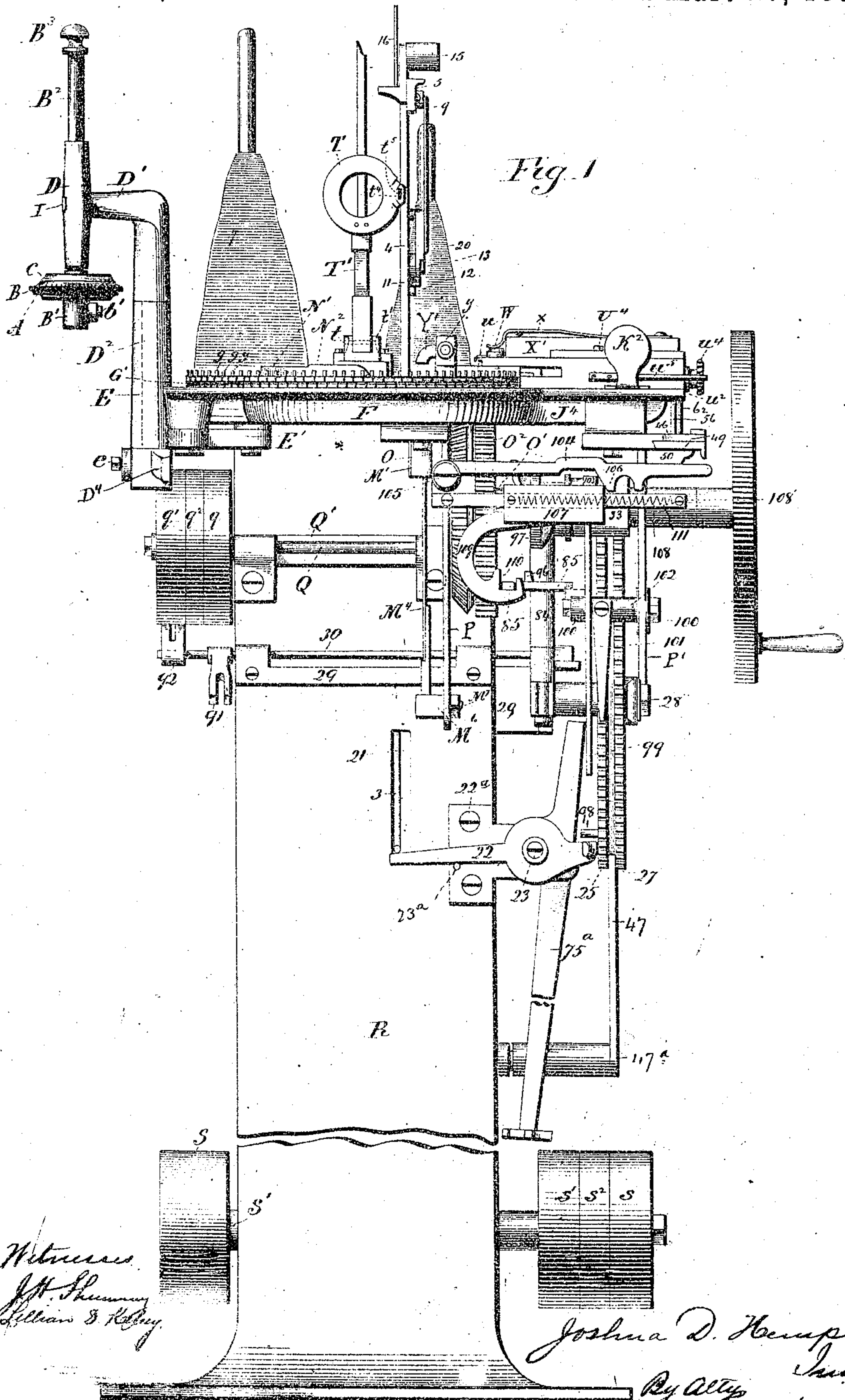


J. D. HEMPHILL.
CIRCULAR KNITTING MACHINE.

No. 516,722.

Patented Mar. 20, 1894.



Witnesses
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William S. Kelley

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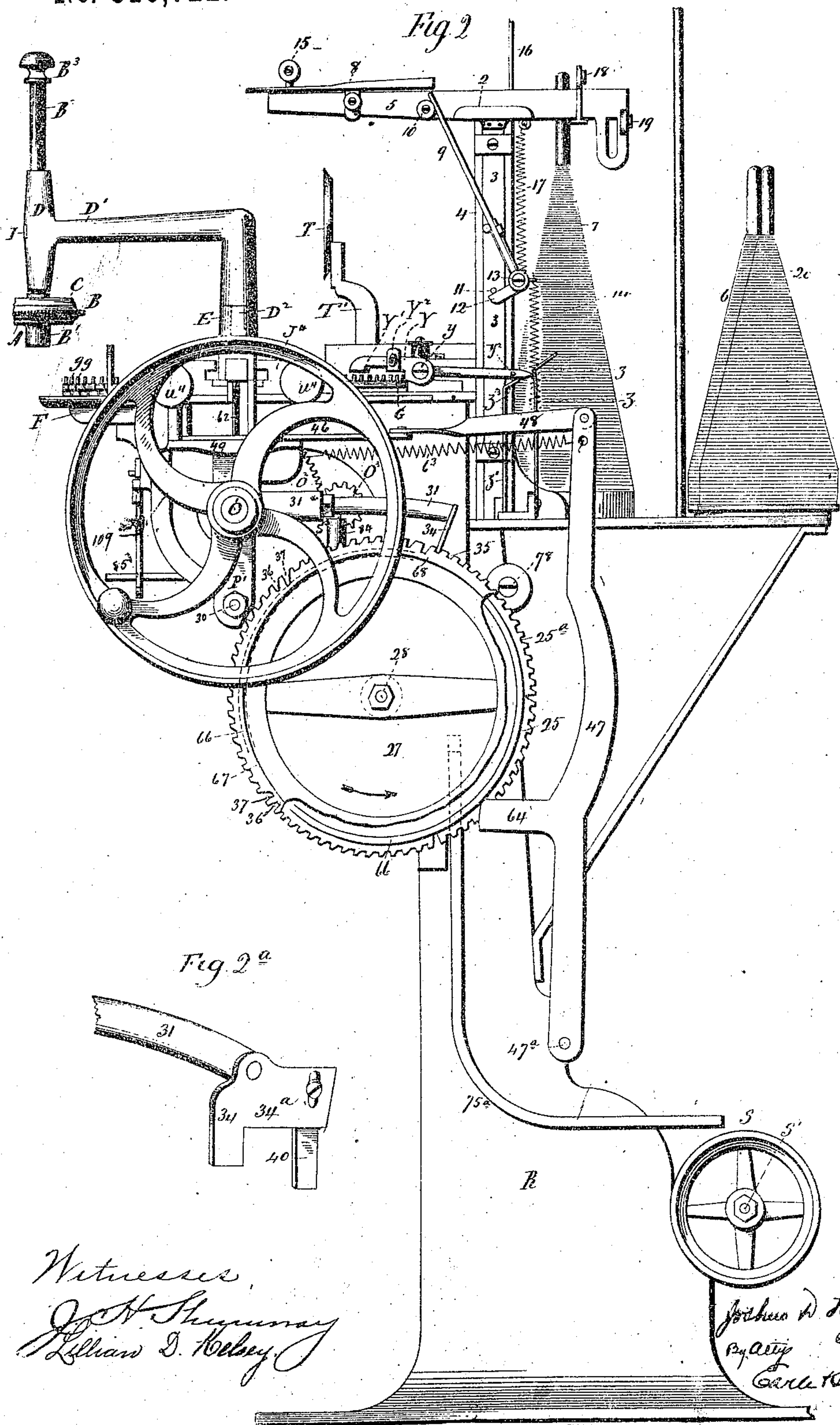
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J. D. HEMPHILL.
CIRCULAR KNITTING MACHINE.

No. 516,722.

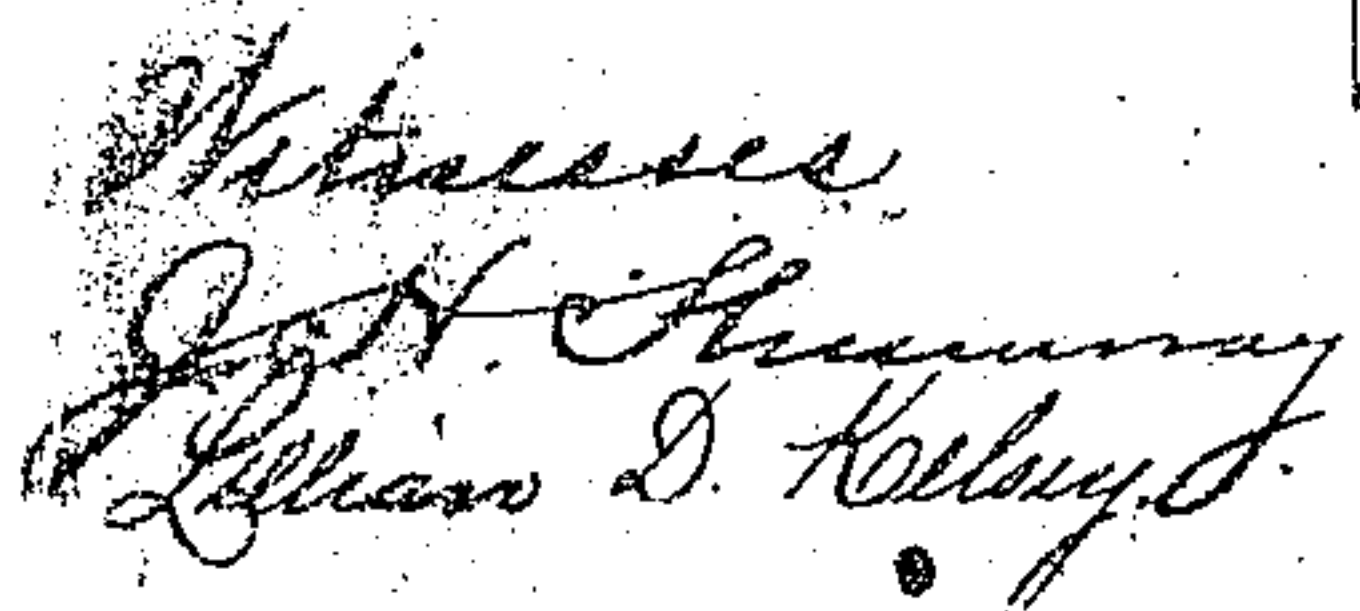
Patented Mar. 20, 1894.



11 Sheets—Sheet 3.

No. 516,722.

Patented Mar. 20, 1894.



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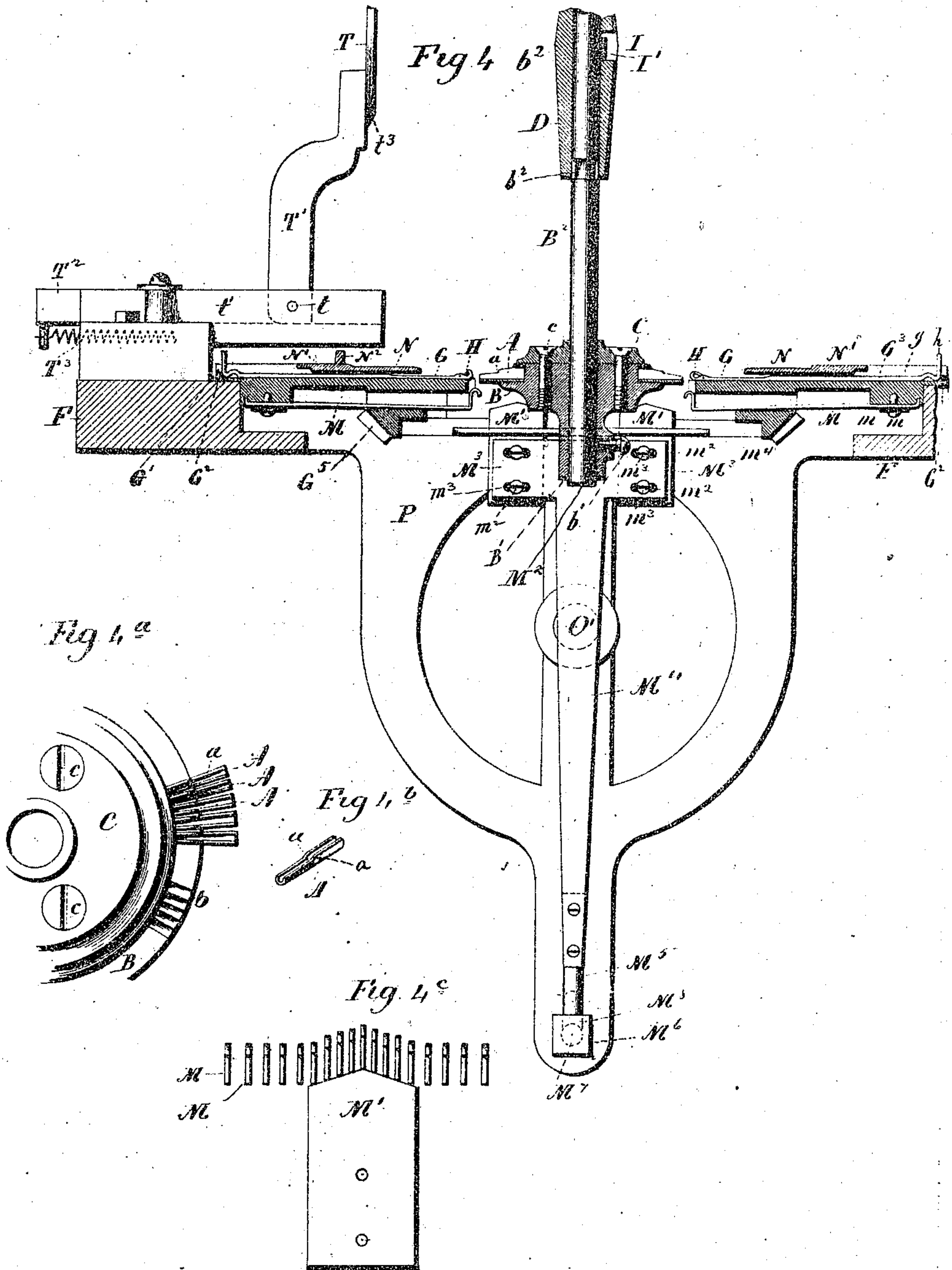
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J. D. HEMPHILL.
CIRCULAR KNITTING MACHINE.

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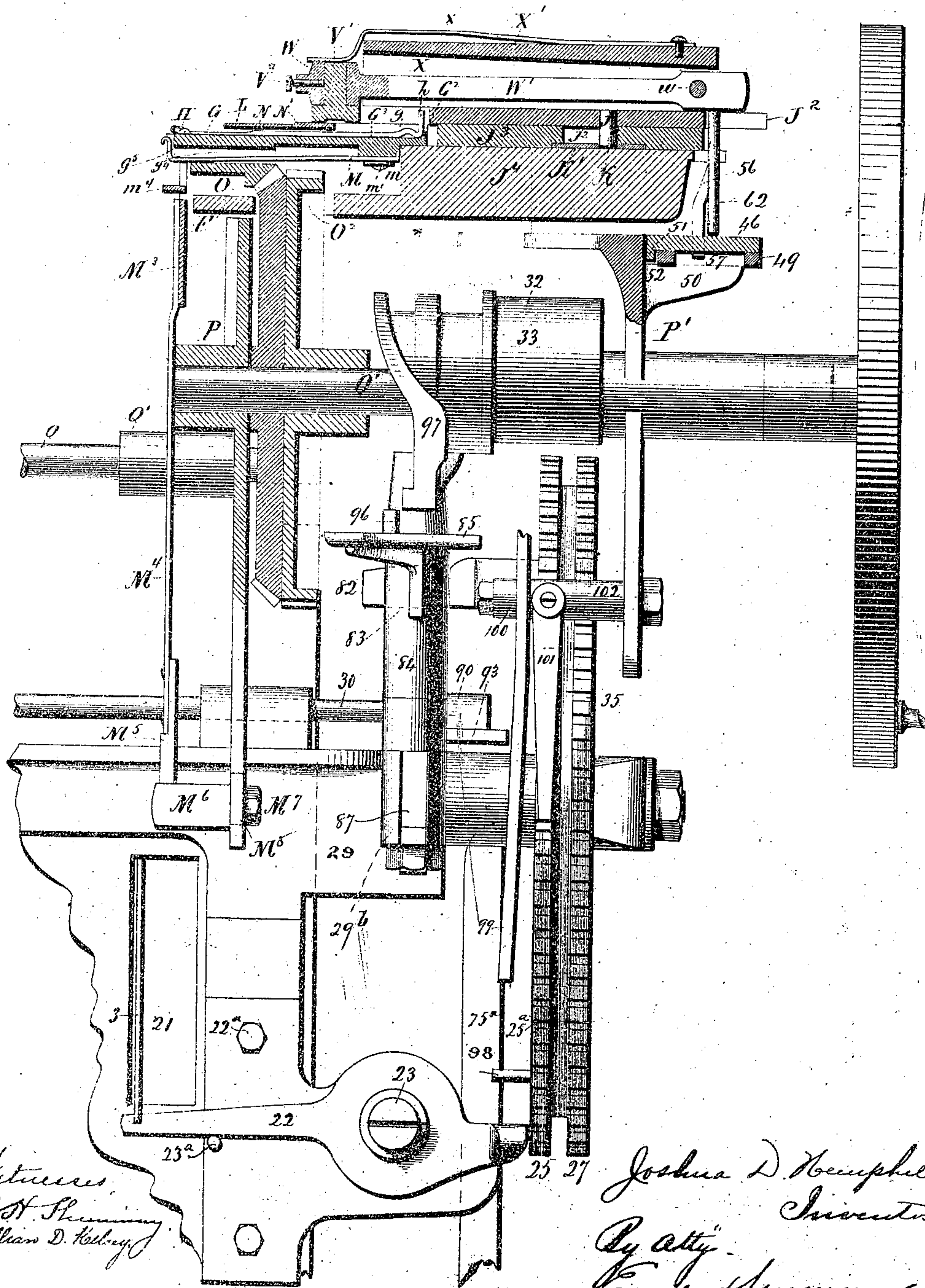
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J. D. HEMPILL.
CIRCULAR KNITTING MACHINE.

No. 516,722.

Patented Mar. 20, 1894.

Fig. 5



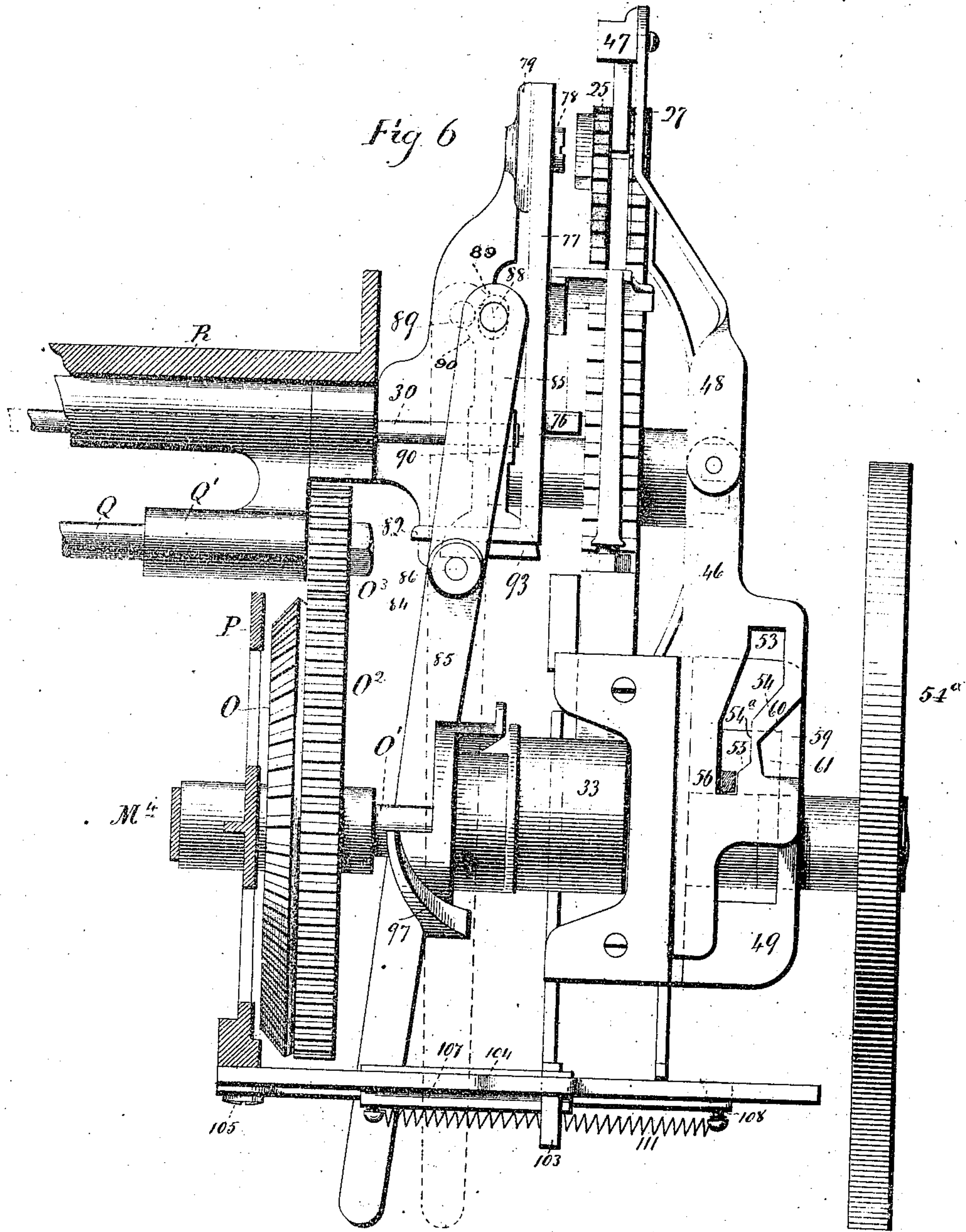
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J. D. HEMPILL.
CIRCULAR KNITTING MACHINE.

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11 Sheets—Sheet 7.

J. D. HEMPHILL.
CIRCULAR KNITTING MACHINE.

No. 516,722.

Patented Mar. 20, 1894.

Fig. 7

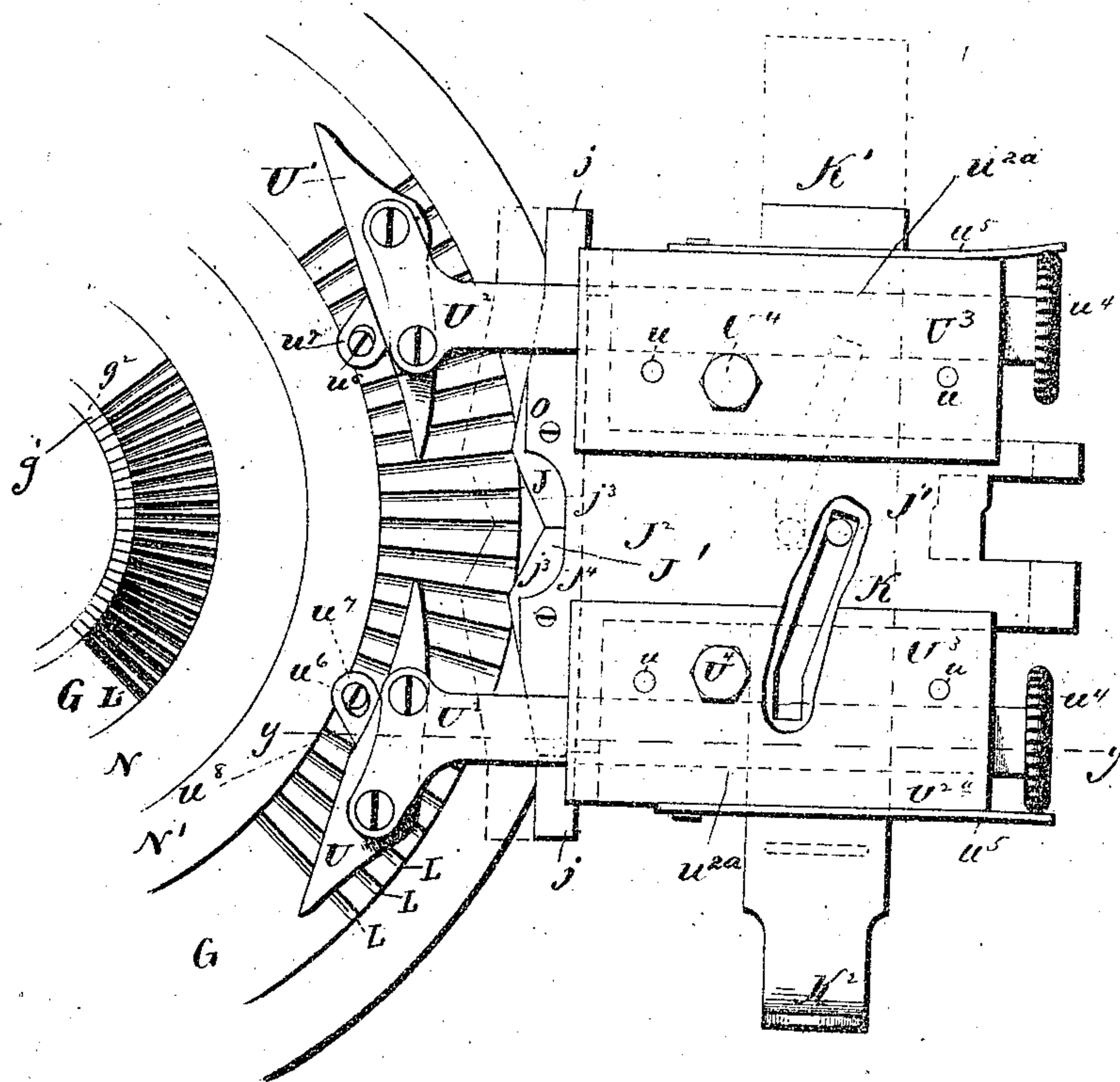
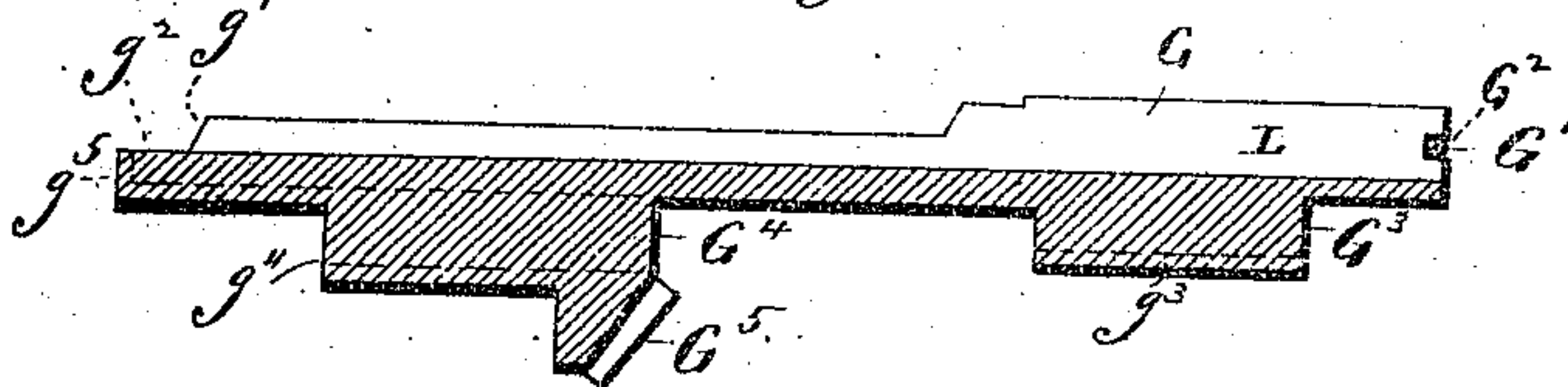


Fig. 7^a



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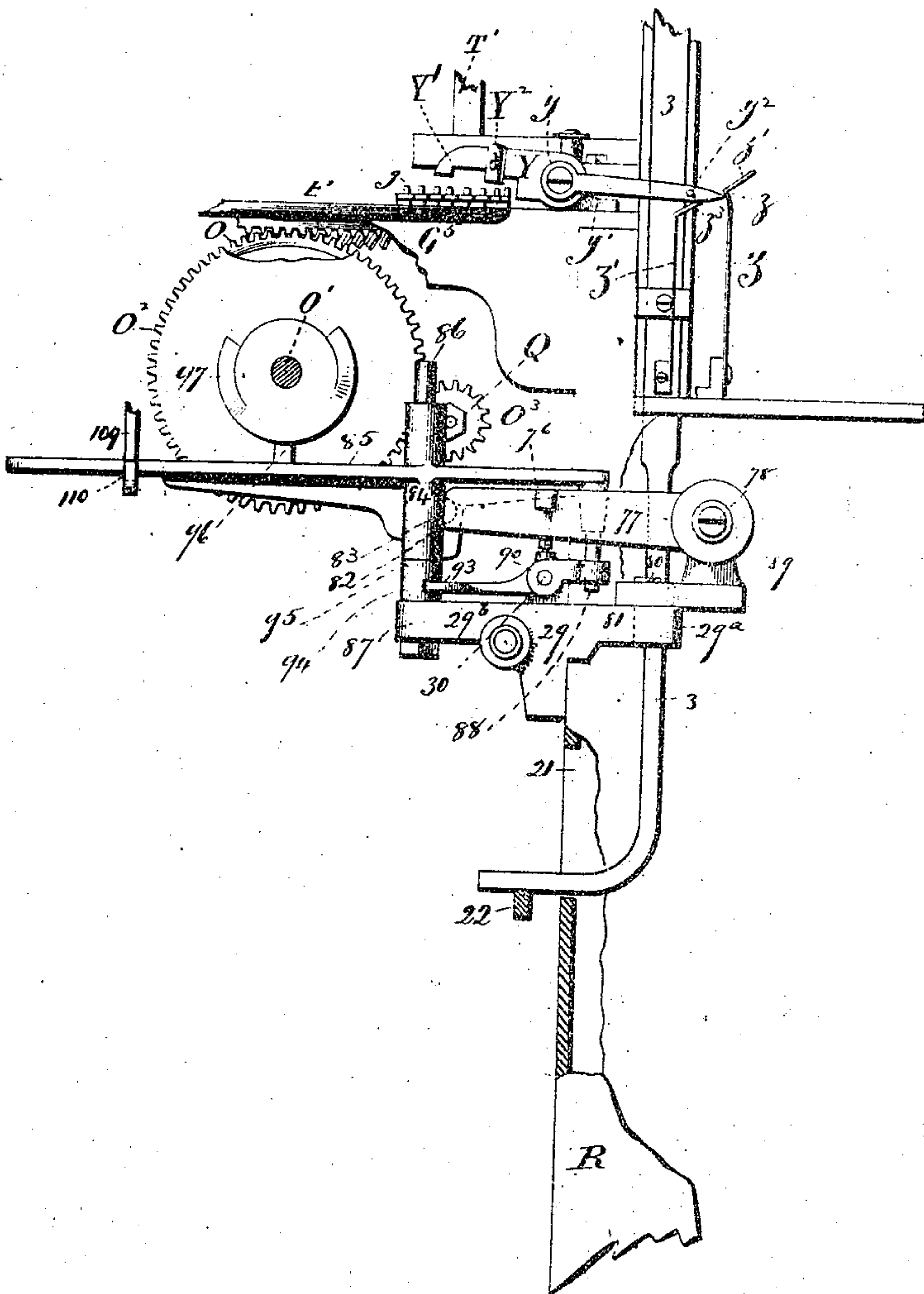
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J. D. HEMPHILL.
CIRCULAR KNITTING MACHINE.

No. 516,722.

Patented Mar. 20, 1894.

Fig 8



Witness
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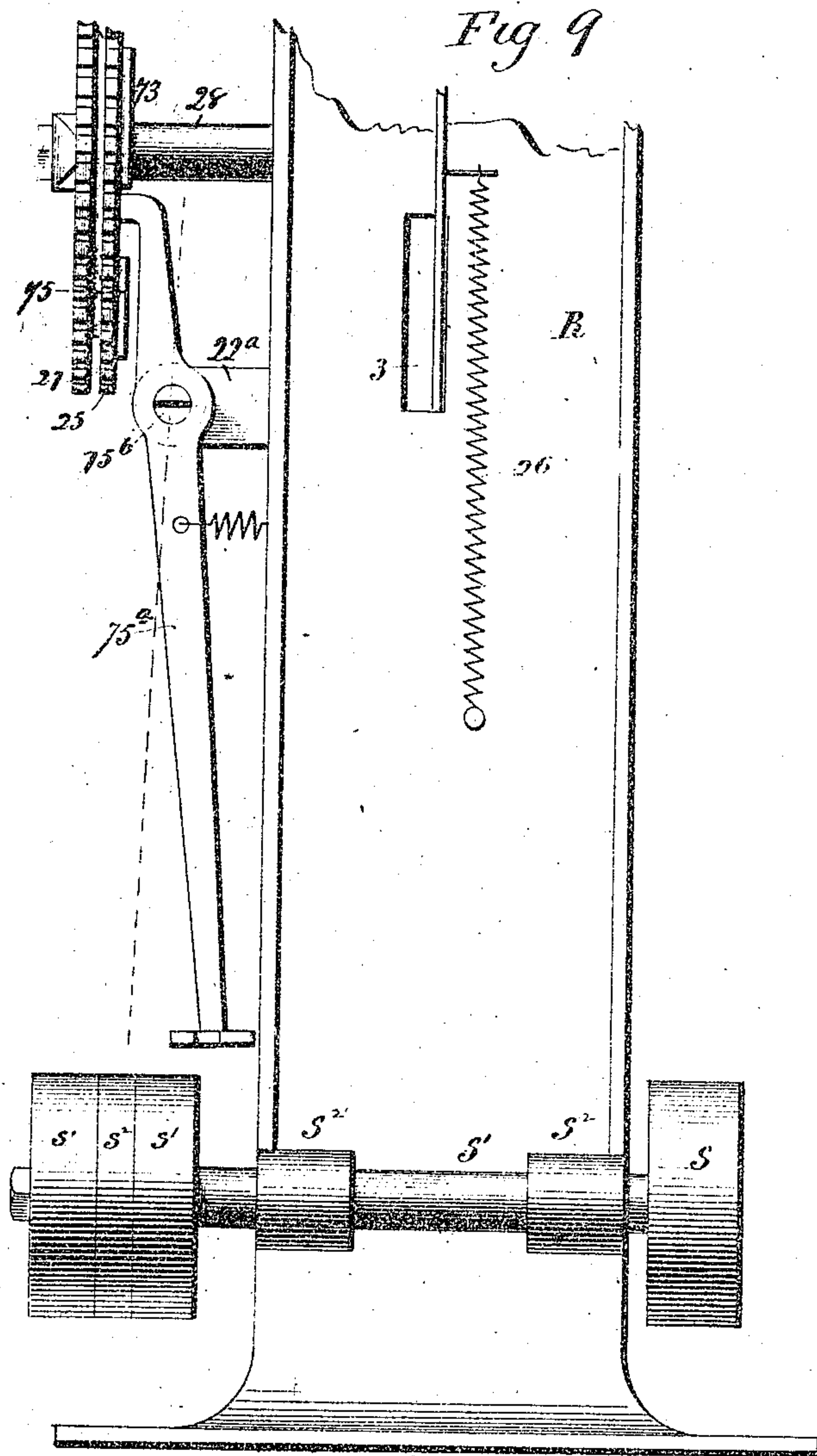
(No Model.)

11 Sheets—Sheet 9.

J. D. HEMPHILL.
CIRCULAR KNITTING MACHINE.

No. 516,722.

Patented Mar. 20, 1894.



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11 Sheets—Sheet 10.

J. D. HEMPHILL.
CIRCULAR KNITTING MACHINE.

No. 516,722.

Patented Mar. 20, 1894.

Fig. 10

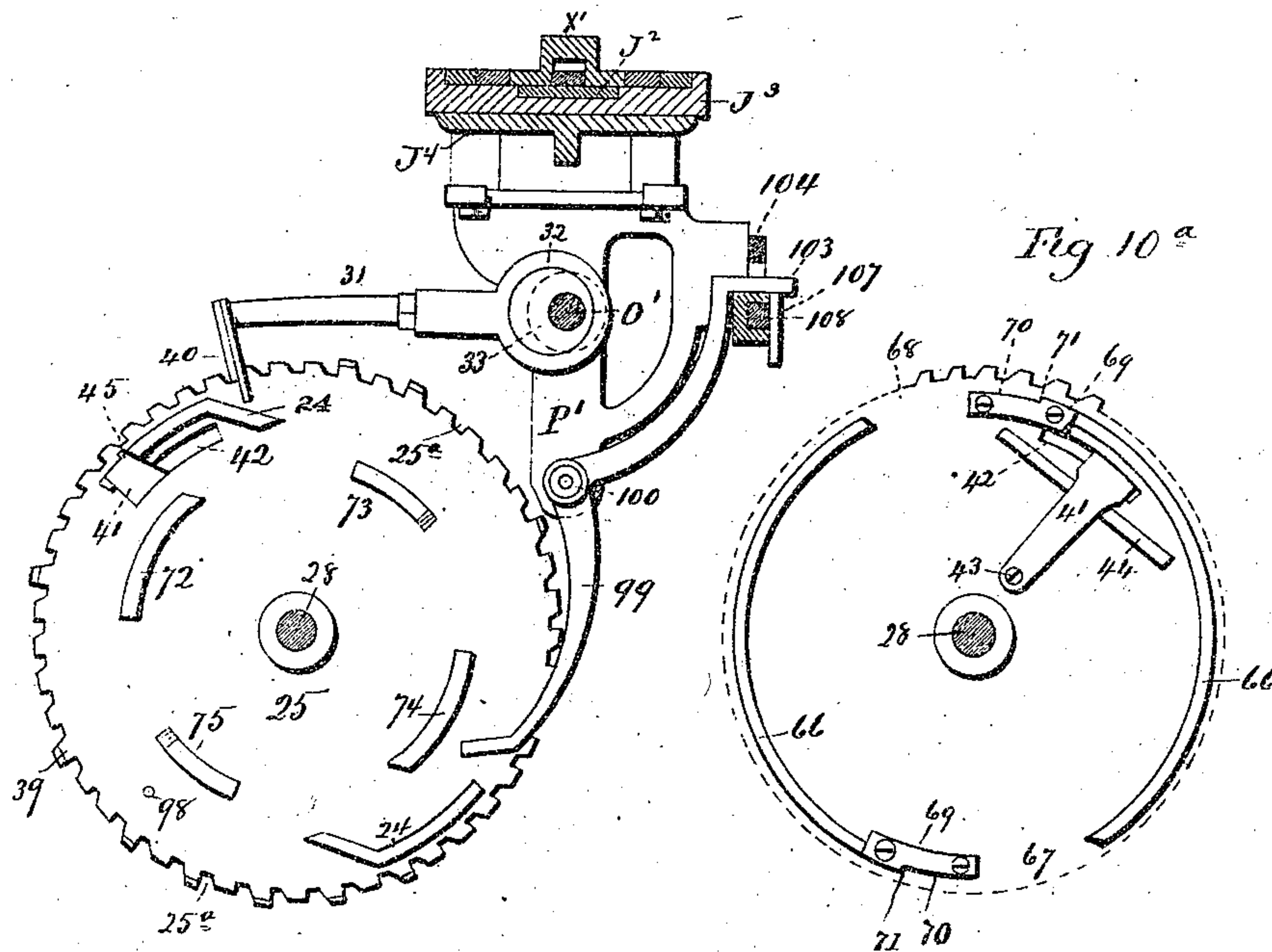


Fig 10^b

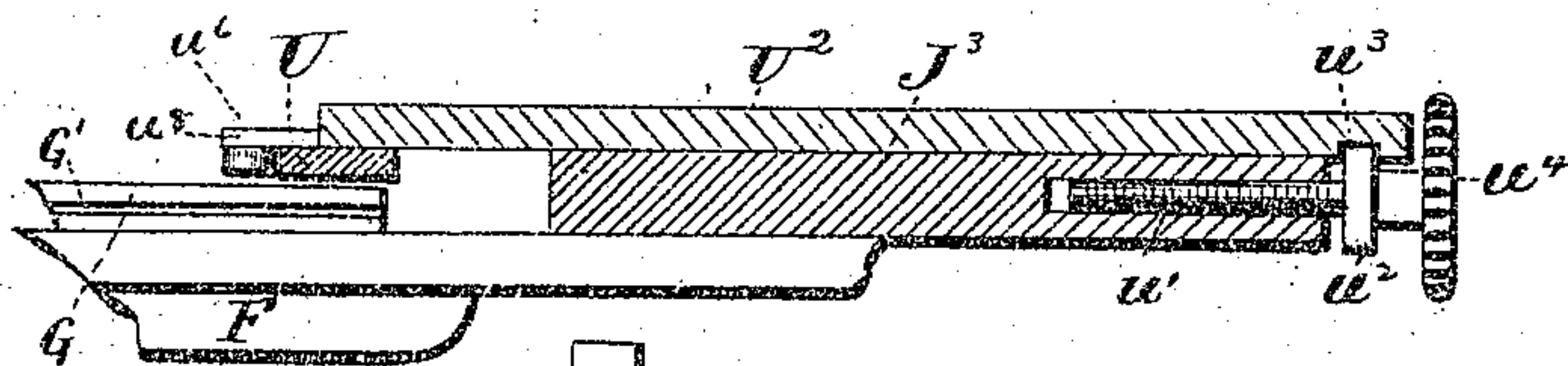
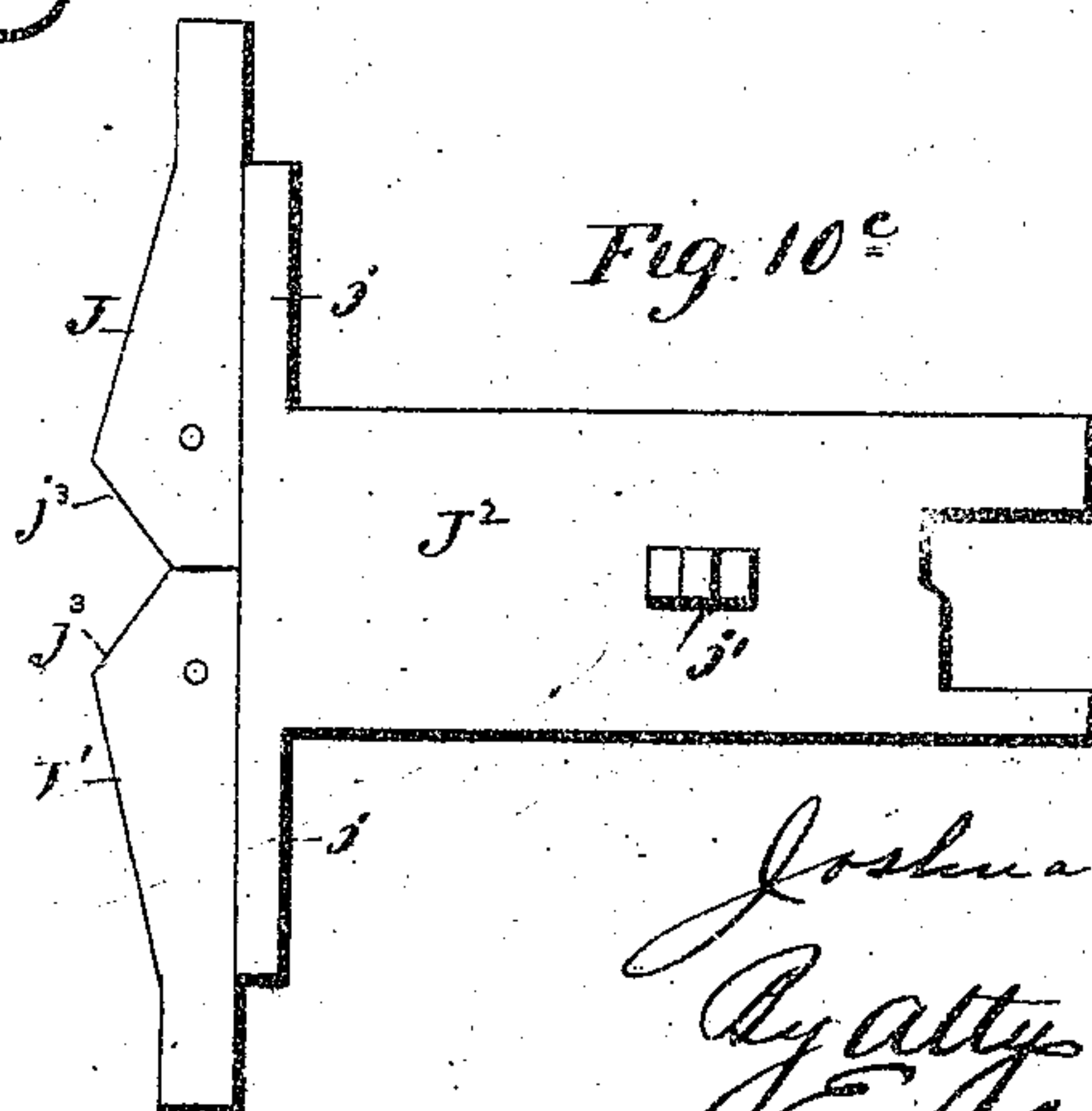


Fig 10^c



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11 Sheets—Sheet 11.

J. D. HEMPHILL.
CIRCULAR KNITTING MACHINE.

No. 516,722.

Patented Mar. 20, 1894.

Fig 11

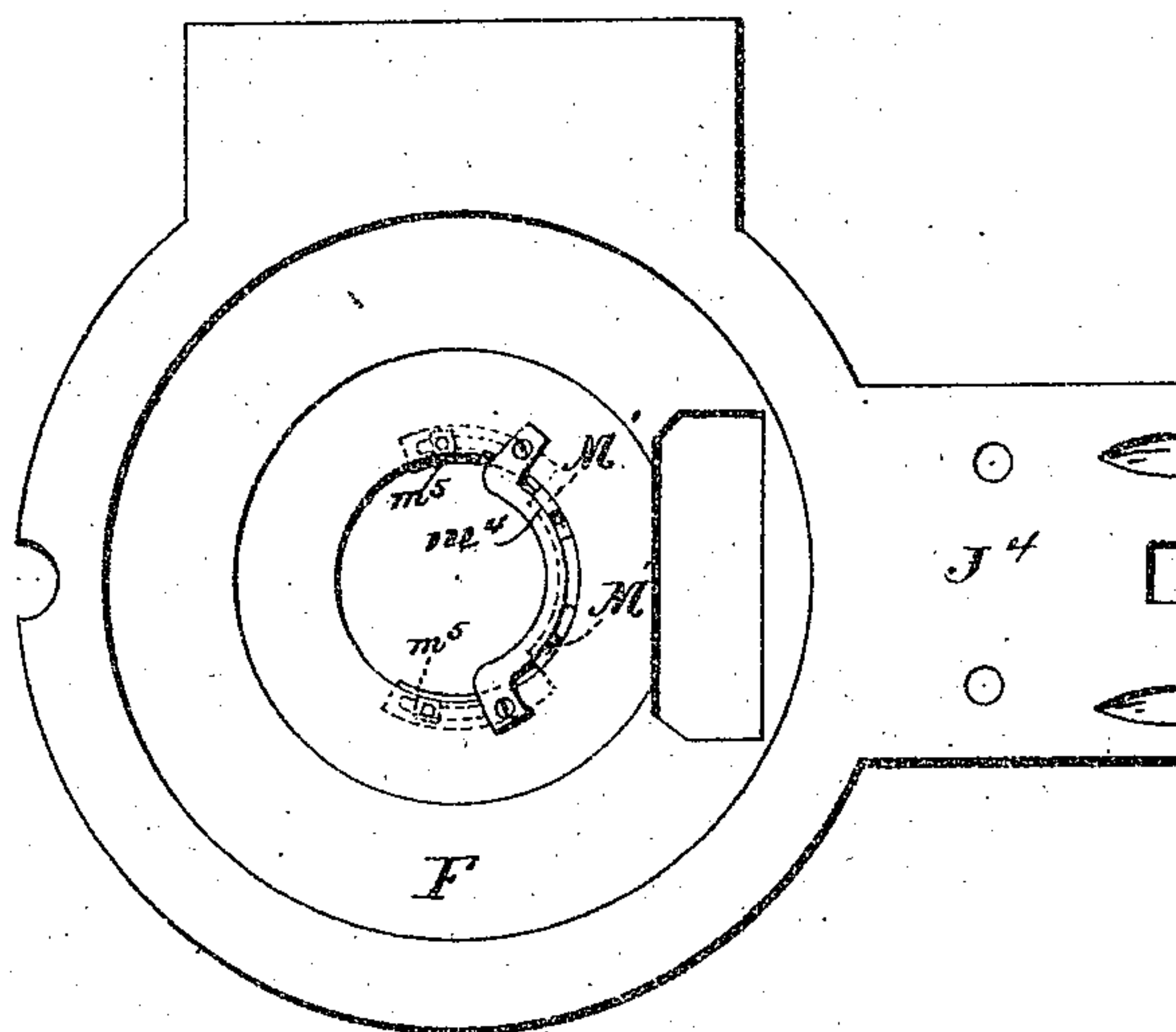


Fig. 11^b

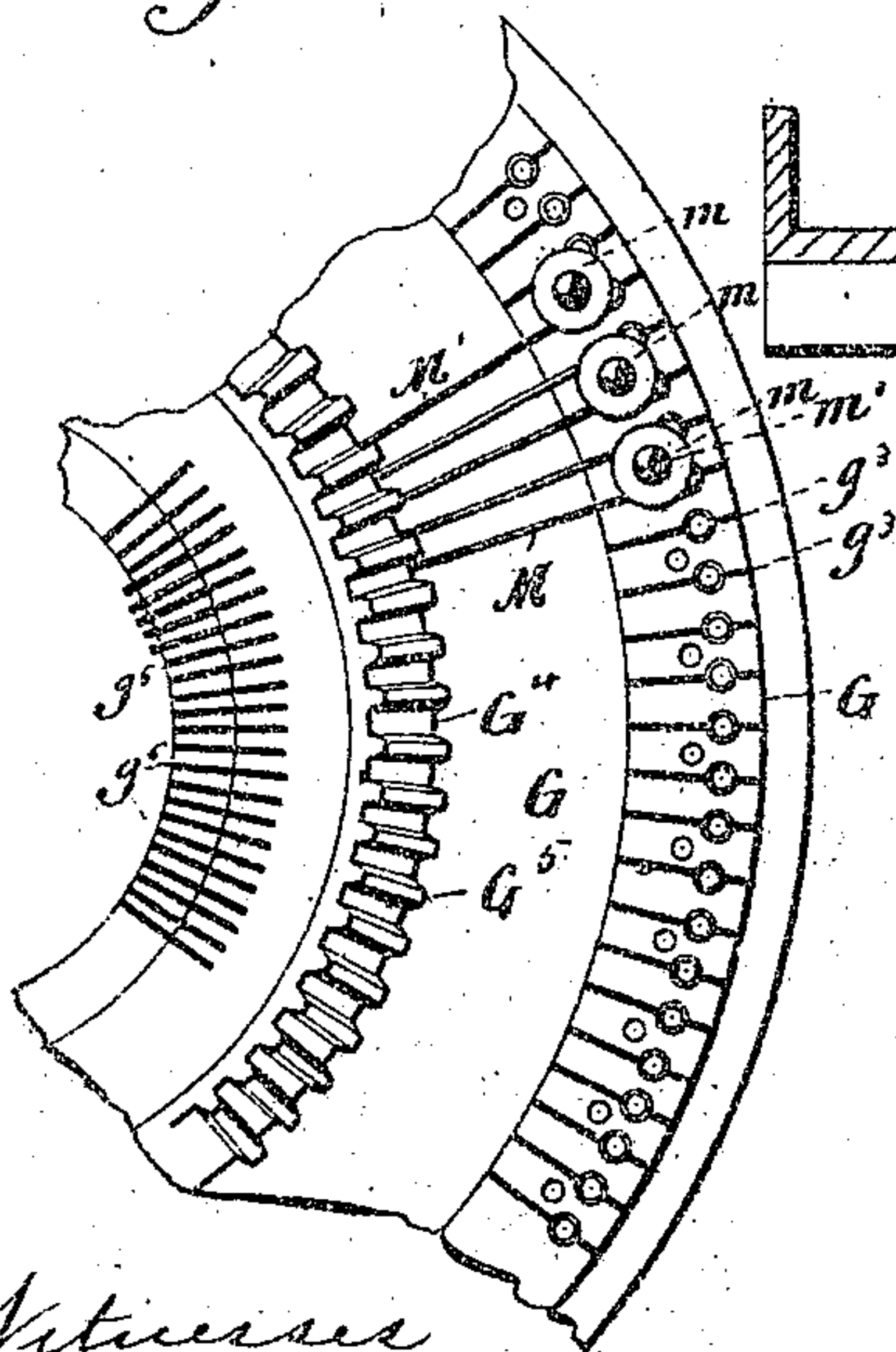
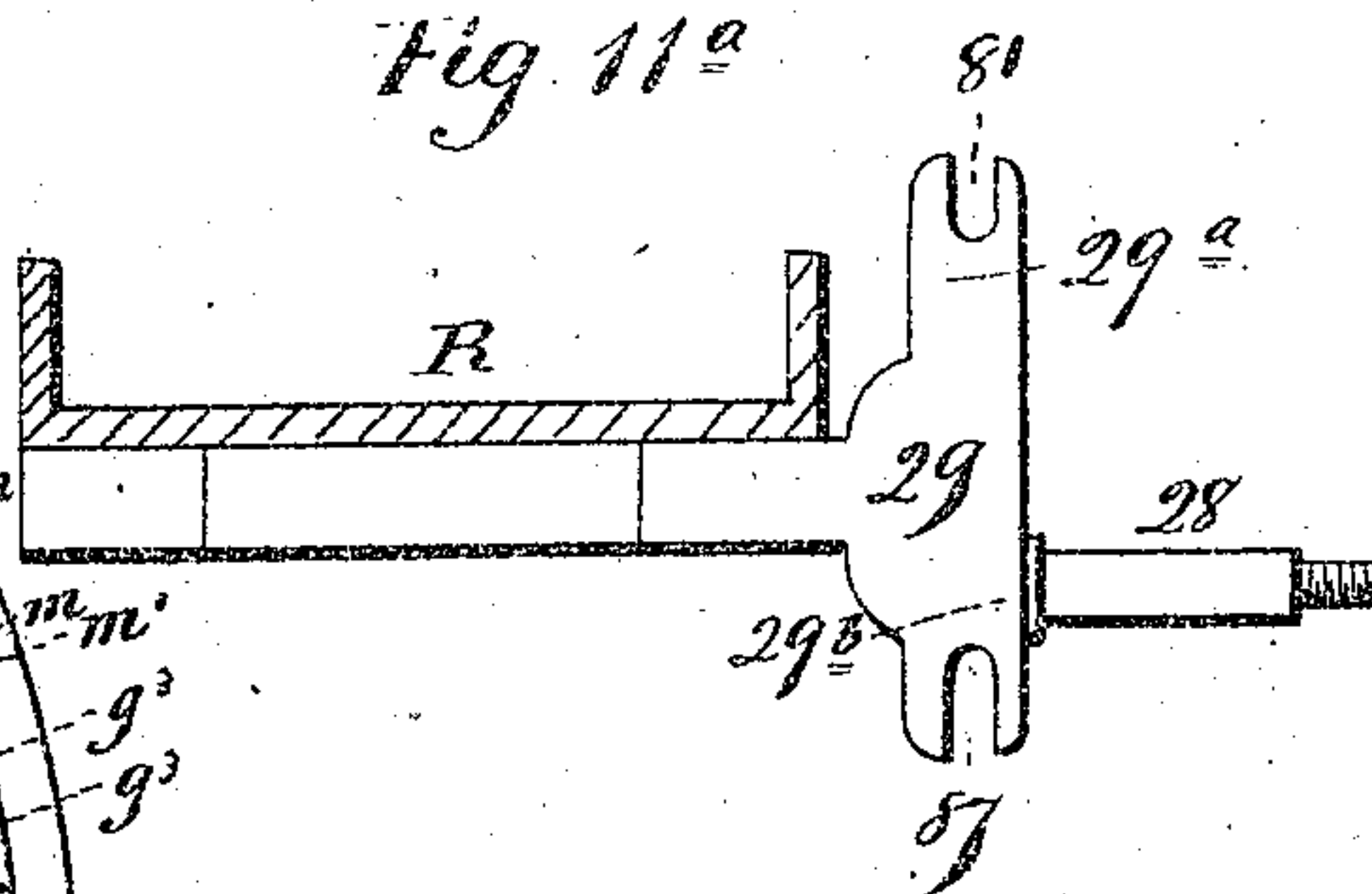


Fig. 11^a



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UNITED STATES PATENT OFFICE

JOSHUA DARLING HEMPHILL, OF HUNTINGTON, ASSIGNOR TO CHARLES B. ALING, OF DERBY, CONNECTICUT.

CIRCULAR-KNITTING MACHINE.

SPECIFICATION forming part of Letters Patent No. 516,722, dated March 20, 1894.

Application filed January 31, 1893. Serial No. 460,431. (No model.)

To all whom it may concern:

Be it known that I, JOSHUA DARLING HEMPHILL, of Huntington, in the county of Fairfield and State of Connecticut, have invented new
5 Improvements in Circular-Knitting Machines; and I do hereby declare the following, when taken in connection with accompanying drawings and the letters and figures of reference marked thereon, to be a full, clear, and exact
10 description of the same, and which said drawings constitute part of this specification, and represent, in—

Figure 1, a view in front elevation of an automatic machine constructed in accordance
15 with my invention; Fig. 2, a view thereof in side elevation looking toward the pattern-wheels of which the outer or secondary wheel is partly broken away; Fig. 2^a, a broken perspective view on a larger scale of the outer
20 end of the operating-pawl; Fig. 3, a plan view of the machine with the mechanism for delivering the yarn to the yarn-feed and for cutting in and cutting out the reinforce thread, broken away; Fig. 3^a, a detached reverse view
25 of the universal cam, its carrier, and the carriage in which the same is pivotally mounted; Fig. 3^b, a detached view of the universal cam in end elevation; Fig. 3^c, a similar side view thereof; Fig. 3^d, a detached plan view of the
30 ring N, which sets into the upper face of the dial and contains the semi-circular putting-up flange N'; Fig. 4, a view in vertical section on the line *a—b* of Fig. 3, looking in the direction of the arrow *c*, drawn on a larger scale
35 than said figure, and showing the transfer in place for transferring a cuff to the needles of the machine; Fig. 4^a, a broken plan view of the transfer; Fig. 4^b, an enlarged perspective view of one of the chutes of the transfer;
40 Fig. 4^c, a detached view in inside elevation of one of the sinker cams together with a series of sinkers to show how they are lifted in passing over it; Fig. 5, an enlarged view in vertical section on the line *e—e* of Fig. 2,
45 showing in particular the pattern mechanism of the machine; Fig. 6, a plan view on the same scale, of the same mechanism, with the universal draw and raise cams and the mountings thereof removed; Fig. 7, a plan view particularly designed to show the draw and raise
50 cams in their relations to the needle-dial, and

the mechanism for retiring the latter to facilitate the transfer of the cuff to the needles; Fig. 7^a, a detached view in vertical section, showing the outline of the needle-dial, and the
55 grooves formed in it to receive the sinkers; Fig. 8, a detached view in side elevation showing in particular the mechanism for oscillating the dial during the formation of the heel and toe of the stocking and the mechanism
60 for putting up the instep-needles; Fig. 9, a view in rear elevation showing the lower portion of the standard of the machine, and particularly the main belt-shifting lever and the spring which pulls down the slide operating
65 the putting-up lever, &c.; Fig. 10, a detached view in inside elevation showing the outer or exposed surface of the pattern-wheel; Fig. 10^a, a detached inside view of the said wheel;
70 Fig. 10^b, a view in vertical longitudinal section on the line *y—y* of Fig. 7, showing how the draw-cams are adjusted; Fig. 10^c, a detached reverse plan view of the raise-cam slide and the raise-cams; Fig. 11, a plan view of the dial bed stripped of everything but the
75 fender of the sinker-cams; Fig. 11^a, a detached plan view of the bracket which carries the pattern-wheels and supports the lifting and shifting levers. Fig. 11^b, is a detached broken reverse plan view of the dial,
80 with all but two or three of its sinkers removed.

My invention relates to automatic machines for knitting stockings, the object being to produce a machine having a large capacity for a
85 high grade of work, composed of few parts, so simply made and organized as to be readily accessible for adjustment and repair, and of superior convenience, particularly in respect of putting the cuffs or tops on the needles
90 preparatory to starting it.

With these ends in view, my invention consists in a knitting-machine having certain details of construction and combinations of parts as will be hereinafter described, and pointed
95 out in the claims.

I propose first to describe my improved transfer (Figs. 4, 4^a, and 4^b) by means of which the tops of the stockings which are knit in another machine, are transferred to the needles
100 of my machine, preparatory to starting the same.

I construct the transfer with a circular series of needle-chutes A, each made of a narrow strip of sheet-metal, bent longitudinally into U-form, the inner ends of the strips being wider than their outer ends, so that each completed chute, (Fig. 4^b) has two shoulders *a a*, located in the same transverse line, about midway the length of its upper edges. The chutes are arranged in shallow radial grooves *b*, formed in the edge of the upper surface of a circular head B, (Fig. 4^a) and held in place by a disk C, of smaller diameter than the said head, and attached thereto by screws *c*. A socket B', (Figs. 1, 2, and 4) centrally depending from the said head B, receives the lower end of a vertical rod B², from which the transfer is suspended, and to which it is secured by means of a set-screw *b'*, mounted in the said socket into which the rod passes through an opening in the center of the disk C. A long vertical sleeve D, (Figs. 1, 2 and 4) forms a bearing for the said rod, which is moved up and down in it in the manipulation of the transfer, the said rod being provided at its upper end with a knob or button B³, which not only serves as a handle, but also by engaging with the upper end of the said sleeve, prevents the rod from passing downward through the same. The said sleeve is located at the outer end of the horizontal portion of a pivotal transfer-arm D', the rear end of which extends downward at a right angle, and is provided with a shaft D², which passes through an upright tubular bearing E, having at its lower end an inwardly extending arm E', by means of which it is firmly bolted to the under face of one edge of the bed F, of the needle-dial G. A stop, (Figs. 1 and 3) secured by a set-screw *e*, to the projecting lower end of the shaft D², is constructed with two arms D³ D⁴, designed to engage with a nut *d*, or equivalent thereof for limiting the swinging movement of the transfer-arm, and hence of the transfer, the said nut being located so that it will be engaged by the stop-arm D⁴, when the transfer is exactly above the circular opening formed by the inner ends of the circular series of radially arranged knitting needles H, while, on the other hand, the nut is engaged by the stop-arm D³, when the transfer has been swung outward into a position convenient for the attendant to put a cuff or top onto it. The transfer is held in a normally elevated position by means of a stiff spring I, secured to the horizontal portion of the transfer-arm D', in a long groove *i*, (Fig. 3) formed therein, the vertical sleeve carried at the outer end of the said arm being transversely cut away as at I', (Fig. 4) to permit the said spring to ride upon the rod B², so as to enter a circular groove *b*², formed therein, when the rod is in its raised position, as shown by Fig. 1 of the drawings. The transfer is supported in convenient position by the said spring for the application of a cuff to it, being at this time swung outward and steadied by the engagement of the stop-arm D³, of the stop with the

nut *d*, as aforesaid. Then when the cuff has been applied, it is swung inward over the circular opening formed by the inner ends of the needles H, and the spring I, sprung out of the groove *b*² in the rod B², to permit the transfer to be lowered into the said opening, at which time it passes sufficiently below the needles H, to permit them to be entered into its chutes A. The adaptation of the machine to have the transfer let down past the needles, as described, forms another part of my invention, which will be set forth later on. By attaching the transfer permanently to a swinging arm connected with the machine, the attendant is enabled to apply cuffs to it more conveniently, and hence more rapidly than could be done as transfers have been used heretofore.

The adaptation of the machine to have the transfer let down below all of its needles, consists in making the raise-cams J J' radially movable, so that the same may be temporarily retired to permit those needles which are ordinarily projected into the circle formed by the inner ends of the needles, to be "put down" or moved back into line with the other needles, whereby clearance is made for the transfer to be let down below the needles, after which the cams are moved inward into intermediate positions, so that they may do their work of projecting the needles into the chutes of the transfer, whereby the stitches of the cuff are transferred from the chutes to the needles. Then after that has been done, the cams are moved outward again, and the needles projected inward at the time, put down again, to permit the transfer to be removed. Then after the transfer has been removed, the cams are again moved inward into operative position, before the knitting is begun. In this way I simplify the transference of the cuffs or tops from the transfer to the needles, and keep them in view during the entire operation, for heretofore, the transfer has been held in an inverted position just above the needles, that mode of operation being necessary, because the needles projected by the raise-cams, which have heretofore been immovable, have prevented the transfer from being passed below them. Under the old method the transfer obscured the needles, as has been mentioned, so that the attendant could not watch the operation of transference, and pick up stitches that might be dropped. The objections to the old way, which I have referred to, are avoided by my invention under which the cuff or top is transferred in full sight of the attendant, who, when the operation is completed, has simply to retire the raise-cams, lift the transfer above the needles, swing it to one side out of the way, restore the raise-cams to operative position again, and start the machine. As herein shown, the said raise-cams J J', which are counterparts of each other, and made of steel are secured by screws in recesses formed in the under faces of transverse extensions *j j* formed in the in-

ner end of a raise-cam slide J^2 , which fits into a guideway formed to receive it in the center of what I term a cam-box, or housing J^3 , which is secured to a table J^4 , offsetting from the bed F , of the needle-dial G . The said slide is provided with a depending stud j' , which passes through an elongated slot j^3 , formed in the bottom of the box J^3 parallel with the length of the said slide, and enters a cam-slot K , extending at about a right angle to the slot j^3 , and formed in an operating-slide K' , mounted in the said box, so as to extend transversely under the cam, and having one of its ends turned up as at K^2 , for convenience in operating it. By means of this operating-slide, the cam-slide and hence the cams, are moved inward as shown by broken lines in Fig. 7 to cause the needles to move inward, and take the yarn, and are only moved outward as shown in full lines in said figure and thus retired when it is desired to transfer a cuff to the needles. The said broken lines show the normal or knitting positions of the said cams.

The needle-dial G , before mentioned, is constructed with a circular series of radial grooves L , formed in its upper face, and extending from its outer edge through a raised shoulder, located close to its inner edge. These grooves receive the needles II , all of which are of the same length, and constructed at their outer ends with upwardly turned butts h . The outer edge of the dial is provided with an annular groove G' , (Fig. 7^a) in which, as herein shown, a cord G^2 , (Fig. 4) is placed, for holding the needles against outward displacement under the action of centrifugal force. When, however, it is desired to remove a needle, that may be readily done by seizing its butt and drawing it outward against the cord, which will spring out of the way, and allow the needle to pass over it. The inner ends of the needles rest upon the depressed annular seat g^2 , formed within the shoulder g' , as shown by Figs. 7 and 7^a. The lower face of the dial (Fig. 7^a and 11^b) is constructed with concentric ribs G^3 G^4 , the latter having a bevel gear G^5 formed upon it. The rib G^3 has a circular series of radially arranged grooves g^3 , formed in it, and the rib G^4 a corresponding series of aligned grooves g^4 , which extend above the bevel gear aforesaid. The inner ends of the grooves g^4 merge in a corresponding series of vertically arranged grooves g^5 , formed in the inner edge of the dial. The said grooves g^3 , g^4 and g^5 located in the lower face of the dial, are alternated with the grooves L , formed in the upper faces thereof, and receive the sinkers M , which are secured in place by washers m , applied over the grooves g^3 in the rib G^3 , and held in place by screws m' entering the dial between the said grooves g^3 . Each washer holds two sinkers in place. The inner ends of these sinkers, which are bent upward at a right angle, and then turned inward to form hooks, play up and down in

the vertical grooves g^5 formed in the inner edge of the dial.

By grooving the under face of the dial as described, I am enabled to employ long spring sinkers which are not only cheap, but highly effective. Furthermore, a dial made as described, is so thin that the hand may easily be reached up under it to manipulate the fabric, or sinkers, or needles, or perform other offices which the running of such a machine often demands.

The sinkers M are actuated in the upward movement by means of laterally adjustable sinker-cams M' M' (Figs. 4 and 4^e) having wedge-shaped upper ends which form operating-faces with which the sinkers are engaged, as the dial G , rotates, at points just within their upwardly bent inner ends. As the sinkers ride up over the cams, they are lifted, returning to place again by their own resilience as soon as they are carried off the cams. The said cams are secured each by two screws m^2 , to the opposite edges M^3 , of a vertically adjustable bowed cam-plate M^2 , the said edges being thereto constructed with laterally elongated slots m^3 , through which the said screws pass, and which permit the cams to be laterally adjusted. The said cam-plate has a long downward extension M^4 , terminating at its lower end in a short rod M^5 , which is seated in a block M^6 , carried by a bolt M^7 , (see also Figs. 1 and 5) which is vertically adjustable in a vertical slot M^8 , formed in the lower end of a hanger P , depending from the dial-bed F . The cams and upper end of the said cam-plate are held in place against lateral movement by the confinement of the cams between that portion of the wall of the central circular opening in the dial-bed F , which is adjacent to them, and a fender m^4 (Fig. 11) segmental in form, and secured to the dial-bed F in position to engage with the inner faces of the cams. The edgewise movement of the said cams and plate is prevented by two adjustable segmental blocks m^5 m^5 , secured to the under face of the dial-bed F , in position to engage with the outer edges of the respective cams.

The construction above described provides, as it will be noted, for the vertical and lateral adjustment of the sinker-cams, the provision for their lateral adjustment being two-fold, viz: by moving the plate to which they are secured, and by moving them upon the said plate. The said sinker-cams are employed by me for relieving the strain on the stitches while the needles carrying the same are passing outside of the draw-cams on their way to the raise-cams, which move them inward to cast the said stitches back over their latches, for instead of employing switch-cams to cause the needles to pass inside of the draw-cam, which is not knitting, and thus avoid straining the stitches on the needles, I invariably pass the needles on the outside of the said draw-cam, and by means of the sinker-cam not knit-

ting, allow all the stitches themselves to rise enough to make up for the outward movement of the needles as they pass on the outside of the draw-cam. Thus when the machine is doing straight work, and the dial working, the rear sinker-cam will raise the sinkers to assist in forming the stitches which are drawn through the old stitches by the rear draw-cam. At this same time, the forward sinker-cam will raise the sinkers to let the stitches on the needles lift enough to permit the needles to pass on the outside of the forward draw-cam without straining the stitches. When, on the other hand, the machine is doing heel and toe work, and the dial oscillating, the sinker-cams will operate to relieve the stitches which they themselves formed. Thus, supposing the dial is moving from left to right, then the rear sinker-cam and the rear draw-cam will assist in forming stitches. Then when the dial swings back, the needles carrying those same stitches will be obliged to pass on the outside of the same rear draw-cam, the same sinker-cam operating at this time to lift the stitches so as to permit the needles to be moved outward by the said draw-cam without straining the stitches. At the same time that the dial is swinging back from right to left, and while the rear sinker-cam is operating as described to prevent the stitches just formed from being strained, the forward draw-cam and the forward sinker-cam are assisting in the formation of new stitches. Now as the dial swings back again, from left to right, the forward sinker-cam will permit the stitches to lift, so that they will not be strained, while the needles are passing on the outside of the forward draw-cam, and so on.

By employing two sinker-cams as described, I am enabled to employ fixed draw-cams, and to dispense with the switch-cams generally used to prevent the needles from straining the stitches, whereby I greatly simplify the construction and operation of my machine.

A detachable ring or annulus N (Figs. 3, 4, 5, and 3^d) set into the upper face of the dial, is constructed with an upwardly extending semi-circular flange N', which on account of its function, I shall hereinafter speak of as the "putting-up" flange. This flange is provided at one end with an elevated step N² the function of which will be described at another time. The said dial is actuated in rotary and oscillatory movement by means of a bevel-gear O, (Figs. 1, 5, 6, and 8,) meshing into its bevel teeth G⁵, and mounted on a horizontal driven shaft O' the opposite ends whereof have bearings in hangers P and P' respectively depending from the dial-bed F, and the arm or table J¹ offsetting therefrom. A gear-wheel O², mounted on the said shaft, and placed directly against the bevel gear wheel O, meshes into a pinion O³, (Figs. 6 and 2) mounted on the inner end of a horizontal driven shaft Q, supported in bearings formed at the opposite ends of a bracket Q', (Fig. 1) bolted to the front of the upright

standard R, of the machine. The opposite end of the said shaft Q, is provided with two loose pulleys q q', and a fixed pulley q² located between the same. These pulleys receive two oppositely running (one being twisted) driven belts, which are not shown, but which run over a driving pulley S, located at the outer end of the horizontal driving-shaft S', mounted in bearings S² S², (Fig. 9) secured to the back of the said standard R, near the base thereof, and provided at its opposite end with two loose pulleys s s', and a fixed pulley s², located between the same, the said pulleys s, s' and s², receiving a fast driving-belt, which is shifted back and forth between the loose pulley s, and the fixed pulley s², and a slow driving belt, which is shifted between the loose pulley s', and the said fixed pulley s², both of the said belts being driven from any convenient source of power, and both being connected with and shifted by the lower end of the belt-shifting lever 75^a, which thereto is constructed with a double fork. The said lever 75^a is hung upon a horizontal stud 75^b, projecting rearwardly from the bracket 22^a, which also carries the lever 22 as before set forth, the upper end being arranged to engage with the lugs 73 and 75 of the primary pattern-wheel 25. The said fast and slow driving belts form the main driving belts of the machine, and their respective functions are to drive the machine rapidly when the dial is rotating for doing straight work, and to drive it slowly when the dial is oscillating for doing the heel and toe work, all as will appear later on.

The yarn is fed to the needles by means of an annular yarn feed T, (Figs. 1, 2, 3 and 4) rigidly secured to the lower face of the inner end of a pivotal curved arm T', the curved outer end of which is hung on a horizontal pin t, mounted in a box t', bolted to the top of the standard R, and extending at its inner end over the dial. The rear end of this box is occupied by a plunger T², the inner end of which abuts against the curved outer end of the said pivotal arm T', the said plunger being constantly urged against the said end of the arm by means of a spring T³, (Fig. 4,) whereby the feed is maintained in its normal horizontal position, or in its retired vertical position. By making the feed annular in form, it is easily manipulated, as the attendant can put a finger into it and lift it up, and in the same way draw it down into place. Its outer edge is beveled, as at t³, and constructed on one side with a beveled wedge-shaped offset t⁴, containing an eye t⁵, through which the yarn passes, the said offset being in line, when the yarn-feed is in its normal or operating position, with the universal cam V, yet to be described.

By beveling the edge of the yarn-feed, the yarn that is not knit up when the machine is on heel and toe work, rides up the said beveled edge, so that it is readily taken up by the take-up, whereby I avoid the snarling of

the slack yarn in the latches of the needles, and insure its being taken up. Furthermore by beveling the edge of the yarn-feed I avoid the breakage of needles, for if their latches did not have that clearance, they would sometimes engage with the edge of the feed and break.

The draw-cams $U U'$ (Figs. 3 and 7) of the machine are located on opposite sides of the raise-cams $J J'$, and the universal cam V , and secured to the lower faces of the inner ends of flat draw-cam slides $U^2 U^2$, by means of which they are supported in fixed positions over the edge of the upper face of the dial in the paths of the butts of the needles II , the said slides being located in guide-ways U^2 , formed for them in the cam-box J^3 before mentioned, which is supported upon the table J^4 , offsetting from the dial-bed F . Plates or covers $U^3 U^3$ applied to the ends of the box over the said guide-ways, confine the slides $U^2 U^2$ therein, the said plates being respectively secured in position by bolts $U^4 U^4$, and two pins $u u$ located on opposite sides of each bolt. The draw-cams are readily adjusted with reference to their exterior over the needle-dial, for regulating the tension of the mesh of the fabric being knitted, by means of set-screws $u' u'$, (Fig. 10^b) extending parallel with the slides $U^2 U^2$, and respectively entered into the opposite end of the box J^3 from the outer edge thereof, each of the said set-screws being provided with a collar u^2 , which takes into a transverse groove u^3 , formed in the under face of the outer end of the slide above it, whereby the slide is coupled to the screw, and will move back and forth with the same. The outer end of each screw is furnished with a notched wheel u^4 , the notches whereof receive a spring u^5 , whereby the screw, and hence the slide, are fixed in position. It will be clear that by turning the screws, the slides may be moved so as to change the positions of the draw-cams with respect to their extension over the needle-dial, which moves under them. Each of the draw-cams $U U'$, is furnished with a guard u^6 , (Figs. 3, 7 and 10^b) consisting of a button adjustably attached by a screw u^7 to a small finger u^8 , extending inward from the inner edge of the cam, the function of the said guards being to put down any needles that may be thrown too far inward, into position to be engaged by the faces $v^2 v^3$ of the universal cam which puts them down into the knitting path.

A cam V , (Figs. 3, 3^a, 3^b, 3^c and 5) which, from the work it performs of putting-up and putting-down the needles, I shall call the universal cam, is located between the draw-cams and centrally above the raise-cams, projecting inward beyond the same. The inner edges of the said raise-cams (Figs. 7 and 10^c) are cut away as at $j^3 j^3$ to give clearance to the said universal cam when the same is drawn outward, the raise-cam slide J^2 , being also cut away as at j^4 , for the same purpose. This universal cam V , has the inner edge of

its lower face cut away as at $v v'$, to form downwardly inclined converging run-ways for the butts of the needles, and its corresponding outer edge correspondingly cut away, to form downwardly inclined converging run-ways $v^2 v^3$, whereby its lower face is given a convex diamond shape or what may be so described. The cam is provided in the center of its upper face, with a short shank V' , (Figs. 3^b and 3^c) by means of which it is held in place by a set-screw V^2 , in a vertical socket formed to receive the said shank, in a head W , of a bar W' hung at the outer end on a horizontal pivot w , within the chamber X , of the sliding carriage X' , which is moved back and forth in the cam-box J^3 , in which it is located between the draw-cam slides, and over the raise-cam slide J^2 . A horizontal sheet-metal spring x , secured at its outer end to the outer end of the said carriage, extends inward, and is bent downward at its inner end, to engage, (Fig. 5) with the upper end of the head W , of the pivotal bar W' , whereby the said cam V , is steadied, and prevented from jumping upward under the impingement of the butts of the needles against it. The mechanism for sliding the carriage X' back and forth, and for raising and lowering the cam V , will be described later on. The universal cam V , just described, performs the work of putting up and putting down the needles, one at a time, operating upon them, as it might be said, individually. The work of collectively putting-up the needles preparatory to heel and toe work, is done by the putting-up flange N' , and its elevated step N^2 , (Figs. 3 and 3^a) before referred to, in combination with a pivotal spring-actuated putting-up lever Y , (Figs. 1, 2, 3 and 8) located at the back of the machine, and extending forward over the dial, the said lever being provided at its inner end with a finger Y' , which co-operates with the said flange N' and step N^2 , and with a putting-up cam Y^2 , which extends downward into the path of the needles to which it is inclined at an angle, and which consists in fact of a plate of hardened metal. The said lever is mounted to rock on a horizontal screw-stud y , entered into a bracket y' , screwed to the upper end of the standard R of the machine. The outer end of this lever is tapering in form, and has its upper and lower faces slightly beveled for co-operation with the upper end of a stiff spring Z , which is thereto shaped to form the retaining shoulder z , and the inclined operating-face z' . The said outer end of the lever is also provided with an inwardly projecting, horizontal tripping-pin y^2 , which co-acts with a tripping spring Z' , arranged parallel with the spring Z , and having its upper end constructed with a clearance notch z^2 , Fig. 3, and an inclined operating face z^3 .

The means employed for supplying yarn to the yarn-feed T , before described, will not be set forth in detail, further than is necessary to the description of the devices used to feed

and cut off the reinforce-thread, which is woven into the heels and toes of the stockings, for strengthening them. Thereto, I employ a horizontal chute 2, (Fig. 2) having a deep longitudinal groove formed in and extending throughout the length of its upper face, and fixed to the upper end of a slide 3, mounted for vertical reciprocation in a groove formed in one face of an upright 4, of a frame-piece, which also comprises a horizontal cross-piece 5, the lower end of the said upright being bolted to the upper end of the standard R, of the machine. The end of the reinforce or splicing thread normally lies in the deep groove of the chute 2, which is lifted by the upward movement of the slide 3, so that the said end of the thread is lifted into frictional contact with the yarn being fed from the bobbins 6 and 7, into the main chute 8, which is pivotally attached to the forward end of the cross-piece 5. The threads from the bobbins 6 and 7 being thus engaged by the reinforce thread, pick the same up and thenceforth feed it to the knitting-needles until the said chute 2 descends and the thread is cut off by a cutting-off arm 9, arranged to swing over the descending chute, and jam or cut off the reinforce thread on the cutting-off block 10, which is secured to the arm 5, and consists of a short cylinder of steel. The said arm 9, is actuated in cutting off the reinforce-thread in the manner described, by means of a pin 11, carried by the slide 3, and engaging, when the same is drawn down into its retired position, with a finger 12, formed at the lower end of the said arm 9, which is hung on a horizontal screw stud 13, entering an offsetting lug of the upright 4. A spring 14, connected with the lower end of the said arm, operates to move it into position for operation, to the right of the secondary chute 2, just as soon as the slide 3, lifts the same into the same plane with the chute 8, for at other times the said arm 9, is held in its retired position, in which it is shown by Fig. 2 of the drawings, by the engagement of the pin 11 with the finger 12. It will be observed that the chute 2 carrying the reinforce thread is depressed and the said thread disengaged from the yarn supplied by the bobbins 6 and 7, simultaneously with the action of the cutting-off arm 9, which cuts off the said thread, leaving its end in the chute so that when the same is elevated again the reinforce thread will be again lifted into frictional contact with the threads supplied by the bobbins 6 and 7. The cross-piece 5 is provided with a friction-disk 15, a tension-rod 16, controlled by a spring 17, a bushing 18, to receive the yarn from the bobbins 6 and 7, and a bushing 19, to receive the reinforce thread from the bobbin 20, all of the said parts being of well known construction and operation, but it may be said that the spring 17 acts on the rod 16, which is furnished with an eye through which the yarns from the bobbins 6 and 7 pass, to take up any slack yarn during the knitting

of the heels and toes in particular. The tripping-spring Z' before mentioned, is secured at its lower end to the said slide 3, and moves up and down therewith in co-acting with the outer end of the putting-up lever Y, already mentioned. The said slide is provided with a long tapering lower end, (Figs. 1, 8, and 9) bent forward to extend through a vertical elongated opening 21, formed in the machine standard R, its projecting forward end engaging with the outer end of a horizontal slide-lever 22, (Fig. 1,) having its inner end adapted to be engaged by a lug 24, formed upon the exposed face of the primary pattern-wheel 25, (Fig. 10.) A spring 26, attached to the lower end of the slide 3, and to the rear of the machine standard R, restores the slide to its normally depressed position after its elevation by the slide lever 22. The said lever 22 is hung upon a horizontal screw stud 23, projecting from a bracket 22^a, bolted to the front of the machine standard R, and also carrying a horizontal stop-pin 23^a, which holds the outer end of the lever up in engagement with the lower end of the slide 3, as shown by Fig. 1.

The putting-up and putting-down cam V, the putting-up lever Y, and the slide 3, which cuts in and cuts out the reinforce thread, so to speak, are all timed and controlled in their operation by means of the primary and secondary pattern-wheels 25 and 27 (Figs. 1, 2, 3, 5, 6, and 9) which are mounted with a narrow space between them, on a horizontal stud 28, which is carried by the same bracket 29, that forms bearings for the rock-shaft 30, the said bracket being secured to the front of the machine-standard R, at a point thereon beneath the bracket Q', before mentioned. The said pattern-wheels will, of course, be constructed with particular reference to the work to be done by the machine, as they determine the product thereof, and will be changed or modified when it is desired to change the same. The particular mechanism by means of which the said cam-lever and slide are controlled by the pattern-wheels, may be varied, and I do not limit myself to the devices shown, although they afford simple and effective means for doing the work in question. The pattern-wheels have the additional office of controlling the stopping of the machine when a stocking has been completed, and of automatically starting and stopping the dial in the oscillating movement which it has during the formation of the heel and toe.

Before proceeding to describe in detail the devices by which the pattern-wheels are caused to control the described features of the machine, it will be well to note that they are operated by means of a pawl 31 (Fig. 2^a) attached at its inner end to an eccentric strap 32 (Fig. 10) embracing an eccentric 33, mounted on the driven shaft O'. The said pawl is provided at its outer end with a finger 34, which co-operates with the shallow notches 35, the intermediate or medium notches 36,

and the deep notches 37, of the secondary pattern wheel 27, which is moved through the distance represented by one tooth by every movement of the pawl. The notches 35 of the said pattern wheel are, however, so shallow that they do not permit the main edge 34^a, of the pawl to drop into the notches 25^a (Fig. 10), of the primary pattern wheel 25. The notches 37, before mentioned of the secondary pattern-wheel, are deep enough to permit the pawl to fall inward sufficiently for the engagement of its main surface 34^a, with any of the notches 25^a, of the primary pattern-wheel, which will therefore be actuated with the secondary pattern wheel every time one of the deep notches 37 of the latter is brought under the pawl. Each notch of the secondary pattern-wheel, of whatever depth, represents a single course of knitting, except when the machine is turning the heel and forming the toe, when each notch represents two courses of knitting for the said wheel is moved through the distance represented by one notch every time the needle-dial makes a complete revolution and knits one course of stitches, in straight knitting, while on the other hand, the wheel is moved only through the distance represented by one notch for a movement of the dial forward and back in heel and toe knitting, both of the said movements of the dial forming a course of stitches. The said deep notches, 37, it will be noticed, are arranged at equal intervals apart, and virtually divide the wheel 27 up into blocks, each of an equal number of notches, which, in the machine shown, are of nine notches each, but that number may of course be varied according to the character of the work to be done. Under the arrangement shown, the primary pattern-wheel 25 would be actuated for changing the pattern, only between intervals of nine courses of straight knitting, or eighteen courses of heel or toe knitting. It is often desirable, however, in order to make the stocking of the right form, to move the pattern-wheel oftener than this, and to provide for that requirement, I furnish the secondary pattern-wheel with the medium or intermediate notches 36, which in every case are located adjacent to the deep notches 37. These intermediate notches, however, are not deep enough to allow the pawl to fall inward sufficiently far to engage its main edge 34^a, with the notches 25^a of the primary wheel, unless the teeth between same are built up, so to speak by little blocks 39 (Fig. 10) which are screwed to the teeth of the primary pattern-wheel, whereby some of the notches thereof are made virtually deeper than others. These little blocks may obviously be shifted around as desired. Now when the pawl drops into one of the intermediate notches 36 in the secondary pattern-wheel 27, the said notch being at that time in alignment with a built up notch of the primary pattern-wheel 25, then both of the wheels will be moved together, whereby the primary pattern-wheel is given

an additional movement. It will be noted that this additional movement of the primary pattern-wheel must always immediately precede its regular and uniform movement, because the intermediate notches 36 of the secondary pattern-wheel are in every case located directly in front of the deep notches thereof. By the provision of the secondary pattern-wheel with the intermediate notches 36, and the use of blocks 39 for building up some teeth of the primary pattern-wheel, I am enabled to modify the operation of the primary pattern-wheel as the particular work to be done may require. The pawl 31 is also provided with a vertically adjustable finger 40, (Fig. 2^a) made somewhat longer than its finger 34, and arranged to co-operate with the auxiliary tooth 41 of the primary pattern-wheel. The said auxiliary tooth 41 (Figs. 6, 10 and 10^a) projects at its outer end, which is bent at a right angle to its main-portion, through a segmental slot 42, formed in the primary pattern-wheel 25, its inner end being extended nearly to the center of the said wheel, and hung on a horizontal screw-stud 43. A bowed spring 44, passed between the inner end of the tooth and the said wheel, frictionally holds it against displacement. The outer end of the said tooth, which is engaged by the adjustable finger 40 of the pawl, is constructed with a small lug 45, which is also engaged by the said finger, whereby the auxiliary tooth is drawn forward out of the way, so that it will not be in position to co-operate with the said finger of the pawl the next time the pawl is operated. The said tooth is restored again into its operative position by its engagement with the inner end of the lever 22, which, as has before been described, is operated by the lug 24 of the pattern-wheel to control the slide 3, which in turn controls the operation of the putting-up lever and the introduction and cutting off of the reinforce thread. It will be understood that the auxiliary tooth, by coming under the adjustable finger 40 of the operating pawl 31, prevents the same from dropping inward far enough to operate the secondary pattern-wheel 27, after which the tooth is retired by the said pawl, and restored to its operative position again, after it has passed beyond the range of the pawl, which it prevents from operating only once during the revolution of the primary pattern-wheel. The said auxiliary tooth 41, is employed to avoid the formation in the heel of small openings at points therein where the regular or full courses of the knitting end, and begin again, or in other words, where the narrowing for the heel begins and the widening therefor ends. I avoid forming an opening at the points described, by an arrangement under which all the needles used in knitting the first course of the heel are not used in knitting the last course thereof. If the first and last courses of the heel were knitted by the same needles, the stitches formed by the outer or end needles

would come opposite each other, and the openings or holes before referred to would result. I avoid finishing the heel proper with the needles by which it was begun, by means of the auxiliary tooth 41 which by co-operating with the adjustable tooth 40, of the operating pawl, prevents the same from falling into a notch of the secondary pattern-wheel, which is thus temporarily cut out of operation, and misses one movement, and as in the heel and toe work one movement of the secondary pattern-wheel represents two courses of stitches, it will be apparent that when the primary pattern-wheel gains one notch upon the secondary pattern-wheel, the machine will knit two more courses of stitches than it otherwise would, before the pattern is changed by the action of the primary pattern-wheel. These two extra courses of stitches belong to the narrowing courses of stitches in the heel. These two extra courses are, however, left out of the widening courses of the heel, so that the machine does not, in completing the heel, go back, so to speak, and finish the same on the needles which knitted its first two courses, but stops just short of the said needles, and is finished by the needles next to them. The two courses of stitches knitted by the needles which began the heel, will not therefore be duplicated, in finishing the heel, by the same needles, for if so then there would be four stitches opposite each other, uniting to form the holes referred to, but by failing to use the needles which began the heel, in finishing it, the points of those holes will be occupied only by two stitches, which do not leave enough of an opening to amount to a defect. In all the other courses of the heel, four stitches are formed opposite each other, without however making any holes, inasmuch as the yarn is drawn across them in a manner to close them. The yarn is not, however, drawn across the needles which form the first two courses of the heel, and hence the opening ordinarily formed is avoided by my invention. This point may be better understood by illustration. Suppose, for instance, that there are thirty-eight narrowing courses in the heel, the thirty-seventh and thirty-eighth courses thereof being added to the number by means of the auxiliary tooth which causes the secondary pattern-wheel to skip one movement. If there were thirty-eight narrowing courses in the heel, there would be only thirty-six widening courses. It will be seen from this that in finishing the heel, the machine did not return to the needles which knitted the first and second of the narrowing courses, for otherwise there would have been two more widening courses, namely, thirty-seven and thirty-eight.

As herein shown, the devices (Figs. 2, 3, 5, 6, and 7) employed to impart vertical and lateral movement to the individual putting up and putting-down cam V from the pattern wheels, consists of a horizontal cam-plate 46, a vertically arranged lever 47, hung at its

lower end on a horizontal stud 47^a, and a horizontal link or bar 48, which pivotally connect the upper end of the said lever with the rear end of the said plate. The said cam-plate has bearing upon a horizontal table 49, which is secured to two outwardly projecting brackets 50, made integral with the hanger P', which depends from the arm or table J', off-setting from the dial-plate F. The inner edge of the cam-plate 46 is constructed with a downwardly projecting rib or flange 51, which enters a narrow guide-way 52, formed between the inner edge of the table 49, and the outer face of the hanger P', whereby the cam-plate is held in place and guided in its reciprocations. The said cam-plate is constructed with an irregular longitudinal slot 53, (Fig. 6) having inclined or cam surfaces 54 and 55, and a straight surface 54^a, located between the same, all of the said surfaces being pitched and arranged with particular reference to the degree and timing of the reciprocal movement to be imparted to the chambered carriage X', which carries the universal putting-up and putting-down cam V. The rear end of the said carriage is furnished with an operating-finger 56, which extends downward into the said cam-slot 53, and also projects slightly into an oblong rectangular clearance opening 57, formed in the table 49, whereby the said inclined surfaces 54 and 55 of the slot 53, acting on the said finger 56, operate to move the carriage X' inward against the tension of a spring 58, connected with its inner end, and attached to the outer edge of the cam-box J', and exerting a constant effort to move the carriage, whereby the said finger is kept in engagement with the outer wall of the opening 53, including the said cam and straight surfaces 54 and 55 and 54^a. The said cam-plate is also provided with a cam-block 59, having cam-faces 60 and 61, which are engaged by an operating-pin 62, depending from the extreme outer end of the pivotal cam-bar W' located within the chamber X, of the carriage X', and having the universal putting-up and putting-down cam V, mounted in its inner end, whereby the co-operation of the faces 60 and 61 of the block 59, with the lower end of the operating-pin 62, causes the cam-bar W' to swing on its pivot *w*, and its forward end, and hence the cam V, to be lifted, this occurring at the same time that the cam is moved forward and back, by the reciprocation of the carriage, as before described. A spiral spring 63, connecting the upper end of the lever 47, with the frame of the machine, keeps the operating-finger 64, of the said lever in its position between the edges of the primary and secondary pattern-wheels, the former being furnished with two flanges or ribs 65, 66, (Fig. 10^a) with which the said finger normally engages. At such time the cam-plate 46 is retired, and inoperative, being brought into operation by the dropping of the said finger into the openings 67 and 68, formed between the adjacent ends of the

said ribs, the said openings being thereto presented to the finger by the rotation of the primary pattern-wheel. The ribs 66 are extended into the openings 67 and 68 by means of segmental blocks 69, (Fig. 10^a) which are located opposite each other, one being virtually an extension of one end of one rib, and the other an extension of the opposite end of the other rib. Each of these blocks has its outer end cut away below the level of the ribs to form a long step 70, and a shoulder 71, the said step and shoulder of each of the blocks 69, co-operating with the finger 64 of the lever 47 in producing the particular movements of the cam-plate 46 as will be described at another time.

The means by which the operation of the putting-up lever Y is controlled from the pattern wheels, have already been described, and will not receive further attention more than to mention that they comprise the lug 24, formed on the face of the primary pattern-wheel 25, the horizontal lever 22, and the vertical slide 3, and the spring 26 thereof.

For the function of the pattern-wheels in stopping the rotary movement of the needle-dial and causing it to oscillate, and then stopping its oscillating movement and causing it to rotate again, and for changing the speed of the machine from fast to slow and from slow to fast according as it is being run on straight work or on heel and toe work, the primary pattern-wheel is provided upon its exposed face with four lugs 72, 73, 74 and 75 (Fig. 10) arranged quartering with each other, and varied in character to produce the required action of the machine in the respects described. Of these lugs 73 and 75 co-operate with the upper end of the belt-shifting lever 25^a before described, whereby they cause the speed of the machine to be changed as required. The lugs 72 and 74 are, in the rotation of the pattern-wheels, engaged by a finger 76 projecting outward from a horizontal lifting lever 77, (Figs. 3, 6, and 8) hung for movement in a vertical plane on a screw-stud 78, mounted in a horizontally adjustable bearing 79, attached by a bolt 80 to the rear arm 29^a, of the bracket 29 (Fig. 11^a) which is bolted to the front of the standard R, the said arm being constructed with an open slot 81, in which the said stud 80 is movable. The said lifting-lever 77 is provided at its extreme forward end with an inwardly projecting lifting-arm 82 (Fig. 6) which enters a transverse notch 83, formed to receive it in the rear face of the lower end of the sleeve 84 of the shifting-lever 85, which swings in a horizontal plane on a long vertical stud 86, adjustably mounted in an open slot 87, (Fig. 11^a) formed in the forward arm 29^b of the bracket 29. The rear end of the shifting lever is provided with a depending pin 88 (Fig. 6) which plays in an elongated slot 89, formed in the rear end of a coupling-head 90, which is mounted upon the adjacent end of the longitudinally movable shifting-rod 30, which at

its opposite end carries the belt-shippers 91 and 92 (Fig. 1) by which the oppositely running driven belts are shifted upon the pulleys q q' q'' . The forward end of the said coupling-head 90, is constructed to form a flat leaf or edge 93, (Figs. 6 and 8) which enters a transverse slot 94, formed in an enlargement 95 of the lower end of the vertical stud 86, on which the said shifting-lever swings as a center, the said coupling-head being thus steadied in its lateral reciprocations. The said shifting-lever 85 is provided upon its forward end with an upwardly projecting lug 96, (Fig. 8) which is engaged by a cam 97, secured to the driven-shaft O', between the eccentric 33 of the operating-pawl 31, and the gear wheel O². The said cam 97 is constructed to engage with the opposite faces of the stud 96, so as to swing the lever 85 back and forth in a horizontal plane, whereby the belt-shifting rod 30, will be correspondingly moved by its connection with the shifting-lever through the pin 88, and coupling-head 90. The said cam has two flanges located about opposite each other and corresponding to each other except in their arrangement, which is reversed, the faces of the said flanges being alternately engaged with the stud 96 of the lever 85 which is thus swung back and forth. The shifting-lever will not, however, be actuated as described, except when it is vertically supported in position for its lug 96 to be engaged by the cam 97, and it will not be supported in such position except when the lug 76 of the lifting-lever 77 is engaged with one of the lifting-lugs 72, or 74 carried upon the exposed face of the primary pattern-wheel 25. As soon as any one of the said lifting lugs passes beyond the lug 76, the shifting-lever 85 and the lifting-lever 77 will drop by gravity into their retired positions, so that the cam 97 rotates without effect, but when the lever is lifted and oscillated as described, the belt-shifting rod 30, will shift the oppositely running driven belts on the pulleys q q' and 22, so as to constantly reverse the rotation of the driven shaft O, and thus cause the oscillation of the needle-dial. As the lifting-lugs on the primary pattern-wheel operate the lifting-lever, and hence the shifting-lever automatically, the transition from rotary to oscillating movement in the dial, and vice-versa, is accomplished without interference with the machine on the part of the attendant. The automatic stopping of the machine when the stocking has been completed, is also effected through the pattern-wheels by the provision of the primary pattern-wheel with an inwardly projecting stop-pin 98, (Figs. 1, 5, and 10) which engages with the lower end of a stop-lever 99, hung on a horizontal bolt 100, mounted in the lower end of the hanger P'. A spring 101, (Figs. 1 and 5) attached at its upper end to a block 102, carried by the said bolt 100, engages at its lower end with the primary pattern-wheel, and prevents a retrograde movement thereof, without interfering

with its regular forward movement. The upper end of the said lever is bent at about a right angle to it, to form a stop-finger 103, (Fig. 10) which normally passes under a latch 104, (Fig. 1,) extending at a right angle to it, and hung on a screw-stud 105, from the hanger P, which depends directly from the dial bed. The said latch is provided toward its outer end with a lug 106, which is engaged by the outer end of a box 107, the same being arranged to slide back and forth on a horizontal bar 108, the opposite ends of which are fastened to the said hangers P and P'. A locking-arm 109, depending from the said box, has a notch 110, adapted to receive the forward end of the shifting-lever 85. A spiral spring 111, attached to the said box, and to the outer end of the bar 108, exerts a constant effort to pull the box outward, and engage the outer end of the said box with the inner edge of the hanger P'. This movement of the box, and hence the arm 109, is sufficient to move the shifting-bar 85, and hence the belt-shifting-rod 30, so as to bring both of the driven belts onto the loose pulleys *q* and *q'* thus stopping the machine. It will therefore be clear that if it is at any time desired to stop the machine, that can be done by lifting the outer end of the latch 104, when the spring 111, will act to operate the lever 85, in shifting the belts onto the loose pulleys. The same thing results when the latch is lifted through the medium of the stop-pin 98 on the primary pattern-wheel. The lugs 72, and 74 on the said pattern-wheel are arranged so that they will release the lifting and shifting levers in position for the latter to drop into the notch 110 of the locking-arm 109, when the same is in its retired position. When therefore, the machine is knitting straight ahead, the shifting-lever will be held in place by the said locking-arm 109, in the position in which it is shown by Fig. 1 of the drawings, and will be instantly thrown into position for stopping the machine by manually lifting the outer end of the latch. It is automatically lifted out of its said notch and operated for shifting the belts for reversing the dial for heel and toe work, by means of the said lugs on the primary pattern-wheel, and the lifting lever, being always dropped, at the conclusion of such work, into its normal position in the notch of the locking arm.

It will be observed that while the secondary pattern-wheel has a uniform intermittent movement, the primary pattern-wheel has a variable intermittent movement, by which is meant an intermittent movement the intervals of which are varied according to the pattern of the stocking, and in conformity with the particular part thereof being knitted.

Having now described the construction of my improved machine in detail, I will proceed to set forth the mode of its operation.

A cuff or top knitted in a separate machine, having been put on to the transfer, which for that purpose is swung to one side, the same, with the cuff or top depending from it, is

swung over the center of the needle-dial, the yarn-feed having been previously moved into its retired position in which it stands upright. The two raise-cams J, J' are now retired by pulling out the raise-cam slide, after which the dial is rotated sufficiently to cause the draw cams U U' to put down the needles which had been moved up by the said raise-cams. All the needles in the dial being now put down, the spindle or rod of the transfer is unlocked, and the transfer allowed to settle down to a point just below the inner ends of the needles. The raise-cams are now moved by the raise-cam slide into an intermediate position, which will put the needles up sufficiently to cause them to enter the little chutes of the transfer, and take up the stitches of the cuff or top, for which purpose the dial is moved through one revolution. The raise-cams are now retired again, and the dial revolved enough to cause the draw-cams to put all the needles down, thus permitting the transfer to be lifted above them, after which it is swung to one side, and there allowed to remain until another stocking is to be begun. The raise-cams are now advanced into their knitting positions, the yarn-feed thrown down into its operating position, and the yarn thrown over the needles that are put up by the raise cams. The machine is then started manually by moving the shifting-lever from right to left, until the latch has locked the box carrying the locking-arm in its normal position. The machine now runs and knits the leg of the stocking, the dial being rotated. During this time the universal cam V occupies what I call its normal position in which it stands at the limit of its inward movement, and out of the way, having then only an incidental guard function to prevent any needles from being put up too far. After the last course of stitches in the leg of the stocking has been finished, the lug 24 of the primary pattern-wheel, operates the slide-lever in raising the slide 3, whereby the operating-face z^3 of the spring Z', carried by the slide, is engaged with the pin y^2 located in the outer end of the putting-up lever. The said spring being lifted against the said pin, the putting-up lever is turned on its pivot so that its forward end is depressed until it engages with the upper edge of the putting-up flange N' of the ring N carried by the needle-dial, which will soon carry the said flange out of the range of the forward end of the putting-up lever, which will now be thrown farther down and upon the face of the dial by the operating-face z' of the spring Z. The last movement of the putting-up lever brings the putting-up cam Y² into the path of the needles, one half of the whole number of which are then put up out of the knitting path by the said cam. The inner end of the putting-up lever now rides upon the elevated step N² formed at one end of the putting-up flange N', whereby the inner end of the said lever is lifted to clear its putting-up cam from

the path of the needles, the outer end of the lever being depressed so as to pass under the transverse retaining shoulder z , formed in the spring Z , which thereby maintains the putting-up lever in its retired position. The slide 3, now completes its upward movement, and brings the chute 2 into line with the chute 8, whereby the reinforce thread is brought into contact with the main yarn. In this upward movement of the slide 3, the spring Z' clears the pin y^2 , which passes under the operating-face z^3 of the said spring, through the clearance notch z^2 (see Fig. 3) therein. At the same time also, the spring 14, moves the cutting-off arm 9, into its position to make its operating stroke. At the same time also, the lug 76 of the lifting-lever 77, engages with the lug 72 of the primary pattern-wheel, and lifts the said lever, which in turn lifts the shifting-lever 85 until the finger 96 thereof is brought into the range of the main cam 97 on the driven shaft of the machine. After this, the said cam operates to shift the said lever back and forth, whereby the lever 25 through the coupling-head, moves the belt-shifting rod back and forth, so as to shift the oppositely running driven belts alternately onto and from the fixed driven pulley q^2 , thus causing the driven-shaft to be rotated alternately in opposite directions, so as to impart an oscillating movement to the needle-dial, instead of the full rotary movement which it had while it was knitting the leg of the stocking. At the same time the lug 73 of the primary pattern-wheel engages with the bent upper end of the belt-shifting-lever 75^a, and shifts the fast driving belt from the fixed pulley s^2 , onto the loose pulley s , and the slow driving belt from the loose pulley s' , onto the fixed pulley s^2 , so that the machine will be driven slower during the formation of the heel. At the same time the finger 64 of the lever 47, is drawn by the spring 63 into one of the openings 67, located between the adjacent ends of the ribs 66, formed on the inner face of the primary pattern-wheel, which is at this moment rotated by the operating pawl to present the said opening to the finger of the lever 47. When the said finger drops into the said opening, the lever is drawn forward, whereby the cam-plate 46 is moved on its bearing-plate 49 to the extreme limit of its forward motion. During this forward movement of the cam-plate, the spring 58, attached to the carriage X' , draws the same outward, first impinging the pin 62 of the cam-bar W' , against the face 61 of the block 59, the said face being inclined so that as the plate is moved forward, the pin will be thrown inward, and the cam-bar W' , turned on its pivot w , whereby the universal cam V , at its forward end will be elevated above the butts of the needles. The cam having been thus elevated, will be sustained in its elevated position, as the plate 49 continues to move forward, by the impingement of the pin against the face 60 of the block 59, under the power of the spring 58, which

after the cam has once been lifted, is sufficient to sustain it in an elevated position against the force of gravity and its own spring x . Meanwhile, after the cam has been lifted, and while its pin is engaged with the face 60, of the block 59, the carriage which carries the cam-bar is being drawn outward by the spring 58, whereby the cam is also drawn outward over the butts of the needles. Very soon after the cam has thus been drawn outward over the butts of the needles, the pin 62 is disengaged from the incline 60, whereby the cam is allowed to drop down into position for putting the needles up one by one out of the needle path, the finger 56 of the carriage being at this time in the rear end of the cam slot 53. The auxiliary tooth 41 is now brought under the adjustable tooth of the operating pawl, so as to hold the same out of engagement with the secondary pattern-wheel, which is therefore caused to skip one movement, whereby two courses are in effect added to the narrowing courses of the heel, as has been described at length before. When the pawl is drawn back after having thus been engaged with the auxiliary tooth, it catches onto the little lug 45 thereof, and draws the said tooth out of the way, so that the next time the pawl is moved forward, it will drop down into engagement with the tooth of the secondary pattern-wheel. Although I have chosen to arrange the auxiliary tooth in the machine herein shown and described so that it will operate very soon after the narrowing of the heel has been begun, it is apparent that it is immaterial at what time during the narrowing of the heel it operates, for it might just as well be arranged to operate any time before the narrowing operation is concluded. It is only necessary that it shall operate at some time during the narrowing of the heel, so as to cause the secondary pattern-wheel to skip one tooth. The purpose of this auxiliary tooth has been so fully described elsewhere that it will not be set forth again. The universal cam has now been brought into position for individually putting up the desired number, in this machine 36, of the remaining half of the needles which were left after the other half of the needles were collectively put up by the action of the putting-up cam of the putting-up lever, the needles being put up by each oscillating movement of the needle-dial, from the respective ends of the row of needles left in the knitting path. The operation of the universal cam in the exercise of this function is as follows: Supposing the dial is moving from left to right, then the butts of the needles in the knitting path will pass on the outside of the draw-cam U , and engage with the face of the forward raise-cam J , by which they will be moved inward and brought into position to enter the inclined run-way v of the universal cam. Now when the foremost needle of the row enters the said run-way of the cam, it will be moved up out of the knitting path, but while the cam is mov-

ing the needle inward, the butt of the needle is lifting the cam, so that the needle next back of the said foremost needle instead of entering the said runway v , of the cam, will strike centrally under the end thereof, and pass under the same without deviation from its path, and as there will always be more than one needle under the cam, it will be sustained in the elevated position into which it was lifted by the foremost needle which it put up, until all of the needles have passed straight under it in the path marked v^4 of Fig. 3^a of the drawings. Now when the needle-dial swings back again, the needles will pass on the outside of the rear draw-cam U' , and be moved inward by the rear raise-cam J' , into position for the end needle at the other end of the row to enter the runway v' of the universal cam, whereby the said needle will be moved inward of the knitting path, and the cam raised so as to allow the remaining needles to pass directly under it on the line v^4 . In this way, as the needle-dial swings back and forth, one needle is put up at a time from the ends of the row of needles in the needle path, until the narrowing of the heel is completed. The universal cam having now performed its function of putting up the needles one by one for the operation of narrowing the heel, is shifted into position to put the said needles down one by one for the widening of the heel. The described movement of the cam is effected by the action of the primary pattern-wheel, which having moved once since the finger 64 of the lever 47 dropped into the said opening 67, now moves again and abuts the segmental block 69, which forms one wall of the said opening, against the said finger 64 of the lever 47, so as to draw the lever backward, the said finger being at this time lifted out of the opening 67, up onto the adjacent end of the long step 70 of the block. In the backward movement of the lever, the inclined face 60 of the block 59 on the cam-plate 46, is engaged with the pin 62, of the cam-bar W' of the universal cam V , which is now lifted above the butts of the needles. This occurs just before the finger 56 of the carriage X' engages with the incline 54 of the cam-slot 53, the said incline now operating to move the carriage inward against the tension of its spring 58, whereby the cam V , is carried over the butts of the needles. The pin 62 now runs by the block 59, whereby the cam V is allowed to drop down into its operative position in line with the row of needles which have been put up or retired, and the finger 56, of the carriage X' , is left in engagement with the straight portion 54^a of the cam-slot 53, which is between the inclines 54 and 55 thereof. The machine is now in position for putting down the needles one by one for widening the heel. During this operation the universal cam operates in the same manner as it did before, but for the difference that this time it is inside of the needle path, whereby its inclined faces v^2 v^3 are brought into

operation. Supposing, for instance that the needle-dial is moving from left to right, the needles that are now put up will pass in front of the forward draw-cam U , and the foremost needle enter the runway v^2 of the universal cam, whereby the said needle will be thrown outward into the knitting-path and the cam lifted, so that all of the remaining needles of the row may pass straight under it, on the line v^4 of Fig. 3^a. Now when the needle-dial is returning from right to left, the needles that are put up will pass in reverse direction in front of the rear draw-cam U' , the end needle at the other end of the row entering the runway v^3 of the universal cam, which will then move the said needle out into the knitting path, while the needle lifts the cam to let the other needles pass straight under it on the same line v^4 , and so on. The needles that have been put up for the purpose of widening the heel, are thus put down one by one by the action of the universal cam, until all of them have been put down into the knitting path, except two, for we have already seen that by the action of the auxiliary tooth two more needles were put up above the knitting path in narrowing than the machine would have otherwise called for, and those two needles are not put down individually in widening. During the widening of the heel as described, the finger 64 of the lever 47, is moved along the long step 70 of the block 69 which it engaged at the beginning of the said widening operation. The said finger now engages with the shoulder 71 of the said block, whereby the lever 47 is operated in drawing the cam-plate rearward, engaging the finger 56 of the carriage X' with the incline 55 of the slot 53, whereby the cam-bar is thrown farther inward inside of the needle path, and into its normal position, in which it remains during the knitting of the foot of the stocking. The heel has now been completed, but two courses before its completion, the slide lever 22 dropped off from the lug 24 of the primary pattern-wheel, and thus left the spring 26 free to pull down the slide 3 to cut out the reinforce thread, which is cut or jammed off by the action of the pin 11, mounted in the slide, upon the finger 12 of the cutting-off arm 9, which is thus thrown forward over the chute 2, and jammed against the cutting off block 10. It will be clear that the reinforce thread must be cut off before the heel is entirely completed, for otherwise, the end of the thread left in the machine would be worked into the body of the foot beyond the heel. When the slide 3 was drawn down, the spring Z' carried by it was drawn below the pin y^2 of the putting-up lever, into position to engage with the said pin for operating the lever at the time the slide is lifted again, the spring Z' , snapping over the pin so to speak. When the heel has been completed as described the finger 76 of the lifting-lever 77, drops off from the lug 72 of the primary pattern-wheel, and permits the shifting-lever 85 to drop down by

the action of gravity, so that its finger 96 is cleared from the shifting-cam 97. When the shifting-lever drops, its outer end falls into the notch 110 of the arm 109, which depends from the box 107. The belt-shifting lever 75^a of the main driving-belts, now drops off from the lug 73 of the primary pattern-wheel, and shifts the slow driving-belt from the fixed pulley s² to the loose pulley s', and shifts the fast driving-belt from the loose pulley s, onto the fixed pulley s², causing the machine to be driven more rapidly. Now as the dial starts to make full revolutions again in the beginning of its first movement, the needles which were put up collectively by the putting-up lever, and which are often called the "instep" needles, are collectively put down by the universal cam. Thus as the dial starts from left to right, the said needles will pass in front of the forward draw-cam, and engage with the rear edge of the universal cam, which will move them all down into the knitting-path, for this time the said cam is so far inward that it will not be lifted by the needles, which strike its inner edge and not under it. All of the knitting-needles being now in the knitting path, the dial continues to make full revolutions, and knits the body of the foot of the stocking without interruption, the universal cam remaining in its normal position, in which its only function is to prevent any of the needles being thrown out of place as they are moved over the raise-cams. The operations described for forming the heel are all reproduced in forming the toe, with the single exception that the auxiliary tooth is not again brought into play, for the reason that the little holes which it is designed to avoid in producing the heel, are practically obliterated in finishing the toe of the stocking. No strain comes upon them in the toe at any rate, and their presence is not particularly objectionable. After the narrowing and widening courses forming the toe are knitted, the machine goes on, and knits several more full courses to form a little extra material to be used in closing the toe. As constructed herein, the machine provides for nine of these extra courses, but the number may be varied as required. Then after these nine courses are formed, the pin 98 engages with the stop-lever 99, which is then actuated in lifting the latch 104, whereby the box 107 is left free to be drawn out by its spring 111, until the box engages with the hanger P', at which time it will have brought the shifting lever into an intermediate position, in which the driving belts run on the loose pulleys q q' without contact with the pulley q², whereby the machine is automatically stopped. The yarn feed is now lifted into its retired position; the yarn broken off, and the stocking run off by turning the dial once around by hand. A new cuff or top is now put onto the transfer and the operations above described are repeated.

Having fully described my invention, what

I claim as new, and desire to secure by Letters Patent, is—

1. In a machine for knitting stockings, a transfer having a radially arranged series of needle-chutes, each consisting of a narrow piece of sheet-metal bent into U-form, and having its upper edges shaped to form a transverse shoulder, between its ends, and connected with the machine frame with the concave faces of its chutes uppermost, substantially as described. 75

2. In a machine for knitting stockings, a transfer having a radially arranged series of needle-chutes, and a transfer arm supported by the machine-frame, and movable in a horizontal plane over and away from the needles of the machine, substantially as described. 80

3. In a machine for knitting stockings, the combination with a transfer having a radially arranged series of U-shaped needle-chutes, a transfer-arm pivotally secured to the machine-frame so as to swing in a horizontal plane, and constructed at its outer end with a vertical sleeve, an operating-rod passing through the said sleeve, and carrying the said transfer at its lower end, and means for holding the said rod in its elevated position in the sleeve, substantially as described. 85 90

4. In a machine for knitting stockings, a transfer having a radially arranged series of needle-chutes, a transfer-arm pivotally secured to the machine-frame so as to swing in a horizontal plane, and constructed at its outer end with a vertical sleeve, an operating-rod passing through the said sleeve and carrying the said transfer at its lower end, and a stop for limiting the swinging movement of the said arm, substantially as described. 95 100 105

5. In a machine for knitting stockings, a transfer having a radially arranged series of needle-chutes, a transfer arm pivotally secured to the machine-frame so as to swing in a horizontal plane, and constructed at its outer end with a vertical sleeve, an operating-rod passing through the said sleeve and carrying the said transfer at its lower end, and a stop connected with the said arm and arranged to engage with a fixed portion of the machine to limit the swinging movement of the said arm and transfer, substantially as described, and whereby the latter is brought to a stop over the needles of the machine when the arm is swung inward. 110 115 120

6. In a machine for knitting stockings, the combination with a revoluble needle-dial, and means for operating the same, of two draw-cams supported above the dial which moves under them, two raise-cams located between and outside of the said draw-cams, and a universal cam, substantially as described. 125

7. In a machine for knitting stockings, the combination with a needle-dial having a central aperture, of movable raise-cams substantially as described, and whereby by moving the said cams, all of the needles may be put down so as to leave a free circular opening 130

within them through which a transfer may be passed.

8. In a machine for knitting stockings, the combination with a needle-dial having a central aperture, of movable raise-cams, and an operating-slide therefor, substantially as set forth, whereby by moving the said slide and retracting the cams, all of the needles may be put down so as to leave a free circular opening within them through which a transfer may be passed.

9. In a machine for knitting stockings, the combination with a transfer having a radially arranged series of needle-chutes, of a needle-dial, and movable raise-cams, substantially as set forth, and whereby by retiring the said cams a free circular opening is obtained within the needles for the reception of the transfer, the chutes whereof may thus be passed below the needles in the dial, and whereby by retracting the cams after the transferring operation, and putting down the needles, the transfer may be lifted directly upward out of the dial.

10. In a knitting-machine, the combination with a revoluble needle-dial, of two draw-cams, two raise-cams located between the same and adjacent to their outer faces, and a universal cam located between the draw-cams and inside of the raise-cams, substantially as described.

11. In a knitting-machine, the combination with a needle-dial and means for operating the same, of two draw-cams, two raise-cams located between the same and adjacent to their outer faces, and having their inner edges cut away, and a universal cam located above the raise-cams, the cut away portions whereof give it clearance, and means for moving the said universal cam inward and outward with respect to the needle-paths, and upward to lift it over the needle-butts, substantially as described.

12. In a knitting-machine, the combination with a needle-dial, and means for operating the same, of two draw-cams, two raise-cams, a universal cam, and two sinker-cams constructed and arranged to operate alternately in forming and relieving the stitches, substantially as described.

13. In a knitting-machine, the combination with the needle-dial and means for operating the same, of two laterally and vertically adjustable sinker-cams arranged under the same, substantially as described.

14. In a knitting-machine, a needle-dial having bevel-teeth located upon its lower face, and constructed with grooves passing above the said teeth to receive the sinkers, substantially as described.

15. In a machine for knitting stockings, the combination with a circular radially arranged series of needles, and means for operating the same, of a movable annular feed normally located within the circle which the inner ends of the needles inclose and containing an eye

through which the yarn passes, substantially as described.

16. In a machine for knitting stockings, the combination with a needle-dial and means for operating the same, of an annular yarn-feed movably mounted to one side of the dial to be swung over and lifted above the same, and having an offset containing an eye through which the yarn passes, substantially as described.

17. In a machine for knitting stockings, the combination with a needle-dial and means for operating the same, of an annular yarn-feed movably mounted to one side of the dial to be swung over and lifted above the same, and having an offset containing an eye through which the yarn passes, the edge of the said feed and its offset being beveled, substantially as described.

18. In a machine for knitting stockings, the combination with a dial provided upon its upper face with a semi-circular putting-up flange, means for operating the said dial in rotary and oscillatory movement, a putting-up lever extended over the said dial to engage with the said flange, and furnished with a putting-up cam which puts up the instep needles, and means for operating the said lever, substantially as described.

19. In a machine for knitting stockings, the combination with a dial provided upon its upper face with a semi-circular putting-up flange having an elevated step at one end, means for operating the said dial, in rotary and oscillatory movement, a putting-up lever extended over the said dial to engage with the said flange and its step, and furnished with a putting-up cam which puts up the instep needles, and means for operating the said lever and holding it in its retired position into which it is thrown by the said step, substantially as described.

20. In a machine for knitting stockings, the combination with a dial provided upon its upper face with a semi-circular putting-up flange having an elevated step at one end, means for operating the said dial in rotary and oscillatory movement, a pivotal putting up lever extended over the dial to engage with the said flange and the step thereof, and furnished with a putting-up cam which puts up the instep needles, a pattern-wheel, and operating connections between the said wheel and lever, substantially as described.

21. In a machine for knitting stockings, the combination with a dial provided upon its upper face with a semi-circular putting-up flange having an elevated step at one end, means for operating the said dial in rotary and oscillatory movement, a pivotal putting-up lever extended over the dial to engage with the said flange and the step thereof, and furnished with a putting-up cam which puts up the instep needles, a spring, shaped to cooperate with the outer end of the said lever to rock it on its pivot, a movable tripping

spring also adapted to co-operate with the said lever, a pattern-wheel, and operating connections between the said wheel and the movable tripping spring, substantially as described.

22. In a machine for knitting stockings, the combination with a dial provided upon its upper face with a semi-circular putting-up flange having an elevated step at one end, means for operating the said dial in rotary and oscillatory movement, a pivotal putting-up lever extended over the dial to engage with the said flange and the step thereof, and furnished with a putting-up cam which puts up the instep needles, a spring having its upper end shaped to form an operating face which rocks the lever to throw its inner end down upon the said flange, and a retaining shoulder which normally holds the lever, with its inner end elevated, a movable tripping spring constructed to engage with the said lever and disengage it from the said shoulder to permit the said face to act, a pattern-wheel, and connections between the said wheel and tripping-spring, whereby the same is caused to act, substantially as described.

23. In a machine for knitting stockings, the combination with a dial provided upon its upper face with a semi-circular putting-up flange having an elevated step at one end, means for operating the said dial in rotary and oscillatory movement, a pivotal putting-up lever extended over the dial to engage with the said flange and the step thereof, and furnished with a putting-up cam which puts up the instep needles, an operating spring and a movable tripping-spring for the said lever, a vertically movable slide carrying the tripping-spring, means controlled by the said slide for cutting in and cutting out a reinforce thread, a pattern-wheel, and operating connections between the said slide and wheel, substantially as described.

24. In a knitting-machine, the combination with the pattern mechanism thereof, of a vertically movable slide, operating connections between the said mechanism and slide, a chute carried by the slide for cutting in or feeding a reinforce thread, a pivotal cutting-off arm arranged to swing over the said chute, a cutting-off block with which the said arm engages to sever the thread, and a connection between the said arm and slide, the downward movement whereof causes the arm to be thrown against the said block, substantially as described.

25. In a machine for knitting stockings, the combination with a primary and a secondary pattern-wheel, corresponding to each other in size, but differentiated in the depth of their notches and the former having movable blocks which are disposed upon its edge in accordance with the pattern, of a pawl arranged to co-operate with the notches of both wheels, the actuation of the primary wheel

being variable and intermittent, substantially as described.

26. In a machine for knitting stockings, the combination with a primary and a secondary pattern-wheel corresponding in size, but differentiated in the depth of their notches, the latter having shallow, medium, and deep notches, and the former uniform notches which are virtually deepened by blocks applied to the wheel in conformity with the movement which it is desired to impart to it; of a pawl to co-operate with the notches of both wheels, whereby the primary wheel has a variable intermittent movement, while the secondary wheel has a constant intermittent movement, substantially as described.

27. In a knitting machine, the combination with a primary and a secondary pattern-wheel corresponding in size, but differentiated in the depth of their notches, of an auxiliary tooth combined with the primary pattern-wheel; and an operating pawl adapted to co-operate with the notches of the said wheels and the said auxiliary tooth which causes the secondary pattern-wheel to skip one movement, substantially as described.

28. In a machine for knitting stockings, the combination with a circular series of needles, and means for operating the same, of a putting-up and putting-down cam, having a substantially diamond-shaped operating face, and means for moving the said cam radially and upwardly with respect to the said needles, substantially as described.

29. In a machine for knitting stockings, the combination with a circular series of needles, of two draw cams, two raise-cams located between the same, a universal putting up and putting-down cam located above the raise-cams, and means for moving the said universal cam radially and upwardly with respect to the needles, substantially as described.

30. In a machine for knitting stockings, the combination with a needle-dial and means for operating the same in rotary and oscillatory movement, of two draw-cams and two raise-cams located between the same, a universal cam located above the raise-cams extending over the edge of the said dial in the path of the butts of the needles carried thereby, and constructed to have putting up and putting-down functions, pattern-mechanism, and operating connections between the said cam and mechanism, whereby the cam is jumped over the butts of the needles and moved across the path thereof, substantially as described.

31. In a machine for knitting stockings, the combination with a needle-dial and means for operating the same in rotary and oscillatory movement, two draw-cams, two raise-cams located between the same, a putting-up and putting-down cam located above the raise-cams, extending over the dials in the paths of the needles thereof, and having a substantially diamond-shaped operating-face, a piv-

otal cam-bar hung by its outer end and carrying the said cam at its inner end, a reciprocal carriage in which the said bar is mounted, pattern mechanism, and connections between the said mechanism and bar and carriage, whereby the cam is moved across the paths of the needles and jumped over the butts thereof, substantially as described.

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

JOSHUA DARLING HEMPHILL.

Witnesses:

FRED C. EARLE,
GEO. D. SEYMOUR.