-slides are caused to reciprocate together or make two strokes for each revolution of the actuating-gear a' and to operate the two rows of main knitting-needles by their cams in the manner hereinafter described.

The mechanism just described for operating the cam-slides is substantially the same as that shown in my Patent No. 585,589, of June 29, 1897.

The main yarn-carrier D is actuated by a pitman D', which is pivotally connected with the upper end of a lever G', jointed at g to the elbow-lever c^2 and provided at its lower end with a roller-carrying stud g', engaging the forked end of a lever g^2, pivoted at g^3 to the main frame-bracket c^3, and at its upper end carrying a roller g^4, which enters a groove in the actuating-gear a'. The groove is suitably shaped to give the proper movement to the yarn-carrier and to the cams for operating the presser-hooks, allowing of the usual proper amount of dwell at each stroke and at the proper times. The mechanism for operating the main yarn-carrier is also substantially the same as that shown in my patent of June 29, 1897, before mentioned.

The front presser-hooks E and the back presser-hooks E' are for the most part constructed, mounted, and operated in the same manner as heretofore. One of the presser-hooks at one end of the front row and one at the opposite end of the back row are, however, operated in a somewhat different way, as will be hereinafter explained. The front cam-carrying slide E^2 for the front row of presser-hooks is connected with the yoke c' by an arm E^3. As shown in Fig. 11, the arm E^3 operates in a recess e in the cam-slide, so that the yoke and the main cam-slides C^4 C^5 may have a movement at the end of each stroke independent of the presser-hook cam-carrying slides in order that the presser-hooks may be operated at the proper time relatively to the movement of the needles, as in the prior Nelson machines. The cam E^4, carried by the slide E^3, is arranged opposite a recess e', and the construction and operation are such that the presser-hooks are elevated and depressed at proper times to hold down the loops of the fabric during the operation of the needles. A recess e^2 is formed in the slide E^2 to permit the end presser-hook to operate in the manner hereinafter described.

The back cam-carrying slide F is provided with a cam F', arranged opposite a recess f. The slide F is connected with the back cam-slide C^5 by an arm f', secured to the slide C^5 and operating between stops f^2 f^3 on the slide. The front of the arm f' slides through a re-

cess f^4 in a lug F^2, secured to the slide F. This lug F^2 engages with a downwardly-projecting arm d of the pitman D′, which operates the main yarn-carrier D. The slide F is provided with a recess f^5 just below the lug F^2 to accommodate the presser-hook on the end needle, as hereinafter described. The slides E^2 and F and their cams operate upon the presser-hooks in substantially the same way as heretofore, the only practical difference being that the slides are provided with recesses e^2 and f^5 to allow the presser-hooks on the end needles to operate twice during each stroke. When the slides are moving to the right, the arm E^3 moves the slide E^2 by abutting against the shoulder at the right-hand end of the recess e, and when moving to the left the arm E^3 abuts against the shoulder of the left-hand end of this recess. When knitting the body of the sock and the back slide C^5 is moving to the left, the arm d abuts against the stop f^3 to move the slide F. When the slide C^5 is moving to the right, the arm d abuts against the lug F^2 and moves the slide F to the left until the pitman D′ stops. These movements continue during the entire operation of the machine while forming a sock.

When knitting the rib, the pitman D′ is raised by the lever D^{16}, so that in the movement of the slide C^5 to the left the arm d of the pitman D′ is raised above the plane of the stop f^3 and does not move the slide F, but the arm f' causes the slide F to move by striking against the portion $f^\times$ of the stop. When the slide C^5 moves to the right, the arm d strikes against the lug F^2, and when the pitman D′ stops at the right the slide F is moved still farther by the arm f', which engages with the stop f^2.

The presser-hook at the right-hand end of the front row and that at the left-hand end of the back row are arranged to operate differently from the others. Each of these presser-hooks is provided with a spring a^{10}, as indicated in Fig. 29, the arrangement being such that the spring will cause the presser-hook to rise when it is free to move. It will be observed by reference to Fig. 29 that when the slide E^2 moves to the right, for instance, the presser-hook at the right-hand end of the row will be first caused to rise by means of the spring a^{10}, the shank of the hook being thrown back into the recess e^2. As the slide farther advances the inclined portion on the left-hand side of these recesses will move the shank of the presser-hook upwardly and backwardly, thus causing its front or hooked end to be depressed. As the slide E^2 continues to move the recess e' will come in line with the end presser-hook and the spring a^{10} will force the shank of the hook into the recess, as will also the cam E^4. As the slide E^2 continues to move the inclined portion at the left-hand end of the recess e' will move the shank of the presser-hook backward and depress its hooked end. It is thought that this operation will be clearly understood without further explanation. The presser-hook at the left-hand end of the back row operates in substantially the same way, and need not be explained.

The presser-hooks E E′ are mounted to oscillate in bars D^2 on opposite sides of the central longitudinal opening of the machine. The cam-slides E^2 F are reciprocated in guides between the bars D^2 and C^3.

The pattern-cylinder G is mounted in suitable bearings g^6 in the main frame and revolves in the direction indicated by the arrow. It is actuated by means of a pinion h on a shaft h', with which the star-wheel B is connected. This pinion is provided with a single laterally-projecting tooth h^2 in line with one of the teeth of the pinion h, and adapted to gear with the toothed segments I I′, mounted on the pattern-cylinder. The pinion itself gears with a circular row of teeth h^3, formed on the right-hand edge of the periphery of the cylinder. As in the prior Nelson machines the pinion h turns the cylinder by its engagement with the teeth h^3 when the toe and heel of the sock are being formed and also during a portion of the time when the foot, leg, and ribbed top are being made. During the main part of the time when the foot or that part of the sock between the toe and the heel and the leg or that part of the sock above the heel are being formed and while the ribbed top is being formed the pinion will occupy one of the spaces 1 2 3, while the tooth h^2 will engage one of the segments I or I′. These segments are constructed and operated in much the same manner as in the prior Nelson machines. The segment I is used in my improved machine during the formation of the leg and the ribbed top, while the segment I′ is used during the formation of the foot. Each of the segments is formed with a flange i, that fits loosely in a groove i' in the cylinder, as shown in Fig. 8^a, and is guided therein to allow of a proper amount of movement of the segments about the periphery of the cylinder. The cylinder is provided with four series of holes i^2 i^3 i^4 i^5 to receive pins i^6, i^7, and i^8, which extend across the groove i' between the ends of the segments. In the present machine the holes i^4 are not used. Soon after the toe of the sock has been completed the pinion works in the space 1 and the tooth h^2 on the pinion engages with the segment I′ and moves it forward until its front end strikes the pin i^7. During the time when the segment is thus being moved the knitting is progressing without any movement of the pattern-cylinder, and as the tooth h^2 engages with the segment only once in every revolution of the pinion a sufficient time is given to knit the foot before the pattern-cylinder begins to move. As soon, however, as the end of the segment I′ strikes the pin i^7 it will press against this pin, and a further movement of the segment will cause the pattern-cylinder to move. The pinion will then soon engage the teeth h^3 of the cylinder, which will

be moved forward, and the pinion will continue to actuate the cylinder during the changing of the switches and during the formation of the heel. After the completion of the heel and after the switches are changed and a portion of the foot is knit the pinion h enters the space 2, the cylinder stops moving, and the knitting of the leg is continued, the tooth h^2 operating on the segment I until it is moved forward against a spring-dog I^2, carried by the cylinder. Then the cylinder is moved forward and the pinion h engages the teeth h^3 between the spaces 2 and 3, and the cylinder continues to revolve during the transferring operation, hereinafter described, when passing to the ribbed top. After the transferring is completed the pinion h enters the space 3, where it remains during the formation of the rib. The segment I is moved forward, during the formation of the rib without moving the cylinder until it strikes the pin i^6, when the cylinder is again moved forward, and soon after this the toe of a new sock is begun. During the movement of the cylinder, while the transferring operation was going on, the spring-dog I^2 was engaged by a stop I^3 on the casing of the machine and forced inward, so that the flange i of the segment I was permitted to pass through the recess i^9 in the stop.

In order to prevent the segments I I' from being engaged prematurely by the tooth h^2, a spring-bolt I^4 is employed, which engages the front end of the segment and in effect pushes it back until its rear end abuts against one of the pins i^6 or i^8. As soon as this occurs the continued movement of the cylinder will cause the segment to force back the spring-bolt and pass by it, and then continue to move without interference. The construction and operation of the segments are similar to those employed in the prior Nelson machines, but in these machines no provision was made for stopping the cylinder during the formation of a rib.

The pattern-cylinder is provided with guide grooves at its opposite ends and with guide-grooves and patterns on its periphery for operating various mechanisms. These will be described hereinafter in connection with descriptions of the mechanism in connection with which they are designed to operate. It will be understood that it is not essential that the movable segments should be employed. The object of using them is mainly to avoid the necessity of employing a very large cylinder. By the use of the segments a comparatively small cylinder can be used, which need only be moved when fashioning or when operating switches or the like. It should be understood also that the pinion h may be made to move the cylinder during a part of the operation of forming the foot, leg, and rib, as well as during the formation of the toe and the heel, but preferably the cylinder is allowed to remain stationary during the greater portion of the time when the foot, the leg, or the rib is being formed.

The needles b b' are of usual construction and are connected with jacks B^2 B^3, which are provided with upwardly-projecting lugs b^5, as usual. The needles are also supported by swinging supports M, and the needles on the back row have their jacks mounted in supporting-levers N, pivoted on a shaft m, carried by a frame N^2, secured to the frame of the machine. The supporting-levers N are operated by the pattern-cylinder. The front jacks are carried by supporting-levers N', pivoted on a shaft n', carried by brackets N^3, secured to the front of the machine. The swinging supports M are of usual construction and are supported by the longitudinal bars $M' M^2$, which may be withdrawn to allow the supports M to drop when it is desired to remove or replace one or more needles. The supporting-levers N N' are so constructed, as shown, as to hold the jacks up in proper line to reciprocate correctly during the operation of the needles; but at times the supports are moved in such manner as to cause the jacks to be depressed and their lugs b^5 to be moved out of the path of the operating-cams. The rear ends of the jacks of both the front and back rows may be formed with teeth b^6, adapted to engage with teeth b^7 on the supporting-levers N N' to prevent the accidental movement of the jacks when they are depressed. The supporting-levers N are guided in slots in the front needle-bed, and the supports N are guided in slots in the back needle-bed. The frame N^2 is in like manner slotted to guide the supporting-levers N. The levers N are provided with triangular lugs adapted to ride on the periphery of the pattern-cylinder and in grooves therein in the usual way. In Fig. 5 the supporting-levers N are shown in position to hold the lugs of the jacks in position to be operated upon by the cams on the slide C^5; but when the levers are turned on the shaft m—that is, when their rear ends are elevated and their front ends depressed—the jacks will be depressed and the lugs b^5 will be out of the paths of the cams. The supporting-levers N' are operated to move the lugs b^5 of the front jacks into and out of the paths of the cams on the slide C^4 in the manner hereinafter described.

The main yarn-carrier D is mounted to slide on the top of two flanges d' on the upper ends of the two supporting-frames D^3 D^4 of the ribbing-needles. These supporting-frames are secured at their ends to brackets D^5, attached to the opposite ends of the frame A' of the machine. The flanges have a space between them, through which the main yarn-carrier projects, as indicated in Fig. 18. The top plate d^2 of the main yarn-carrier, which slides on the flanges d', is secured to a vertical plate d^3, that has on opposite sides flanges d^4, sliding in grooves d^5 in the supporting-frames D^3 D^4. An arm D^6 projects rearwardly from the

top plate d^2 and is provided with a lug d^6, which extends into a notch d^7 in the end of the pitman D′. A yarn-guide D⁷, provided with two passages for yarn, is secured to a plate D⁸, pivoted at d^9 to the arm D⁶. Yarn is fed through the passages d^8 in the usual way, and the frame D⁹ for operating the brushes that feed the yarn forms no part of my present invention and is somewhat similar in construction and operation to that shown in John Nelson's patent, No. 214,309, of April 15, 1879. The plate D⁸ is formed with an extension d^{10}, which is pivotally connected with a lever D¹⁰, pivoted at d^{11} to the top plate d^2 and formed with a lug d^{12}, adapted to move either between the flanges d' or along the back side of the back flange, these movements being governed by the position of the switch D¹¹, pivoted to the rear flange d' at the right-hand end of the rear flange d' and connected to a crooked lever d^{13}, provided with a pin d^{14}, entering a groove g^7 in the pattern-cylinder. The lever d^{13} is pivoted at d^{15} to the right-hand end of the machine, and the arrangement is such that at proper times the switch d^{11} is shifted to cause the lug d^{12} to be transferred from the front to the back of the rear flange d', or vice versa, thus causing the plate D⁸, and consequently the guide D⁷, to be shifted to bring one or the other of the two passages d^3 over the eye of the yarn-carrier, through which the yarn is delivered to the needles. The switch D¹¹ is moved when the yarn-carrier is at the limit of a stroke to the right. It is never moved when the yarn-carrier is in any other position. The switch has inclined surfaces on opposite sides, and when the lug d^{12} rides along one of these surfaces it causes the lever D¹⁰ to move in one direction or the other, and thus correspondingly move the yarn-guide D⁷ to effect the change of yarns. The passages d^8 are connected with tubes d^{16} and d^{17}, extending down through a curved slot d^{18} in the top plate d^2 and through a cut-away portion or open space d^{19} in the vertical plate d^3. The tubes are guided also by a curved slot d^{20} in a plate bridging the space d^{19}. Horns d^{22} and d^{23} are employed for holding down the needles as the yarn-carrier reciprocates over them, so that the points of the latch-openers d^{24} will enter the hooks of the needles and open the latches.

The cutting mechanism for the yarn comprises a frame consisting of three bars d^{25}, d^{26}, and d^{27}. This frame is pivoted to move about a vertical pivot in the vertical plate d^3. The lower horizontal bar d^{25} has an enlarged bifurcated end provided with two knife-edges e^3 e^4, which coöperate with stationary knife-edges e^5 e^6. The upper curved bar d^{26} carries a lug e^7, arranged to travel between the flanges d'. The tube d^{16} is adapted to engage with the end of the bar d^{26} and to move it outward when passing by it in either direction, so as to withdraw the knife-edges e^3 e^4 from the knife-edges e^5 e^6. This occurs when the tube is moved in either direction by the lever d^{10}, and when thus moved outward the bar d^{26} holds the lug e^7 in line to engage with a cam e^8 on the front flange d'. The yarn-guide D⁷ is shifted when the yarn-carrier is at the extreme right-hand end of the machine, and when at this end the knife-edges are separated and the thread to be cut is laid between the proper knife-edges. When the yarn-carrier is moving to the left, the lug e^7 engages the cam e^8, and the cutting-frame is moved inward, causing the knife-edges to come together, and thus cut the thread which is to be thrown out of operation. In general the operation of the yarn-carrier, including the mechanism for changing the yarns, is like that heretofore employed; but the yarn-carrier used in my improved machine possesses some novel features, which are hereinafter claimed.

A spring-latch D¹² is pivoted to a bracket D¹³ by a pivot-pin d^{37} at the right-hand end of the machine to prevent the yarn-carrier from moving too far to the right. This latch may, however, be opened by hand to permit the withdrawal of the yarn-carrier whenever desired.

The yarn-carrier is reciprocated back and forth by the pitman D′ in the manner hereinbefore explained during the operation of forming all portions of the sock excepting the ribbed top. The pitman D′ carries a plate D¹⁵, having an inclined lower edge adapted to ride on the upper end of a lever D¹⁶, pivoted at d^{15} to the right-hand end of the machine and carrying at its lower end a pin D¹⁷, entering a groove g^8 in the right-hand end of the pattern-cylinder G. This groove is of the shape shown in Fig. 9. It is so formed that normally the upper end of the lever D¹⁶ is out of the path of the plate D¹⁵, so that the pitman may reciprocate back and forth and always move the yarn-carrier with it. The groove g^8 is, however, provided with a portion g^9, which so moves the bell-crank lever D¹⁶ as to throw the upper end thereof into the path of the plate D¹⁵. When this occurs, the pitman D′ is raised when the slides and the yarn-carrier are at the extremity of their movement to the right. The lever D¹⁶ remains in this position during the formation of the rib, and therefore the pitman D′ will reciprocate back and forth without moving the yarn-carrier D, inasmuch as the notch d^7 will be raised above the lug d^6 at the end of each stroke of the pitman until it has moved to such an extent as to prevent its engagement with the lug. The lever D¹⁶ is only operated at the commencement of the formation of the rib and at the completion thereof.

The front main cam-slide C⁴ carries on its under side four cams J, J′, J², and J³. The cam J is formed on the end of a lever j, pivoted at its opposite end j' to the slide near its left-hand end. This cam is provided with a laterally-projecting plate j^2, sliding in a guide-groove j^3 and carrying a lug j^4, which is adapt-

ed to shift the cam J in the manner hereinafter described. It is also provided with a lug $j^{\times}$ for a purpose presently to be explained. The cam J′ is secured to the end of a lever j^5, which projects through a slot j^6 in the slide and extends along the upper side thereof. It is pivoted at j^7, so that it may be raised and lowered to correspondingly raise and lower the cam to move it into and out of operation. An arm j^8 of the lever j^5 projects through the slot j^6 and carries a lug j^9, operated as hereinafter described. The cam J^2 has no up-and-down movement, but is provided with a guide-block j^{10}, sliding in a guide j^{11}. This cam has only a slight movement and is connected with a tension-bar L, mounted on levers l, connected with a shaft L′, carrying an arm l', provided with a screw l^2, bearing on the pattern-cylinder. The cam J^3 is secured to the end of a lever j^{12}, pivoted to the under side of the slide C^4 at j^{13}. The cam J^2 is cut away at j^{14}, opposite the cam J^3, to permit the lugs b^5 of the jacks to advance when moved forward by the cam J^3. A bar J^4, secured to the slide C^4, extends from the cam J^2 to the right-hand end of the slide and serves at times to guide in a straight line the lugs of the jacks. The cam J^3 is used only for operating the end needle at the right-hand end of the machine on the front side, and it operates only when ribbed work is being made. The cam J is out of operation, as shown in Fig. 31, when the toe or the heel of the sock is being made; but when the foot or leg is being formed the lever j on which the cam is formed acts as a guide to the lugs of the jacks, as shown in Fig. 33. When forming the rib, the cam J acts to retract the needles, as shown in Fig. 35, when the slide is moving to the right. The cam J′ is elevated and out of operation during the formation of the toe and heel. When forming the foot and leg, it is an advancing cam, as shown in Fig. 33, and when forming the rib it acts both to advance and retract the needles, as shown in Fig. 35. The cam J^2 has only a slight movement transversely to the movement of the slides. During the formation of the toe or heel the cam is out of the path of the jacks, as shown in Fig. 31. When forming the foot or the leg, the left-hand end of the cam acts to retract the needles when the slide moves to the left, as shown in Fig. 33, and it operates in a similar way when the rib is being made, as indicated in Fig. 35. In order to change the position of the cam J at the proper times, the lug j^4 is made to travel either on the inside or the outside of a flange l^3 on the upper front bar C^3. This flange is formed by cutting a longitudinal groove l^4 on the under side of the upper part of the bar C^3. This groove extends from end to end of the bar; but the flange is cut away at l^5, and this opening is controlled by a switch l^6. The switch is adapted to be shifted from the position shown in Fig. 28 to that shown in Fig. 29. When the switch is in the position shown in Fig. 28, the groove l^4 is closed at its left-hand end, and the lug j^4 moves back and forth on the outside of the flange, thus holding the cam J in the position shown in Fig. 33; but when the switch is in the position shown in Fig. 29 the lug moves in the groove back of the flange l^3 and the cam J is held in the position shown in Fig. 31. The switch l^6 is provided with an arm l^7, free to oscillate in a groove l^8 in the bar C^3, and it is pivoted at l^9. The inner end of the arm engages with the upper bifurcated end of a bell-crank lever L^3, pivoted to the machine at l^{10} and connected with a rod L^4, which is pivotally connected at its lower end to the rear end of a shoe O, bearing on the pattern-cylinder. The shoe O is pivoted to a hanging bracket O^{10}, secured to the frame of the machine at its front left-hand end, as shown in Fig. 1. The pattern-cylinder is formed with a groove 10, which is divided by raised portions, the arrangement being such that the lugs at the front and rear ends of the shoe O are made to ride either on the groove or on the raised portions of the cylinder. When the rear lug is in the groove, the rod L^4 will be depressed and the switch l^6 will be open, as shown in Fig. 37; but when the rear lug is on one of the raised portions the switch will be closed. The lug j^9 of the cam J′ is adapted to move in longitudinal grooves l^{12} l^{13} above and below a rail or flange l^{14} on the front guide-bar C^2. The grooves are always open at their right-hand end, but at their left-hand end they are controlled by a switch L^5, pivoted at l^{15} to the left-hand end of the rail or flange l^{14}. At l^{16} the switch is connected with a rod L^6, extending through a guide-opening in the bar C^2 and connected at its lower end to a shoe O′, which bears on the pattern-cylinder and is controlled by a groove 11 therein. The shoe O′ is shaped similarly to the shoe O. When the front end of the shoe is elevated, as shown in Fig. 36, the switch L^5 is elevated and the groove l^{12} is closed and the lug j^9 is caused to travel in the lower groove l^{13}, thus holding the cam J′ down and in operation, as shown in Fig. 33. When the switch L^5 is shifted to the other position, the lug j^9 travels in the upper groove l^{12} and the cam is elevated and out of operation, as shown in Fig. 31. The cam J^3 is adapted to be elevated or depressed, so as to move in either of the grooves l^{17} or l^{18} on opposite sides of the rail or flange l^{19}. At the right-hand end of the rail l^{19} is secured a spring-switch l^{20}. When the cam J^3 is moving in the under groove and its edge l^{21} strikes the switch l^{20}, it elevates the switch and passes by it, the switch springing back automatically into the position shown in Fig. 33 when the cam has passed. On the return movement to the left the cam rides up over the switch l^{20} and into the groove above the rail or flange l^{19} until it reaches the left-hand end of this groove. If the rib is being formed, a switch l^{22} will be in the position shown in Fig. 35, and the cam J^3 will strike against its in-

clined end and move downward into line with the lower groove l^{18}, which it traverses on the return movement to the right. Thus during the formation of the rib the cam J^3 will be raised or lowered at the end of each stroke. When traveling to the right, it will always travel in the lower groove, and will thus be in position to act upon the end needle. When traveling to the left, the cam will always be in the upper groove and will be out of line with the end needle, and therefore will not operate it. When the machine is not forming the rib, the cam J^3 will always move above the rail l^{19}, and consequently will not operate the end needle. The switch l^{22} is pivoted at l^{23} to the inner grooved side of the lower front bar C^2, and it is connected at l^{24} to a rod L^7, sliding in the guide-opening l^{25}, and at its end connected with the shoe O^2, pivoted at o^3 to the bracket O^{10} and bearing on the pattern-cylinder. The shoe O^2 is similar in shape to the shoes O O', and it is adapted to work in a groove 12 in the pattern-cylinder and on raised portions interposed in the groove, the pattern being such as to operate the switch at the proper time. Fig. 8 represents as accurately as can well be shown in a drawing the shapes of the grooves 10, 11, and 12. The shoes O, O', and O^2 are shown in Fig. 8 in the positions they occupy relatively to the grooves.

The lug x^4 of the plate j^2 is adapted to enter a groove $l^\times$ formed between the upwardly-projecting flange $l^{\times\times}$ of the tension-bar L and the edge $l^{\times\times\times}$ of the bar C^3. When the parts are in the position shown in Fig. 31, the lug $j^\times$ travels in the groove $l^\times$ and the tension-bar L holds the cam J in contact with the cam J^2, so that when the cam J^2 moves for tension the cam J will be moved also; but when the cam J^2 moves back it does not shift the cam J, but the latter is shifted by the tension-bar L, which operates on the lug $j^\times$. When the parts are in the positions shown in Fig. 33, the lug $j^\times$ travels outside the edge of the bar L, and this bar does not operate on cam J. The groove l^4 is much wider than the lug j^4, so that the cam J can shift when the lug is in the groove.

The back cam-slide C^5 carries five cams K, K', K^2, K^3, and K^4. The cam K is provided with a guide-block k, sliding in a guide k'. It is connected with a tension-bar K^5, carried by arms K^6, secured to a shaft K^7, to which is attached a shoe K^8, working on the pattern-cylinder. The tension-bars are connected by a spring K^9 and are operated in substantially the same manner as in the prior Nelson machines. The screw l^2 of the front tension-bar operates on the periphery of the cylinder and in grooves 15 therein. The shoe K^8 operates on the periphery of the cylinder; but at a certain time in the operation of the machine it drops into a recess 16, so as to vary the tension. The periphery of the cylinder may also be formed with proper elevations and depressions other than the recess 16 to regulate the tension. The cam K^2 is a stationary cam. The cam K' is secured to the end of a lever k^2, pivoted to the slide C^5. An arm k^3 of this lever projects through a slot in the slide and carries a lug k^4, which operates in grooves k^5 k^6 above and below a rail k^7 in the inner side of the back lower bar C^2. At their left-hand ends the grooves are opened and closed by a switch l^{26}, pivoted at the end of the rail k^7 and provided with a pin l^{27}, which extends through an opening in the bar C^2 and connects with a rod l^{28}, which extends through a guide-opening, and at its lower end is connected with a shoe O^4, similar in construction to the shoes O O', &c., and pivoted to the rod m. It is adapted to bear on the pattern-cylinder, which is provided with a groove 14, which controls its movements. The shoe is adapted to move either on the periphery of the pattern-cylinder or in the groove. When its front lug is in the groove, the back lug is on the periphery of the cylinder, and vice versa. In this way the switch l^{26} is raised and lowered. The cam K^3 is formed on the end of a lever k^8, pivoted at k^9 to the under side of the slide C^5 near its right-hand end. This cam is provided with a plate k^{10}, guided in a groove k^{11} and carrying a lug k^{12}, extending through a slot k^{13} and arranged to move on the opposite sides of a flange k^{14} in the upper back bar C^3. It is also provided with a lug $k^\times$, for a purpose hereinafter specified. The groove in rear of the flange k^{14} is opened and closed at one end by a switch L^8, pivoted at m^{10} and connected, as shown in Fig. 39, with a shoe O^3, carried by the rod m and operating in a groove 13 in the pattern-cylinder and on raised portions of the cylinder between portions of the groove, the arrangement being such that the ends of the shoe are raised or depressed at the proper times to correspondingly shift the switch L^8. The shoe O^3 is similar to the shoes O O' O^2 and operates in substantially the same way. In Fig. 28 the switch L^8 is shown in such position as to close the groove in rear of the flange k^{14}, and thus the lug k^{12} is made to travel on the outside of the flange. In Fig. 29 the switch is shifted so that the lug k^{12} will travel in the groove in rear of the flange. When the switch is in the position shown in Fig. 28, the cam K^3 will be in the position shown in Figs. 30 and 32, and when the switch L^3 is in the position shown in Fig. 29 the cam K^3 will be located as indicated in Fig. 34. The cam K^4 is secured to the end of a lever k^{15}, pivoted at k^{16} to the slide C^5. It is adapted to slide back and forth in grooves k^{17} k^{18} above and below a flange k^{19} on the lower back bar C^2. At one end of the rail k^{19} is attached a spring-switch m^{11}. (Indicated in Fig. 34.) This switch is similar in construction and operation to the switch l^{20} on the front side of the machine. At the right-hand end of the grooves l^{17} l^{18} is secured a stop k^{24}, having an inclined edge facing the grooves. The cam K^4 by this arrangement will be raised or lowered at the end of each stroke during the entire operation of the machine; but the support for the jack of the end needle at the left-hand

end of the back row of needles is so controlled by the pattern-cylinder that the end needle is only actuated by the cam K^4 when ribbed work is being made. Therefore no special switch mechanism is required to control the movement of the cam K^4. When traveling to the right, the cam K^4 rides in the upper groove k^{17}. It then strikes against the stop k^{24}. On the return movement to the left the cam rides in the groove k^{18}. When it reaches the switch m^{11}, it raises it, passes by it, and on the return movement enters the groove k^{17}. It will be understood that the cams J^3 and K^4 are not provided with lugs to operate in the guide-grooves; but the rear edges of the cams themselves travel in the guide-grooves. It should also be understood that the cams J^3 K^4 are not arranged to operate on the jacks of any of the needles except one end needle in each row of needles, the jacks being specially formed to be acted on by the cams, as hereinafter explained. A rail K^9 is secured to the back slide on its under side and extends from the cam K′ to the left-hand end of the slide. A guide-rod k^{20} is pivoted to the side of the rail K^9 and is secured to the lever k^2 by a pin k^{21}, which extends through the rail k^9, the arrangement being such that as the cam K′ is elevated the end k^{22} of the rod is depressed, and vice versa. This is for the purpose of guiding the jacks when the cam K′ is out of operation.

The shapes of the several cams and their exact relative positions at various stages of the knitting are clearly shown in the drawings, especially in Figs. 28 to 35, inclusive.

When knitting the toe of a sock, the front and back cams are arranged as shown in Figs. 30 and 31. The cams of the front slide are all out of operation and the needles are withdrawn. The cam K^4 is moved up and down at the end of each stroke; but as the end needle is thrown out it does not operate it nor does it touch the lugs b^5 of the other needles. The cam K^3 lies close to the cam K^2, and the lugs b^5 of the jacks are in contact with the edge of the lever k^8. The cam K′ is also lowered and active. When moving to the right, the cam K operates as a retracting-cam and the cam K′ as an advancing-cam. When the slides move to the left, this cam K retracts the needles and the cam K^2 advances them. In this way a course is knitted during each stroke or twice during each reciprocation or double stroke of the slides. Figs. 32 and 33 show the positions of the cams when knitting the foot or the leg. The cam J′ on the front slide advances the needles when the slide is moved to the right, and when moving to the left the cam J^2 retracts them. The cam K on the back slide retracts the needles when the slide moves to the right. When the slide moves to the left, the cam K^2 advances the needles. The cams remain in the positions shown in Figs. 32 and 33 during the entire operation of forming the foot and the leg.

When forming the rib, the cams of the front and back slides are in the positions shown in Figs. 34 and 35. When the slide moves to the right, the cam J′ advances the needles and the cam J retracts them. When moving in the opposite direction, the cam J′ advances the needles and the cam J^2 retracts them. The cam J^3 acts on the end needle and gives it an additional movement.

The lug $k^\times$ on the plate k^{10} is adapted to enter a groove a^{20} formed between the edge of the bar C^3 and the flange a^{21} of the tension-bar K^5. When the parts are in the positions shown in Fig. 34, the lug $k^\times$ travels in the groove a^{20}, and the tension-bar K^5 holds the cam K^3 in contact with the cam K, so that when the cam K moves for tension the cam K^3 will be moved also; but when the cam K moves back it does not shift the cam K^3, but the latter is shifted by the tension-bar K^5, which operates on the lug $k^\times$. When the parts are in the positions shown in Fig. 30, the lug $k^\times$ travels outside the edge of the tension-bar, and the bar does not operate the cam K^3. The groove in rear of the flange k^{14} is much wider than the lug k^{12}, so that the cam K^3 can shift while the lug is in the groove. The pattern-cylinder and the connections between the tension-bars and the pattern-cylinder are such as to impart the proper tension to the cams while knitting the several parts of the stocking.

The jack of the end needle is indicated at Y. The shape of the jack is shown clearly in Fig. 25. It will be seen that in addition to the lug b^5 the jack has an additional lug b^{55}, the arrangement being such that the main knitting-cams are adapted to operate on the lug b^5, while the cam J^3 or the cam K^4 is adapted to act on the extension or additional lug b^{55}.

Referring now to Fig. 35, when the slides move to the right the advancing end of the cam J^3 will operate upon the end of the extension b^{55} and advance the jack Y, the lug b^5 entering the recess j^{14} of the cam J^2. As soon as the cam J^3 has passed the extension b^{55} the lug b^5 will strike against the end of the recess in the cam J^2 and the inclined end b^{11} thereof will move the jack backward. Immediately thereafter the cam J′ comes in contact with the lug b^5 and advances the jack Y, and next the cam J acts to retract the jack. In this way it will be seen that the end needle is advanced twice and retracted twice during the movement of the front slide to the right. When the slide moves to the left, the cam J^3 will be above the rail l^{19} and consequently out of operation. The purpose of giving to the end needles the additional movements will be hereinafter explained.

Referring to Fig. 34, when making the rib the cam K^2 of the back slide advances the needles when the slide is moving to the right and the cam K retracts them. When moving in the opposite direction, the cam K^2 advances the needles and the cam K^3 retracts them. The cam K^4 operates upon a jack similar to the jack Y. (Shown in Fig. 25.) When moving to the left, the cam K^4 acts on

the end of the lug b^{55} and advances the needle. Cam K then retracts the needle by acting on the lug b^5. Next, cam K^2 advances the needle, and then the cam K^3 retracts it. When the slide is moving to the right, the cam K^4 is in the upper groove k^{17}, and therefore does not operate upon the jacks.

The ribbing-needles P are pivotally mounted on bars Q, which extend through openings in the supporting-frames D^3 D^4. These frames are formed with a series of slots q' to permit the needles to oscillate transversely across the central longitudinal openings between the needles. The bars Q are stationary, and the needles have independent pivotal movements thereon. Each needle is formed with a central bearing portion q^2, through which its supporting-bar Q extends, and an upwardly-projecting arm q^3, which extends above the top of the frame, and with a downwardly-projecting portion or shank q^4, to which the needle proper, q^5, is connected. The heel of the needle is curved, forming a recess q^6, and it is formed with a hook and latch of usual construction. The needles are so pivoted that those on one side of the machine can pass over to the other side thereof in the manner illustrated in Figs. 46 and 47. The shanks extend through slots in guide-bars P', which are mounted to slide longitudinally of the machine in guide-grooves p^2. These slotted bars are for the purpose of guiding the lower ends or shanks q^4 of the needles and to keep them in proper line. The slots are widest at their rear ends, and the portion P^3 in front of the rear wide portions of the slots form resting-places for the main knitting-needles when the ribbing-needles are out of operation. Furthermore, the ribbing-needles when out of action are locked in the wide portions of the slots. When the main portion of the sock is being knit, the needles when they are advanced project above the bars P' and their hooked ends rest thereon, those opposite the ribbing-needles resting at the points p^3. When ribbed work is being made, the needles that formerly rested at these points p^3 are thrown out of operation and the bars P' are shifted, bringing the open slots in line with the ribbing-needles to permit them to oscillate. The bars P' are slotted at p^4, and through these slots extend rods p^5, pivotally connected at their lower ends to a link p^6, which in turn is connected with a lever p^7, pivoted at p^8 to the frame of the machine and carrying a pin p^9, which works in a groove p^{10} in the left-hand end of the pattern-cylinder. This groove is so formed that it holds the bars P' in the position shown in Fig. 22 at all times except during the transferring operation and during the formation of the rib. At the commencement of the transferring operation the pin p^9 rides along the incline p^{11} of the groove and shifts the bars P', permitting the needles to oscillate freely. During the formation of the rib the pin p^9 rides in the portion p^{20} of the groove when the pattern-cylinder is being moved, and at the end of the ribbing the pin p^9 rides in the inclined portion p^{12} of the groove, and the bars P' are shifted back to the position shown in Fig. 22. The rods p^5, which pass through the slots p^4 in the bars P', are formed with notches p^{13}, the inclined edges p^{14} of which operate to shift the bars P' at the proper times.

The ribbing-needles are locked, except during the formation of the rib, by toothed bars P^3. (See Fig. 24.) Each of these bars slides in a longitudinal groove in one of the frames D^3 D^4, and a lug p^{15} on the bar extends into a recess p^{16} in a rod p^{17}, which is recessed at p^{18}, and these recesses are engaged by the recessed ends p^{19} of the rods p^5, the arrangement being such that as the rods p^5 are raised and lowered the toothed bars p^3 are shifted. The teeth are so disposed that at times they lie in the slots q' behind the ribbing-needles and hold them securely in the position shown in Fig. 22; but when the bars P^3 are shifted the teeth clear the slots q' and the needles are permitted to oscillate transversely. Without some such provision for locking them the ribbing-needles might be shaken out of position, so as to interfere with the operation of the main knitting-needles. The toothed bars are also so constructed and arranged that when slid in one direction they will operate to move the knitting-needles from the position shown in Fig. 47, for instance, back to the position shown in Fig. 40. This operation occurs after the ribbed top has been finished, as will be hereinafter described.

Parallel guide-bars R are mounted in brackets r at opposite ends of the machine. These bars are arranged on opposite sides of the needles and above the plane of the bars P'. They have an axial movement which is effected by levers R' R^2, having pins r' r^2 extending into a groove r^3 in the right-hand end of the pattern-cylinder and connected by links r^4 r^5 to brackets R^4 R^5, secured to the right-hand ends of the guide-bars. The groove r^3 is clearly illustrated in Fig. 9. For the most part it is plane or concentric with the axis of the pattern-cylinder; but at r^6 it is so formed as to act upon the pins r' r^2 to properly move the levers R' R^2 to give proper axial movements to the guide-bars R, which movements are hereinafter explained.

A description of the precise formation of the groove seems unnecessary, as the groove is accurately shown in the drawings.

The yoke c' extends across the guide-bars R, and to this yoke are hinged levers s, carrying cams S S', adapted to act on the upper ends of the arms q^3 of the ribbing-needles. Each guide-bar R carries a sleeve S^2, Fig. 13, which has a feather-and-groove connection with the bar and is free to slide therein and to turn therewith, both bars being grooved from end to end for this purpose. The yoke c' carries recessed blocks r^7, entering recesses s^2 in the sleeves S^2, and as the yoke is reciprocated the sleeves are correspondingly

moved along the bars R. Each sleeve S^2 carries a slotted arm s^3, extending through a slot s^4 in the lever s. When the bars R are turned in one direction, the arms s^3 will hold the cams S S′ elevated and out of the paths of the ribbing-needles; but when these guide-bars are turned in the opposite direction the cams are lowered and held in the paths of the needles and act upon them to move them out of the position shown in Fig. 40 into the paths of the cams that operate them while knitting the rib. The slots in the arms s^3 are so formed that the cams S S′ are held up and out of operation except when they are used to move the ribbing-needles into operative position. When the arms s^3 are lowered, the cams S S′ drop into the paths of the ribbing-needles; but the slots are so formed that the bars R can have a further axial movement without further tending to move the cams S S′. The operation of these devices will be further explained hereinafter.

There are two yarn-guides T T′ for feeding yarn during the operation of forming the rib. They are practically the same in construction and are free to slide back and forth on the guide-bars R and to turn relatively thereto, as well as to permit the bars to have an independent axial movement. The tube t of each yarn-guide, through which the yarn is fed, is connected with a sleeve t' on the guide-bar R. The latch-openers t^2 are carried by a plate t^3, provided with sleeves t^4 t^5, mounted on the bar R. The sleeve t' is arranged between the sleeves t^4 and t^5 and has a slight movement between them at the end of each stroke, as illustrated in Fig. 21. An eye t^6, which may be made of wire, is secured to the sleeve t'. The tube t abuts when moving in one direction against a block t^7 on the plate t^3, as shown in Fig. 21. These yarn-guides are held down by the frames D^3 and D^4 and slide along the guide-beds T^2, as indicated in Fig. 18. At the right-hand end of the machine the guide-beds have sunken or depressed portions t^{10} connected with the main portions T^2 by inclines t^{11}. The purpose of this arrangement is as follows: When the yarn-guides T T′ are in operation, the main yarn-carrier D is at rest at the right-hand end of the machine, as shown in Fig. 18; but when in this position its lower end, including the latch-openers d^{24}, &c., are in the path traversed by the yarn-guides T T′ when feeding yarn to the needles, and consequently the yarn-guides T T′ would strike against these devices of the yarn-carrier D if the yarn-guides T T′ continued to move in the same path; but by causing the yarn-guides T T′ to drop into the depressed portions t^{10} they will clear the yarn-carrier D and operate without interference. On the return movement to the left the yarn-guides T T′ rise on the inclines t^{11}, and therefore move in proper line upon the guide-beds T^2.

The cam-slides U for operating the ribbing-needles are mounted on the guide-bars R on opposite sides of the machine. Each slide is formed with two sleeves u u', adapted to slide on one of the guide-bars, and the sleeves t' t^4 t^5 of the yarn-guides are arranged between the sleeves u u', the arrangement being such that the yarn-guides are allowed to turn on the bars relatively to the cam-slides to move them, with the slides, as they reciprocate, having but a very slight independent movement, which is allowed by a space between the opposite ends of the sleeves t^4 t^5 and the sleeves u u'. Each of the slides carries two cams U^2 U^3, secured to the end of a lever u^2, centrally pivoted at u^3 to the slide. The shape of the cams is shown in Fig. 15. The lever u^2 carries two laterally-projecting pins u^4 u^5 on opposite sides of the pivot u^3, which are engaged by a sliding rod U^4, having recesses v^6, formed with inclined sides engaging the pins u^4 u^5, the arrangement being such that as the rod U^4 is reciprocated it acts on the pins to alternately raise and lower the cams U^2 U^3. The rod U^4 is properly guided in a recess on the top of the slide next to the sleeves u u', and a spring u^{20} guides one end of the rod and holds it in proper alinement. A plate U^5, pivoted in rear of the cams U^2 U^3, at its ends carries guide-flanges u^7 u^8. It is also provided with laterally-projecting lugs u^9 u^{10}, carrying pins u^{11} u^{12}, projecting over the rod U^4 and adapted to be operated by the inclined sides of the recesses u^6, the arrangement being such that when one of the cams is elevated the adjacent flange u^7 or u^8 is depressed. This is for the purpose of guiding the ends of the arms of the ribbing-needles with which the cams engage, so that the arms will follow the proper courses in the ways between the cams and the edges of the stationary plates or cams U^6 U^7 U^8 U^9, secured to the under sides of the slides. The paths which the needles traverse are indicated by arrows in Fig. 15. At the end of the movements of the slides to the right the rods U^4 strike against stops u^{15} u^{16} on the brackets R^4 R^5. This causes the rods U^4 to be shifted to the left in such manner as to depress the cams U^3 at the right-hand end of the slides and to raise the cams U^2 at the opposite ends, at the same time raising the flanges u^7 at the right-hand end of the slides and depressing the flanges u^8 at the left-hand ends. At the end of the movement of the slides to the left the cams and flanges are similarly operated to cause the cams U^2 to be depressed and the cams U^3 to be raised and their corresponding guide-flanges similarly moved. The rods U^4, however, do not strike against stops at the ends of the guide-bars R, inasmuch as the yoke c' is in the path of the rods. The rods U^4 are, however, arranged to strike against slide-rods u^{21}, that are adapted to move back and forth in the blocks r^7. The left-hand ends of these slide-rods strike against stops u^{17} u^{18} on the brackets r at the left-hand end of the machine, and when these rods are arrested they serve as stops for the rods U^4 and cause them to shift properly to change the positions of the cams

U^2 U^3 and the corresponding guide-flanges. The sleeves S^2 are provided with hooks s^5, adapted to engage with hooks s^6 on the sleeves uu'. It will be remembered that the guide-bars R are adapted to be first turned sufficiently to allow the cams S S′ to drop into the paths of the ribbing-needles. At the proper time the bars R are further turned and the hooks s^5 are caused to engage with the hooks s^6, so that the sleeves S^2 and uu' will be locked together, and as the yoke c' travels back and forth across the machine the cam-slides U U′ and parts connected therewith are reciprocated with it. The operation of this mechanism will be further described when describing the operation of the entire machine.

Two bars V extend through slots n^3 and recesses n^2 in the jack-supporting levers N′. One of the bars extends through a recess n^2 in each alternate jack and through a slot n^3 in the other jacks, while the other rod V in like manner extends through recesses in each alternate jack and through slots in the remaining jacks, the arrangement being such, as indicated in Fig. 25, that when one of the bars is elevated or depressed it will elevate or depress each alternate supporting-lever or one-half of the supporting-levers, while the others remain stationary. The bars V are connected at their ends to upright rods V^2, which extend through guide-openings in the frame of the machine, and at their lower ends are connected to the front ends of shoes O^5, (see Fig. 1,) bearing on the pattern-cylinder and in grooves 17 therein, the arrangement being such that at proper times the bars V are independently operated to raise or lower one-half of the supporting-levers N′ to cause the corresponding jacks B^2 to be thrown into or out of operation.

The pattern-cylinder is so formed as to cause the supporting-levers N of the jacks of the back row to be shifted to throw corresponding jacks into and out of operation. When passing from plain knitting to the knitting of the ribbed top, the supporting-levers N N′ are operated to throw one-half of the jacks (each alternate one) on each row out of operation, the needles of these jacks being supplanted by special ribbing-needles, as hereinafter described.

Each alternate jack on both the front and back side of the machine has on each side a transferring-point W, the form and arrangement of which are shown particularly in Figs. 25, 26, and 27. The front ends of the points are inclined, and on their inner faces are formed recesses w to receive the hooked ends of a ribbing-needle, as indicated in Fig. 27. The shanks of the transferring-points extend rearwardly alongside of the jacks B^2 above the rods V. Each transferring-point in both front and back rows is formed on its upper edge with lugs w', between which extends a longitudinal bar W′, connected at its ends to vertically-arranged levers W^2, that are connected at their lower ends to sleeves W^3, surrounding the shafts L′ K^7. These sleeves are provided with arms W^4 W^5, carrying pins w^2 w^3, entering a groove w^4 in the left-hand end of the pattern-cylinder. This groove is for the most part concentric with the axis of the cylinder, and when the pins w^2 w^3 move in this concentric portion of the groove the bars W′ are so held as to hold the transferring-points in their retracted positions. The groove w^4 is, however, provided with branches or offsets w^5 w^6, into which the pins w^2 w^3 are adapted to enter. These offsets of the groove are so shaped that they cause the bars W′ to be first advanced a short distance, then advanced to a greater extent, and subsequently to be withdrawn to their original positions. The details of the mechanism for operating the transferring-points on both the front and back sides of the machine are clearly indicated in Figs. 5, 6, 25, 26, and 27. Some of the parts are also shown in other figures of the drawings.

The machine thus constructed and organized is specially adapted for knitting socks; but with certain modifications it might be used for knitting other articles. The ribbing mechanism might obviously be used separately from the other mechanism. It may be arranged to make either plain or tubular work—that is to say, my invention comprehends the mechanism hereinafter claimed, whether used in a machine for making socks or other knitted articles.

In order to more fully understand the construction, organization, and operation of the machine herein shown, I will describe the operation of the machine as organized for knitting socks throughout the entire process of knitting a sock.

In commencing the knitting the "set-up" is made as in the prior Nelson machines, the cams on the front and back slides being in the position shown in Figs. 30 and 33. As soon as the set up is made the front row of needles is thrown out of operation and the toe is knit on the back side of the machine, the cams on the back slide being in the position shown in Fig. 30, while those on the front slide are all out of operation, as indicated in Fig. 31. The main yarn-carrier is actuated in the usual way by the mechanism hereinbefore described during the formation of the set-up and the toe, and the pinion h operates on the teeth h^3, included between the points y y', as indicated in Fig. 8, and also for a time on the segment I′. After the toe is completed the cams on the front slide are thrown into operation to coöperate with the cams on the back slide to form the foot of the sock, the cams on the two slides at this time being in the positions shown in Figs. 32 and 33, and the pinion h operating for the most part in the space 1, as indicated in Fig. 8. The tooth h^2 on the pinion engages with the segment I′, which is operated as hereinbefore described. After the foot is completed the pinion h again engages with the teeth h^3 between the points y'

y^2 to form the heel, during which operation the cams on the front slide are out of operation, as shown in Fig. 31, while the cams on the back slide are in the positions shown in Fig. 30. Soon after the heel is completed the pinion h enters the space 2, and the tooth h^3 on the pinion engages the toothed segment I. When the pinion is arranged in the space 2 and its tooth operates upon the segment I, the cylinder ceases to move. During the formation of the leg the cams on the front and back slides are arranged as shown in Figs. 32 and 33. The yarn-carrier reciprocates continuously during the formation of the set-up, toe, foot, heel, and leg, but is shifted at certain times to change the yarns. I have shown the yarn-guide D^7 as provided with two guide-tubes for two yarns. For instance, if I use blue and white yarns one tube may be used to guide the white yarn, while the other is used to guide the blue yarn. The blue yarn may be used to form the set-up, and as soon as this is formed the yarn-guide D^7 may be shifted by the mechanism hereinbefore described to sever this blue yarn and to bring the white yarn into position to be fed to the needles during the formation of the toe. After the toe is completed the yarn-guide D^7 is again shifted, the white yarn is cut, and the blue yarn is fed to the needles. In like manner white yarn is used in forming the heel and blue yarn in forming the leg. The mechanism for changing the yarn is illustrated in Figs. 17, 18, and 19 and has been hereinbefore fully described. While forming the set-up, toe, foot, heel, and leg of the sock, the front row of jack-supporting levers N′ are all elevated so as to hold the lugs b^5 of the jacks in position to be acted on by the cams. The jack-supporting levers N on the back of the machine are operated by the pattern-cylinder. As soon as the leg of the sock is knit the segment I abuts against a spring-dog I^2 and moves the cylinder forward. The pinion h then engages the teeth h^3 between the points y^2 and y, and the operation of transferring from plain knitting to ribbed work is performed. The first thing that happens in the transferring operation is that when the main yarn-carrier is at the left-hand end of the machine and the main cam-slides are at the extremity of their movement to the left the pattern-cylinder is moved and operates upon the shoes O^5 to move one set of rods V, connected with them, to shift the supporting-levers N′ of the jacks of the front row of needles so as to cause one-half of them—namely, every alternate one—to drop out of active position. While the jacks are withdrawn, their teeth b^6 engage with the teeth b^7 of the supporting-levers, so that they will not be advanced when the other needles advance. When the slides next move to the right, each alternate needle in the front row—namely, those not thrown out of position—is advanced through the loops of the fabric carried by them. During this stroke to the right, the back row of needles draws back and knits in the usual way. At the end of this movement to the right the pattern-cylinder moves, and the main yarn-carrier is disconnected or thrown out of operation by means of the lever D^{16} and parts connected therewith, as before described. At the same time the branch w^5 of the groove w^4 at the left-hand end of the pattern-cylinder operates on the front lever W^4 to move the transferring-points on the front side of the machine part way up and into the position shown in Fig. 40. At the same time one-half (each alternate one) of the jack-supporting levers N on the back side of the machine are moved to throw one-half or each alternate jack of the back row out of operation, and the switch l^{22} is shifted. When these operations have been performed, the cam-slides move to the left and the needles of the front row which were not thrown out of operation are drawn down and leave their loops on the front transferring-points. At the same time each alternate needle on the back side of the machine rises. While at the extremity of the movement of the slides to the left, the pattern-cylinder will again be moved and the transferring-points on the front side of the machine are fully advanced and they carry the loops of the fabric away from the front needles, as indicated in Figs. 27 and 41. At the same time the transferring-points of the back row are moved half-way up, (see Fig. 41;) also, at the same time the front levers N′ are dropped, so that the front needles will not be advanced during the next stroke of the cam-slides to the right. During this same time the bars P′ and P^3 are moved to their full extent, thus leaving the slots q' free to permit the ribbing-needles P to oscillate, also bringing the slots of the bar P′ into line with the ribbing-needles and the resting-places p^3 into position for the main knitting-needles, which are to be used in the process of forming the ribbed top. The lever R^2 is also operated at this time to turn to a certain extent the rear guide-bar R, so that it will cause the cam S′ to drop into the paths of the upwardly-projecting ends of the ribbing-needles of the back row. At the same time the switch l^6 is moved to throw the cam J into operation. After these operations have been performed the slides move to the right, the needles of the back row of main knitting-needles draw back, and the cam S′ moves the ribbing-needles of the back row through the transferring-points of the front row, as indicated in Fig. 42. When thus moving to the right, the needles of the front row of main knitting-needles do not operate, as the jacks were all dropped, as above explained. As soon as the slides have reached the end of this stroke to the right the pattern-cylinder is moved and the back transferring-points are fully advanced, and the front transferring-points are drawn half-way back, as shown in Fig. 43. At the same time the cam S is dropped into the path of the shanks q^3 of the ribbing-needles of the front row, and the switch L^8 is shifted. The cams

on the back slide C^5 are then changed from the position shown in Fig. 32 to that shown in Fig. 34, and about this time the end needle on the back row is brought into operation by the pattern-cylinder. At the same time the supporting-levers N are all dropped, so that the back needles will not be advanced on the next stroke. The slides then move to the left, and the front ribbing-needles are moved by the cam S through the back transferring-points, as indicated in Fig. 44, and the front needles are inoperative, as the levers N′ have all been dropped. When the slides are at the left, the pattern-cylinder again moves, the front transferring-points are fully withdrawn, and the back transferring-points are withdrawn half-way, as shown in Fig. 45. Then the slides move to the right, and as soon as they complete the end of their movement to the right the pattern-cylinder again moves, the back transferring-points are fully withdrawn, and both bars R R are turned so as to cause the hooks s^5 to engage with the hooks s^6, and the ribbing cam-slides will thus be connected with the yoke c' and will travel back and forth with it. Before the slides move to the left the supporting-levers N and N′ on both the front and back of the machine are operated to hold each alternate needle in each row in operative position and each alternate needle in each row out of operation. The transferring operation is now complete, and on the next movement of the slides to the left a course of ribbed work will be made, the ribbing-needles on the front side of the machine coöperating with one-half of all the main knitting-needles on the back side and the ribbing-needles on the back side of the machine coöperating with one-half of all the main knitting-needles on the front side of the machine. In moving to the left on the first stroke after the slides U U′ are picked up the front row of main knitting-needles rises and pulls back and the ribbing-needles on the back row coöperate with them to form a course of ribbed knitting. Immediately after the front row of main knitting-needles has knit and the ribbing-needles of the back row have crossed over and gotten out of the way the back knitting-needles rise and draw back and, in connection with the ribbing-needles on the front side, knit a course. In the same way a course is knit on each side of the machine at each stroke; in fact, knitting two courses simultaneously during one stroke of the cam-slides. The different movements of the transferring-points and the ribbing-needles are illustrated in Figs. 40 to 47, inclusive. It will be observed by reference to Fig. 46 that when the back yarn-guide T′ is feeding yarn to the main knitting-needles of the back row it feeds the same yarn to the ribbing-needles of the front row, the yarn-guide traveling across the machine in rear of the back row of ribbing-needles. Similarly when the front yarn-guide T is feeding yarn to the front row of main knitting-needles it feeds yarn to the back row of ribbing-needles, and the yarn-guide as it travels back and forth operates in rear of the front ribbing-needles, which are crossed over and moved out of the way, as indicated. While knitting the rib, the main yarn-carrier D remains stationary at the right-hand end of the machine, and yarn is fed to form the rib by the yarn-guides T T′. The cams U^2 U^3 are properly shifted at the end of each stroke, as hereinbefore described.

In order to form a tubular rib, it is necessary to interlock the yarn which knits one side of the ribbed fabric with the yarn that knits the other side. To accomplish this, I operate the end needle at the right-hand end of the front side of the machine and the needle at the left-hand end of the back side of the machine in a special way. These needles are operated in the manner indicated in Figs. 29, 34, and 35, and it has already been explained how they are operated twice during each reciprocation. The effect of this operation of the needles is illustrated in the diagrams, Figs. 49 to 55, inclusive. Fig. 48 indicates the three yarns employed. The yarn used for forming the rib on the back side of the machine is shown by full black lines. The yarn used for forming the rib on the front side of the machine is shown by parallel lines, the center being white, while the body-yarn is shown by section-lines.

Referring to Fig. 49, the two yarn-guides T T′ are shown as moving to the right toward the end needle Z. In Fig. 50 the end needle is shown as having been advanced, grasping the back yarn Z^{10}. Fig. 51 shows the next movement. Both yarn-guides have advanced to the right and the end needle Z has been moved forward, causing the back yarn Z^{10} to pass behind the latch of the needle. The presser-hooks operate in the usual way to hold down the yarn while the needles are being advanced. All the presser-hooks except one of the end ones on each row are raised and lowered once for each stroke of the cam-slides. One of the end presser-hooks on each row is raised and lowered twice for each single stroke of the cam-slides, and this presser-hook coöperates with the needle Z in forming the loops at the end of the fabric. As before stated, the needle Z is advanced and retracted twice for each stroke in one direction of the cam-slides, and therefore it is necessary to give to the corresponding presser-hook the double movement above referred to. Fig. 52 shows the next step. The yarn-guide for the front side of the machine has advanced and laid its thread in the open needle (shown in Fig. 51) and the end needle Z has been partially drawn back, the yarn-guide for the back thread having passed to the right and the latch of the end needle having closed. As the yarn-guides move still farther to the right the end needle Z is drawn back and then advanced, as shown in Fig. 53, forming a loop with the front yarn and interlocking it with

the back yarn. In Fig. 53 the yarn-guides are shown at the limit of their movement to the right. They next move to the left, and the front yarn is looped around the back yarn, and as the front yarn-guide moves to the left it feeds to the needles to form a new series of loops on the front side, while the back yarn is passed over to the fabric on the back of the machine and interloops therewith, as shown in Fig. 54. The end needles at the two ends of the machine operate in the same manner and form the loops and join the back fabric to the front fabric in the manner illustrated in the diagrams, Figs. 49 to 54, inclusive.

Fig. 55 shows the manner in which the ribbed work joins the body or upper end of the leg of the sock and the manner in which the ribbed fabric on the back side joins that on the front side. The manner of forming the loops, of closing the tube at the two ends of the machine, and of joining the ribbed top to the leg of the sock are so clearly illustrated in the diagrams that no further description seems necessary. As soon as the ribbed top is finished the cam-slides U U′ are dropped when these slides are at the right-hand end of the machine. At the same time the toothed bars P^3 are moved so as to move all the ribbing-needles upwardly into the position shown in Fig. 45—that is to say, part way up. The bars P′ are not moved at this time. At this time the switch L^8 may be shifted and the rear end needle thrown out of operation. The pattern-cylinder is moved to cause these changes. Then the main cam-slides are moved to the left, and when they reach the end of their stroke to the left the pattern-cylinder moves again, further moves the bars P^3, and this further moves the ribbing-needles and brings them into their inoperative position. At the same time the bars P′ are shifted. As the yarn-guides T T′ have been dropped, this movement of the ribbing-needles and the main needles casts off the sock. While the main cam-slides are at the left, the jack-supporting levers *n n′* are moved to throw all the needles of both the front and back row back into operative position ready to begin a new sock. This same movement of the pattern-cylinder shifts the cam J. When at the end of the next movement to the right the main yarn-carrier is picked up, the lever D^{16} having been moved out of the way, the pitman D′ will therefore carry the main yarn-carrier back and forth in the usual way. A new sock is then produced in the manner before described. While at the end of this movement to the right, the switch l^{22} is shifted, the slides then move to the left, and the set-up is formed. At the end of the movement to the left the pattern-cylinder again moves and cams J J′ are shifted. The machine then proceeds to knit a new sock in the manner before described.

I do not herein claim the machine-knit stocking herein described, as this is claimed in my application for patent filed December 29, 1897, Serial No. 664,356.

I claim as my invention—

1. A knitting-machine, comprising main knitting-needles, ribbing-needles and transferring-points operated independently of the needles for automatically transferring loops from one set of needles to the other, and means for actuating the needles and transferring-points.

2. In a knitting-machine, the combination of the front and back rows of main knitting-needles, means for operating them, two rows of auxiliary or ribbing needles arranged parallel with the main knitting-needles, transferring-points and means for operating the needles and transferring-points.

3. In a knitting-machine, the combination of the main knitting-needles, means for operating them, the pivoted auxiliary or ribbing needles mounted to move transversely of the machine, means for causing one set of ribbing-needles to advance behind the heels of the other set of ribbing-needles, means for giving to the ribbing-needles other appropriate movements, transferring-points for automatically transferring loops from one set of needles to the other and means for operating the transferring-points.

4. In a knitting-machine, the combination of two sets of main knitting-needles, two sets of auxiliary or ribbing needles, means for causing the heels of one set of ribbing-needles to cross over and pass beyond the hooked ends of the opposite set of main knitting-needles, means for giving to the ribbing-needles other appropriate movements, means for operating the main knitting-needles, transferring-points for transferring loops from one set of needles to the other, means for operating the transferring-points, a yarn-guide for laying yarn in a row of main knitting-needles behind the heels of the opposite row of ribbing-needles, and means for operating the yarn-guide.

5. In a knitting-machine, the combination of two sets of ribbing-needles pivotally mounted on opposite sides of the machine, means for moving the ends of one set of ribbing-needles past the heels of the other set of ribbing-needles, means for giving to the ribbing-needles other appropriate movements, two sets of main knitting-needles, means for moving the ends of one set of main knitting-needles past the heels of the opposite set of ribbing-needles, a yarn-guide for feeding yarn to a set of main knitting-needles in rear of the heels of the ribbing-needles on the same side of the machine, and means for operating the yarn-guide.

6. In a knitting-machine, the combination of the two parallel rows of main knitting-needles, two parallel rows of ribbing-needles, two parallel rows of transferring-points, means for actuating the transferring-points to transfer loops from some of the main nee-

dles to the ribbing-needles, and means for actuating the main knitting-needles and the ribbing-needles.

7. A straight-knitting machine provided with main knitting-needles, auxiliary or ribbing needles and transferring-points and mechanism for automatically operating the main needles for a time, then automatically actuating the transferring-points to transfer loops from some of the main needles to the auxiliary or ribbing needles and means for thereafter actuating some of the main knitting-needles and the auxiliary or ribbing needles to make ribbed work.

8. In a knitting-machine, the combination of the front and back sets of main knitting-needles, the two sets of ribbing-needles, a yarn-guide for feeding yarn to the front row of main needles and simultaneously to the back row of ribbing-needles and another yarn-guide for feeding yarn to the back row of main needles and to the front row of ribbing-needles while the back row of ribbing-needles are crossed over and out of the way.

9. In a knitting-machine, the combination of the front and back rows of needles, means for operating the front and back rows to make a set-up, means for then throwing the front row of needles out of operation, means for causing the needles of the back row to form the toe of the sock, means for then throwing the front row of needles into operation, means for causing the front and back rows of needles to form the foot without leaving an open space between the foot and the toe, means for then throwing the front row of needles out of operation and causing the back row to knit the heel, means for then operating the front row of needles in connection with the back row to form the leg of the sock, means for then throwing some of the needles of the front row and some of the back row out of operation, means for transferring the loops of the fabric from the needles thrown out of operation to the auxiliary or ribbing needles and means for then operating said ribbing-needles in connection with some of the main needles of the front and back rows to produce a ribbed top on the sock.

10. In a straight-knitting machine, the combination of the main needles for knitting the main portion of the sock, means for operating these needles to properly form the toe, foot, heel and leg of the sock, ribbing-needles coöperating with some of the main needles for knitting the ribbed top, means for holding the ribbing-needles out of operation while forming the plain portion of the sock, means for automatically throwing some of the main needles out of operation and for casting off the loops therefrom while knitting the rib, means for throwing the rib-knitting needles into operation to coöperate with those of the main needles not thrown out of operation to form the ribbed top, and means for casting off the loops from all the ribbing-needles as soon as they have completed knitting the ribbed portion of the sock, and for holding the loops off of these needles while the main needles are doing plain work.

11. In a straight-knitting machine, the combination of the front and back rows of needles for knitting the body or plain portion of the sock, the ribbing-needles, means for throwing the ribbing-needles into operation to coöperate with some of the main needles to form a ribbed top and means for automatically starting the toe of the new sock after the ribbed top is formed.

12. The combination of a yarn-guide, two rows of main knitting-needles, two rows of pivoted ribbing-needles, means for moving the heels of one set of ribbing-needles across the line of travel of the thread fed by the yarn-guide, to the other set of ribbing-needles, means for actuating the main knitting-needles and means for actuating the yarn-guide.

13. The combination of a row of main knitting-needles, their jacks, the jack-supporting levers, their operating-bars, a pattern-cylinder, and connections between the pattern-cylinder and the operating-bars for moving the jack-supporting levers at the proper time.

14. The combination of a row of knitting-needles, the transferring-points, the bars connecting them, a pattern-cylinder, connections between these bars and the pattern-cylinder, ribbing-needles and means for actuating the ribbing-needles to take loops from the transferring-points.

15. The combination of the main knitting-needles, means for actuating them, means for throwing some of these needles out of operation, the transferring-points, means for actuating them to take loops from the needles thrown out of operation, ribbing-needles, means for actuating them to take the loops from the transferring-points, and means for thereafter continuing the knitting by the ribbing-needles and the main knitting-needles to produce ribbed work.

16. The combination of the pivoted ribbing-needles and an endwise-moving slotted locking-bar adapted to guide the needles as they oscillate and prevent them from oscillating when out of operation.

17. The combination of the pivoted ribbing-needles, the endwise-moving slotted bars adapted to guide them as they oscillate and means for shifting said bars into and out of operation at the proper time.

18. The combination of the pivoted ribbing-needles, an endwise-moving slotted bar for guiding the ribbing-needles, the pattern-cylinder and connections between the pattern-cylinder and the sliding bar for moving said bar into and out of operation at the proper time.

19. The combination of the pivoted ribbing-needles, the slotted frames in which they are mounted, the sliding toothed bar the teeth of which engage with the needles and prevent them from moving and means for operating said toothed bar for opening the slots to per-

mit the needles to oscillate and for also operating upon the needles to move them positively in one direction.

20. The combination of the pivoted ribbing-needles, the slotted frame in which they are mounted, a sliding toothed bar, the teeth of which are adapted to open and close the slots in the slotted frame and to engage with the needles and prevent them from moving and means for operating said toothed bar to open the slots in the frame and to also operate on the ribbing-needles to move them positively in one direction.

21. The combination of a cam-slide for a row of ribbing-needles, a main cam-slide, devices carried by the main cam-slide and adapted to engage with devices on the cam-slide of the ribbing mechanism, and means for engaging and disengaging said devices at the proper time whereby at times the cam-slides of the ribbing mechanism are caused to move back and forth with the cam-slides of the main knitting-needles.

22. The combination of the cam-slides of the ribbing mechanism, the guide-bars therefor, the hooks connected with the slides, the main cam-slides, the sleeves connected with the main cam-slides and adapted to move back and forth on the guide-bars and hooks carried by these sleeves adapted to engage with the hooks carried by the cam-slides of the ribbing mechanism.

23. The combination of the main cam-slides, the ribbing-needles, the cams, S, S′, carried by the main cam-slides and devices for actuating said cams at the proper times to move the ribbing-needles from their inactive to their active positions.

24. The combination of the main cam-slides, the yoke connecting them, the levers pivoted to said yoke, the cams carried by said levers, the guide-bars supported above the main cam-slides, the arms mounted to slide back and forth on said bars, and means for operating said arms to move the cams on said pivoted levers into and out of the path of the ribbing-needles.

25. The combination of the main cam-slides, the yoke connecting them, the ribbing-needles, a cam pivotally connected with the yoke, a bar parallel with the line of movement of the yoke, a sleeve carried by said bar, an arm on said sleeve and means for moving said sleeve to cause the arm to raise and lower the pivoted cam.

26. The combination of the main cam-slides, the cam-slides of the ribbing mechanism, parallel guide-bars, sleeves on the cam-slides of the ribbing mechanism arranged to travel back and forth on said guide-bars, sleeves on said guide-bars permanently connected with the main cam-slides, and mounted to slide on and to turn with said guide-bars, devices carried by said last-mentioned sleeves adapted to interlock with devices on the first-mentioned sleeves and means for actuating the guide-bars to cause the engagement and disengagement of the sleeves.

27. The combination of the ribbing cam-slide, a pair of cams, a pivoted rod by which they are carried, a guide-plate pivoted to the slide, and means for actuating the cams and guide-plate to raise a cam at one end of the rod and at the same time to depress the same end of the guide-plate, substantially as described.

28. The combination of a cam-slide, a longitudinal bar on which said slide is adapted to move, a yarn-guide also carried by said bar, a guide-bed on which the yarn-guide rests as it travels back and forth and which has a depressed portion at one end for the purpose specified.

29. The combination of a row of ribbing-needles, a yarn-guide adapted to travel back and forth across the machine, and a guide-bed for the yarn-guide having a depressed portion at one end.

30. The combination of a row of knitting-needles, a yarn-carrier adapted to move back and forth to feed yarn to said needles, a row of ribbing-needles, means for detaining the yarn-carrier while the ribbing-needles are in operation, a yarn-guide for the ribbing-needles and means for moving the yarn-guide out of the path of the yarn-carrier at the end of each stroke of said yarn-guide in one direction.

31. The combination of a row of ribbing-needles, a cam-slide provided with two sleeves, a bar on which said sleeves are adapted to move back and forth, a yarn-guide connected with said bar between the two sleeves and having an independent endwise movement on the bar between the sleeves, and means for causing the sleeves on the cam-slide to abut against the sleeve on the yarn-guide.

32. The combination of the ribbing-needles, a row of presser-hooks, means for operating them, and devices for causing the presser-hook at the end of the row to operate twice during each stroke in one direction of the presser-hook-actuating mechanism.

33. In a knitting-machine, the combination of a row of presser-hooks, a spring for moving one of the end hooks in one direction and a cam for moving said end hook in the opposite direction.

34. The combination of a row of knitting-needles, a row of presser-hooks, a cam-slide provided with two recesses, a cam arranged opposite one of the recesses, and a spring for moving one of the presser-hooks in one direction.

35. The combination of a series of main knitting-needles, a cam-slide, cams carried thereby for actuating the main knitting-needles to cause them to advance and retract during a movement in one direction of the slide, an auxiliary needle at the end of the row of needles, and devices for giving to said end needle an additional movement for the purpose specified.

36. In a knitting-machine, the combination of a row of needles having an additional or end needle, the jack to which said needle is connected, the cam for actuating said jack, the guides in which said cam moves, a switch at the end of said guides and means for shifting said switch.

37. The combination of a row of knitting-needles, the cams for actuating them, and an additional cam acting on the end needle only.

38. The combination of a row of knitting-needles, the cams for actuating them, and an additional cam for giving an additional movement to the end needle.

39. The combination of a row of knitting-needles, the cams for actuating them, an additional cam for actuating the end needle, the presser-hooks, and means for giving an additional movement to the end presser-hook.

40. The combination of a row of knitting-needles, the cams for actuating them, an additional cam for actuating the end needle, a row of presser-hooks, the end hook being spring-actuated, and means for giving an additional movement to the end presser-hook.

41. The combination of knitting-needles, the ribbing-needles, the two yarn-guides, one of which feeds yarn to the needles on one side and the other to the needles on the opposite side of the machine, and means for joining the yarn used for forming one side of the fabric to the fabric formed by the other yarn.

42. The combination of the yarn-guide having a plurality of guide-grooves, a lever connected with said yarn-guide, a lug on the end of said lever, a guide-rail for said lug, a switch on the end of said rail, a pattern-cylinder and connections between the pattern-cylinder and said switch.

43. The combination of the yarn-guide having a plurality of guide-grooves, a lever connected with said yarn-guide, the pattern-cylinder and connections between the pattern-cylinder and said lever for operating the yarn-guide at proper times.

44. The combination of the main yarn-carrier, the guide-frames between which it reciprocates, the cutting-frame supported on said carrier, the yarn-guide, means carried by the yarn-guide for moving the cutter-frame, to separate the cutters, and a cam on one of the guide-frames engaging the cutter-frame to close the cutters.

45. The combination of a needle, its jack formed with a tooth, b^6, and a jack-supporting lever formed with a tooth, b^7, in front of the tooth b^6 substantially as and for the purpose specified.

46. The combination of two parallel rows of main knitting-needles, two parallel rows of ribbing-needles pivoted above the main knitting-needles, transferring-points arranged to slide back and forth in lines parallel with the main knitting-needles, means for dropping some of the main knitting-needles out of operation, means for actuating the transferring-points to withdraw the loops of the fabric from the needles thus thrown out of operation, means for actuating the ribbing-needles to take the loops from the transferring-points, and means for thereafter actuating the ribbing-needles and some of the main knitting-needles to make ribbed work.

47. The combination of a tension-bar, means for operating it, a cam connected to and operated in both directions by the tension-bar, a pivoted cam at times in contact with the first-mentioned cam and moved while in contact therewith in one direction only, a lug carried by the pivoted cam and engaged by the tension-bar, a guide-bar and a lug carried by the pivoted cam and guided by said guide-bar.

In witness whereof I have hereunto subscribed my name.

JOHN F. NELSON.

Witnesses:
FRITHIOF NELSON,
JOHN P. FISK, Jr.