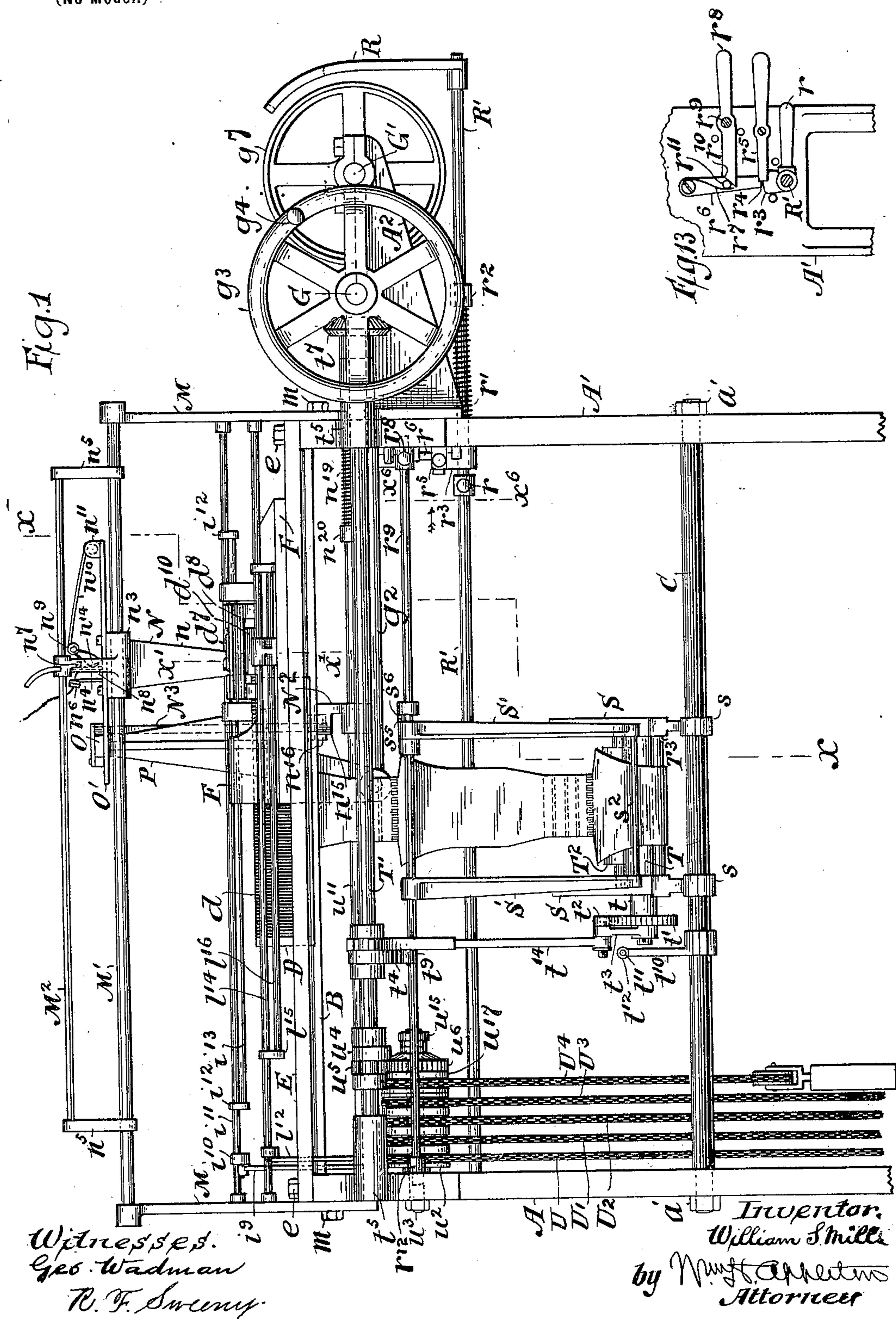


**Patented May 2, 1899.**

(Application filed Apr. 19, 1898.)

(No Model.)

4 Sheets—Sheet 1.





**No. 624,065.**

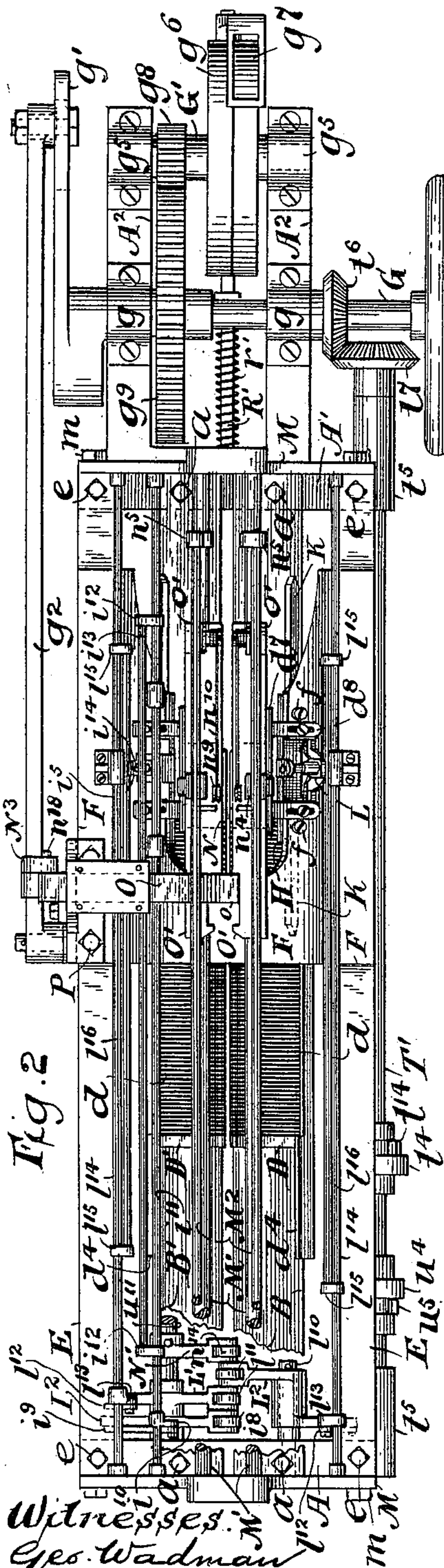
**Patented May 2, 1899.**

**W. S. MILLS.**  
**KNITTING MACHINE.**

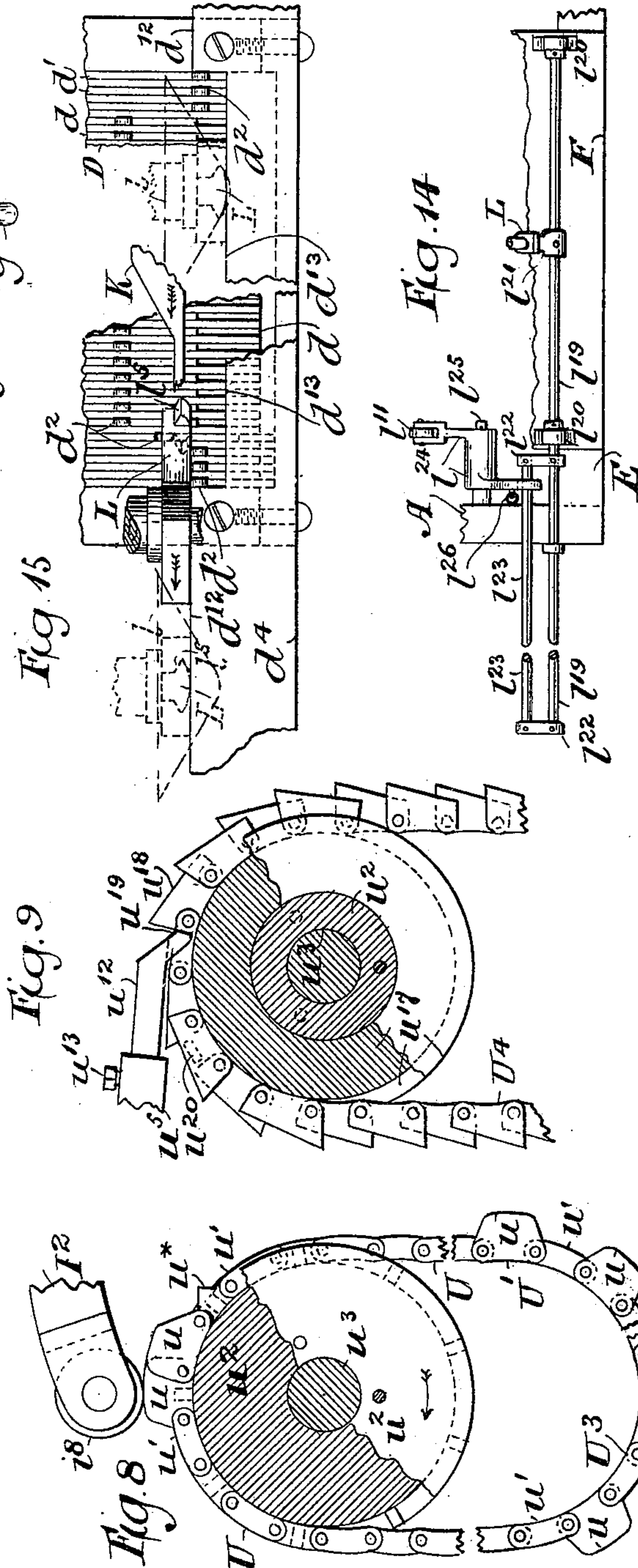
(Application filed Apr. 19, 1898.)

(No Model.)

**4 Sheets—Sheet 2.**



Witnesses:  
Geo. Wadman  
R. F. Smear.



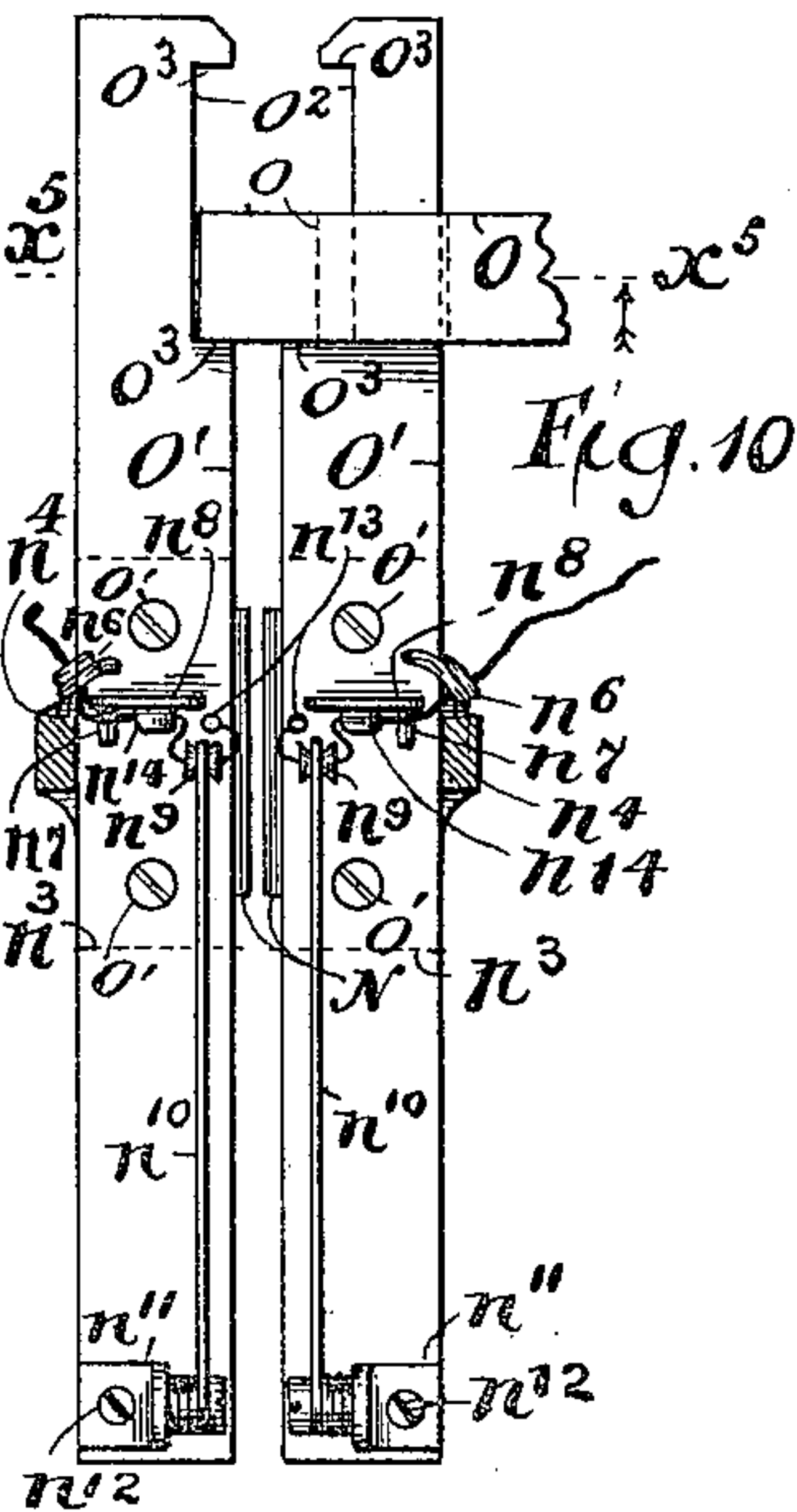
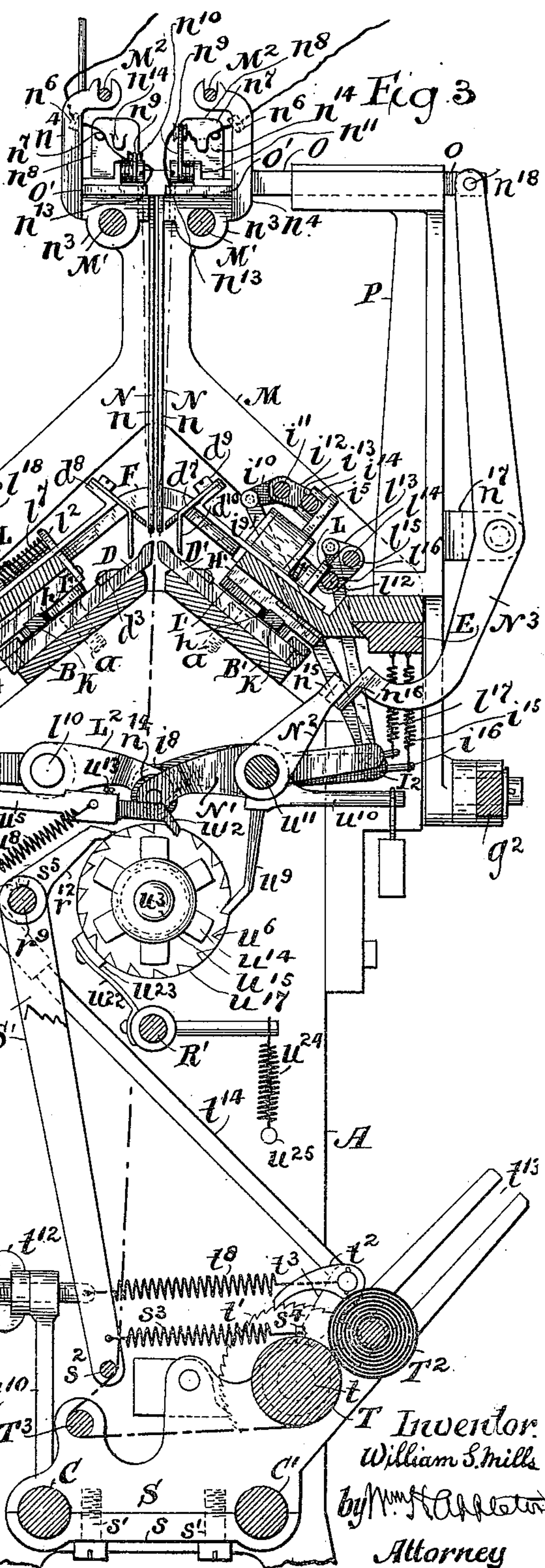
Inventor.  
William S. Mills  
by Wm. H. Applegate,  
Attorney



**Patented May 2, 1899.**

(Application filed Apr. 19, 1898.)

**4 Sheets—Sheet 3.**



Witnesses.  
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*T Inventor:*  
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No. 624,065.

Patented May 2, 1899.

W. S. MILLS.  
KNITTING MACHINE.

(Application filed Apr. 19, 1898.)

(No Model.)

4 Sheets—Sheet 4.

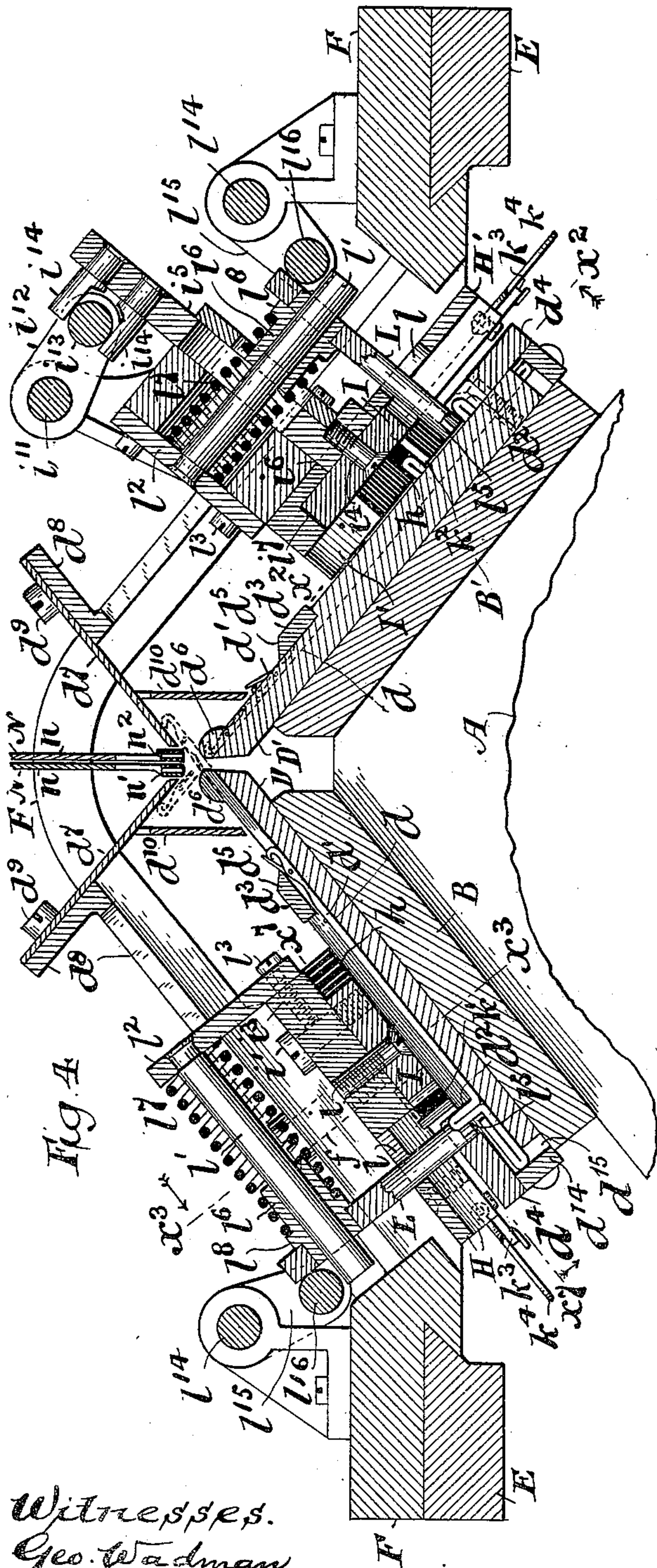


Fig. 4.

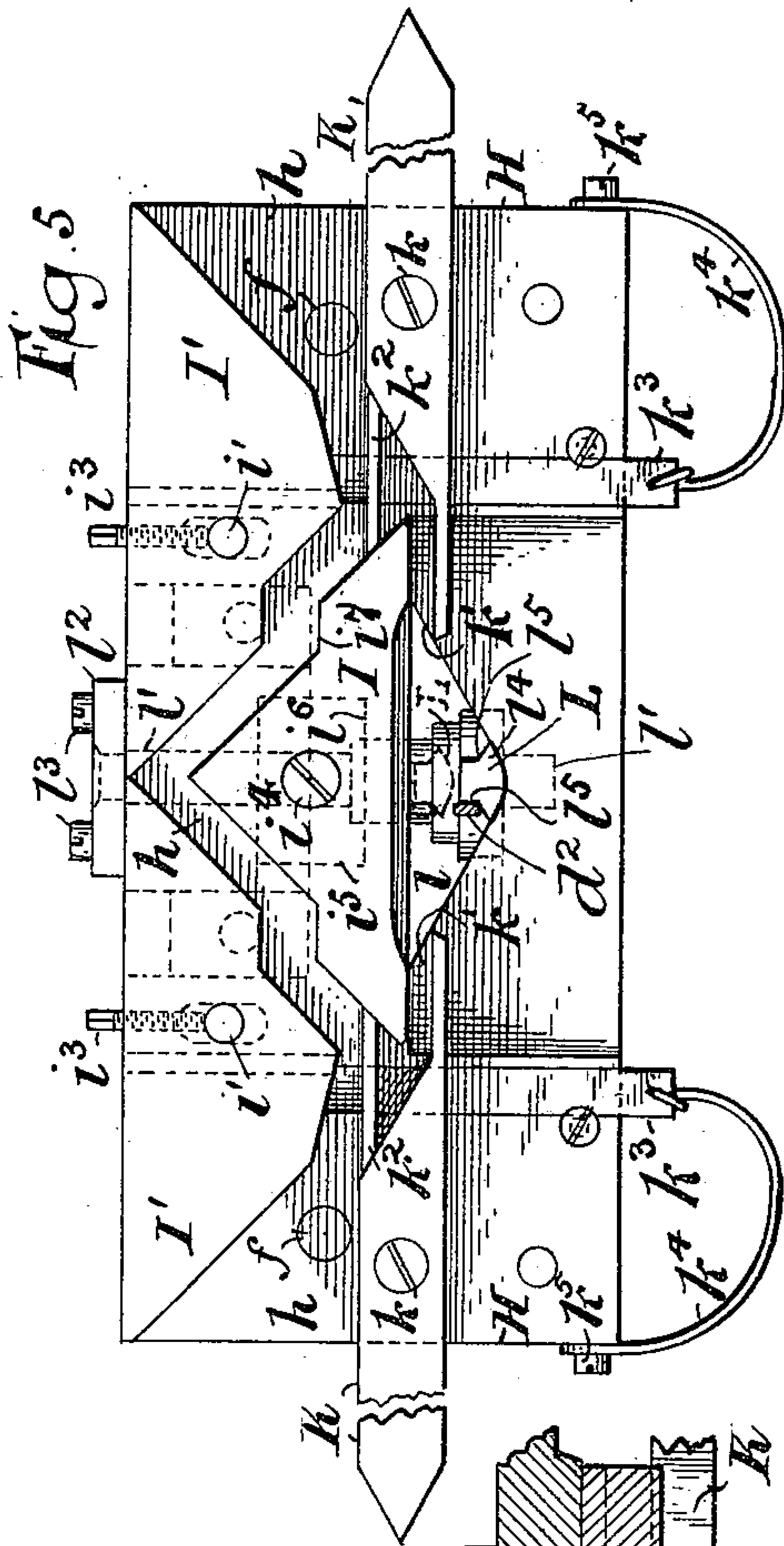


Fig. 5.

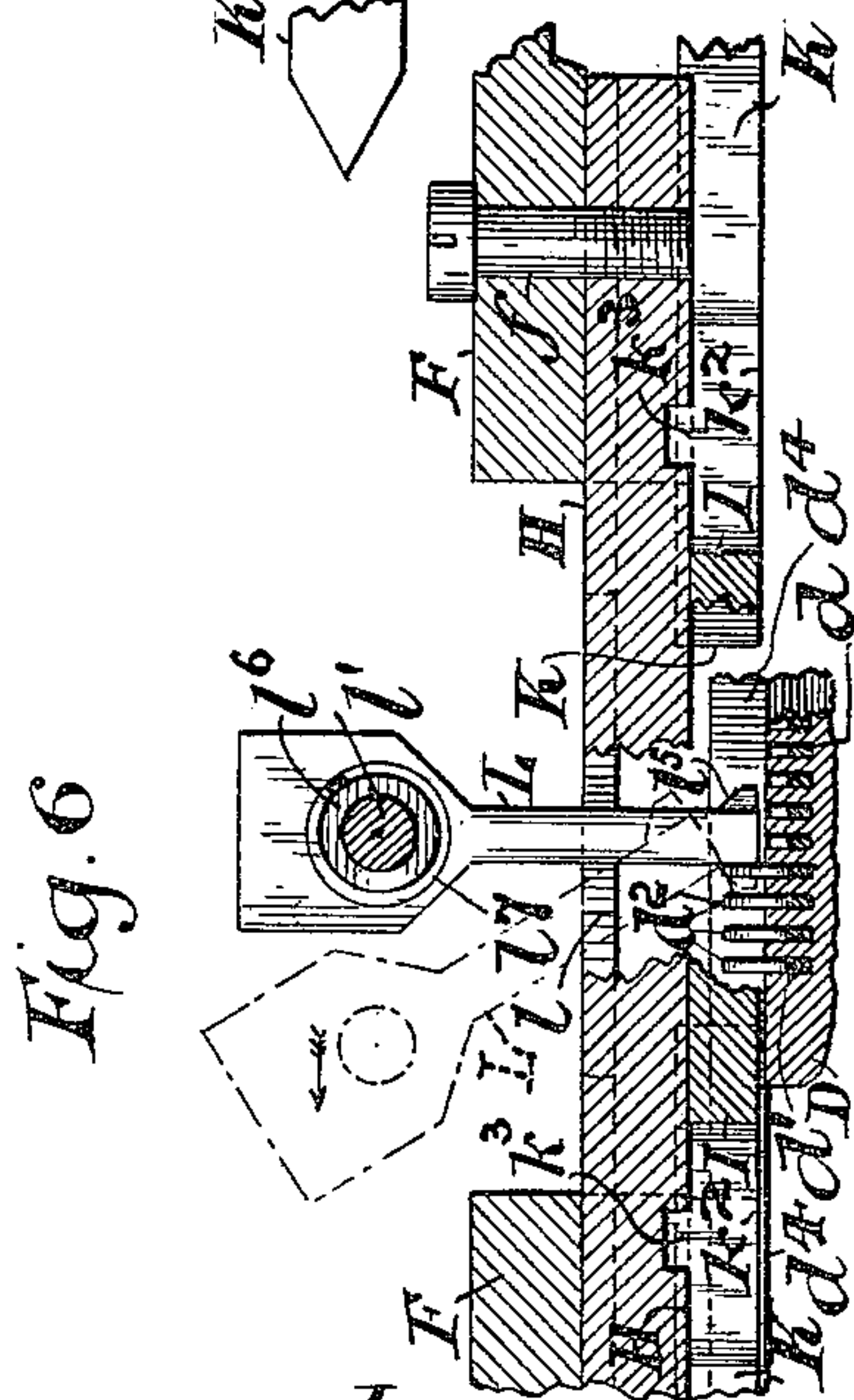


Fig. 6.

Witnesses.  
Geo. Wadman  
R. F. Swamy.

Inventor.  
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by M. H. Appert,  
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# UNITED STATES PATENT OFFICE.

WILLIAM S. MILLS, OF BRIDGEPORT, CONNECTICUT.

## KNITTING-MACHINE.

SPECIFICATION forming part of Letters Patent No. 624,065, dated May 2, 1899.

Application filed April 19, 1898. Serial No. 678,126. (No model.)

*To all whom it may concern:*

Be it known that I, WILLIAM S. MILLS, a citizen of the United States, and a resident of Bridgeport, in the county of Fairfield and State of Connecticut, have invented certain new and useful Improvements in Knitting-Machines, of which the following is a specification.

My invention, while applicable in part to various forms of knitting and other machines, is designed more particularly for application to what are known as "straight-knitting" machines, and especially to that form thereof in which two rows of needles are employed that are inclined to each other and in which the needles of each row in their operation are reciprocated across the needles of the other row, as in what is known to the art as the "Lamb knitting-machine," the objects of the invention being to provide a machine of this class in which the several operations of knitting stripes in the article or fabric being produced at predetermined intervals by a supplementary yarn, of knitting welts in the article or fabric at the required places, of widening the article or fabric at the proper places on one or both edges to fashion the same for its intended use, and of stopping the machine at a predetermined point in the knitting of the article or fabric and when the tension upon it is reduced below a certain limit or otherwise may be automatically accomplished and the delivery of the yarns to the needles during the knitting operation more efficiently controlled.

To these ends the invention consists, first, in the guides for the main and the supplementary yarns and in the means whereby the one is automatically brought into and the other carried out of operation, and vice versa, as the knitting of the plain or body portion of the article or the stripes therein may require; second, in the needle-operating cams and in the means whereby one of these cams may be automatically carried out of and brought back into operative connection with its appropriate row of needles, as the knitting of a welt or the plain or body portion of the article or fabric may demand; third, in the needle-lifters and in the means whereby they are automatically brought into operation to successively raise and bring into operation a needle at each edge of the article or fabric be-

ing knit at each forward and backward reciprocation of the cams to effect the widening thereof and automatically carried out of operation when the widening of the article or fabric is not required; fourth, in the stopping mechanism and in the means through which it is put into operation to stop the movements of the machine at the required time or under certain predetermined conditions; fifth, in the peculiarities of construction of the yarn-controlling devices, whereby the yarns at certain portions of the travel of the needle-operating cams are positively held and at others are left free to pass to the needles, and, sixth, in various other constructions and combinations of parts, all as will hereinafter more fully appear.

Referring to the accompanying drawings, which form a part of this specification, Figure 1 is a front elevation of a knitting-machine constructed in accordance with my invention; Fig. 2, a plan view thereof, parts being broken away for convenience of illustration; Fig. 3, a transverse vertical sectional elevation of the machine, taken on the line  $x x$  of Fig. 1; Fig. 4, a transverse vertical sectional elevation of certain of the parts of the machine, taken in the plane  $x' x'$  of the same figure; Fig. 5, an inverted plan view of one of the cam-plates and cams, taken in the plane  $x^2 x^2$  of Fig. 4; Fig. 6, a longitudinal sectional elevation of the cam-plate, cams, and needle-lifter, taken in the plane  $x^3 x^3$  of Fig. 4; Fig. 7, a view, partly in vertical longitudinal section and partly in elevation, of the pattern mechanism through which various of the parts of the machine are automatically brought into and carried out of operation at predetermined intervals and otherwise with certain levers or arms bearing thereon; Fig. 8, a rear end elevation of the pattern-chain-supporting sprocket wheel or barrel, looking from the right in Fig. 7, with one of the pattern-chains and one of the levers or arms for bearing thereon, the wheel or barrel being broken away and the supporting-stud for the same shown in transverse vertical section; Fig. 9, a transverse vertical sectional elevation of the said sprocket wheel or barrel and supporting-stud, taken in the plane  $x^4 x^4$  of Fig. 7, looking toward the left in that figure, showing also in side elevation one of the pattern-chains and its



actuating-pawl with a portion of the loose wheel or sleeve upon the barrel for supporting such chain broken away for convenience of illustration; Fig. 10, a plan view of the yarn-guides, the tension devices, the carriers therefor, and the locking-bar for operating these carriers, certain of the other parts being shown in section; Fig. 11, a transverse sectional elevation of the said carriers and the locking-bar for operating them, taken in the plane  $x^5 x^5$  of Fig. 10; Fig. 12, a detail elevation of the switching devices through which the locking-bar for operating the carriers for the needle-guides is engaged with one or the other of such carriers, as the exigencies of the fabric being knit may require; Fig. 13, a vertical sectional elevation of the locking and unlocking devices of the stopping mechanisms, taken in the plane  $x^6 x^6$  of Fig. 1, looking to the right in that figure; Fig. 14, a plan view of a slightly-modified arrangement of parts for automatically throwing the needle-elevators into and out of operation at the required times; and Fig. 15 is a detail taken principally in the plane  $x^7 x^7$  of Fig. 4, showing a fragment of one of the needle-bars, the butts of some of the needles, one of the elevators, a portion of one of the lower keepers for the needle, and a part of one of the needle-supporting ledges.

In all the figures like letters of reference are employed to designate corresponding parts.

A A' indicate suitable end brackets or standards, which are connected to form the main frame or housing of the machine by appropriately-shaped rails or girths B B' and tie-rods C C', which extend between them, with the ends of the former secured to their tops by screws  $a$  and with the latter entering suitable orifices therein near their bases and themselves provided at their extremities with clamping-nuts  $a'$ .

Secured to the upper sides of the respective rails or girths B and B' by screws or otherwise are the needle-bars D and D', which are disposed thereon in parallel relationship to each other, with a narrow space between them for the passage of the article or fabric being knit and with the upper surfaces thereof, which are provided with transversely-arranged grooves  $d$  for reception of the needles  $d'$ , inclined upward and inward toward each other, as shown.

The needles  $d'$  are preferably of the latch form and are provided with suitable operating-butts  $d^2$ , projecting upwardly from their upper sides, with the grooves  $d$  in which they are arranged so disposed with respect to one another as to bring the grooves on one bar opposite the space between the grooves in the other, whereby in the operation of the machine the needles of the one bar are reciprocated across and between the needles of the other bar, and vice versa. As thus disposed the raising of the needles from and their tilting upward or downward in their respective grooves are prevented, while they are yet left

free to be longitudinally reciprocated therein by keepers  $d^3$  and  $d^4$ , which are secured to the upper side of each of the bars D and D' by screws or otherwise, the former of which are provided with beveled upper edges  $d^5$ , whereby to prevent injurious engagement of the latches of the needles therewith when such needles are withdrawn and are located in suitable depressions formed near the upper edges of the needle-bars, while the latter are constructed with higher and lower surfaces  $d^{12}$  and  $d^{13}$  at their upper edges for coöperation with the needle-elevators and are located near the lower edges of such bars, as shown. The raising and tilting of the needles in their respective needle-bars being thus prevented by the keepers  $d^3$  and  $d^4$  their backward movement when retracted to carry them out of operation is limited by a stop-bar  $d^{14}$ , which is secured to the lower edge of each of the needle-bars by screws or otherwise, with a space between its inner faces and the lower edge of its respective needle-bar, into which the dirt from the needle-grooves may be carried and from which it may be removed when desired.

Fitted to slide upon guide-rails E E, which extend longitudinally of the machine on opposite sides of the needle-bars D and D', with their ends secured to the end bracket or standards A and A' or other convenient part of the machine by screws  $e$ , is a saddle F, which extends over such needle-bars from one guide-rail to the other and in the operation of the machine is longitudinally reciprocated along and over the same. The means whereby this reciprocation of the saddle is effected may be of various forms. I prefer, however, to effect it from the cross-shaft G, which is fitted to rotate in suitable bearings  $g$   $g$ , secured to the brackets A<sup>2</sup> A<sup>2</sup>, that in turn are attached to and project from the end bracket or standard A', and to impart such movement therefrom to the saddle through the intermediaries of the crank  $g'$  and connecting-rod  $g^2$ . Through these means the reciprocation of the saddle is effected by simply rotating the shaft G, and in order to permit of this rotation being accomplished I find it convenient to provide the shaft G at its end with a hand-wheel  $g^3$ , that is or may be equipped with a suitably-arranged crank-handle  $g^4$ , and to employ in addition thereto a second cross-shaft G', which is likewise fitted to rotate in suitable bearings  $g^5$   $g^5$  upon the brackets A<sup>2</sup> and which, provided with suitable fast and loose pulleys  $g^6$  and  $g^7$ , is connected with the shaft G through the intermediaries of spur-gears  $g^8$  and  $g^9$ , with which the shafts are respectively provided. By these means, as will be seen, provisions are made for the rotation of the shaft G either by the hand of the operator applied to the crank-handle  $g^4$  or by power applied through a belt to the pulley  $g^6$ , as may be desired.

Secured to the under side of the saddle F, over and in parallel relationship to the upper surfaces of the respective needle-bars D and D', by screws  $f$  or otherwise are the cam-car-



rying plates H and H', which are provided  
 with the cams through which the reciproca-  
 tion of the needles is effected. These cams  
 consist of an advancing-cam I and a retract-  
 5 ing-cam I' for the needles of each of the needle-bars, and these are arranged upon the  
 under side of each of the carrying-plates in  
 such a relationship to each other as to form  
 an inverted-V-shaped groove *h* between them  
 10 for engagement with the operating-butts  $d^2$   
 of the needles of its respective needle-bar as  
 it is passed back and forth over them in its  
 travel with the saddle F. As thus arranged  
 the advancing-cam I of the carrying-plate H  
 15 is fixedly secured to the under side of its  
 plate by a screw *i*, which passes through the  
 former and engages with a threaded orifice  
 formed in the latter, while the retracting-  
 cams I' of both of the carrying-plates H and  
 20 H' are secured to their respective plates by  
 screws *i'*, which pass through the latter and  
 engage at their ends with threaded orifices  
 formed in the former, appropriately-shaped  
 adjusting-screws *i*<sup>3</sup>, extending downward  
 25 through threaded orifices formed in the respec-  
 tive plates and engaging at their ends with the  
 screws *i'*, being likewise employed in connec-  
 tion therewith to aid in the adjustment of these  
 cams toward and away from their respective  
 30 cooperating advancing-cams, if desired, as  
 shown in Fig. 5. The advancing-cam I of the  
 carrying-plate H', on the other hand, instead  
 of being secured directly to the under side of  
 that plate is secured by a screw *i*<sup>4</sup> and suit-  
 35 able dowel-pins, if preferred, to the lower end  
 of a carrying-bar *i*<sup>5</sup>, which is fitted to slide per-  
 pendicularly through said plate in a suitable  
 orifice *i*<sup>6</sup> formed therein, whereby to render  
 such cam capable of being not only lowered  
 40 below the under surface thereof to bring it  
 into the plane of its respective retracting-cam  
 I' for coöperation therewith in the reciproca-  
 tion of the needles, but raised above the same  
 to disengage it from the butts of the needles  
 45 when their retirement from action is required,  
 a recess *i*<sup>7</sup> of the proper shape and depth be-  
 ing formed in the under surface of the carry-  
 ing-plate for the reception of this cam when  
 the latter is in its retracted position. The  
 50 several cams being thus arranged the advanc-  
 ing-cams for the needles of both needle-bars  
 may be either brought into coöperative rela-  
 tionship to their respective retracting-cams  
 or one of such advancing-cams withdrawn  
 55 therefrom, as may be desired. When both  
 of the advancing-cams are brought into rela-  
 tionship to their respective coöperating re-  
 tracting-cams, the needles of both needle-bars  
 will be successively advanced and retracted  
 60 from one end of the series to the other at each  
 forward and backward movement thereof,  
 and a fabric produced by the conjoint action  
 of the needles of both bars when a yarn or  
 thread is properly supplied thereto. When,  
 65 on the other hand, one of these advancing-  
 cams is withdrawn from that relationship,  
 then the needles of but one of the needle-bars

will be thus operated during each back-and-  
 forth movement of the cams, while the needles  
 of the other bar will remain inoperative 70  
 in a retracted position, and a fabric will be  
 produced by the operation of the needles of  
 but one bar alone, and thus by simply low-  
 ering or raising the advancing-cam for the  
 needles of the needle-bar D' a fabric may be 75  
 produced by the operation of either the needles  
 of both needle-bars or of but one, as may  
 be desired.

When in position for advancement and re-  
 traction by the cams I and I' to effect the 80  
 knitting operation, the needles *d'* are held at  
 the proper height in their supporting-grooves  
*d* to bring their operating-butts  $d^2$  into line  
 with the lower ends of their respective oper-  
 ating-grooves *h*, as shown at the right in Fig. 85  
 4, by the strain of the loops of the fabric  
 thereon or the friction between themselves  
 and their grooves. When, on the other hand,  
 these needles are not required in the forma-  
 tion of the article or fabric and are withdrawn 90  
 from coöperation with those cams—as, for in-  
 stance, when the narrowing operation is be-  
 ing performed or the narrower portions of the  
 article or fabric are being knit—they rest  
 lower down in their supporting-grooves, with 95  
 their operating-butts below the ends of such  
 grooves and the cams, as shown by full lines  
 at the left of Fig. 4, and in order to insure  
 their maintenance in the one or the other of  
 the positions to which they may be thus ad- 100  
 justed at all times, except when being car-  
 ried from the one to the other to effect the  
 narrowing or widening operation, I provide  
 each of the carrying-plates H and H' on its  
 under side with the supporting-ledges K. 105  
 These ledges are preferably constructed with  
 parallel upper and under edges that termi-  
 nate at their outer ends in downward and up-  
 ward inclined surfaces, respectively, and are  
 secured in place on opposite sides of the ad- 110  
 vancing-cams I, with their upper edges in line  
 with the lower ends of the grooves *h*, by suit-  
 able screws *k* and coöperating dowel-pins, if  
 preferred. As thus arranged they engage 115  
 with the butts of the needles and serve in the  
 back-and-forth movements of their respective  
 carrying-plates to raise and lower such of  
 the needles as may have been accidentally  
 lowered or raised to any slight extent from  
 the respective positions to which they may 120  
 have been adjusted and insure their retention  
 therein.

For carrying the needles from their upper  
 or operative position to their lower or inop-  
 erative position, as in the narrowing opera- 125  
 tion or when the narrower portions of the  
 fabric or article are being produced, any of  
 the well-known means may be employed. I  
 prefer, however, to effect this movement by  
 hand and to move such of the needles as are 130  
 to be retired from operation from one to the  
 other of these positions in the required order  
 thereby.

For carrying the needles from their inop-



erative into their operative position to effect the widening of the fabric or otherwise, on the other hand, I make use of a needle-elevator L for the needles of each needle-bar and employ in connection therewith the grooves  $k'$ , which severally extend upward around one and the other of the lower angles of the advancing-cam I from its under side to the groove  $h$ , as shown. By these means the raising of the needles from their inoperative position and their return into operation through the grooves  $k'$  are automatically effected by the elevators, which in turn are operated by the butts of the needles that are being raised.

In order to permit of this result being accomplished, the elevators are preferably constructed in the form of an arm, with the inner end of each extending through a flattened V-shaped orifice  $l$ , formed in its appropriate carrying-plate H or H' directly below the advancing-cam I, and the outer end thereof pivoted upon a short shaft or stud  $l'$ , that is supported from such plate above and in parallel relationship to its upper side by a stand or bracket  $l^2$  and suitable screws  $l^3$ . As thus arranged it is adapted to be swung back and forth upon its supporting shaft or stud  $l'$  in the direction of the travel of the operating-cams by the action of the butts of the needles upon its free end, and in order to provide for the engagement of these butts therewith this end is constructed with a head  $l^4$ , which in its normal operative position is held in line with the former and is provided on its opposite sides with notches  $l^5$ , with which the butts engage as the elevator is carried back and forth over them with the cams in the operation of the machine.

When the widening of the fabric or article being produced and the return of the needles from their inoperative to their operative position are not required, the elevators are held with the heads upon their free ends near the upper edge of the orifice  $l$  in their respective carrying-plates H and H' above the butts of the needles then in an inoperative position, as shown by dotted lines in Figs. 4 and 5. When, on the other hand, the widening operation is to be performed and one or more of the needles are to be carried from their inoperative into their operative position, the elevators L are lowered until their heads rest in the apexes of the lower portion of the V-shaped orifice  $l$  in their respective carrying-plates H and H' upon the upper surfaces  $d^{13}$  of the keepers  $d^4$ , as shown by dotted lines at the right in Fig. 15, when the notches  $l^5$  in such heads will be brought into line for engagement with the butts of the needles of their respective needle-bars, and in order to provide for the raising and lowering of the elevators from one to the other of these positions and the automatic return of their heads to the apexes in the lower edges of those orifices when disengaged from the butts of the needles without interfering with their freedom of vibration back and forth upon their

respective supporting shafts or studs  $l'$  the elevators instead of being pivoted directly to their respective supporting shafts or studs are each fixedly secured to the lower end of a sleeve  $l^6$ , which is fitted to both oscillate and slide longitudinally thereon and is normally pressed downward along the same, with the head of the elevator in the apex of the V-shaped under edge of its orifice  $l$  upon the surface  $d^{13}$  of the keeper  $d^4$  in line with the butts of the needles, by a coiled spring  $l^7$ , which, surrounding the shaft or stud, bears at one end against the stand or bracket  $l^2$  and at the other against a shoulder  $l^8$  on the sleeve  $l^6$ . The parts being arranged as thus described, when the elevators L are in their lowest position and the needle-operating cams are moved in one direction over the needles  $d'$  by the saddle F the butt of the first inoperative needle of each needle-bar on the opposite edge of the series of operative needles will engage with the foremost notch  $l^5$  in the head of its respective elevator as it is brought opposite thereto and the elevator swung backward on its supporting shaft or stud  $l'$  as the movement of the cams continues. As a result of this swinging movement of the elevator on its supporting shaft or stud  $l'$  the under side of its head will ride up the inclined portion of the V-shaped inner edge of the orifice  $l$  in its respective carrying-plate H or H', thereby raising the elevator as a whole and carrying with it the needle with whose butt  $d^2$  its notch  $l^5$  is engaged. This duplex movement of the elevator will continue until the butt of the needle has been forced upward into the groove  $k'$  that is in its rear, when the head of this elevator will be carried back into the orifice  $l$  away from the butt of the needle, which will then pass up through its appropriate groove  $k'$  to the groove  $h$  for operation by the cams I and I' at the next movement thereof in an opposite direction. The elevator having been thus swung backward by the action of the butt of the needle thereon will when released therefrom by its head having been carried backward in rear thereof, as shown by dotted lines in Fig. 6, be forced downward by the spring  $l^7$  in the orifice  $l$ , and by the action of the inclined side of the latter upon it during this movement it will be swung forward, the result of which and of its forward movement with the cams will be to carry its head forward upon the higher surface  $d^{12}$  of the keeper  $d^4$ , as shown by dotted lines at the left in Fig. 15, upon which it will travel on its outward and return movement until in its latter movement it passes back over the butts of the inoperative needles on that particular edge of the operative series, when it will be forced downward upon the lower surface  $d^{13}$  by the spring  $l^7$  ready for engagement with the butt of the needle on the opposite edge of the series, when the same operation will be repeated, and so on, the higher surfaces  $d^{12}$  serving to hold the elevator from engage-



ment with the butts of any of the needles but the proper ones and the lower surfaces  $d^{13}$  serving to properly guide it and insure of its engagement with the latter as it is carried forward toward them in the operation of the machine. When, on the other hand, the needle-operating cams are moved in the opposite direction by the saddle F, then the notch  $l^5$  on the opposite side of the head of each elevator will be brought into engagement with the butt of the first needle of its respective needle-bar on the opposite edge of the series of operative needles, and thereby the elevator swung backward in an opposite direction and similarly raised, carrying with it such needle-butt and delivering it to the other groove  $k'$  for passage upward into the groove  $h$  for coöperation with the advancing and retracting cams I and I', respectively, at their next movement in a reverse direction, and so on, each elevator at each back-and-forth movement of the needle-operating cams engaging with and carrying into operation a single needle so long as the widening operation is continued. The widening operation having been completed, the elevators will be raised to the upper edges of the orifices in their carrying-plates H and H' and there held until the widening operation is to be again performed, when they will be lowered into operation, as before explained, and so on.

With a view to prevent the descent of the butts of the needles through the grooves  $k'$ , while yet permitting of their free upward movement therein when required, these grooves are severally provided at their upper ends with a gate  $k^2$ . These gates are preferably constructed of a length to extend across the upper ends of their respective grooves, and each is secured to the inner side of a bar-like carrier  $k^3$ , that is fitted to slide in a suitable guideway formed in its appropriate carrying-plate H or H', whereby to be capable of movement toward and away from its appropriate groove to close or open the same. When in its closed position, these gates are held pressed downward into the upper end of their respective grooves, with their upper surfaces in line with the upper surfaces of the ledges K, and are normally held in those positions by light springs  $k^4$ , which are connected at one of their ends to their appropriate carrying-plates H and H' by a screw  $k^5$  and at their other to the lower ends of the carriers of their respective gates. As thus arranged, these gates close the upper end of their respective groove  $k'$  to the passage of the butts of the needles downward therethrough, while such gates are yet left free to be raised by the action of the butts of the needles against their under sides to open the grooves as such needles are passed up through the same in the widening operation.

Supported above the needle-bars D D' in suitable stands M, that are secured to the end brackets A and A' by screws  $m$ , are the guide-rods M' M', upon which the yarn-carriers N N

are fitted to slide. In practice there will preferably be as many of these yarn-carriers as there are kinds and colors of yarn to be incorporated into the fabric or article to be produced. In the present instance, however, I have shown but two, and each of these is preferably constructed with a thin springy depending body portion  $n$ , having its lower end  $n'$  thickened and provided with an eye  $n^2$  for the passage of the yarn therethrough and its upper end secured to a head-like portion  $n^3$ , which is fitted to slide upon its respective guide-rod M'. As thus arranged, the eyes  $n^2$  of both yarn-carriers are brought approximately over the line of crossing of the needles as the latter are reciprocated in the operation of the machine, and in order to maintain each of them in this position during the time it is being separately carried back and forth over the same the carrier in which it is formed is provided with an arm  $n^4$ , that extends upward from its head-like portion  $n^3$  and engages at its upper end with a second guide-rod M<sup>2</sup>, which is supported above and in parallel relationship to the guide-rod M' in suitable stands  $n^5$ , extending upward from the latter rod, as shown. The eyes  $n^2$  of both of the yarn-carriers N, being thus maintained in approximately the line of crossing of the needles  $d'$ , are separately brought into action and operated in the required order to present their respective yarns to the needles for incorporation into the fabric or article at the points demanded and are adapted to pass each other as they are successively brought into operation and reciprocated past the other by the springy construction of their depending body portion  $n$ , which permits of the eyes being carried outward laterally as the thickened lower end  $n'$  of the carriers arrive opposite each other and which to permit of this lateral action being effected have the ends of their inner contacting sides rounded off or beveled back to aid in the passage of the one by the other when brought opposite thereto.

For imparting back-and-forth reciprocation to the yarn-carriers N N, I make use of a locking-bar O, which is constructed with a downturned end  $o$  and is fitted to slide back and forth in the upper end of a stand P, which is secured to and extends upward from the saddle F, whereby to move with the latter as it travels back and forth over the needles  $d'$  in the operation of the machine. As thus constructed and arranged, this locking-bar coöperates with the plates O' O', which are severally secured to the upper sides of the head-like portions  $n^3$  of the carriers N in parallel relationship to each other by screws  $o'$  and are provided on the inner edges of each with a notch  $o^2$ , with one or the other of which the downturned end  $o$  may be made to engage as the locking-bar is slid back and forth in the upper end of its carrying-stand P. By this arrangement, as will be seen, the movement of one or the other of the carriers N with the saddle F to lay its yarn in the hooks of



the needles may be effected, while the other is left inoperative, by simply engaging the downturned end *o* of the locking-bar *O* with the notch *o*<sup>2</sup> in its appropriate plate *O'*, which  
 5 may be done by sliding the locking-bar in the proper direction in its carrying-stand, when the two will be locked together and their synchronous movement in unison insured, and in order to provide for the movement of the  
 10 yarn-carriers in rear of the needle-operating cams in whichever of the two directions the latter may be moving the notches *o*<sup>2</sup> in the plates *O'* instead of being constructed of a length to just receive the downturned end *o*  
 15 of the locking-bar *O* are constructed of a sufficient length to permit of the cams moving to the required distance in the one or the other direction to bring them into the proper relative position with respect to the carriers  
 20 before the downturned end *o* of the locking-bar *O* is brought into contact with the shoulder *o*<sup>3</sup> of the notch *o*<sup>2</sup> to move such carrier, when the two will be moved together and their relation maintained throughout the  
 25 traverse. The yarn-carriers being thus constructed and operated the yarn is conducted from a suitable bobbin (not shown) to the eye *n*<sup>2</sup> of each through a guide-eye *n*<sup>6</sup>, secured to the upward-extending arm *n*<sup>1</sup> of the head-like  
 30 portion *n*<sup>3</sup> of the carrier, thence over a rod or pin *n*<sup>7</sup>, secured to a stand *n*<sup>8</sup>, extending upward from the plate *O'*, thence through an eye *n*<sup>9</sup> in the end of a spring take-up *n*<sup>10</sup>, which is also secured to the said plate through  
 35 the intermediaries of a stand *n*<sup>11</sup> and screw *n*<sup>12</sup>, and thence through a guide-eye *n*<sup>13</sup>, formed through the plate *O'* and the head-like portion *n*<sup>3</sup>, to the eye *n*<sup>2</sup> for delivery to the needles. With the yarn conducted from  
 40 the bobbin to the needles, as thus described, its tension is rendered uniform ordinarily by the action of the take-up *n*<sup>10</sup>. In order, however, to prevent this tension from falling below a given limit and the consequent kinking  
 45 of the yarn, as when, for instance, the yarn-carrier has passed beyond the needles in completing its movement in one direction and is commencing its return movement in the other, I make use of a yarn-clamp, which is  
 50 preferably constructed of a plate *n*<sup>14</sup>, that is secured to the side of the stand *n*<sup>8</sup>, with its lower end bent outwardly therefrom to a slight extent, whereby to form an inverted-V-shaped notch between it and the stand. As thus con-  
 55 structed and arranged, when the tension of the yarn is kept above a certain limit the eye *n*<sup>9</sup> in the end of the take-up *n*<sup>10</sup> will be depressed to such an extent that the yarn will pass directly from the rod or pin *n*<sup>7</sup> to the eye  
 60 *n*<sup>9</sup> in the take-up below the clamp *n*<sup>14</sup> and will be unaffected thereby, as shown at the left in Fig. 3. When, on the other hand, the tension on the yarn falls below that limit, the eye in the end of the take-up will be caused to rise  
 65 through the resiliency of the spring portion of the latter and carry the yarn up into the notch formed in the yarn-clamp, as shown at

the right in Fig. 3, which positively holds the same and prevents any more being passed to the eye in the lower end of the carrier until  
 70 the tension upon the yarn is increased sufficiently to depress the eye *n*<sup>9</sup> of the take-up to near its lower limit of movement, when this eye will withdraw the yarn from the clamp and the same be passed to the take-up  
 75 directly from the rod or pin *n*<sup>7</sup> below the clamp, which will then cease to act upon it, and not return again into operation until the tension is again reduced below the desired limit, when it will be again brought into op-  
 80 eration, and so on. In order to insure of the needles *d'* taking the yarns thus delivered by the carriers *N N* and the incorporation of the latter into the article or fabric during the knitting operation, the throw of the advancing-cams *I* and retracting-cams *I'* is such that  
 85 when the needles are advanced by the former cams the hooks of the needles are carried upward across the space between the inner edges of the needle-bars and beneath the carriers  
 90 into the position shown by dotted lines in Fig. 4, and when retracted by the latter cams the inner hooks are carried downward in the needle-grooves below the inner edges of the needle-bars, which are severally provided on their  
 95 upper sides with a rounded flange *d*<sup>6</sup>, that aids in "knocking over" the old loops when the new are drawn therethrough, as is also shown in Fig. 4. When the needles are in their ad-  
 100 vanced position, the yarn from the appropriate yarn-carrier is laid upon their upper sides between their hooks and their latches, the latter of which are swung backward from their  
 105 respective hooks by the action of the old loops thereon as the needles are thrust forward through them in being advanced from their lowest to their highest position by their respective cams. The yarn having been thus  
 110 supplied to the needles, the latter are retracted by their respective cams and the former drawn in the form of loops through the old loops on the shank of the needles below their latches, which old loops in passing over them will swing them over and close them upon the  
 115 hooks of their respective needles.

In thrusting the needles upward through the old loops by the advancing-cams *I* to take the yarn it not infrequently happens that the latches when those loops pass from off their  
 120 lower ends spring to and close upon their respective needle-hooks in consequence of being relieved from the strain put upon them by such loops in passing over them, and as a result thereof the needles having their  
 125 hooks thus closed are unable to take it. Again, it frequently happens that the latches of the needles as such needles are advanced from their inoperative to their operative position are not opened in consequence of there  
 130 being no loops upon their hooks through which the needles are thrust, and in these cases also the yarn applied thereto is not taken by the hooks thereof. In order, therefore, to obviate the first of these objections,



I make use of a guard-plate  $d^7$  for the needles of each needle-bar, which is preferably supported from the saddle F in such a position with respect to the needles of its appropriate needle-bar by suitable brackets and screws  $d^8$  and  $d^9$ , respectively, as to permit of its lower edge extending downward over the hooks and latches of the same when advanced to the upward limit of their movement by the advancing-cam I, as shown in Fig. 3, while to obviate the other of these objections and insure of the latches being opened at all times when the needles are advanced from their inoperative to their operative position I make use of a latch-opener  $d^{10}$  for the needles of each needle-bar, which is preferably constructed in the form of a plate and secured to the under side of its respective guard-plate  $d^7$  by screws or otherwise, rests with its lower sharpened depending edge in such relationship to the line of travel of the needles that it engages with such of the latches thereof as may be closed when the needles are advanced, and swinging them back upon their pivots opens them from their respective needle-hooks, which are then left free to receive the yarn that may be supplied thereto.

The means whereby the starting and stopping of the machine may be accomplished when driven by power consists of a shipper R, which is preferably secured to the end of a rod R', that extends across the machine and is rotatively mounted in suitable bearings formed in the end brackets or standards A and A', with a handle  $r$  secured thereto at any convenient point along the same, whereby it may be oscillated upon its axis to bring the shipper either before the loose pulley  $g^7$  or before the fast pulley  $g^6$ , as the stopping or starting of the machine may require. In its normal position the shipper is maintained opposite the loose pulley  $g^7$  by a coiled spring  $r'$ , which encircling the rod R' is connected at one of its ends to a collar  $r^2$ , secured thereon, and at the other to the side of the end bracket or standard A'. For locking the shipper opposite the fast pulley  $g^6$  when in operation I make use of an arm  $r^3$ , which is fixedly secured to the rod R' and, provided with a notch  $r^4$  in its free end, coöperates with a pawl  $r^5$ , that is pivoted to the end bracket A'. This pawl is preferably weighted at its outer end, whereby to normally tend to swing its operative end up out of engagement with the notch  $r^4$  in the arm  $r^3$ , and in order to prevent it from rising from engagement therewith when it is desired to maintain the shipper R opposite the fast pulley  $g^6$  I make use of a second arm  $r^6$ , which is pivoted directly above the arm  $r^3$  to the end bracket or standard A', with its lower free end normally held by a light spring  $r^7$  directly over and in contact with the upper side of the operative end of the pawl  $r^5$  when the latter is engaged with the notch  $r^4$ . By this means the pawl  $r^5$  is positively locked in the notch  $r^4$  when brought into engagement therewith and cannot be re-

moved from it until after the arm  $r^6$  has been swung back from over its operative end. To provide for swinging this arm backward away from over the pawl, various means may be employed. I prefer, however, to make use of a hand-lever  $r^8$  for the purpose, which, fixedly secured to a shaft  $r^9$ , that is rotatively mounted in suitable bearings formed in the end standards or brackets A and A', is constructed with an inclined end  $r^{10}$ , that engages with a pin  $r^{11}$ , projecting outwardly from the side of the arm  $r^6$ , as shown in Fig. 13. As thus constructed and arranged when the belt is upon the fast pulley  $g^6$  and it is desired to ship it upon the loose pulley  $g^7$  to stop the machine all that is necessary is to press down the outer free end of the hand-lever  $r^8$ , when the inclined end  $r^{10}$  thereon will ride up against the pin  $r^{11}$ , swinging the arm  $r^6$  back on its pivot from over the pawl  $r^5$  and allowing such pawl to rise out of engagement with the notch  $r^4$  in the arm  $r^3$ , the result of which will be to allow of the rotation of the rod R' in its bearings under the action of the spring  $r'$  and the carrying of the belt upon the loose pulley  $g^7$ .

Clamped upon the tie-rods C and C' by the clamping-plates  $s$  and screws  $s'$  or otherwise secured thereto are the brackets or standards S S, in which is journaled the take-up roll T, by means of which the article or fabric being produced is taken up and a uniform tension upon it maintained. The roll is preferably roughened on its periphery, either by sanding or otherwise, and is provided on the end of its supporting-shaft  $t$  with a ratchet  $t'$ , through which its intermittent rotation may be effected by a pawl  $t^2$ , that is pivoted to the upper end of a vibrating arm  $t^3$ , which is loosely mounted upon the shaft  $t$ . For imparting the required vibratory movement to this arm to effect the rotation of the take-up roll various means may be employed. I prefer, however, to impart the backward movement thereto from a cam  $t^4$  on the shaft T', which, mounted in suitable bearings  $t^5$   $t^5$ , secured to the end brackets or standards A and A', is rotated from the shaft G through the intervention of the bevel-gears  $t^6$  and  $t^7$ , and to impart the forward movement to the same through a spring  $t^8$ . To permit of this being accomplished, the cam  $t^4$  is connected to the arm  $t^3$  through the intermediary of a connecting-rod  $t^{14}$ , which, pivoted at one of its ends to the upper end of such arm, is forked at its other, whereby to straddle and be guided by the shaft T', and is provided on its side with a roll  $t^9$  for contact with the periphery of the cam  $t^4$ , while the spring  $t^8$  is connected at one of its ends to the upper end of said arm and at the other to the upper end of a stand  $t^{10}$ , which is secured to and extends upward from the rods C, a suitable adjusting-screw  $t^{11}$  and nut  $t^{12}$  being employed to regulate the tension thereof.

With the take-up roll T is employed a fabric-roll T<sup>2</sup>, upon which the article or fabric taken up by the take-up roll T is wound and which, resting upon and rotated from the



take-up roll itself, has its journals resting in the open slotted bearings  $t^{13}$ , formed in the brackets or standards S S. In addition to this roll  $R^2$  there is also employed in connection with the take-up roll T a guide-bar  $T^3$ , which extends across from one to the other of the brackets or standards S S, in which its ends are secured, and serves to properly conduct the article or fabric coming from the knitting mechanism thereto. By thus arranging the parts as above explained and operating the pawl  $t^2$  in the direction to take up the article or fabric by a spring not only is the efficient taking up of the same effected, but a uniform tension upon the same insured. In order, however, to arrest the movement of the machine when the tension upon the article or fabric falls below a given limit, I make use of the arms  $S' S'$ , which in addition to being loosely mounted upon the shaft  $r^9$  and connected at their lower ends by a rod  $s^2$  that is drawn backward against the article or fabric by a coiled spring  $s^3$ , extending from one of such arms to a pin  $s^4$  on one of the brackets or standards S, are likewise provided with a pin or abutment  $s^5$ , each of which coöperates with a corresponding pin or abutment  $s^6$ , secured in or to the shaft  $r^9$ . When the tension upon the article or fabric is normal, the arms  $S' S'$  will be held in such a position as to carry the pins or abutments thereon away from the corresponding pins or abutments on the shaft  $r^9$ , as shown in Fig. 3, wherein the course of the fabric is indicated by a dotted line. When, on the other hand, this normal tension is destroyed, as when the article or fabric is cast off the needles by the breaking of the yarn, then the lower ends of the arms will be drawn inward toward the take-up roll T by the action of the spring  $s^3$ , the pins or abutments  $s^5$ , carried against the pins or abutments  $s^6$ , the shaft  $r^9$  thereby rotated, and the arm  $r^6$  swung back from over the pawl  $r^5$  by the action of the inclined end  $r^{10}$  of the hand-lever  $r^8$  on the pin  $r^{11}$ , and the shipping of the belt from the fast pulley  $g^6$  to the loose pulley  $g^7$ , and the consequent stopping of the machine accomplished, as above explained. The machine being thus provided with the various mechanisms above described, the advancing-cams for the needle-bar  $D'$ , the needle-elevators L, and the yarn-carriers N may be brought into and carried out of operation in the required order and at the required times to automatically produce the desired article or fabric by any of the well-known forms of pattern mechanisms that are adapted therefor. I prefer, however, to employ for this purpose the pattern-chains U,  $U'$ ,  $U^2$ , and  $U^3$ , which are severally constructed with appropriate high and low pattern-surfaces  $u$  and  $u'$ , that are arranged thereon in the required order, and to support these chains side by side on a suitably-constructed sprocket wheel or barrel  $u^2$ , that is journaled upon a stud  $u^3$ , which is secured to and extends inward from the inner side of the end bracket

or standard A. The pattern-chains being thus supported and arranged are moved progressively forward to bring their respective high and low pattern-surfaces in operative position by a step-by-step movement by the sprocket wheel or barrel, which is rotated from a cam  $u^4$  upon the shaft  $T'$  through the intermediaries of a pawl  $u^5$  and a ratchet  $u^6$ . Of these the pawl  $u^5$  is preferably constructed with a forked rear end, whereby to straddle and be guided by the shaft  $T'$ , and is provided with a roll  $u^7$ , which is journaled to its side for contact with the periphery of the operating-cam  $u^4$ , while the ratchet  $u^6$  is fixedly secured to the end of the sprocket wheel or barrel  $u^2$ , a coiled spring  $u^8$ , connected at one end with the pawl and at the other with some stationary part of the machine—as, for instance, the end bracket or standard A—being also employed for returning the pawl after having been thrust forward by the cam  $u^4$ , as shown in Figs. 3 and 7. By this arrangement the forward rotation of the sprocket wheel or barrel the distance of one tooth will be effected at each rotation of the shaft  $T'$ , which will be sufficient to bring the required high and low pattern-surfaces on the pattern-chains into operative positions, and in order to prevent the sprocket wheel or barrel from turning backward after having been rotated in a forward direction by the pawl and ratchet I make use of the detent  $u^9$ , which, provided with a weighted or spring-actuated arm  $u^{10}$ , is loosely journaled upon a shaft  $u^{11}$ , that extends across from one of the end brackets or standards to the other and is journaled at its ends therein.

The pattern-chain U is employed for retracting and protruding the needle-advancing cam I of the needles of the needle-bar  $D'$ , whereby to render it inoperative and operative, as may be required in the formation of a welt in the article or fabric being produced, and communicates the appropriate movements thereto through the intervention of a lever  $I^2$ , which is loosely fulcrumed upon the shaft  $u^{11}$ , with its inner end provided with a roll  $i^8$ , that rests upon the pattern-chain, and its outer end connected by a connecting-rod  $i^9$  with the free end of an arm  $i^{10}$ , secured to a shaft  $i^{11}$ , which, journaled at its ends in the stands M M, is provided near its ends with two arms  $i^{12} i^{12}$ , that support at their free ends in parallel relationship to the shaft itself a rod  $i^{13}$ , which engages with and lies between two studs  $i^{14} i^{14}$ , projecting from the carrying-bar  $i^5$ , that supports the cam I. With the parts connected as thus described and with the advancing-cam I protruded from its carrying-plate  $II'$  and in an operative position the passage of one of the high pattern-surfaces  $u$  beneath the roll  $i^8$  as the pattern-chain is moved forward by the pawl and ratchet will raise the inner end of the lever  $I^2$ , and, through the connections above specified, retract the advancing-cam I into an inoperative position. In this position the cam I will be held



so long as a high pattern-surface  $u$  is beneath the roll  $i^8$ , but will be protruded from its carrying-plate and returned into its normal operative position when such high surface is carried from beneath it and a low surface carried into its place by a coiled retracting-spring  $i^{15}$ , which is connected at one of its ends with a pin  $i^{16}$  in the outer end of the lever  $I^2$  and at its other with a stationary part of the machine—as, for instance, one of the guide-rails E—and thus through the operations of the pattern-surfaces on the pattern-chain and the retracting-spring the advancing-cam I through the connections above explained will be automatically carried out of and brought back into operation as the requirements of the machine in the formation of a welt or otherwise may demand, while the studs  $i^{14}$  on the carrying-bar  $i^5$  are yet left free to move back and forth along the rod  $i^{13}$  as they are carried with the cam in the operation of the machine. The pattern-chains  $U'$  and  $U^2$ , on the other hand, are made use of for carrying the needle-elevators L L out of and permitting of their return into operation at the required times, the chain  $U^2$  being employed in connection with the elevator of the needles of the needle-bar D and the chain  $U'$  being employed in connection with the needle of the needle-bar D'. The means through which these needle-elevators are carried out of and permitted to return into operation by these pattern-chains consists of the levers  $L'$  and  $L^2$ , the former of which is fulcrumed upon the shaft  $u^{11}$  and the latter upon the stud  $l^{10}$ , projecting inward from the end bracket or standard A, with each provided on its inner end with a roll  $l^{11}$ , which rests upon its respective pattern-chain and with each connected at its outer end through the instrumentality of a connecting-rod  $l^{12}$  with the outer end of an arm  $l^{13}$ , extending outward from a shaft  $l^{14}$ , which is journaled at its ends in the stands M M and provided near its extremities with the arms  $l^{15}$ , that support at their free ends in parallel relationship to the shaft itself a rod  $l^{16}$ , which engages with the under side of its respective elevator L, as shown in Figs. 3 and 4. In their normal positions these elevators L L are held with their free ends raised above the butts of the needles that are to be carried into operation to effect the widening of the article or fabric, as shown by dotted lines in Fig. 5, and in these positions the rolls  $l^{11}$  rest upon the low surfaces  $u'$  of their respective pattern-chains. When, on the other hand, they are to be lowered to bring them into operative position, then the high surface  $u$  passes beneath the rolls  $l^{11}$ , carrying the rods  $l^{16}$  down away from the elevators, when the latter will then be carried down into operative position and there held by the springs  $l^7$  until the high surfaces on the pattern-chains are carried from under the rolls  $l^{11}$ , when they will be raised and carried out of operation, and so on, the high and low surfaces on the pattern-chain thus de-

termining when they shall be brought into and carried out of operation. The levers  $L'$  and  $L^2$ , with the parts connected therewith, being thus moved in the one direction by the high surfaces on the pattern-chain are returned in the other when these high surfaces are removed from under the rolls  $l^{11}$  by the springs  $l^{17}$  and  $l^{18}$ , respectively, the former of which is connected at one end to a pin on the outer end of the lever  $L'$  and at the other to the under side of the guideway E, while the latter is connected at one end with the free end of the arm  $l^{13}$  and at the other with a stationary part of the machine—as, for instance, one of the stands M. With the needle-elevators connected with their cooperating pattern-chains, as above explained, not only are the movements of the former into and out of operation controlled by the latter at the required times, but in consequence of the sliding connection between them and their respective cooperating rods  $l^{16}$  they are, as with the advancing-cam  $i$  and its cooperating rod  $i^{13}$ , yet left free to slide back and forth with the needle-operating cams without the connection between them and their pattern-chains being broken at any time. While the pattern-chains  $U$ ,  $U'$ , and  $U^2$  are thus respectively employed in connection with the advancing-cam  $i$  and the needle-elevators L, the pattern-chain  $U^3$  is made use of to bring into and carry out of operation first one and then the other of the yarn-carriers N, as the exigencies of the pattern being produced may require. The means through which this result is accomplished consists of the arms  $N'$  and  $N^2$ , which, extending outwardly in approximately opposite directions, are fixedly secured to the shaft  $u^{11}$ , with the free end of the former provided with a roll  $n^{14}$ , that rests upon the pattern-chain, and the free end of the latter bent over at right angles to its body and provided with a wedge-shaped end  $n^{15}$ , which cooperates with a similar wedge-shaped overturned end  $n^{16}$  of a lever  $N^3$ , that is pivoted to a suitable ear  $n^{17}$  on the upwardly-extending stand P and connected at its upper end with the locking-bar O by a pivot  $n^{18}$ , as shown in Figs. 3 and 12. As thus organized, when the roll  $n^{14}$  is resting upon the low pattern-surfaces  $u'$  of the pattern-chain the lower overturned end  $n^{16}$  of the lever  $N^3$  will contact with the under inclined side of the wedge-shaped end of the arm  $N^2$  as the lever is carried along with the saddle F and the parts supported therefrom, which contact will thereby force the lower end of this lever outward and the upper end inward with the locking-bar O, the result of which operation will be to carry the downturned end  $o$  of this locking-bar into engagement with the notch  $o^2$  of the plate  $O'$ , that is over the needle-bar D, thereby locking the yarn-carrier N of that plate to the saddle F and causing it to move back and forth therewith as it is reciprocated longitudinally of the needle-bars in the operation of the machine. On the other hand,



when the high pattern-surfaces  $u$  on the pattern-chain is carried under the roll  $n^{14}$  the outer wedge-shaped overturned end of the arm  $N^2$  will be carried downward and the lower end  $n^{16}$  of the lever  $N^3$  will as it is carried past it contact with the upper side thereof and be thereby forced inward, carrying the upper end of the lever outward and with it the locking-bar  $O$ . As a result of this, the downturned end  $o$  of the locking-bar  $O$  will be withdrawn from the notch  $o^2$  in the plate  $O'$ , that is over the needle-bar  $D$ , and carried into engagement with the notch  $o^2$  of the plate  $O'$ , that is over the needle-bar  $D'$ , thereby retiring from operation the yarn-carrier of the former plate and bringing into operation the yarn-carrier of the latter plate, and thus by the successive interposition of high and low pattern-surfaces beneath the roll  $n^{14}$  the overturned wedge-shaped end  $n^{15}$  of the arm  $N^2$  is forced outward and inward, and through the vibration of the lever  $L$  by the contact of its lower end therewith as it is carried past the end of such arm the locking and unlocking of first one and then the other of the yarn-carriers to and from the saddle  $F$  is effected, and so on. The oscillation of the shaft  $u^{11}$  with the arms  $N^1$  and  $N^2$  thereon in one direction being effected by the passage of a high pattern-surface  $u$  of the pattern-chain under the roll  $n^{14}$ , its oscillation in the opposite direction with such parts when the high surface  $u$  passes from under the roll and the maintenance of the roll in contact with the surfaces of the chain at all times are accomplished by a torsional spring  $n^{19}$ , which, coiled around the shaft  $u^{11}$  and connected at one of its ends to a collar  $n^{20}$  thereon, is connected at the other to the end bracket or standard  $A'$ , as shown in Fig. 1. While thus the movements of the advancing-cam  $I'$ , the needle-elevators  $L$ , and the yarn-carriers are individually controlled by their respective pattern-chains, the mounting of the several chains upon a common sprocket wheel or barrel, whereby they are all caused to move together and in unison, permits of the relation of the movements of these several parts, whereby in the operation of the machine they are effected at the proper time and in the required order with respect to one another to automatically produce the desired article or fabric and arrest the motion of the machine at predetermined intervals. To permit of this last-mentioned result being accomplished, I make use of the pattern-surfaces  $u^x$ , which are secured to the pattern-chain  $U$  in the required positions thereon and coöperate with an arm  $r^{12}$ , that is fixedly secured to the shaft  $r^9$ . By these means when one of the surfaces  $u^x$  is carried by the chain  $U$  past the upper end of the arm  $r^{12}$  the shaft  $r^9$  is rotated upon its axis, the inclined end  $r^{10}$  of the hand-lever  $r^8$  thereby carried up against the pin  $r^{11}$ , which, forcing it back, carries the arm  $r^6$  from over the pawl  $r^5$  and allows of its rising from engagement with the notch  $r^4$

in the arm  $r^3$  and the stopping of the machine, as before explained.

In order to provide for adjusting the sprocket wheel or barrel  $u^2$  circumferentially of its axis to bring the high and low surfaces  $u$  and  $u'$  on the several pattern-chains directly under their respective rolls  $i^8$ ,  $l^{11}$ ,  $l^{11}$ , and  $n^{14}$  when moved into those positions, the pawl  $u^5$  instead of being constructed in one piece is provided with a detachable end  $u^{12}$ , which is fitted to slide longitudinally of the pawl in a suitable socket or seat formed therein and be secured in adjusted position in the same by a clamping-screw  $u^{13}$ , while in order to prevent the sprocket wheel or barrel from being carried forward by the momentum of the chain or otherwise beyond the positions to which it is carried by the pawl a friction-spring  $u^{11}$  is employed, which is arranged upon the stud  $u^3$  and may be forced against the head of the wheel or barrel with a greater or less pressure by a nut  $u^{15}$ , that is threaded upon the end of the stud, as shown, a rubber or other washer  $u^{16}$  being interposed between the nut and the end of the wheel or barrel, if desired.

In some instances where the pattern to be produced is not too long the pattern-chains  $U$ ,  $U'$ ,  $U^2$ , and  $U^3$  may be made of a sufficient length to permit of being moved forward at each forward movement of the pawl  $u^5$ , in which cases the links of each chain intermediate those carrying the pattern-surfaces that determine the movements of the respective part controlled by it will be provided with pattern-surfaces of the same height as that of the surface last operated to determine one of those movements. It is preferred, however, to construct these chains of approximately such length as will permit of their respective links carrying only those pattern-surfaces that are operative to determine the movements of the respective parts controlled therefrom and such further inoperative surfaces as may be required and to employ in connection with these chains an additional chain  $U^4$ , whereby to permit of their being brought into operation by the pawl  $u^5$  when the movement of the part or parts controlled by any one or more of them is or are required and to interrupt and suspend such operation when the movement of that part or those parts is or are not demanded. This additional pattern-chain is supported by a pulley or sleeve  $u^{17}$ , that is rotatively mounted upon the sprocket wheel or barrel  $u^2$ , adjacent to the ratchet  $u^6$ , and is provided throughout its length with high and low pattern-surfaces  $u^{18}$  and  $u^{19}$ , respectively, which are preferably constructed in the form of ratchet-teeth. As thus constructed and arranged, the pattern-surfaces  $u^{18}$  and  $u^{19}$  are engaged by the pawl  $u^5$ , which is made of sufficient breadth to engage therewith and with the ratchet  $u^6$ , and the chain, except as hereinafter explained, moved forward thereby as such pawl is moved forward by its operating-cam  $u^4$  in the operation of the ma-



chine. The chain  $U^4$  being thus moved progressively forward by a step-by-step movement, the high pattern-surfaces  $u^{18}$  are made of such height that when its pawl  $u^5$  is engaged therewith it is raised above and out of engagement with the teeth of the ratchet  $u^6$  and only the chain  $U^4$  moved forward thereby, leaving the sprocket wheel or barrel  $u^2$  and the chains carried thereby stationary, while the low pattern-surfaces  $u^{19}$  are made so low that when the pawl is engaged therewith it engages with the teeth of the ratchet  $u^6$  and the latter, with the chains carried by it, moved forward by the same. While the pattern-chain  $U^4$  is thus moved forward by the pawl when the latter engages with the higher pattern-surfaces  $u^{18}$ , its movement is arrested when the pawl is brought into engagement with the low pattern-surfaces  $u^{19}$  in consequence of the pitch of these latter surfaces being greater than that of the travel of the pawl, and in this position the chain  $U^4$  will remain inoperative until moved forward by other means. In order to provide for moving the chain forward when in this position, I provide it with a projection  $u^{20}$ , extending outward from its side, which is engaged and the chain moved forward by a similar projection  $u^{21}$ , extending outward from the side of the chain  $U^3$ . By this arrangement, as will be seen, the pattern-chains  $U^1$   $U'$   $U^2$   $U^3$  and their carrying sprocket wheel or barrel  $u^2$  will be carried out of operation when the high pattern-surfaces  $u^{18}$  on the pattern-chain  $U^4$  are carried under the operative end of the pawl  $u^5$  and brought into operation when the low pattern-surfaces  $u^{19}$  thereon are carried under the same, and thus by properly arranging the high and low pattern-surfaces upon this additional pattern-chain  $U^4$  the other pattern-chains may be brought into and carried out of operation as the movements of the respective parts controlled by them may require.

For preventing the forward movement of the wheel or sleeve  $u^{17}$  by the momentum of the chain  $U^4$  or the rotation of the sprocket wheel or barrel  $u^2$  within the same I make use of a lever  $u^{22}$ , which, loosely journaled upon the shipper-rod  $R'$ , carries at one end a friction-pad  $u^{23}$ , that is pressed against the periphery of this wheel or sleeve by a coiled spring  $u^{24}$ , which is connected at one of its ends to the opposite end of the lever and at its other to a stud  $u^{25}$ , extending inward from the end bracket or standard  $A$ , as shown.

In Fig. 14 I have shown a modified arrangement of parts for communicating the required movements from each of the friction-rolls  $l^{11}$  to its respective needle-elevator  $L$ , wherein a shaft  $l^{19}$  is journaled in suitable bearings  $l^{20}$  on the saddle  $F$  and is provided with an arm  $l^{21}$  for engagement with its respective elevator and also with two other arms  $l^{22}$ , which have secured in their free ends and extending across from one to the other in parallel relationship to the shaft  $l^{19}$  itself a rod  $l^{23}$ , that is free to

slide through a suitable orifice formed in the inner end of a lever  $l^{24}$ , which, journaled intermediate its length upon a stud  $l^{25}$ , projecting inward from one of the end brackets or standards  $A$  or  $A'$ , is provided at its other or outer end with the pivot for the friction-roll  $l^{11}$ , a suitable retracting-spring  $l^{26}$  being employed in connection with the lever to move the parts in opposition to their respective pattern-chains. By this arrangement, as will be seen, the elevators instead of sliding along their respective rods  $l^{16}$ , as in the construction shown in Figs. 1, 2, and 3, the shafts  $l^{19}$  move back and forth with their respective elevators, and the rods  $l^{23}$  slide back and forth through the orifice formed in the inner end of their respective levers  $l^{24}$  when the machine is in operation, as shown. This arrangement of parts, while here shown as applied only in connection with the needle-elevators, may, as is obvious, be applied in connection with the advancing-cam  $I$  of the needles of the needle-bar  $D'$  to effect its movements, the inner end of the arm  $l^{21}$  in that case being jointed to the carrying-bar  $i^5$  of the cam.

With the various parts constructed and organized as above explained a machine is produced in which not only are the operations of bringing into and carrying out of action one and then the other of a plurality of yarns to form transverse stripes therefrom in the article or fabric being knit and of bringing into action certain of the needles to effect the widening of the same to fashion it for its intended use accomplished automatically at predetermined intervals, but the throwing of the needles of one needle-bar out of and the bringing of them back into action to form welts and the stopping of the machine as well.

Although in the foregoing I have described the best means contemplated by me for carrying my invention into effect, I wish it distinctly understood that I do not limit myself strictly thereto, as it is obvious that I may modify the same in various ways without departing from the spirit thereof. Again, while I have shown and described my invention as applied to a "straight-knitting" machine, so called, it is obvious that various of its parts may be applied in connection with what are known as "circular-knitting" machines, while others—as, for instance, the pattern mechanism—may be applied to other kinds of machine, and I contemplate so applying them. Still, again, while I have shown the part  $L$  employed as a means for carrying the needles from an inoperative into an operative position to effect the widening of the article or fabric being produced it is obvious that it may be employed in connection with various forms of cams—as, for instance, that shown in Figs. 5 and 6 of the United States Patent No. 309,691—as a means for carrying the needles from an operative into an inop-



erative position to effect the narrowing thereof, in which case it will be arranged above the butts of the needles instead of below the same and engage with such butts as they are raised above the truncated apex of the cam 32, carrying them in its operation above the cam 30 through appropriate grooves formed therein, which may be provided with gates, as is the case with the grooves  $k'$  and gates  $k^2$  in the drawings.

Having thus described my invention and specified certain of the ways in which it is or may be carried into effect, I claim and desire to secure by Letters Patent of the United States—

1. The combination, with the advancing-cam I, the carrying-plate II', the carrying-bar  $i^5$ , and the pattern-chain U, of the lever I<sup>2</sup>, the shaft  $u^{11}$ , the roll  $i^8$ , connecting-rod  $i^9$ , shaft  $i^{11}$  provided with the arms  $i^{10}$  and  $i^{12}$ , rod  $i^{13}$ , connections between this rod and the carrying-bar  $i^5$ , and devices for rotating the pattern-chain, substantially as described.

2. The combination, with a carrying-plate, and an advancing-cam I, and a retracting-cam I' supported upon it, of ledges, K, secured thereto on opposite sides on the advancing-cam with their inner ends extending beneath it, whereby to guide the butts of the needles and form grooves,  $k'$ , between the inner ends of such ledges and the lower corners of the advancing-cam, and movable gates for normally closing the upper ends of these grooves, substantially as described.

3. The combination, with the needles, the needle-bed, the advancing and retracting cams for such needles, and the support upon which said cams are carried, of a needle-elevator arranged below the advancing-cam, and adapted to engage with and raise a needle from an inoperative to an operative position to effect the widening of the article or fabric when moved in either direction across the needles and be operated itself therefrom, grooves extending upward around the advancing-cam for cooperation with the elevator, and means for reciprocating the various parts back and forth across the needles and along the needle-bed, substantially as described.

4. The combination, with the needles, the needle-bed, the advancing and retracting cams for such needles, a carrying-plate for said cam provided with a flattened V-shaped orifice beneath the advancing-cam, and a support for such plate, of a needle-elevator pivoted to the upper or outer side of said carrying-plate and extending through the V-shaped orifice therein, whereby to engage with and raise a needle from an inoperative position below the cams to a position to be operated by them when moved in either direction over such needles and be operated itself therefrom, grooves extending upward from the bottom around the advancing-cam for cooperation with the elevator, and devices for supporting the carrying-plate and for reciprocating it

back and forth across the needles and along the needle-bed, substantially as described.

5. The combination, with the needles, the needle-bed, the advancing and the retracting cams for such needles, a carrying-plate for said cam provided with a flattened V-shaped orifice below the advancing-cam, and a saddle for supporting and carrying the said carrying-plate, of a needle-elevator extending through said orifice and capable of a swinging movement therein in the direction of the travel of the cams, with its inner free end adapted to engage with and raise a needle from an inoperative position below the cams to a position to be operated by them when moved in either direction over such needles and be operated itself therefrom, guiding-edges arranged on opposite sides of the advancing-cam with grooves between their inner ends and the lower corners of such cam, and devices for reciprocating the saddle back and forth across the needles along the needle-bed, substantially as described.

6. The combination, with the needles, the needle-bed, the advancing and retracting cams for such needles, a carrying-plate for said cams provided with a flattened V-shaped orifice below the advancing-cam, and a saddle for supporting and carrying the said carrying-plate, of a needle-elevator extending through said orifice and capable of a swinging movement therein in the direction of the travel of the cams, with its inner free end adapted to engage with and raise a needle from an inoperative position below the cams to a position to be operated by them when moved in either direction over said needles and be operated itself therefrom, guiding-edges arranged on opposite sides of the advancing-cam, with grooves between their inner ends and the lower corners of such cam, yielding gates for normally closing the upper ends of these grooves, and devices for reciprocating the saddle back and forth across the needles along the needle-bed, substantially as described.

7. The combination, with the needles, the needle-bar, the advancing and the retracting cams for such needles, a carrying-plate for said cams provided with a flattened V-shaped orifice below the advancing-cam, a saddle for supporting and carrying the said carrying-plate, a needle-elevator extending through said orifice and capable of a swinging movement therein in the direction of travel of the cams, with its inner free end adapted to engage with and raise a needle from an inoperative position below the cams to a position to be operated by them when moved in either direction over said needles and be operated itself therefrom, guiding-edges arranged on opposite sides of the advancing-cam, and grooves between the inner ends of these ledges and the lower corners of such cam for cooperation with the needle-elevator, of pattern mechanism for determining when the said needle-elevator shall be brought into and car-



ried out of operation, and devices for imparting a reciprocation to the saddle, substantially as described.

8. The combination, with the needles of a knitting-machine, the advancing and retracting cams therefor, and their carrying-plates provided with a flattened V-shaped orifice below the advancing-cam, of a needle-elevator loosely sleeved upon a shaft that is disposed in parallel relationship to the said carrying-plate, with the free end of such elevator extending through the said orifice and capable of a swinging movement therein in the direction of travel of the cams, and a spring for holding the elevator normally pressed downward with its head in line with the butts of the needles that are to be carried into operation thereby, substantially as described.

9. The combination, with the carrying-plate for the needle-operating cams provided with a flattened V-shaped orifice, of a shaft supported from such plate in parallel relationship to its upper side and transversely of the same, a needle-elevator loosely sleeved upon such shaft, and a spring for normally holding such elevator in a depressed position with its inner free end resting in the apex of the orifice, substantially as described.

10. The combination, with a carrying-plate constructed with a flattened V-shaped orifice formed therein, a shaft arranged in parallel relationship to the said plate and transversely of the same, a needle-elevator loosely sleeved upon such shaft, and a spring for normally pressing such elevator downward to the lower edge of such orifice, of a pattern-chain and intermediate connecting devices between the chain and the elevator for raising such elevator in the orifice at predetermined intervals against the action of the spring, and devices for moving the pattern-chain in the direction of its length, substantially as described.

11. The combination, with the needles of a knitting-machine, a support provided with a V-shaped orifice formed therein, a shaft arranged in transverse relation to such orifice, a device loosely sleeved upon said shaft and extending through such orifice to engage with and move a needle longitudinally when carried over the same in either direction, and a spring for normally pressing the said device toward the apex of the V-shaped orifice in the support, of a pattern-chain, and intermediate connecting devices between the chain, and devices to move it at predetermined intervals in opposition to the spring, and devices for moving the chain in the direction of its length, substantially as described.

12. The combination, with the carrying-plate H provided with the V-shaped orifice  $l$ , the advancing-cam I, the retracting-cam I', the shaft  $l'$ , stand  $l^2$ , needle-elevator L, extending through the orifice  $l$  for engagement with the butts of the needles, the sleeve  $l^6$  to the lower end of which the elevator is secured,

and the spring  $l^7$ , as and for the purposes set forth.

13. The combination, with a carrying-plate provided with a V-shaped orifice therein, the needle-advancing cam I, the needle-retracting cam I', the shaft  $l'$ , means by which the shaft is supported from the carrying-plate, the needle-elevator L extending through the orifice  $l$ , the sleeve  $l^6$ , to the lower end of which the elevator is secured, the spring  $l^7$ , the pattern-chain U', the lever L', roll  $l^{11}$ , the fulcrum-shaft  $u^{11}$ , the connecting-rod  $l^{12}$ , the shaft  $l^{14}$  provided with arms,  $l^{13}$  and  $l^{15}$  respectively, and the rod  $l^{16}$ , as and for the purposes set forth.

14. The combination, with a plurality of yarn-carriers provided with notched plates, guide-rods upon which they are supported, a locking-bar having a downturned end for engagement with the notches in said bars, a stand in which such locking-bar is fitted to slide, means for supporting and reciprocating said stand, a lever pivoted to said stand and connected at its upper end to the locking-bar and provided with a wedge-shaped lower end, a pattern-surface and means for moving it in a direction of its length, a shaft provided with arms one of which rests at its outer end upon the pattern-surface, and the other of which is constructed at its outer end with a wedge-shaped portion, with which the wedge-shaped end of the lever connected with the locking-bar engages as it is carried past the same in the operation of the machine; substantially as described.

15. The combination, with the yarn-carriers N provided with eyes  $n^2$  at their lower ends and with the head-like portions  $n^3$  at their upper ends, the guide-rods M' upon which they are fitted to slide, the upwardly-extending arms  $n^4$ , guide-rods M<sup>2</sup>, plates O' provided on their inner edges with notches  $o^2$ , the locking-bar O provided with the downturned end  $o$ , the stand P, the saddle F, the lever N<sup>3</sup>, provided with the wedge-shaped lower end,  $n^{16}$ , shaft  $u^{11}$ , arms N' and N<sup>2</sup> respectively, the former of which is provided with a roll,  $n^{14}$ , and the latter with a wedge-shaped overturned end,  $n^{15}$ , and a pattern-chain U<sup>3</sup>, as and for the purposes set forth.

16. The combination, with the head-like portion  $n^3$ , the plate O', and the spring take-up  $n^{10}$  provided with the eye  $n^9$  in its free end, of the eye  $n^6$ , the pin  $n^7$ , and the clamp  $n^{14}$ , as and for the purposes specified.

17. The combination, with the oscillatory shipper-rod R' provided with a shipper, R, at its end, the arm  $r^3$  provided with a notch,  $r^4$ , and the pawl  $r^5$ , of the arm  $r^6$  provided with a pin,  $r^{11}$ , the spring  $r^7$ , the hand-lever  $r^8$  provided with the inclined end for engagement with the pin  $r^{11}$ , the shaft  $r^9$  and the spring  $r'$ , as and for the purposes set forth.

18. The combination, with the take-up roll T, the means by which it is rotated to take up the article or fabric being produced, and the guide-bar T<sup>3</sup>, of the arms S', the rod  $s^2$ , the



shaft  $r^9$ , the spring,  $s^3$ , the abutments  $s^5$  and  $s^6$  respectively, whereby when the tension upon the article or fabric being produced falls below a certain limit the shaft  $r^9$  will be oscillated and the motion of the machine thereby arrested, as and for the purposes set forth.

19. The combination, with a sprocket-wheel provided with an actuating-ratchet, a support upon which it is rotated, a pattern-chain mounted thereon and provided with pattern-surfaces, and a reciprocating pawl for imparting a rotary motion to said wheel or barrel, of a wheel or sleeve rotatively arranged upon the sprocket wheel or barrel in near relationship to its actuating-ratchet, and a second pattern-chain mounted upon this wheel or sleeve and provided with high and low pattern-surfaces that are constructed in the form of ratchet-teeth, and also with a pattern-surface for coöperation with the pattern-surface on the first-mentioned pattern-chain, whereby both the sprocket wheel or barrel and the pattern-chain carried by the wheel or sleeve are rotated by the said reciprocating pawl, and the former carried out of and brought back into operation by the latter at predetermined intervals, while this latter is also brought into operation by the pattern-surfaces on the pattern-chain carried by the former, substantially as described.

20. The combination, with the sprocket-wheel  $w^2$  provided with the ratchet  $w^6$ , the supporting-stud  $w^3$ , the pattern-chain  $U^3$  provided with high and low pattern-surfaces  $u$

and  $u'$ , respectively, and the pattern-surface  $u^{21}$ , the wheel or sleeve  $u^{17}$ , and the pattern-chain  $U^4$  provided with high and low pattern-surfaces which are constructed in the form of ratchet-teeth, and also with a pattern-surface,  $u^{20}$ , for coöperation with the pattern-surface  $u^{21}$  on the pattern-chain  $U^3$ , of the pawl  $w^5$ , actuating-cam  $w^4$ , and shaft  $T'$ , substantially as described.

21. The combination, with a series of needles, a support therefor, and cams by which the needles are reciprocated in their support, of latch-openers whereby the latches are thrown back from the needle-hooks when the needles are carried from an inoperative into an operative position, substantially as described.

22. The combination, with a series of needles, a support therefor, and means whereby the needles are reciprocated in their support, of a guard-plate for preventing the closing of the latches upon the hooks of the needles when such needles are forced upward through the old loops, and latch-openers for throwing such latches back from the hooks of the needles when raised from an inoperative into an operative position carried by the guard-plate, substantially as described.

In testimony whereof I have hereunto set my hand this 12th day of April, 1898.

WILLIAM S. MILLS.

Witnesses:

WM. H. APPLETON,  
R. F. SWEENEY.