

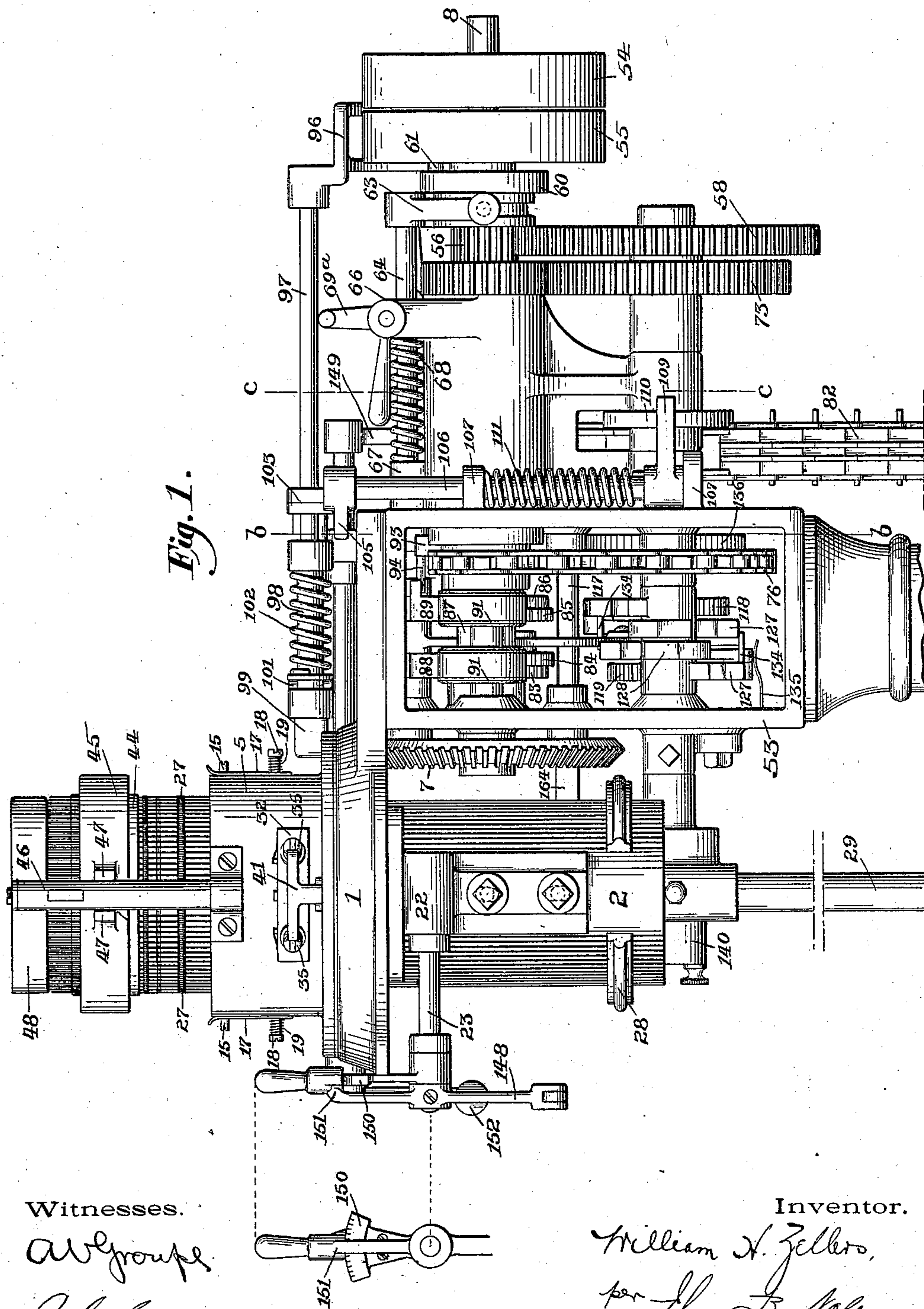
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8 Sheets—Sheet 1.

W. H. ZELLERS.
AUTOMATIC KNITTING MACHINE.

No. 548,946.

Patented Oct. 29, 1895.



Witnesses.

W. H. Zellers
A. B. Graham

Inventor.

William H. Zellers
per John F. Nolan

Attorney.

8 Sheets—Sheet 2.

No. 548,946.

Patented Oct. 29, 1895.

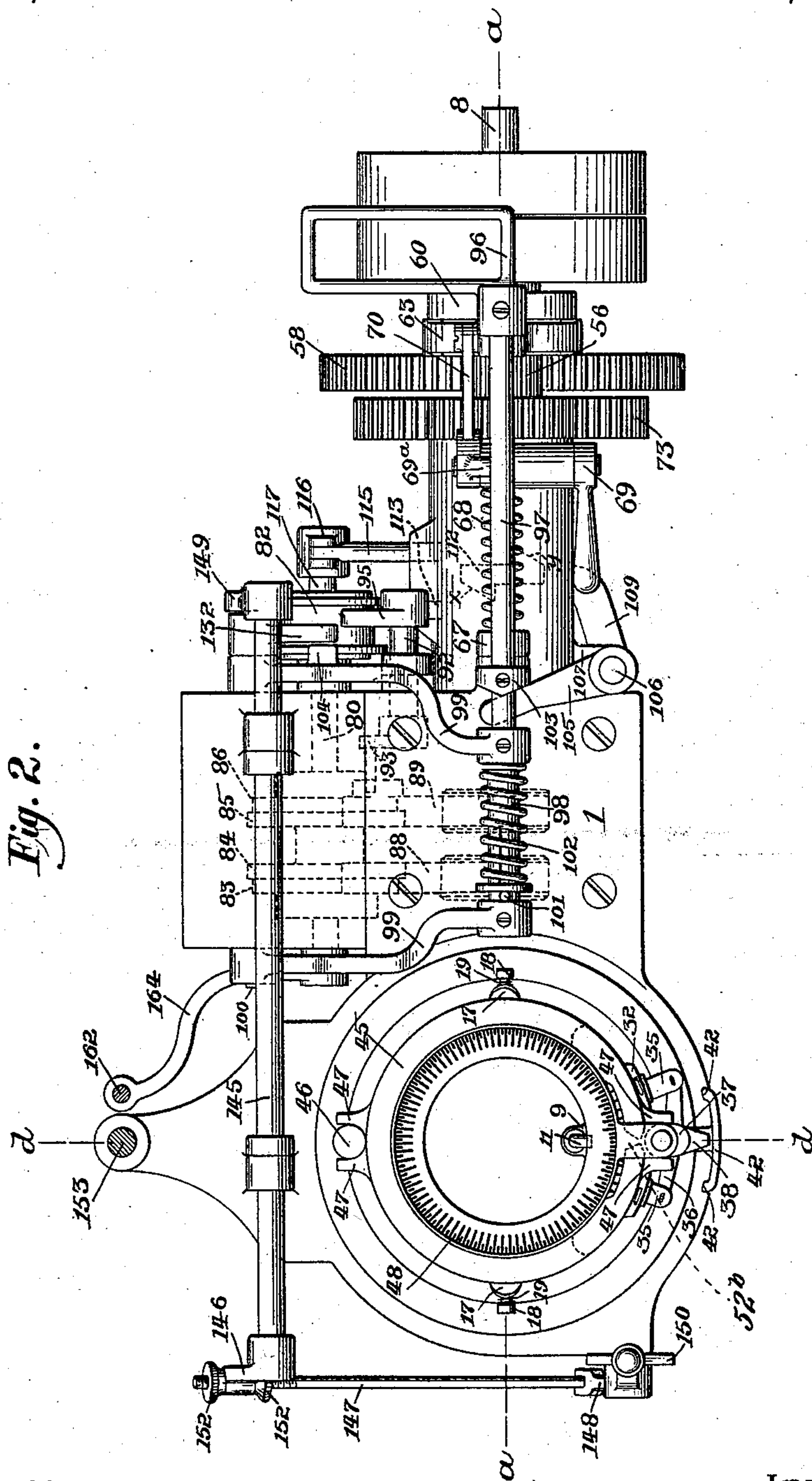


Fig. 2.

Inventor,

awlgroupe
A. Somers

William N. Zeller.
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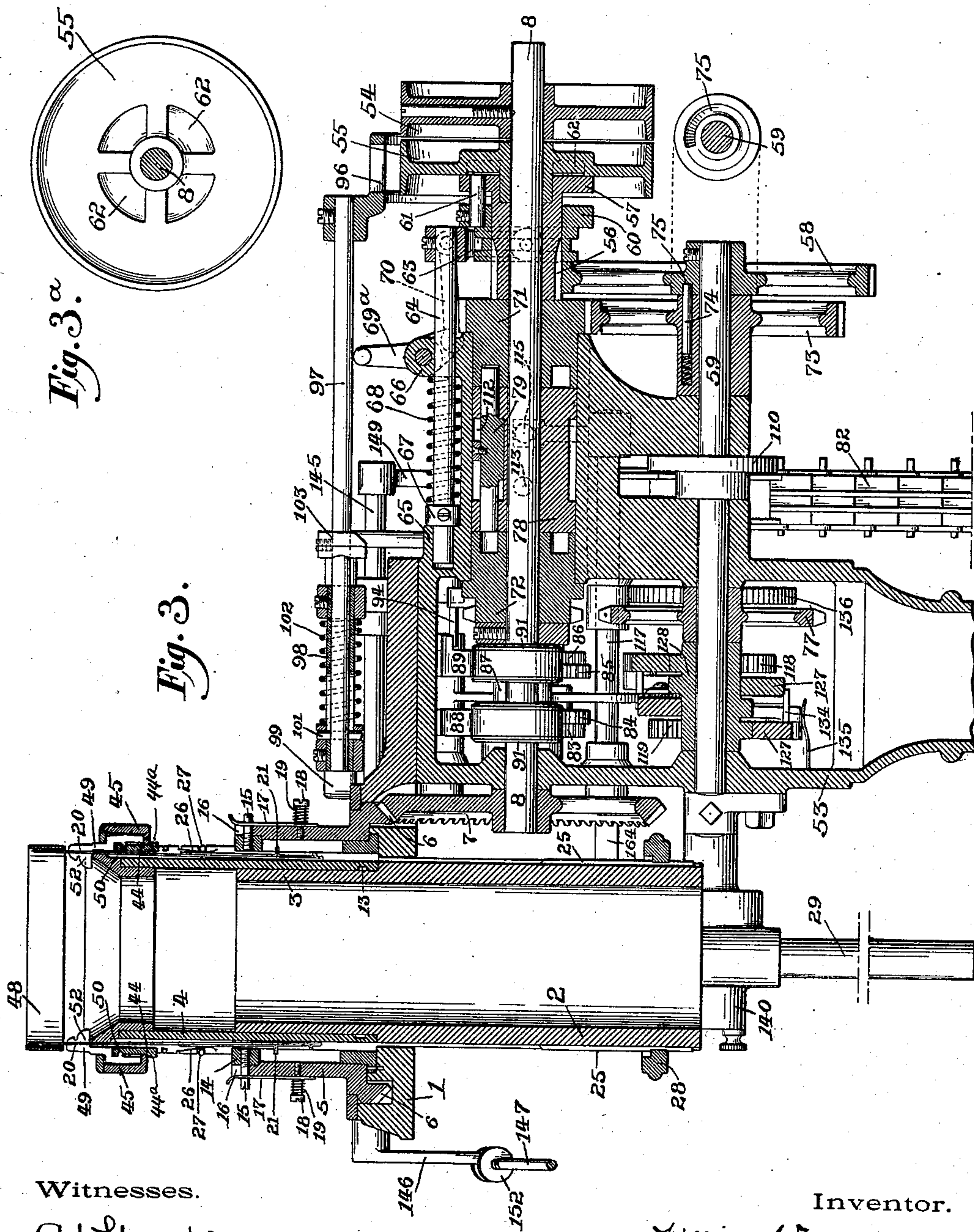
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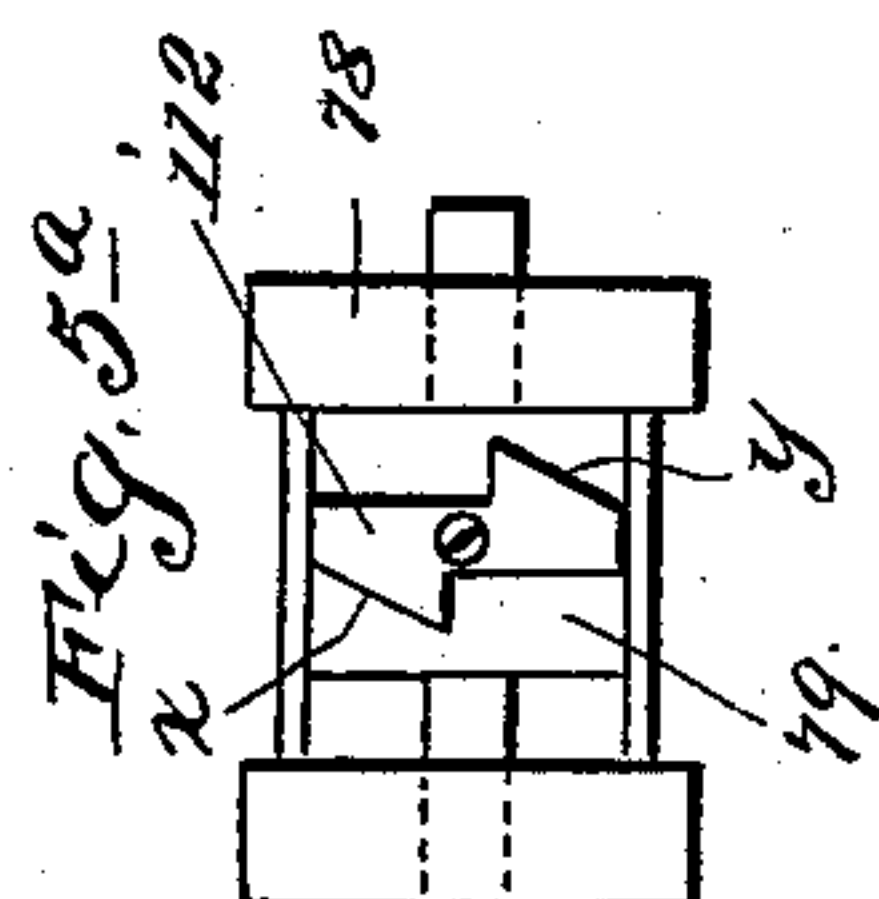


Fig. 5.

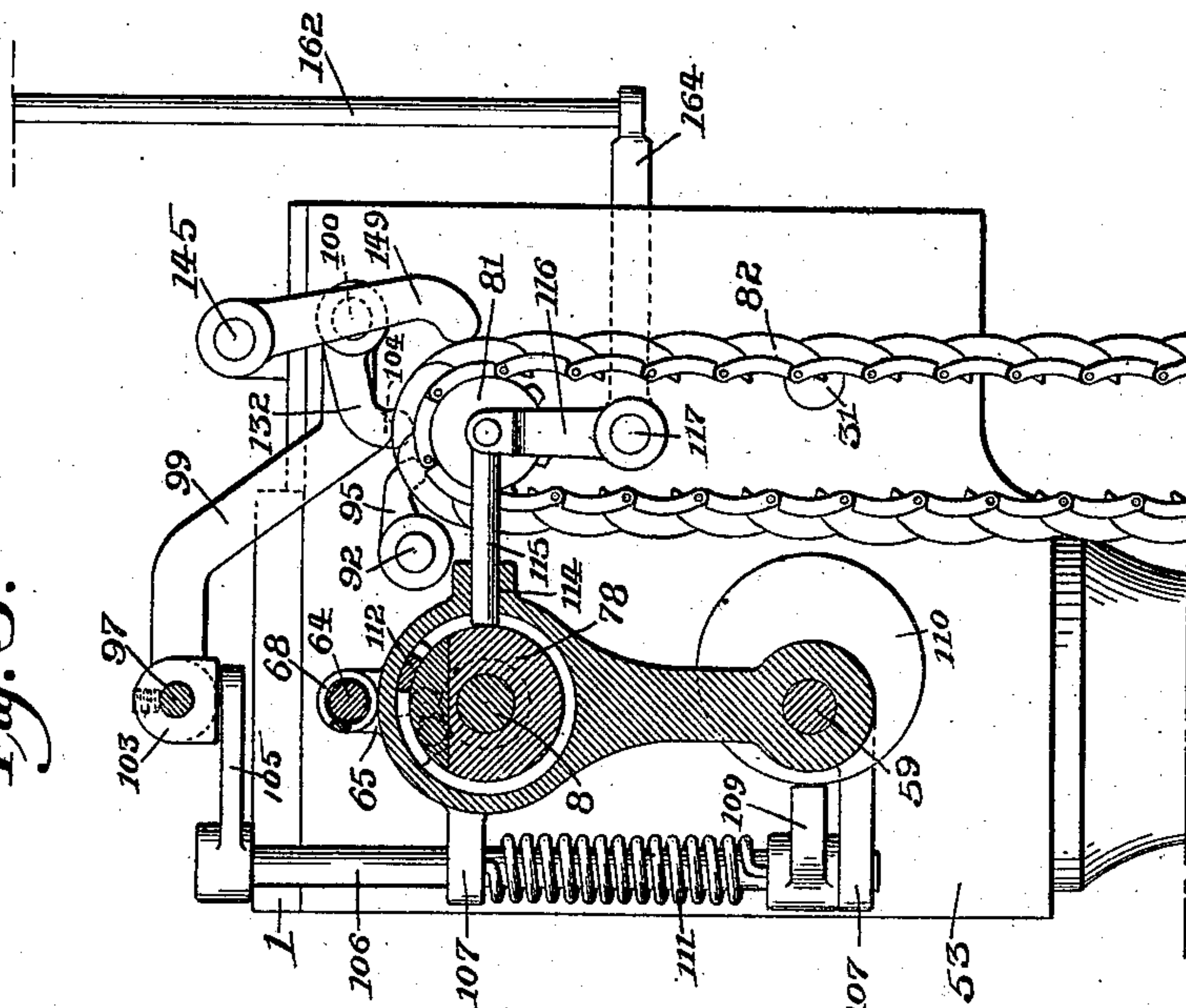


Fig. 4.

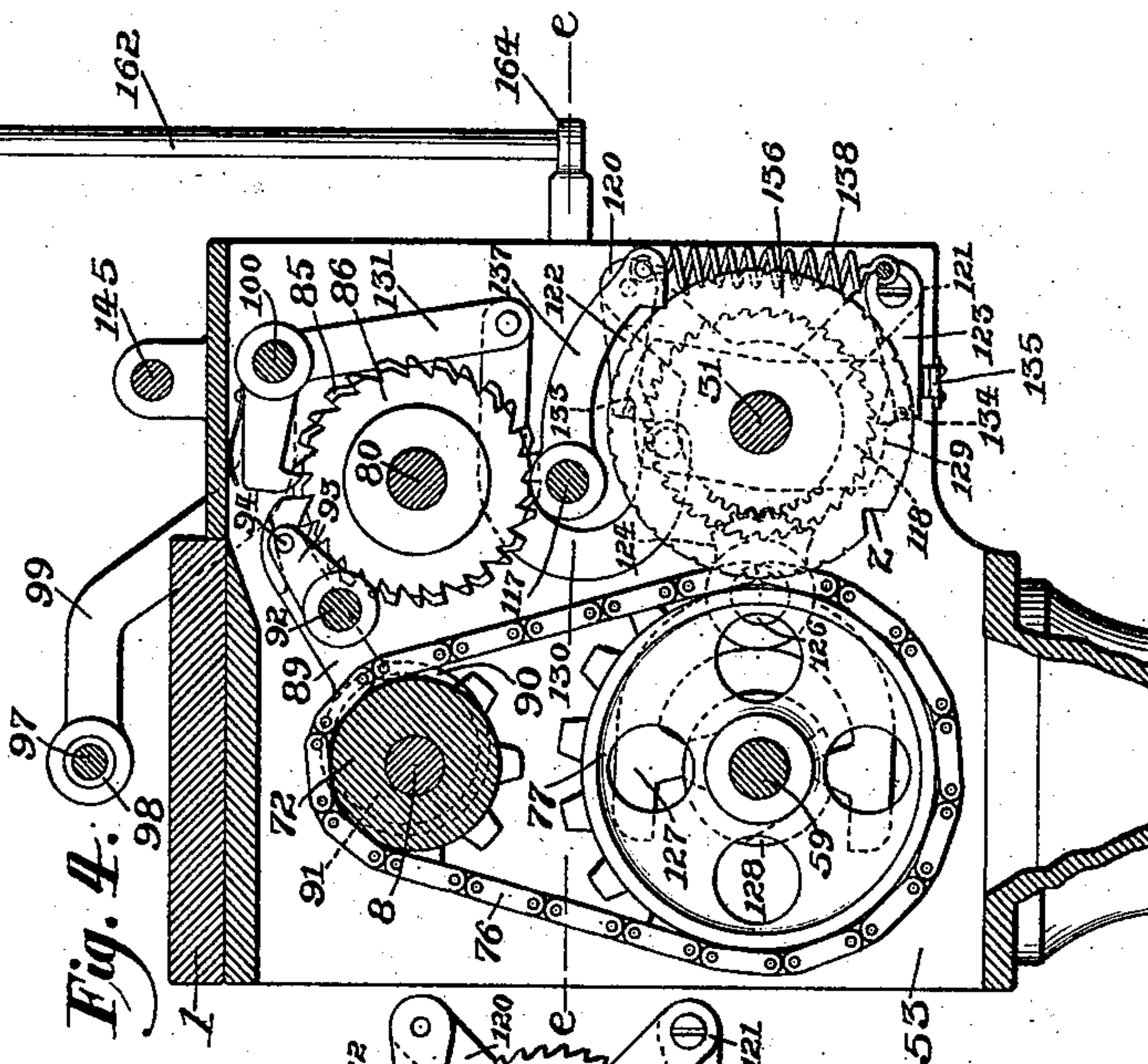
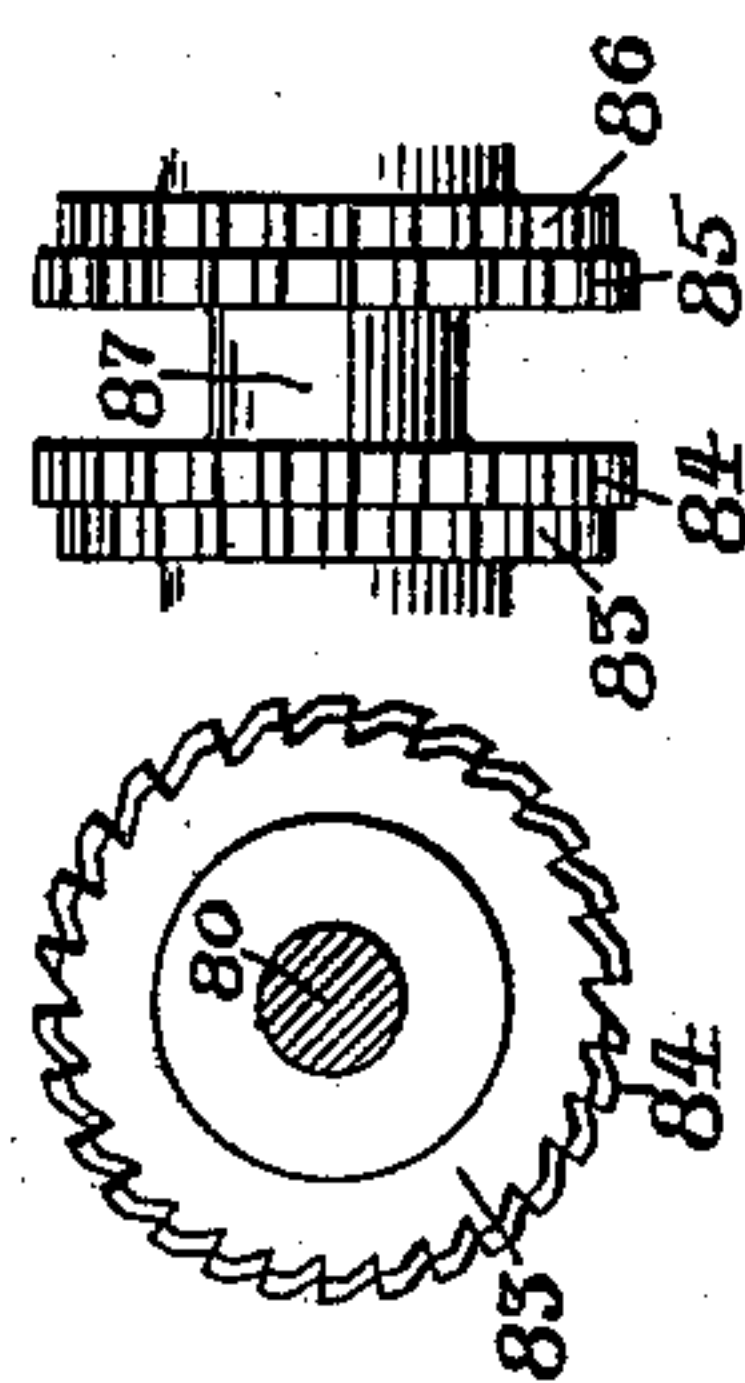
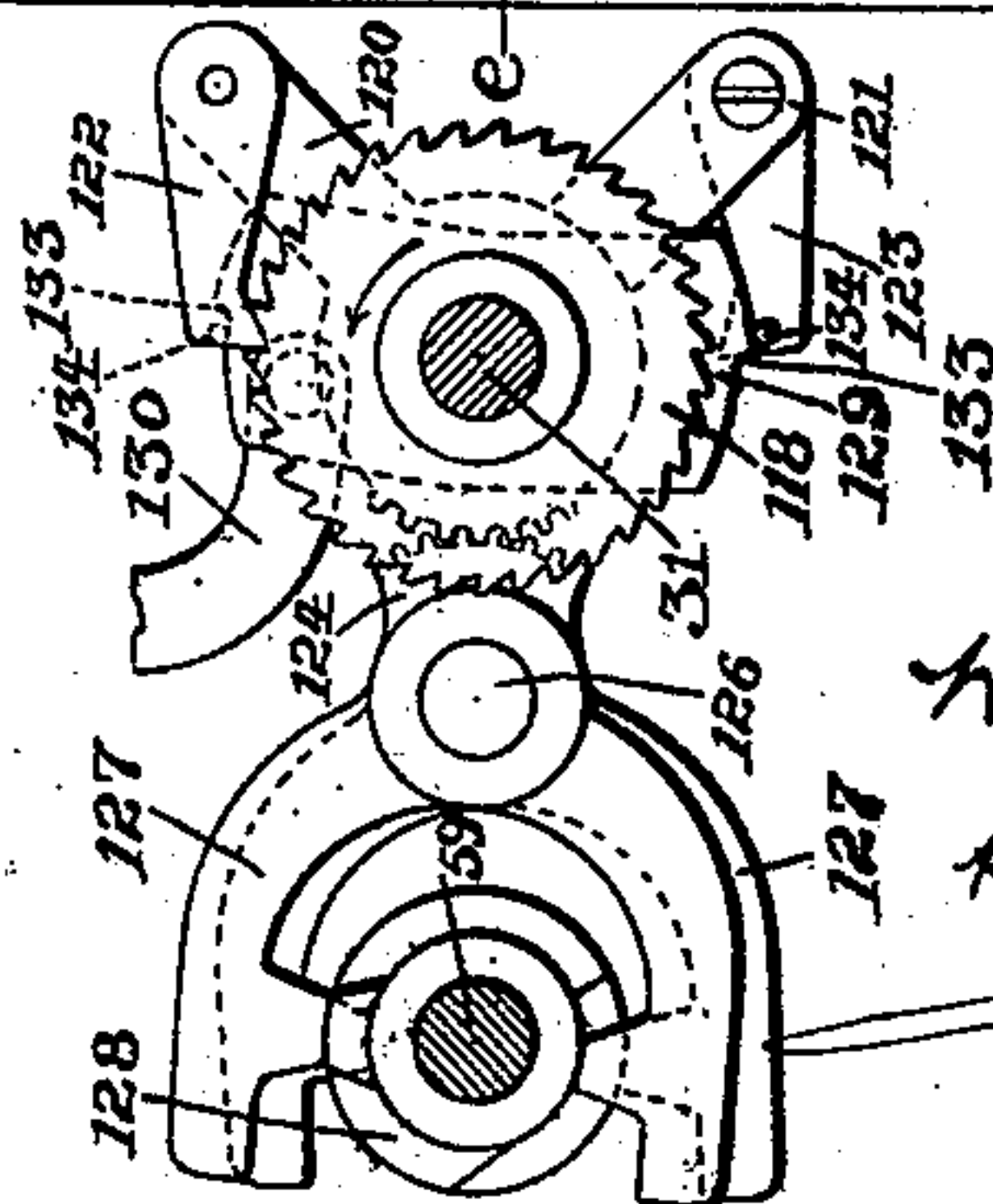


Fig. 4.



Witnesses:

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(No Model.)

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Fig. 8.

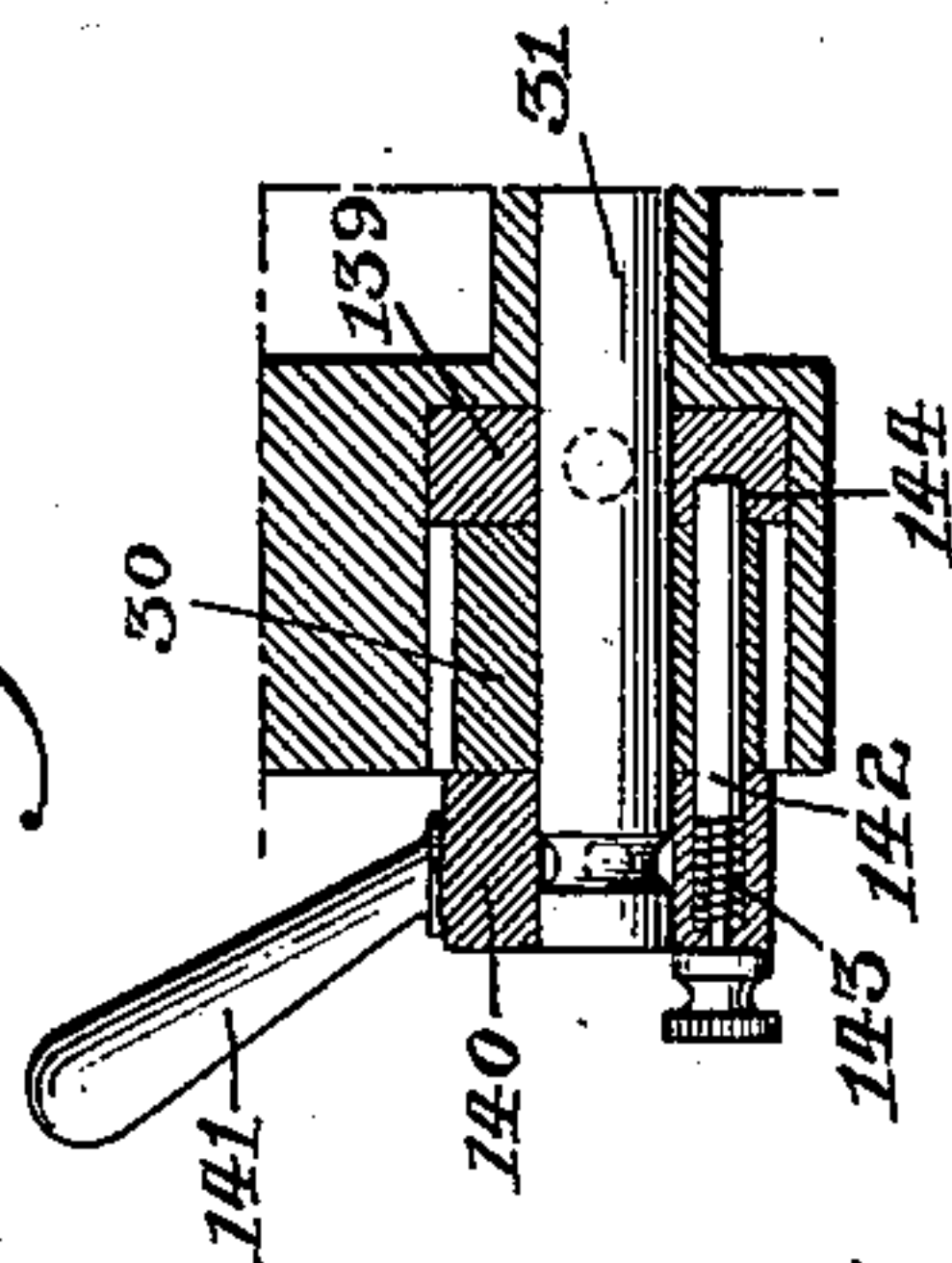
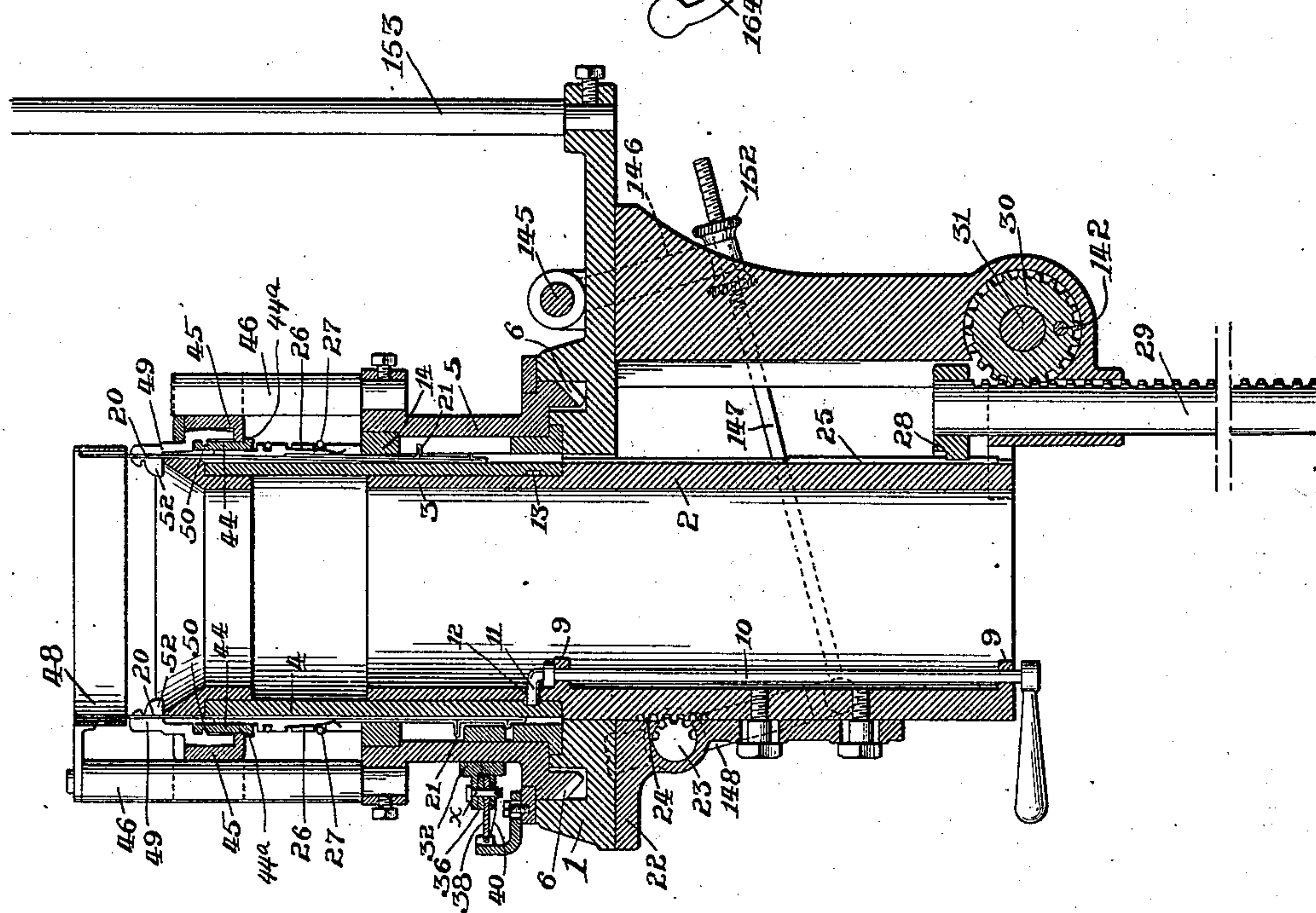
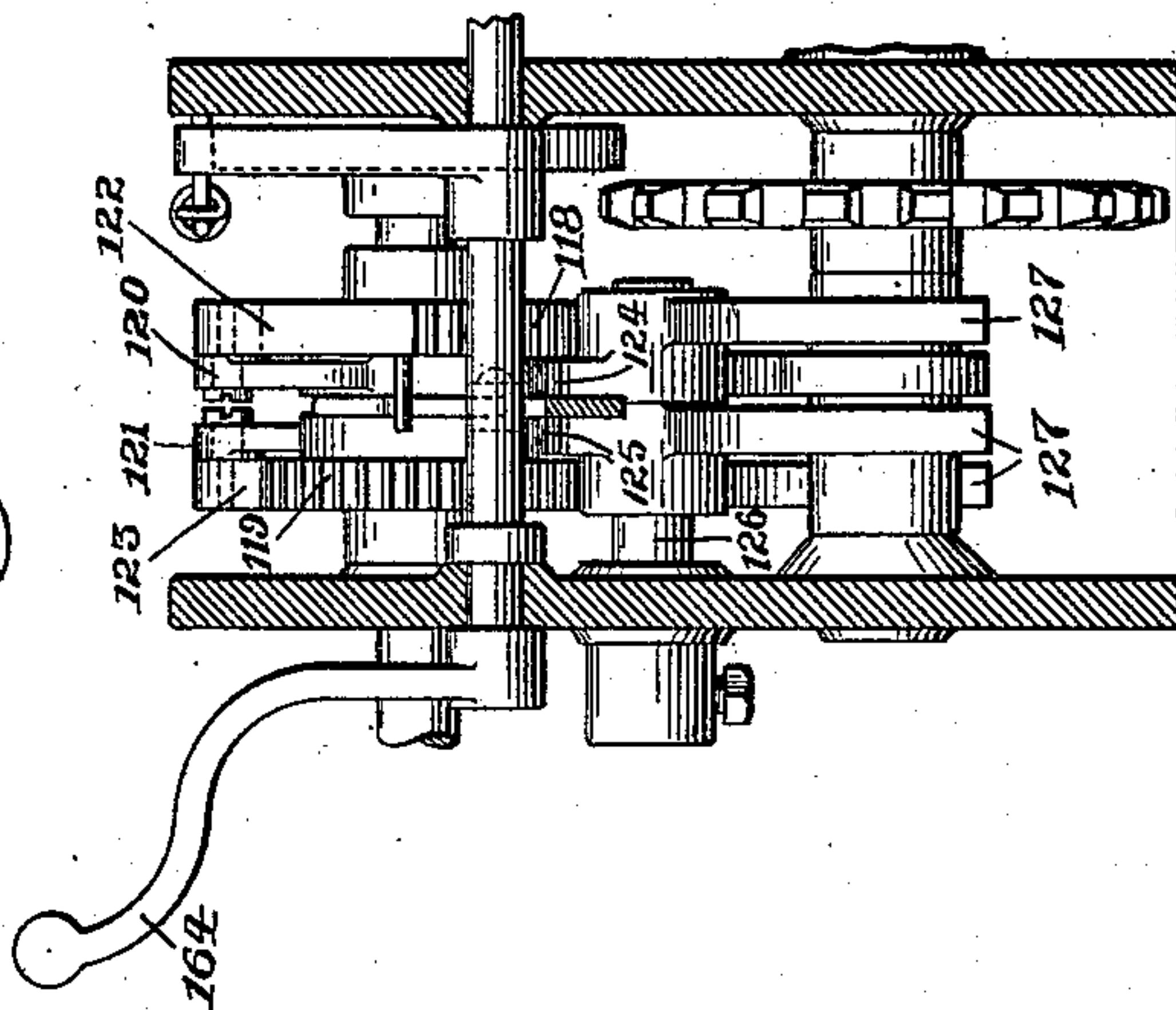


Fig. 7.



Witnesses.

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Fig. 6.

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(No Model.)

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Fig. 9.

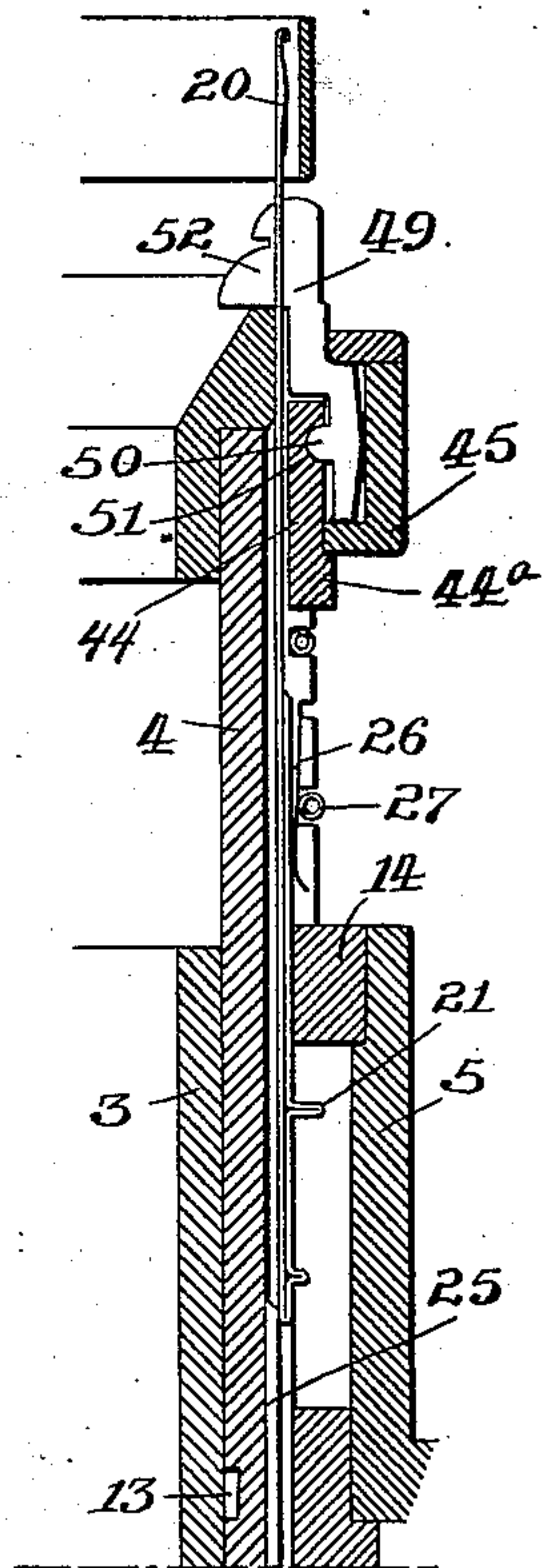


Fig. 10.

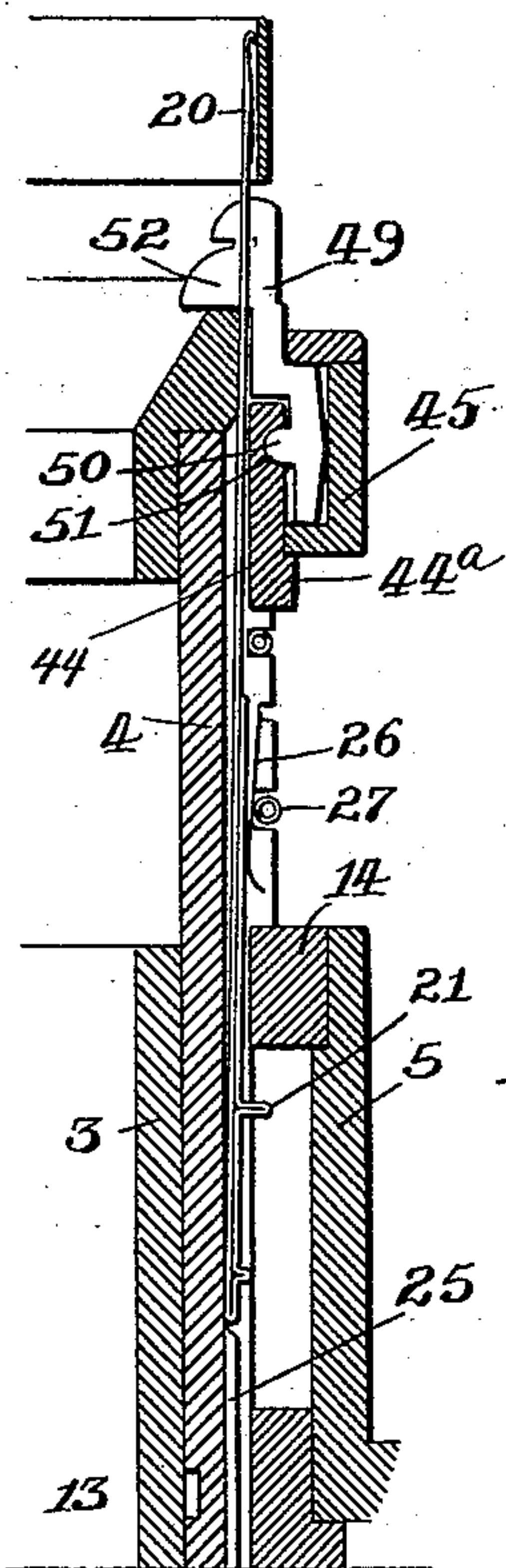


Fig. 12.

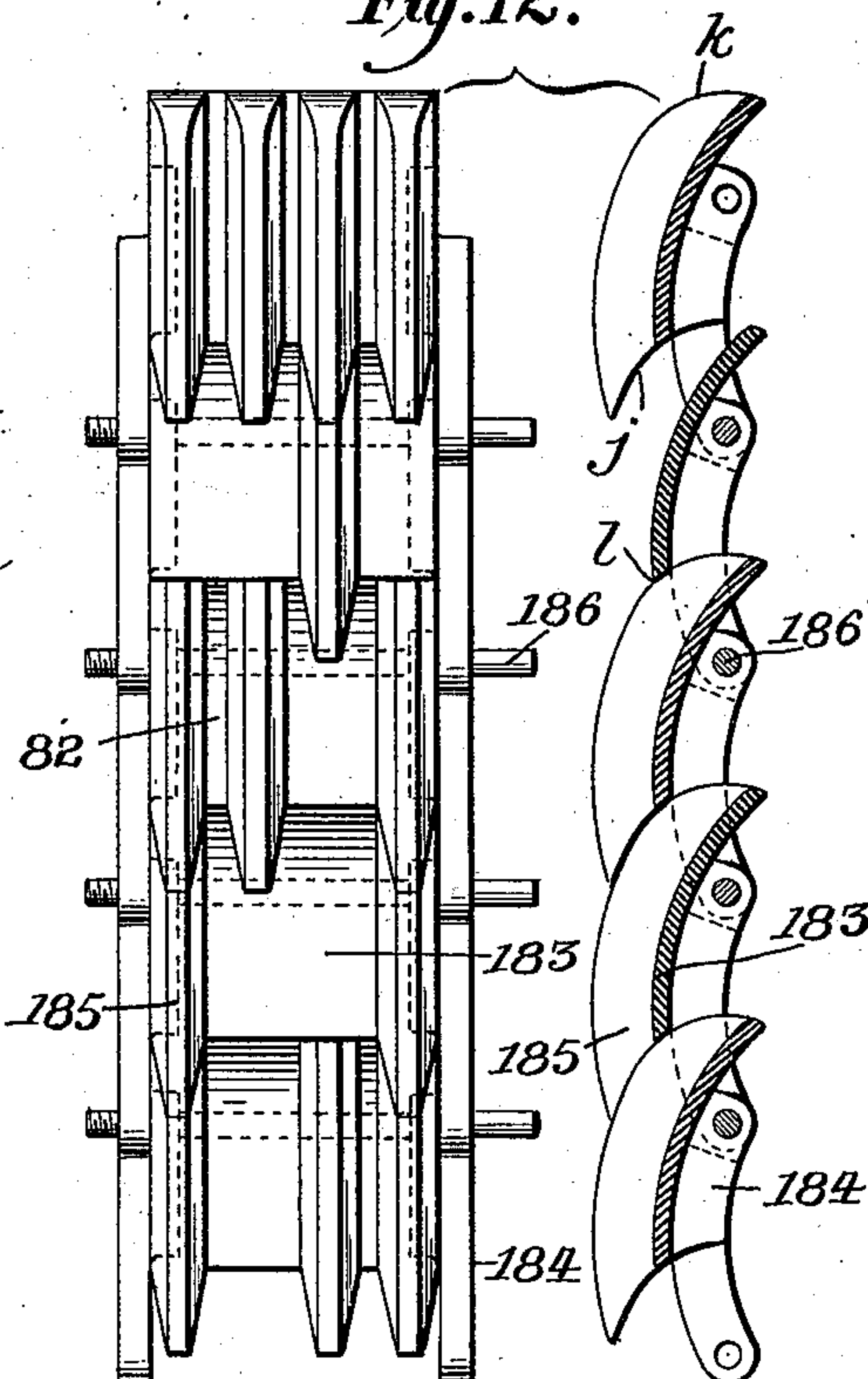


Fig. 9^a.

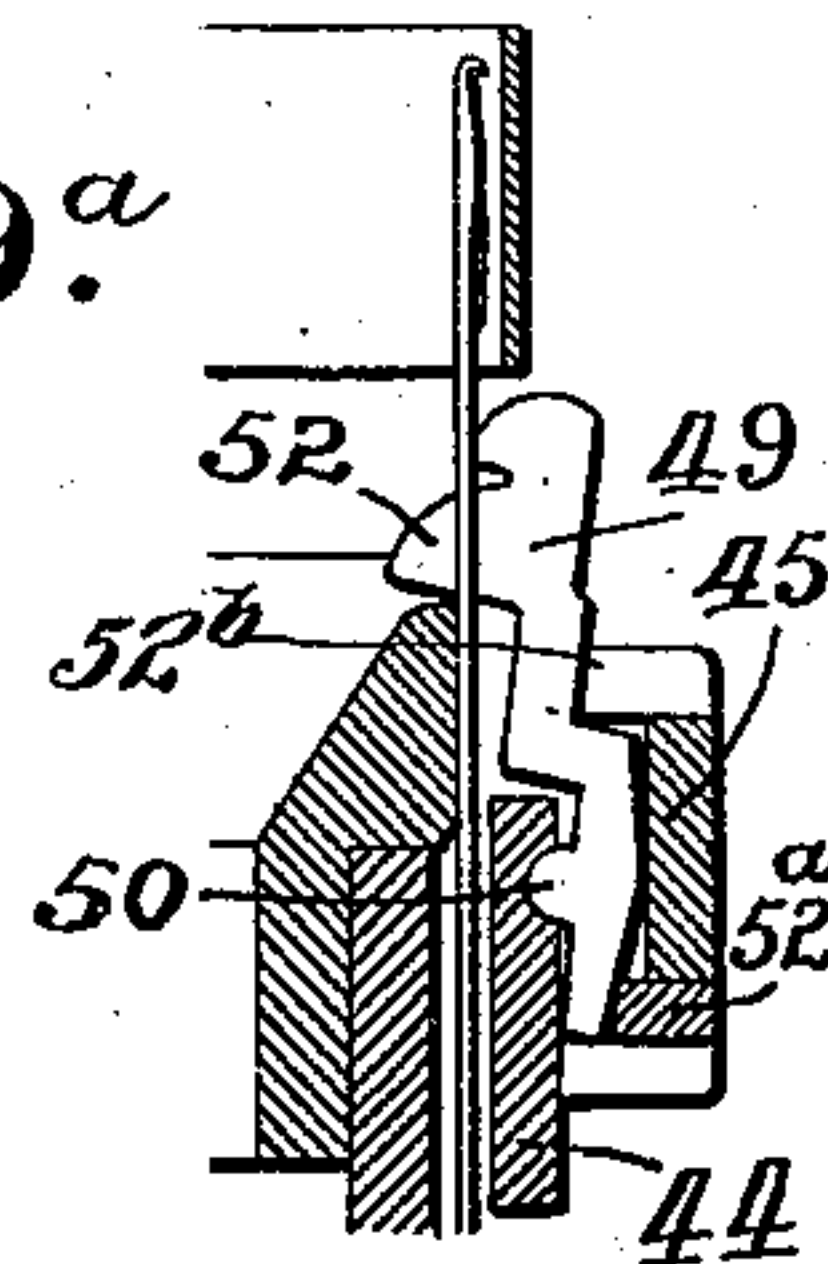
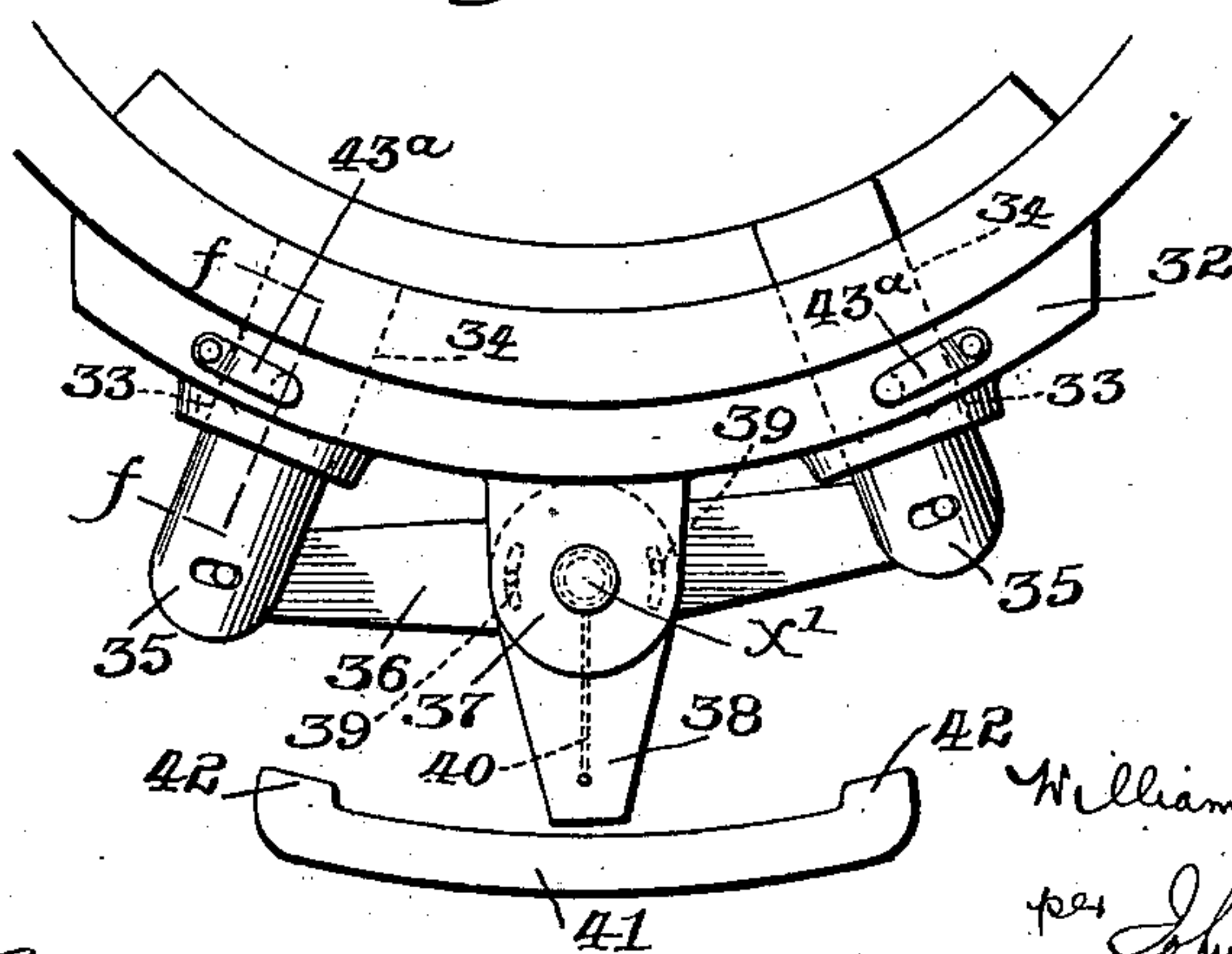
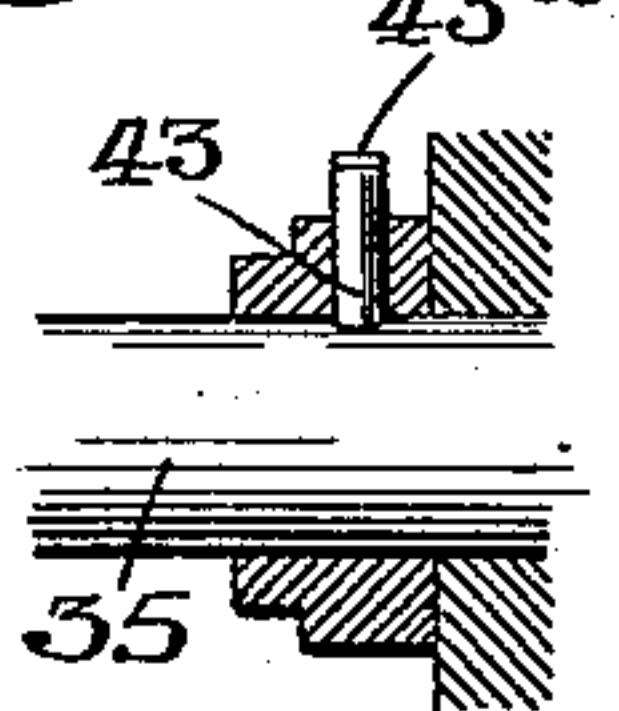


Fig. 11.

Fig. 11^a.



Witnesses.

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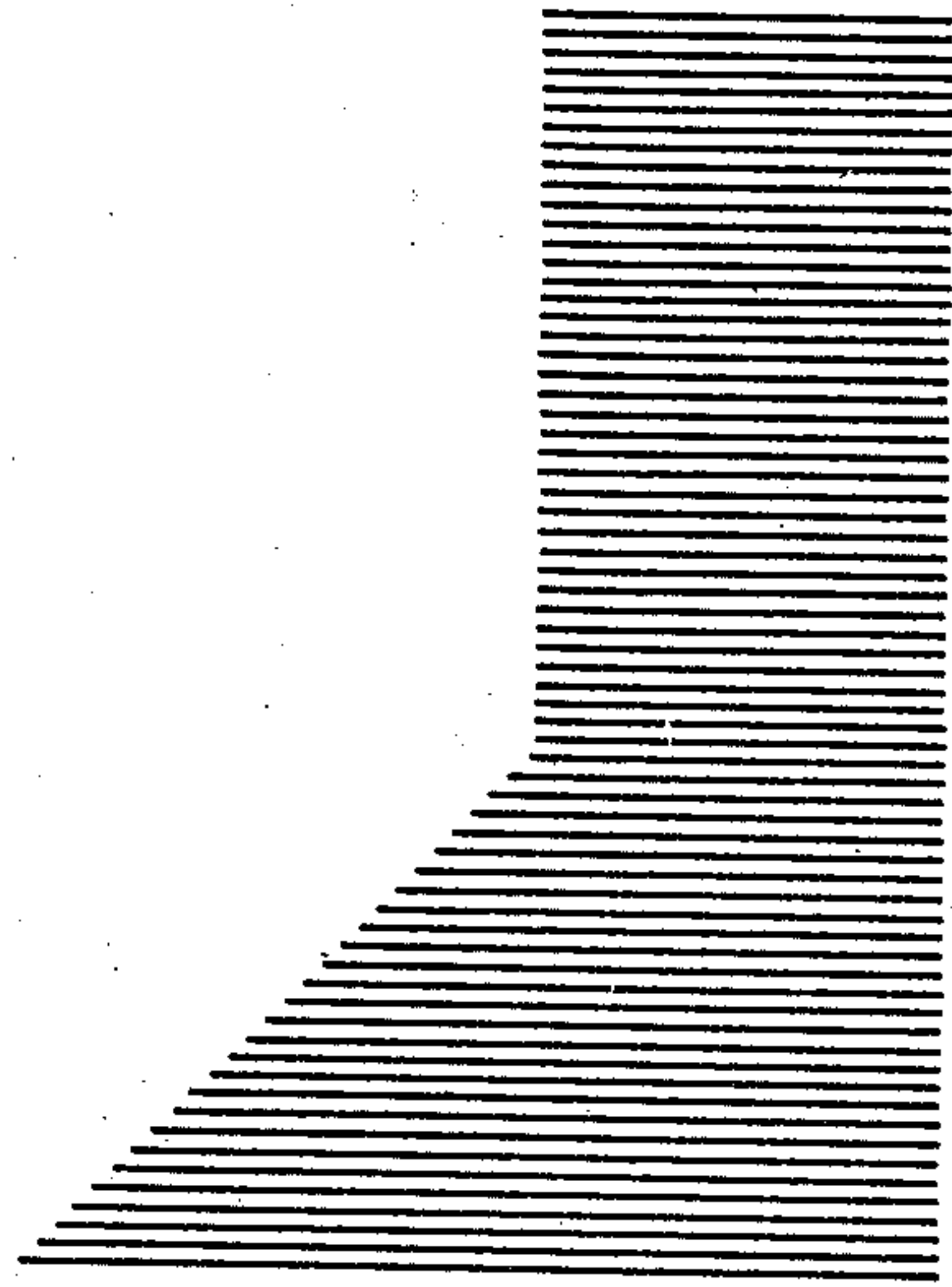


Fig. 13.

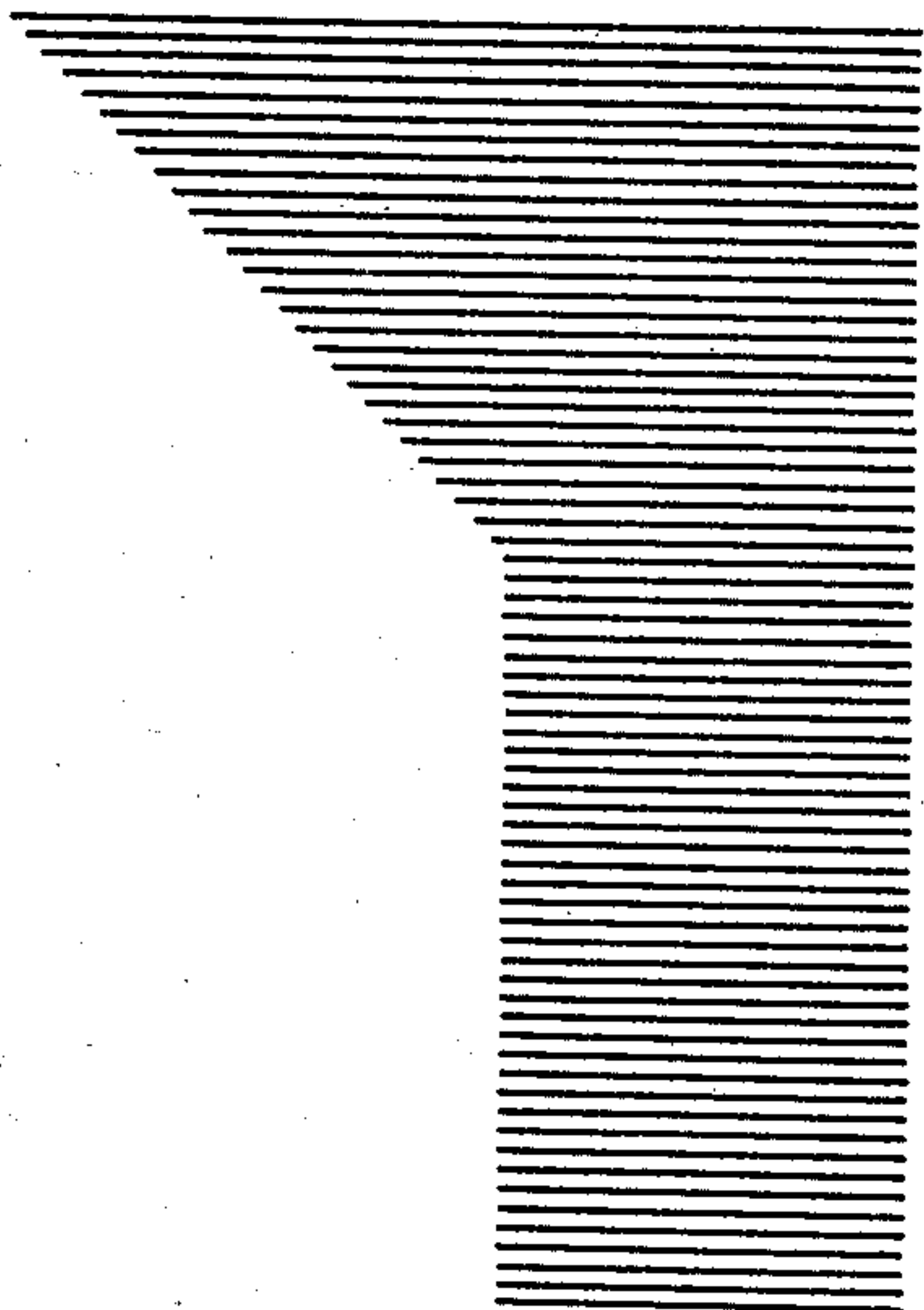


Fig. 14.

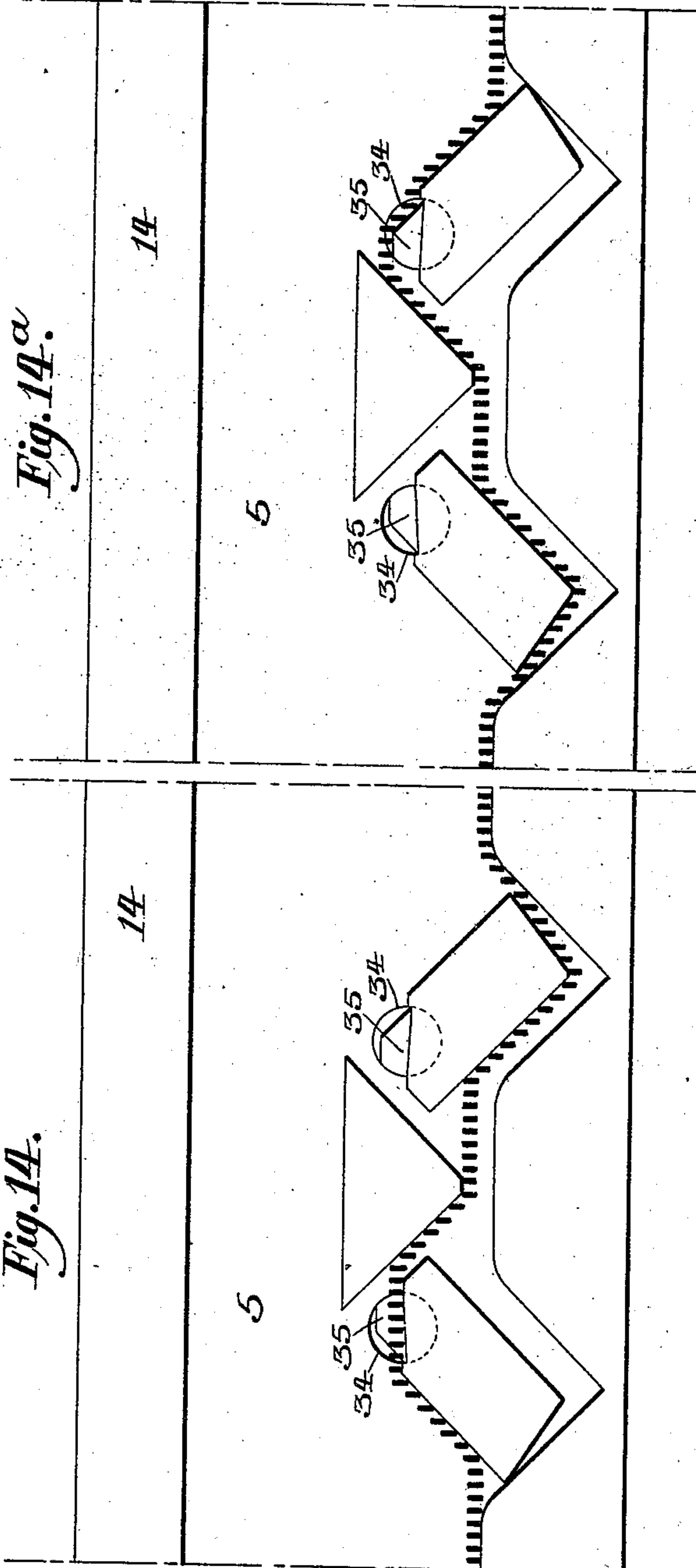


Fig. 14^a.

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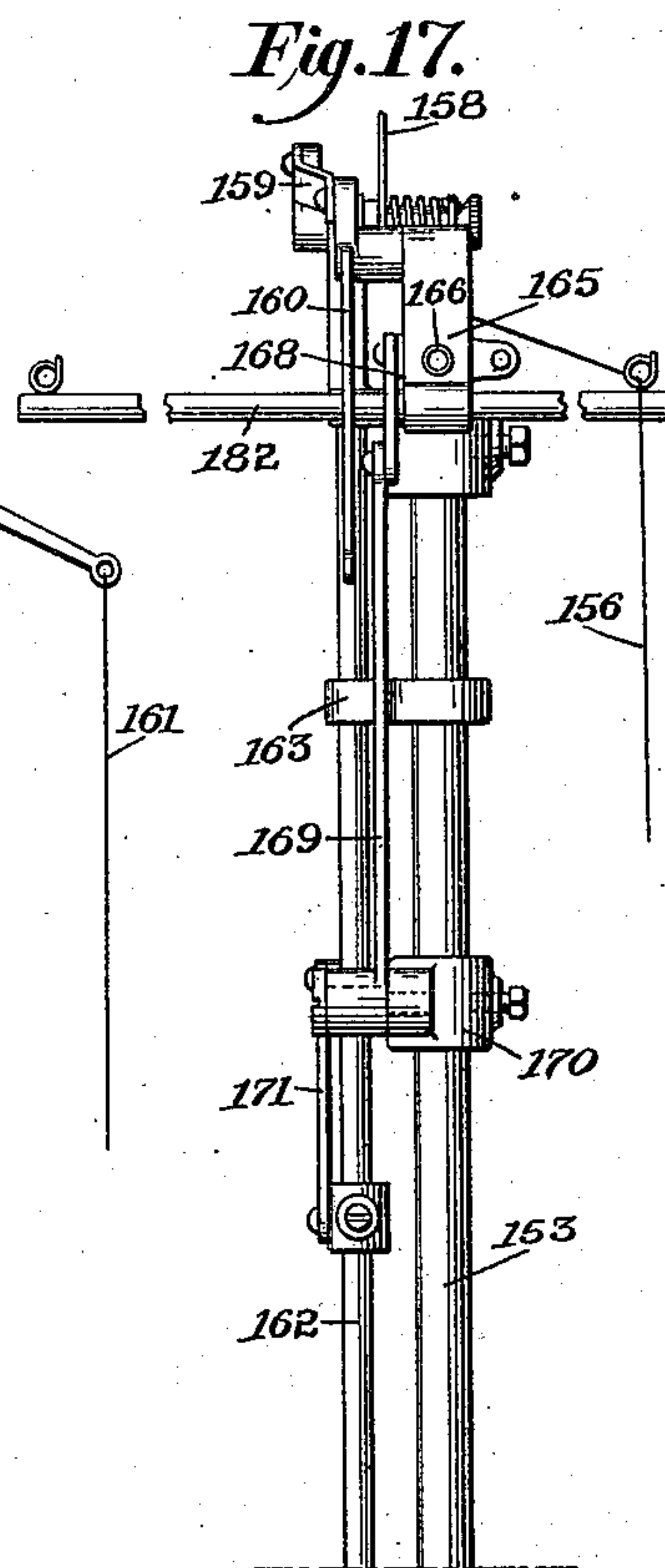
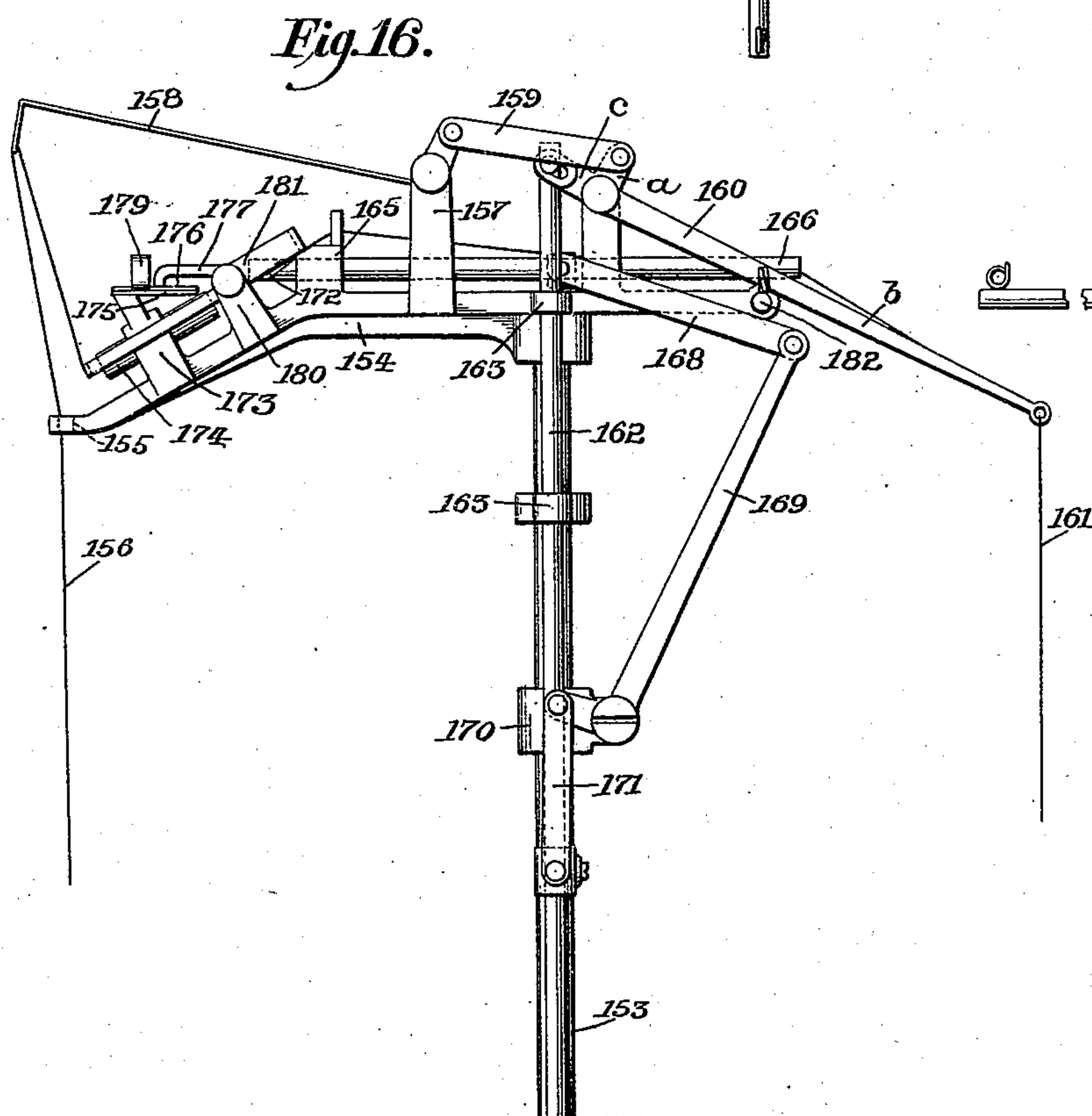
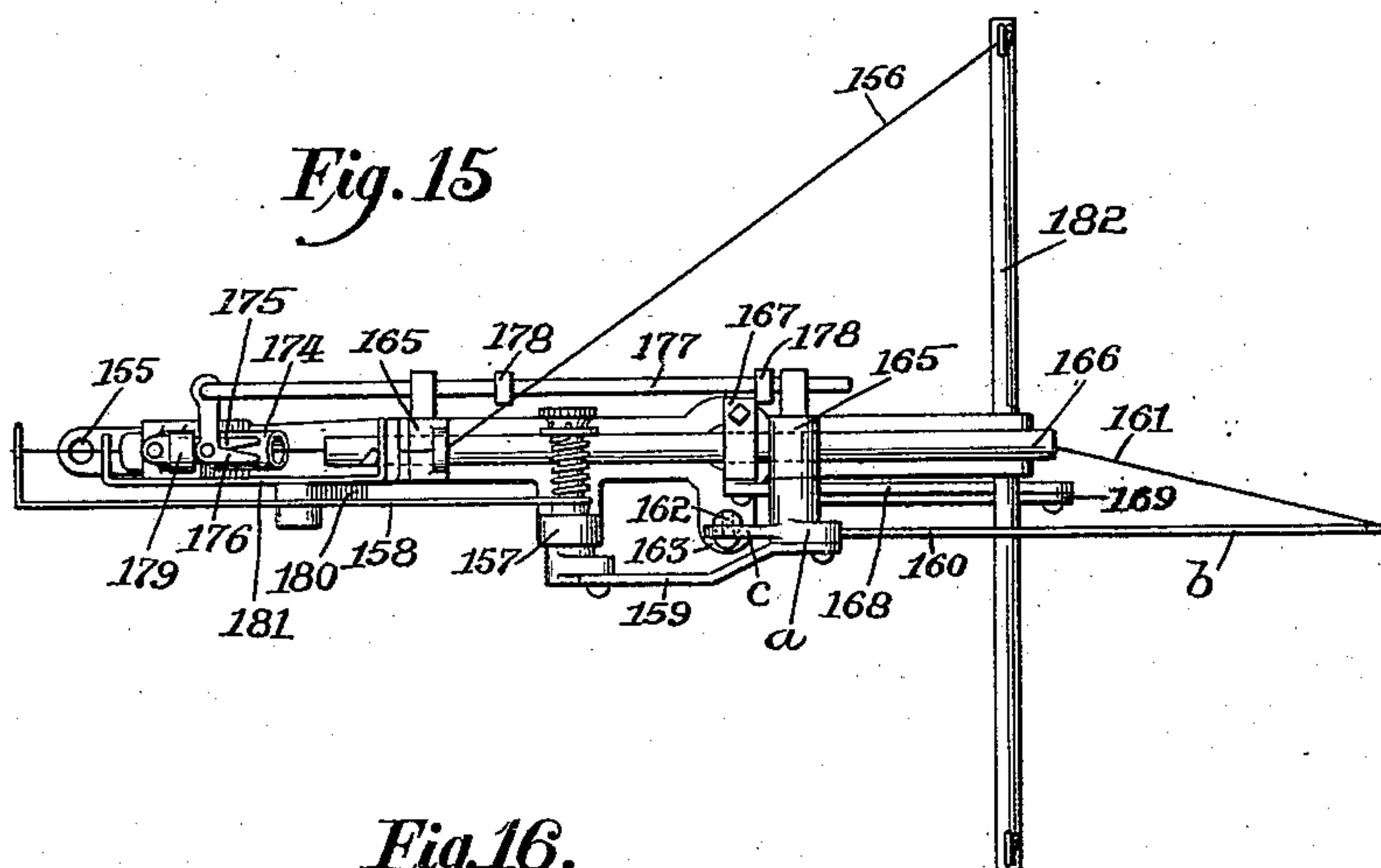
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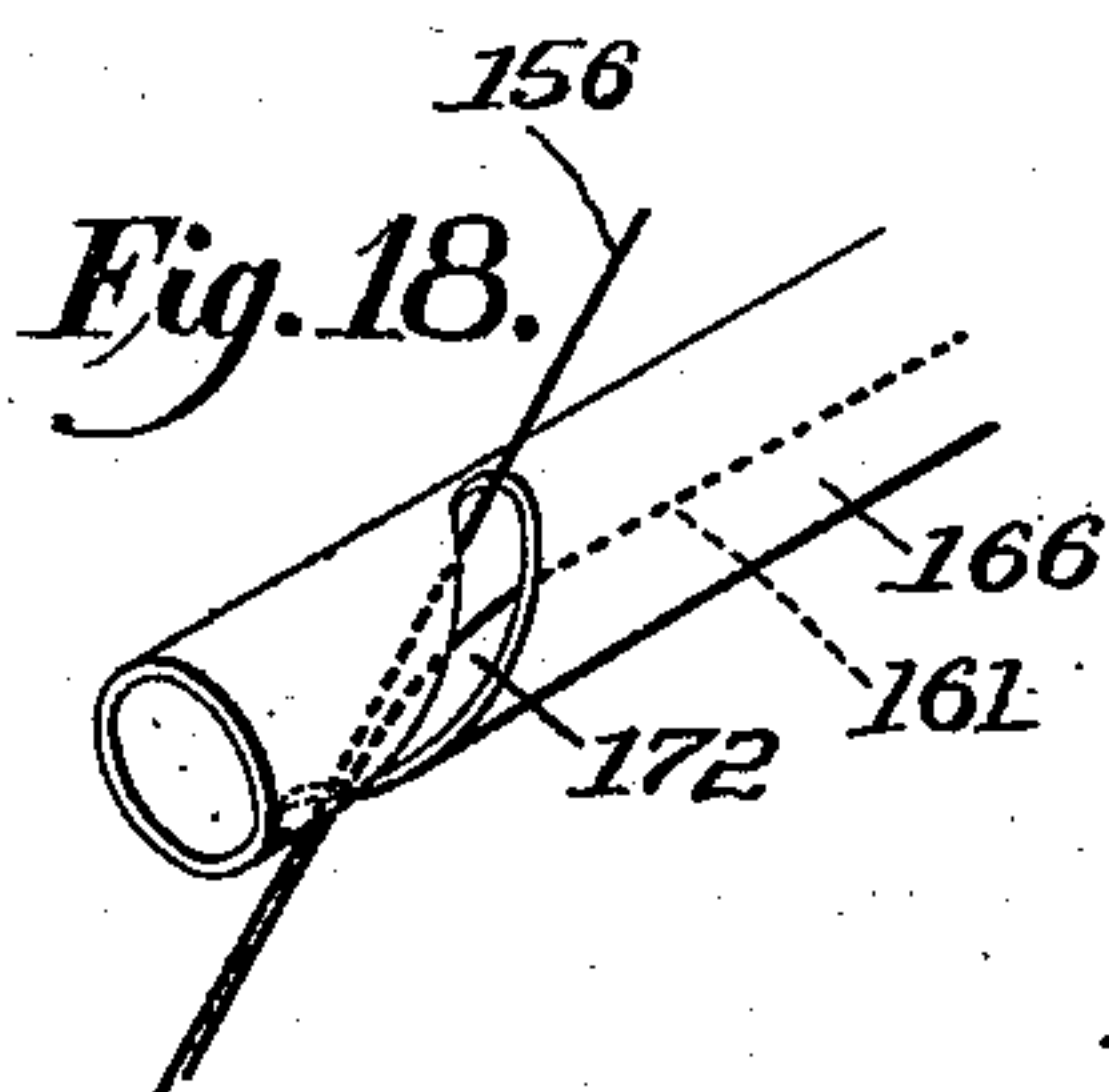
No. 548,946.

Patented Oct. 29, 1895.



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UNITED STATES PATENT OFFICE.

WILLIAM H. ZELLERS, OF PHILADELPHIA, PENNSYLVANIA.

AUTOMATIC KNITTING-MACHINE.

SPECIFICATION forming part of Letters Patent No. 548,916, dated October 29, 1895.

Application filed December 8, 1894. Serial No. 531,182. (No model.)

To all whom it may concern:

Be it known that I, WILLIAM H. ZELLERS, a citizen of the United States, residing at the city and county of Philadelphia and State of Pennsylvania, have invented certain new and useful Improvements in Automatic Knitting-Machines, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings, forming a part of this specification.

This invention relates particularly, though not exclusively, to that class of circular-knitting machines wherein automatic mechanism is employed for periodically effecting the disengagement and re-engagement of certain needles from and with the knitting-cams for the purpose of narrowing and widening the web, respectively, the same being requisite during the formation of the heel and toe parts of a stocking.

The present invention applies more especially to the mechanism comprehended in and by my Letters Patent of the United States No. 476,110, dated May 31, 1892, wherein is described a series of vertically-movable bits or fingers of varying lengths constructed and arranged to co-operate with a corresponding series of needles to maintain the latter normally engaged with the knitting-cams, together with means for operating said bits or fingers as a unit, to render such needles idle and active at predetermined intervals, as will more fully appear by reference to said patent.

The leading features of the invention herein embrace, first, certain improvements in the construction and arrangement of the needle-cylinder, the bit-cylinder, and the cam, cylinder, and of their adjuncts, respectively, whereby advantages are secured; secondly, automatic means whereby the continuous rotary and the rotary reciprocating movements are imparted to the cam-cylinder at prescribed stages of the knitting operation; thirdly, means whereby the requisite step-by-step movements are imparted to the needle-controlling bit mechanism during the reciprocating operation; fourthly, means for periodically supplying an additional or splicing thread with the main thread or threads; fifthly, a novel and advantageous construction of the pattern-chain, and, finally, various features of construction and organization of the several

parts of the mechanisms referred to whereby a compact, efficient, and comparatively simple automatic knitting-machine is provided, all of which will be hereinafter particularly described and claimed.

In the annexed drawings, Figure 1 is a side elevation of the machine with the thread-feeding mechanism omitted. Fig. 2 is a plan thereof. Fig. 3 is a longitudinal vertical section as on line *a a* of Fig. 2. Fig. 3^a is a face view of the loose pulley on the driving-shaft. Figs. 4 and 5 are transverse vertical sections as on the lines *b b* and *c c*, respectively, of Fig. 1. Fig. 4^a is a detail in end and front view of the coacting ratchet-wheels on the pattern-chain shaft. Fig. 4^b is a detail of the ratchet mechanism for controlling the bit devices. Fig. 5^a is a detail of the bolt-reciprocating cam and its adjuncts. Fig. 6 is a transverse vertical section as on the line *d d* of Fig. 2. Fig. 7 is a transverse horizontal section as on the line *e e* of Fig. 4. Fig. 8 is a detail in section of devices for independently operating the bit-supporting segment. Figs. 9 and 10 are vertical sections, on an enlarged scale, through one side of the cylinders, showing a needle in and out of action, respectively, together with their adjunctive parts. Fig. 9^a is a sectional detail showing the operation of the sinker-cam. Fig. 11 is an enlarged plan of a portion of the cam-cylinder, showing the reciprocative stud-cams and the means for operating them. Fig. 11^a is a section on line *f f*. Fig. 11. Fig. 12 illustrates a front view and a vertical section of a portion of the pattern-chain. Fig. 13 is a development of the bits. Figs. 14 and 14^a illustrate the knitting-cams developed, showing their action upon the needles during the knitting of straight and fashioned work, respectively. Fig. 15 is a plan of the thread-feed devices. Figs. 16 and 17 are side and end elevations thereof, respectively. Fig. 18 is a perspective view, enlarged, of the forward end of the reciprocative thread-guiding tube.

The numeral 1 designates a bed-plate in which is supported an elongated peripherally-grooved cylinder 2, hereinafter termed the "bit-cylinder." The upper portion of the cylinder is reduced, as at 3, to receive the usual needle-cylinder 4. Surrounding the lower portion of the needle-cylinder is the cam-cylinder

5, the flanged bottom of which is supported upon the bed-plate and is provided with bevel gear-teeth 6, which are engaged by the teeth of a bevel-wheel 7 on a horizontal driving-shaft 8, as usual.

On the interior of the bit-cylinder are two vertically-opposite perforated lugs 9, in which is supported a vertical rod 10, the upper end of which is bent to form a stud 11, that may be turned into or out of a registering slot 12 and groove 13 in the overlapping portions of the bit and needle cylinders, respectively, whereby said parts may be readily locked together or released. The lower end of this rod extends below the bit-cylinder and is provided with a suitable handle whereby it may be manipulated. Fitted loosely on the periphery of the needle-cylinder is a ring 14, which rests upon an internal shoulder on the cam-cylinder when the former cylinder is applied to the machine. On this ring are two diametrically-opposite pins 15, which extend through slots or recesses 16 in the top of the cam-cylinder and through orifices in vertically-arranged latch-plates 17 on the exterior of the cam-cylinder. Hence while the ring rotates with the cam-cylinder it closes the space between the latter and the needle-cylinder to the exclusion of dust, &c. The lower ends of the latch-plates are loosely applied to screw-pins 18 on the cam-cylinder, springs 19 being interposed between the plates and the screw-heads, respectively. By this construction the plates are held normally engaged with the pins on the ring, yet they may be readily disengaged therefrom by the act of drawing the plates outward against the stress of their respective springs, in which case, assuming the needle and bit cylinders to be unlocked, the needle-cylinder, with its needles 20, may be lifted bodily from the machine. The ring performs the additional function of preventing the needles from being thrown too high by the knitting-cams, said needles being provided with suitably-disposed hubs 21, which impinge against the ring when the needles are violently up-thrown.

Depending from the bed-plate, contiguous to the depending portion of the bit-cylinder is a bracket 22, into which freely extends a shaft 23, the inner end of said shaft being provided with gear-teeth that engage with corresponding teeth 24 on the cylinder, whereby the act of partially turning said shaft to the right or to the left will raise or lower the bit-cylinder and, perforce, the needle-cylinder, in consequence of which the length of the stitches may be increased or diminished, as required. By means of mechanism herein-after described the shaft 23, preparatory to the knitting of the ankle portion of the stocking, is automatically turned to effect the lowering of the bit and needle cylinders, in which position the latter are maintained until the ankle is completed. Hence the stitches forming the ankle are tighter than those in the preceding portion of the leg, and in conse-

quence the ankle portion is reduced. This being done, the cylinders are returned to their previous position to permit the knitting of normal stitches in the heel. Similarly, tight and normal stitches are knit in the foot and toe portions, respectively, of the stocking, as will farther on appear.

The grooves in which are contained the half series of needles that are thrown out of action preparatory to the knitting of the heel and toe parts, as also the grooves containing the two series of needles (usually each one-sixth of the entire needles) which are manipulated during the operations of widening and narrowing such parts, are of sufficient depth to permit the needles therein to be moved backward out of action from the knitting-cams. These needles are held normally in the track of the cams by means of vertically-arranged bits 25, which are fitted to the grooves in the bit-cylinder and are extended into the deepened grooves in the needle-cylinder in a manner to support the backs of the proximate needles. Said needles are held against the bits by spring-pressure, the same, for instance, being attained by the hair-pin-like devices 26, which straddle the ribs or walls of the alternate needle-grooves, the depending limbs of the devices being pressed yieldingly against the respective needles by means of an encircling spring-band 27, or, instead, the hair-pin-like devices may in themselves possess elasticity, the band in that case being rigid or non-elastic. Hence when a bit or bits are dropped below the contiguous needle or needles the latter, being unsupported rearwardly, is or are pressed out of action. The bits are connected at their lower ends to a segment 28, whereby they may be raised or lowered as a unit. Those bits which coact with the half series of needles are of uniform length, while those which coact with the two fashioning sets of needles are graded in length—that is, they are gradually increased in height from the uniform set of bits, as seen in Fig. 13. During the knitting of tubular work the bits occupy the extreme upward position, so that they support the respective needles and maintain them in action. Preparatory to the knitting of the heel, the bits are dropped one step, the tops of the uniform bits thus being below the highest point to which the lower extremities of the needles are raised during the knitting operation. Hence during the traverse of the cam-cylinder the half series of needles are raised above their supporting-bits, and in consequence said needles are pressed out of action by the spring devices above mentioned. Thereafter, during the knitting of the heel the cam-cylinder is reciprocated by mechanism hereinafter described. During each reciprocation the bits are dropped one step to the end that in each stroke of the reciprocation the first or outside fashioning-needle in the path of the cams will be thrown out of action, continuing which operation the outside fashioning-needle-

dles will be alternately thrown out of action, and consequently a gradual narrowing of the web will be had. This being accomplished, the bits are correspondingly moved upward, thereby returning the needles to action in inverse order to the preceding operation, and, perforce, effecting the requisite widening of the web. In the final upward movement of the bits the uniform set will coact with the first out-thrown series of needles to return the latter simultaneously to action. Tubular knitting is then performed to knit the foot similarly with the leg, following which reciprocating work is carried on to knit the toe similarly with the heel. The bit-supporting segment is provided with a depending rack 29, with which engages a pinion 30 on a shaft 31, by the act of intermittently rotating which shaft the requisite movements will be transmitted to the bits. The mechanism for actuating the shaft at the proper intervals will be hereinafter described.

In view of the fact that the corresponding bits of the respective graded series are of uniform length and that said bits consequently at all times occupy the same positions relative to each other it is obvious that in order to effect the disengagement of the initial fashioning-needle of the first set in the path of the knitting-cams during the stroke of the latter without correspondingly disengaging the last or end needle of the other set during the stroke it is necessary that provision be had to elevate somewhat above the summit of the lateral stitch-cam the first opposed needle during each stroke of the cam-cylinder, which needle is, perforce, thrown out of action. Hence means are provided to insure the increased ascent of the needles above the lateral cams alternately during the successive strokes of the reciprocating cam-cylinder, which means are of the following construction: On the exterior of the cam-cylinder opposite to the internal knitting-cams is fixed a bracket 32, which is provided near its respective ends with orifices 33, that register with radial perforations 34 in the cam-cylinder, said perforations opening into the cylinder at the summits of the lateral stitch-cams, respectively. (See Figs. 14 and 14^a.) Fitted to these openings are radially-reciprocative studs 35, respectively, the outer ends of which extend beyond the bracket and are pivotally connected with the respective arms of a horizontal rocking lever 36, which is fulcrumed midway of its ends to a lug 37 on the bracket. The length of the studs is such that if the lever be oscillated the inner ends of the studs will be alternately projected and retracted above the summits of the lateral cams, respectively. The forward faces of these inner ends are beveled coincidentally with the adjacent working edges of the lateral cams. Pivoted to the lug at X' is an outwardly-extending tappet-arm 38, which is connected with the respective arms of the rocking lever by pin-and-slot

connections 39, to the end that if the tappet-arm be moved to the right or to the left said lever will be correspondingly actuated. Secured to the pivot is a spring 40, one end of which is fastened to the tappet-arm so as to maintain the latter in a central position irrespective of the position of the lever. The lost motion occasioned by the pin-and-slot connections enables the arm to assume such central position relative to the lever, and, moreover, it enables said arm to be moved farther than is requisite to operate the studs.

Located on the bed of the machine opposite the space intermediate the fashioning-needles is a bracket 41, provided with inwardly-turned ends 42, which project into the path traversed by the tappet-arm during the rotation of the cam-cylinder. During the traverse of the cylinder in one direction the tappet-arm will abut against the opposed end of the bracket and be thrust rearwardly thereby to effect the withdrawal of the leading stud from and the insertion of the rearward pin into the interior of the cylinder. In the reverse motion of the cylinder said arm will impinge against the other end of the bracket and the several parts be conversely actuated.

As a means to hold the studs in the respective positions to which they are set, there are fitted to perforations in the bracket 32 vertically-movable pins 43, that are yieldingly depressed upon the studs by the action of suitably-disposed springs 43^a.

During the knitting of tubular work—as, for example, the leg of the stocking—the forward or leading stud is maintained retracted, as in Fig. 14, in order that the needles may be unaffected thereby. The rearward or inwardly projected stud does not affect the needles, owing to the latter passing under (and not over) the rearward lateral cam.

Just before the completion of the leg the speed of the cam-cylinder is reduced by means such as hereinafter described to the end that the succeeding reciprocations of said cylinder during the knitting of the heel shall be steady and easy. The last three courses, say, of the leg are knit at the slower rate of speed, during which time the bits are lowered one step. The knitting-cams preparatory to their reversal for reciprocating work conclude their stroke about the middle of the semicircular series of needles. In the reverse stroke such needles ride upon the inwardly-projecting end of the leading stud, and are thereby raised above the tops of the contiguous bits and rendered inactive, the positions of the studs being reversed in this stroke, so as not to affect the remaining needles of the semicircular series until the succeeding stroke of the knitting-cams, in which case said needles will be rendered inactive similarly to the others. In the next stroke the tappet-arm abuts against the opposed end of the bracket, so as to reverse the positions of the studs—that is, the rearward one becomes active and the leading one idle. At the same time the bits are lowered another

step. During the first stroke of the knitting-cams in the next reciprocation the first set of fashioning-needles ride upon the inwardly-projecting end of the leading stud, the initial or outside needle in that set thus being raised sufficiently to clear the end of the bit, and in consequence being moved out of action. As the cams in this stroke traverse the space occupied by the intermediate set of active needles, the tappet-arm abuts against the opposed end of the bracket and is moved thereby to effect the reversal of the positions of the studs. Hence the other set of fashioning-needles is not raised by the leading stud, and, therefore, the outer needle thereof is not freed from its bit. In the return stroke of the knitting-cams the leading stud, being projected, acts upon such outer needle and effects its disengagement from the cams. During this stroke the tappet-arm is actuated by the bracket, as in the other instances, to reverse the positions of the studs, and so on during each succeeding stroke of the knitting-cams, while knitting the heel, the positions of the studs are reversed. The heel being completed, the studs are set in their last stroke to the positions occupied by them during the knitting of the leg, whereupon the foot is formed, (with the quick speed,) following which the toe is produced, (with the slower speed,) the studs in the latter operation being actuated as described in regard to the formation of the heel.

The sinker or web-holder mechanism herein comprises a radially-grooved annulus 44, surrounding the needle-cylinder near the top, and being encircled by a rotatable cam-ring 45, which is supported by a flange 44^a on the annulus. This ring is connected with the cam-cylinder by means of laterally-disposed posts 46, which rise from said cylinder and extend between lugs 47 on the cam-ring. One of these posts supports the usual thread-carrier 48. The sinkers, marked 49, are fitted to the respective grooves of the annulus so as to alternate with the needles as usual, and they, the sinkers, each comprise a vertically-arranged lever provided with a lug or stud 50 on its inner edge, the same being engaged with a circumferential groove 51 in the annulus which constitutes the fulcrum of the lever. The upper end of the lever is provided with the usual notched finger 52, which is adapted to be engaged with and disengaged from the stitches during the knitting of the successive courses, the cam 52^a on the ring during its traverse engaging the depending arm of the lever and effecting the requisite movements thereof. By constructing the sinker in the form of a vertical lever a compact arrangement of the parts is had without impairing the throw of the upper or stitch engaging portion of the sinker. The inward movements are imparted to the sinkers by the flanged upper edge of the cam-ring taking against the upper arms of the sinkers. The flange is cut away, as at 52^b, in line with the cam 52^a so as to permit the outward movement of the

sinkers when they are actuated by said cam, as described. (See Figs. 2 and 9^a.)

The driving-shaft hereinbefore referred to is mounted in suitable bearings in an appropriate framework or housing 53, to which the bed-plate is secured. On the outer end of the shaft are the fixed and loose pulleys 54 55, respectively. Adjacent to the pulley 55 is loosely mounted on the shaft a pinion 56, the body of which is elongated and provided with a peripheral flange 57, that takes against the web of said pulley. This pinion engages with a spur-wheel 58, fixed on a lower parallel shaft 59, whereby when the pinion is made fast to the loose pulley, as hereinafter explained, and power is thereupon applied to the latter motion will be transmitted through the coacting gear-wheels to the lower shaft. Surrounding the pinion is a sliding collar 60 or clutch member, on which is a stud 61, that extends into a perforation in the flange of the pinion. On the opposed face of the web of pulley 55 is a series of sockets 62, into which the stud may be projected by proper movement of the clutch member to lock the pinion and the pulley together. Said clutch member is connected with a yoke 63 on one end of a longitudinally-movable shaft 64, which shaft is fitted to perforated brackets 65 66 on the frame. On the shaft is a collar 67, between which and the bracket 66 is an encircling spiral spring 68, that acts to force the shaft 64 normally inward in a manner to maintain the clutch disengaged from the loose pulley. Fitted to the bracket 66 is the stud or pivot of a lever 69, one arm of which is connected with the yoke by means of a link 70, whereby by properly manipulating said lever the clutch member may be engaged with or disengaged from the loose pulley, as desired. Loosely mounted on the shaft 8 at an interval apart are two wheels 71 72, one of which 71 is a pinion and the other of which 72 is a sprocket-wheel. The pinion engages a spur-wheel 73, which is loosely mounted on the lower shaft 59 adjacent to the wheel 58, the hub of said spur-wheel being provided with a spring-controlled pin 74, which is projected yieldingly against an inclined circular tooth 75 on the opposed hub of the wheel 58, whereby if the latter be turned in one direction the tooth thereof will engage the pin and correspondingly turn the wheel 73; but if the wheel be driven in a reverse direction the pin will ride idly upon the tooth without effecting the coupling of the two wheels. The sprocket-wheel 72 is geared by means of a chain 76 with a larger sprocket-wheel 77, fast on said shaft 59. Fixed on the shaft 8 between the flanges or collars of the pinion and sprocket-wheels is a block or head 78, to which is fitted a longitudinally-movable clutch-bolt 79. The ends of this bolt comprise pins which are constructed to be engaged with and disengaged from sockets in the opposed faces of the collars, respectively—that is, when the bolt is engaged with one col-

lar it is disengaged from the other, and vice versa. Hence by properly moving the bolt either the pinion or the sprocket-wheel may be locked upon the shaft, as desired. The means for automatically actuating the bolt at predetermined intervals will appear farther on.

Mounted in suitable bearings in the frame 53, rearward of and parallel with the shaft 8, is an intermittently-rotatable shaft 80, on the outer end of which is a sprocket-wheel 81, which carries the pattern-chain 82. Suitably located on the shaft 80 are four ratchet-wheels 83, 84, 85, and 86, the two outer wheels 83 and 86 being fast on the shaft and the two inner wheels 84 and 85 being connected by a sleeve 87, which is loosely mounted on the shaft, said last-named wheels thus being practically one wheel. All the wheels have a corresponding number of similarly pitched or inclined teeth, but the inner wheels 84 and 85, as will be observed, are larger in diameter than the others. The alternate teeth in the wheel 85 are deepened, so as to register with the corresponding teeth in the adjacent smaller wheel 86, while in the wheel 84 only two diametrically-opposite teeth are deepened to register with the proximate teeth of the wheel 83. Engaging with the wheels are two pawls 88 and 89, respectively, which are connected by means of straps 90 with corresponding eccentrics 91 on the shaft 8, whereby during the rotation of said shaft the pawls are reciprocated and the said ratchet-wheels intermittently rotated. Each of the pawls is wide enough to extend over the two ratchet-teeth. Hence when the alternate deep teeth of the wheel 85 are engaged by the pawl 89 said wheel and, perforce, the wheel 86 and shaft 80 will be thereupon advanced—that is, said shaft will be advanced one step during every second stroke of the pawl while the latter is in action. Similarly the pawl 88 will engage the two diametrically-opposite deep teeth in the wheel 84 during each half-revolution thereof and thus engage the fixed wheel 83. While the shaft is being intermittently rotated, the pattern-chain is advanced link by link to control the various parts of the machine, the links having appropriately-formed surfaces thereon to effect the end in view. During tubular or straight-ahead knitting the chain is at rest; otherwise a multiplicity of uniform links would be required. The action of the shaft 80 is arrested preparatory to the commencement of the leg of the stocking by raising the pawl 89 out of engagement with the ratchet-wheels, which operation is effected by means of a suitably-disposed rockshaft 92, having on one end a crank-arm 93, provided with a projecting pin 94, which is adapted to take against a lateral lug on the pawl-arm, and having on the other end a toe 95 that rests upon the pattern-chain. When a link with a riser thereon coacts with the toe, the shaft 92 is turned sufficiently to raise the pin against the lug on the pawl-arm,

thereby throwing the latter out of action. Meanwhile the pawl 88 engages the teeth of the wheel 84 and moves the latter idly on the shaft half a revolution, whereupon said pawl engages the deep tooth in the wheel 84 and advances the latter and, perforce, wheel 83 and the shaft 80 a distance of one tooth. The raised link is thus moved beyond the toe 95 and a plane or low link takes its place. The arm drops, and in consequence the pin is removed from the pawl 89, whereupon the latter re-engages the ratchet-wheels and operates the same as before. In this operation the shaft 80 is rotated a half-revolution, the links as they are successively advanced controlling the mechanism for producing the heel of the stocking. Upon the completion of the operation a link with a riser is brought below the toe on the rock-shaft 92, as in the other instance above described, and the pawl 89 is thus likewise raised out of action to render the chain quiescent. The knitting of the foot is now pursued, the other pawl 88 racking the wheel 84 idly on its shaft a half-revolution until the deep tooth is engaged, whereupon the riser-link is moved onward and a plane or low link is brought below the toe on the rock-shaft. The pawl 89 thus becomes active, as before, the chain is impelled, and the operation of knitting the toe of the stocking is carried on. Following this, the knitting of the leg is taken up, and the foregoing-described operations are repeated in the order named.

During tubular knitting the belt runs upon the fixed pulley, so as to impart continuous rotary motion to the shaft 8, and, perforce, to the cam-cylinder, the clutch-bolt being engaged with the pinion 71, so as to lock the latter on the shaft. Hence the pinion turns the spur-wheel 73 idly on the shaft 59.

The shipper-frame 96 is supported on one end of a longitudinally-movable horizontal shaft 97, whereby the belt may be transferred from one pulley to the other. This shaft is fitted to a sleeve 98, which is fixedly supported on the free ends of a pair of rearwardly-extending arms 99, that are loosely mounted on a transverse shaft 100, borne in the frame 53. The sleeve is partially slotted longitudinally, and the shaft 97 is provided with a pin 101, that extends through the slots in the sleeve. Interposed between the pin and one of the arms is a spiral spring 102, the tendency of which is to move said shaft toward the cylinder and thus maintain the shipper-frame adjacent to the loose pulley. Suitably disposed on the shaft 97 is a fixed head 103, the function of which will directly appear. One of the arms is provided with a heel 104, that rides upon the links of the pattern-chain, the predetermined variations in such links raising or lowering the arm and, perforce, correspondingly moving the shaft 97. During tubular knitting the heel rides upon the plane or low faces of the links and therefore the shaft 97 occupies the down position, said

shaft under such circumstances being forced outward against the stress of the spring in a manner to maintain the shipper adjacent to the fixed pulley. The shaft is forced outward
 5 and held in this position by an arm 105 bearing against the head on the shaft. This arm is fixed to the upper end of a vertically-arranged rock-shaft 106, which is mounted in brackets 107 on the frame. On the lower end
 10 of the rock-shaft is an arm 109, which is held yielding in contact with the periphery of an eccentric 110 on the shaft 59 by the torsional action of a spiral spring 111, which, encircling the vertical shaft, has its respec-
 15 tive ends secured to the upper bracket 107 and the arm 109. During tubular knitting the shaft 59 is idle and consequently the eccentric maintains the parts in the relative positions described.

20 Upon the completion of the leg of the stocking a link with a riser thereon is advanced beneath the heel on arm 99, such riser thereupon raising the arm and with it the shaft 97 and its connections. The head thus being
 25 lifted above the rocker-arm 105, the spring 102, expanding, returns the shaft to the inward position and in consequence transfers the belt onto the pulley 55. The latter thereupon rotates the pinion 56, which in turn impels the
 30 coacting spur-wheel 58 on the shaft 59. This shaft and, perforce, the eccentric thereon are thus rotated in concert with the pinion, said eccentric in its motion effecting the continuous oscillation of the vertical rock-shaft. Im-
 35 mediately before the first turn of the shaft 59 the clutch-bolt 79, hereinbefore referred to, is engaged with the sprocket-wheel 72 to lock it on the main shaft. Hence the motion is transmitted from the shaft 59 to the main
 40 shaft through the sprocket-gearing, such motion being timed to effect the movement of the cam-cylinder one stroke. This done, the clutch-bolt is disengaged from the sprocket-wheel and engaged with the pinion 71, in
 45 which case the motion is transmitted from the shaft 59 to the shaft 8 in a contrary direction, such motion being timed to effect the reverse stroke of the cam-cylinder. Thus the clutch is alternately engaged with and dis-
 50 engaged from the sprocket-wheel and the pinion, and in consequence a rotary reciprocating movement is imparted to the main shaft and is transmitted therefrom to the cam-cylinder. By means of the system of gearing
 55 above described it will be obvious that the cam-cylinder is driven at a reduced rate of speed while reciprocating.

A means which I have devised for reciprocating the clutch-bolt is as follows: On the
 60 body of the clutch-bolt is fixed a plate 112, having two oppositely-disposed cams or inclines x and y , respectively. On the inner wall of the housing or bearing in which the block 78 is contained is a fixed pin 113, which
 65 is so arranged relatively to the path of the cam that during the rotation of the block the incline x impinges against the pin and thrusts

the bolt toward and into engagement with the pinion. Fitted to a perforation 114 in the said housing, laterally of the stud, is a
 70 radially-movable stud 115, the inner end of which may be projected into or retracted from the path of the cam, as required. During tubular knitting this stud is retracted, so
 75 that it does not act upon the cam; but during reciprocating work it is projected into the path traversed by the incline y in the reverse stroke of the shaft, said incline in that case abutting against the stud and being
 80 forced, together with the bolt, toward the sprocket-wheel for the purpose above described. The outer end of the stud is piv-
 85 otally connected with a crank-arm 116 on a suitably-located rock-shaft 117, by the operation of which shaft the positions of the stud
 90 are determined, as will duly appear. Upon the completion of the heel or the toe of the stocking the shaft 97 assumes the down position, the arm 105 acting upon the head 103 and
 95 resetting the belt-shipper, as above described.

In order that the operation of the machine may be arrested at any time during the knitting of the tubular foot or leg of the stocking, I provide the lever 69 with an arm 69^a, which
 95 is so arranged that if the lever be moved to retract the clutch from the pulley 55 said arm will bear against the shaft 97 and raise the latter sufficiently to dispose the head 103 above the path of the oscillating arm 105 on the ver-
 100 tical rock-shaft.

In the drawings the machine is represented as stopped during the process of knitting the heel of the stocking.

To start the machine at any time, the handle-arm of lever 69 is turned downward, so as
 105 to move upward the other arm of the lever, and thereby force forward the link 70 in a manner to project the pin 61 into engagement with the pulley 55. The link and lever-arm act as a toggle-joint, being in the "open" and
 110 "broken" positions when the pin 61 is engaged with and disengaged from the pulley, respectively. When the lever is turned to start the machine, the arm 69^a is moved downward, so as to lie below the path of the
 115 shaft 97.

I shall now describe the mechanism which I have devised for imparting the requisite in-
 120 termittent rotary movements to the shaft 31, that is geared with the bit-supporting segment hereinbefore alluded to. On shaft 31, a suitable distance apart, are fixed two ratchet-wheels 118 119, the teeth of which are oppo-
 125 sitely pitched. Between these wheels there are mounted on the shaft two levers 120 121, the rearwardly-extending arms of which extend upwardly and downwardly, respectively, as seen. On these arms are pivoted pawls
 130 122 123, respectively, which are adapted to be engaged with the respective wheels adjacent thereto at predetermined intervals. The forward arms of the levers are rounded concentrically with the shaft 31, and are provided with gear-teeth, with which engage toothed

sectors 124 125, respectively, on a stud 126, which is affixed to the frame in advance of the shaft 31. These sectors are each provided with two forwardly-extending yoke-like arms 127, which straddle the shaft 59. On the latter shaft is fixed a cam 128, which engages the respective arms of the sectors, said cam being so constructed that during the rotation of the shaft 59 they will oppositely oscillate the respective yoke-arms, and thus correspondingly actuate the respective sectors. In consequence said sectors will simultaneously oscillate the levers 120 121, by which the pawls are carried. Now if one of the pawls—say that marked 122—be engaged with its ratchet-wheel 118 and the other pawl be thrown out of action the active pawl will coast with the ratchet-wheel to turn the shaft step by step in one direction—viz., that indicated by the arrow in Fig. 4^b—and if the condition of the pawls be reversed the lower pawl 123, coacting with the ratchet-wheel 119, will turn the shaft 31 step by step in a reverse direction. When the pawl 123 is in action, the shaft is turned to raise the bit-supporting segment, and when the pawl 122 is in action the shaft is turned to lower said segment. Preparatory to the narrowing operation—that is, at the commencement of the heel or the toe of the stocking—the pawl 122 is thrown into operation, thereby effecting the requisite movements of the shaft to lower the bit-supporting segment during each reciprocation of the cam-cylinder. Upon the completion of the narrowing and preparatory to the widening operation the pawl 122 is thrown out of action and the other pawl is brought into play, thereby effecting the requisite reverse movements of the shaft to raise the bit-supporting segment periodically.

As a means to control the relative positions of the pawls automatically there is fulcrumed on the shaft 31, intermediate the levers 120 121, a vertically-disposed lever 129, the upper arm of which is connected by means of a link 130 (curved to clear the shaft 117) with a depending arm 131 on the rock-shaft 100. On the outer end of this shaft is a toe 132, that rides upon the links of the pattern-chain, the high and low link-faces of which effect the oscillation of the rock-shaft, the resulting movements being thereupon imparted by the intermediate connections to the lever 129. The extremities of this lever are provided with oppositely-disposed steps 133, and the pawls are equipped with studs 134, that take against such extremities.

Gravity maintains the stud on the upper pawl 122 in engagement with the lever, while a spring 135, which is affixed to the frames, bears against the lower pawl and maintains the stud thereon normally against the lever. Hence when said lever is moved in one direction the lower step bears against the stud on the pawl 123 and throws the latter out of engagement with the ratchet, while, contrarily, the opposed step is removed from the stud on

the upper pawl, which latter thereupon drops into engagement with its ratchet-wheel, and vice versa.

During the knitting of the heel or the toe of the stocking the shaft 31 is reciprocated—that is, it makes a partial revolution intermittently in one direction while narrowing and a reverse revolution while widening. On this shaft is fixed a peripherally-notched wheel 136, the number of notches therein corresponding with the number of teeth on each of the ratchet-wheels. One of these notches (noted Z) is much deeper than the others, for a purpose presently explained.

On the adjacent end of the rock-shaft 117, hereinbefore referred to, is fixed a rearwardly-extending pawl 137, the tooth of which bears upon the periphery of the wheel 136, being maintained thereon by gravity or by the action of a retracting-spring 138, one end of which is secured to the pawl and the other end to the supporting-frame. The parts are so constructed that during tubular knitting the pawl 137 is engaged with the deep notch in the wheel, and the movable stud 115 is thus retracted from the housing, but during the heel- and -toe-fashioning operations the pawl rides upon the periphery of the wheel, engaging the notches successively, and in that way it maintains the stud 115 projected into the path of the cam on the clutch-bolt, as and for the purpose above set forth.

In order that the bit-supporting segment may be lowered or raised by hand, should occasion require it, without disconcerting the pawl-and-ratchet mechanisms on the shaft 31, I have connected the pinion 30 to the latter by means of a clutch-pin device that may be readily manipulated to lock or release the pinion on the shaft.

Referring to Fig. 8, 139 is a collar formed on or affixed to the shaft 31, adjacent to the inner side of the pinion 30, and 140 is a similar collar loosely applied to the shaft on the opposite side of the pinion, which latter collar is provided with a suitable handle 141. 142 is a pin fitted to opposite perforations in the outer collar and the pinion, respectively, and pressed normally inward by the action of a small spiral spring 143, confined in said collar last named. The face of the inner collar is provided with a socket 144, with which the inner end of the pin is adapted to register, the outer end of said pin being provided with a suitable knob. Normally the pin is engaged with the socket in the collar 139, thus locking the pinion on the shaft; but if it be desired to operate the pinion independently of the shaft the spring-controlled pin is retracted from the socketed collar, and the handle is thereupon properly rotated by hand.

Recurring now to the mechanism for varying the tension of the stitches during the knitting of the ankle and foot portions of the stocking, 145 is a longitudinally-arranged rock-shaft mounted in suitably-located bearings. One end of this shaft is provided with

a depending arm 146, which is connected by means of a rod 147 with a similar arm 148 on the shaft 23, hereinbefore described. The other end of the rock-shaft is equipped with
 5 an arm 149, that rides upon the links of the pattern-chain. When the arm is engaged with the raised face of a link, the parts are in position for the knitting of normal stitches; but when the arm is riding upon the plane or
 10 low faces of the succeeding links the rock-arm and the connecting-rod are thrown forward, and the shaft 23 is thereby partially turned to effect a slight lowering of the bit and needle cylinders, and, perforce, a tightening of the stitches. Those links which are
 15 brought into play during the knitting of the heel and toe are provided with appropriate risers, which coact with the arm on the rock-shaft for the purpose stated.

20 In order that the relative tensions of the stitches during the knitting of the stocking may be nicely predetermined, I affix to the bed-plate, concentric with the shaft 23, a graduated sector 150, (said shaft extending freely
 25 through a boss on the sector,) and I provide the arm 148 with an upward handle extension 151, having a suitable lip that traverses the edge of the sector. The rearward end of the rod 147 is screw-threaded. It is extended
 30 through a perforated boss on the depending arm 146 of the rock-shaft 145, and it is provided with set-nuts 152, whereby the point of connection of the boss with the rod may be nicely adjusted. At the outset the handle
 35 extension is moved on the sector to prescribe the length of the normal stitches, and the requisite adjustment of the boss on the connecting-rod is then effected.

40 The thread-reinforcing mechanism which I have devised is of the following construction: Rising from the bed of the machine is a post or standard 153, which supports an inwardly-extending arm 154, the forward end of which is preferably drooped and is provided with an
 45 eye 155 for the passage of the main thread 156 on its way to the thread-guide. Fulcrumed on a suitably-disposed lug 157 on the arm is a take-up lever 158, of usual construction, the shorter or rigid arm thereof being
 50 connected by means of a link 159 with one arm *a* of a tri-armed lever 160, which in its turn is fulcrumed to a rearward lug on the supporting-arm. One of the arms *b* of the lever 160 is extended rearward and is provided
 55 at its extremity with an eye for the passage of the reinforcing-thread 161, the third arm *c* being connected by means of a pin and slot with a vertically-movable rod 162, which is guided in suitably-disposed brackets 163.
 60 The lower end of the rod rests upon the free end of a rearwardly-extending arm 164 on the pawl-bearing shaft 117, so as to partake of the movements of the pawl—that is to say, when the pawl is engaged with the deep notch
 65 in the wheel 136 the arm, and therewith the rod, is lowered, the spring-controlled arm of the take-up lever thus being depressed, and

when the pawl is riding upon the periphery of said wheel the parts occupy a reverse position.

70 Supported in a pair of perforated lugs 165 on the arm 154 is a horizontally-movable tube 166, on the body of which is a projection 167, which is connected by means of a link 168 with the longer arm of a bell-crank lever 169,
 75 the latter being fulcrumed to a suitably-disposed collar 170 on the post. The shorter arm of this lever is connected by means of a link 171 with the rod 162, to the end that when said rod is lowered the tube is moved
 80 forward, and when the rod is raised the tube is retracted. On one side of the tube, near its forward end, is an opening 172, which is preferably in the form of an inclined slot or kerf, as seen most clearly in Fig. 18, while in a suit-
 85 able lug 173 on the forward or drooping portion of the arm 154, in line with said slot or kerf, is supported a similarly-inclined guide or tube 174. On the lug is a fixed blade 175, on which is pivoted a coacting blade 176, the
 90 latter being in effect one arm of a bell-crank lever, the other arm of which is pivotally connected with a horizontally-reciprocative rod 177, guided in lateral extensions of the lugs 165. On this rod, a suitable distance apart, is
 95 a pair of collars 178, between which extends the piece 167 on the tube 166, to the end that when the latter is moved forward, as above described, the piece will abut against the op-
 100 posed collar, and thereby advance the rod in a manner to move the pivoted blade upon the fixed blade with a shear-like action. When the tube is retracted, the piece 167 abuts
 105 against the other opposed collar on the rod and returns the parts just named to their previous condition.

Suitably disposed on the fixed blade is a collar 179, which I term a "stripper," into which the forward end of the tube 166 is adapted to enter freely. Fulcrumed on a lug
 110 180 on the inclined portion of the arm is a tension-lever 181, which I term a "trap-lever," the upper arm of which is provided with a lip, which extends over the tube and is adapted to act upon the main knitting-thread between
 115 it and the beveled face of lug 165, while the lower arm of said lever is provided with an eye to receive said thread on its passage to the take-up lever. On its way from the bobbin to the thread-carrier the main thread
 120 passes, in the first place, through one of the guide-eyes on the usual cross-bar 182, thence through an eye on the lug 165 into and through the slot or kerf in the tube 166, then through the inclined tube 174, next through
 125 the eye on the forward arm of the trap-lever, next through the take-up lever, and, finally, through the eye on the arm 154. The reinforcing-thread passes through the eye on the end of the arm *b* of the lever 160, thence
 130 through the tube 166 and out through the kerf, as seen in Fig. 18. During tubular knitting (the pawl being engaged with the deep notch in the wheel) the rod 162 is de-

pressed, and in consequence the tension upon the main thread is released and the guide-tube is projected forward into the stripper, the supplemental thread being clamped between the engaged parts. Upon the commencement of the heel or toe (the pawl riding upon the periphery of the wheel, as above stated) the rod 162 is elevated, in consequence of which the take-up lever is thrown upward and the tension is, perforce, exerted upon the main thread. At the same time the trap-lever is pressed upon the latter thread, so as to hold it in place, and the tube is retracted, so as to free the clamped end of the supplemental thread, which end, depending from the opening in the tube and lying contiguous to the incoming main thread, is carried by the latter to the knitting-needles. The combined threads are thus delivered to the needles during the knitting of the heel or toe, at the completion of either of which operations the rod is lowered in the manner above described, whereupon the tube 166 is projected into the stripper and the reinforcing-thread drawn between the blades, the movable one of which being moved inward by the advancement of the rod to effect the severance of the reinforcing-thread. In this position the parts remain in readiness for a succeeding operation.

The construction of pattern-chain which I have devised and prefer to employ is shown most clearly in Figs. 5 and 12. Each of the links comprises a curved plate 183, provided with lateral lugs 184 on its under or concave surface and with appropriate risers 185 on its upper or convex surface. The lower ends of the lugs are offset beyond the edge of the plate, while the upper ends of the lugs are correspondingly foreshortened, to the end that when the lugs of the successive plates are connected the extensions thereof will embrace the contiguous plates, respectively. Said lugs are connected by means of cross-pins 186, the respective pins being preferably screw-threaded at one end and being fitted to correspondingly-threaded orifices in the proximate lugs of the adjacent sections. The acting edges of the risers are rounded, so that they will assume a curve concentric with the sprocket-wheel as they travel on the latter, the meeting ends of the risers in the adjacent links being cut under and rounded, respectively, (as at *j* and *k*, respectively,) so as to overlap and present a practically unbroken or continuous surface when the chain is flexed. Where the rounded upper end of a riser succeeds a plane portion of the link-plate, (as at *l*,) such portion will overlap the riser and remain in contact therewith while the links are on the sprocket-wheel, thus presenting an uninterrupted surface to the parts controlled thereby.

I claim as my invention—

1. In a knitting machine, the combination of the needle-cylinder, the depending bit cylinder, and a latch device whereby said cylinders may be locked together or released, substantially as described.

2. The combination of the needle cylinder provided with a groove therein, a bit cylinder fitted to the lower end of said needle cylinder and provided with an opening registering with said groove, and a vertically-disposed rod supported within the bit cylinder and provided with a stud constructed to co-act with said opening and groove, substantially as described.

3. The combination, with the needle cylinder and the cam cylinder, of the interposed ring, pins extending therefrom through slots or recesses in the top of the latter cylinder, and latch plates on the cam cylinder adapted to engage said pins, substantially as described.

4. The combination, with the needle cylinder, its needles, the cam cylinder, its knitting cams, the needle-controlling step device, and means for supporting and operating the latter, of means whereby the needles are raised above the normal height of the stitch cams, alternately, during the successive strokes of the cam cylinder, while reciprocating, in order to effect the disengagement of certain needles from said step device at predetermined intervals, substantially as described.

5. The combination, with the cam cylinder and its knitting cams, of reciprocative stud cams movable above the summits of the lateral stitch cams, respectively, and means whereby said stud-cams are operated so as to project them into, and retract them from, the interior of the cam cylinder alternately, substantially as described.

6. The combination, with the cam-cylinder, and its knitting cams, of radially-reciprocative stud cams mounted in said cylinder adjacent to the lateral stitch cams, a lever connecting said stud cams, and means for oscillating said lever so as to project said stud cams into, and retract them from, the interior of the cam cylinder, substantially as described.

7. The combination, with the cam cylinder, and its knitting cams, of radially-reciprocative stud cams mounted in said cylinder adjacent to the lateral stitch cams, a lever connecting said stud cams, and means for oscillating said lever so as to project said stud cams into and retract them from, the interior of the cam cylinder, and means for retaining said stud cams in their respective positions, substantially as described.

8. The combination, with the cam cylinder, and its knitting cams, of radially-reciprocative stud-cams mounted in said cylinder adjacent to the lateral stitch-cams, a lever connecting said stud cams, a pivoted tappet arm connected with said lever, and means for operating said arm at predetermined intervals, substantially as described.

9. The combination, with the needle cylinder, its needles, the cam cylinder and its cams, of the driving shaft, gearing between the same and the cam cylinder, fast and loose pulleys on said shaft, a second shaft, normally inactive transmitting mechanism between said

shafts, and means whereby said mechanism is operatively engaged with the loose pulley so as to turn the said second shaft continuously in one direction, two sets of oppositely-acting transmitting mechanisms between the shafts, means whereby said transmitting mechanisms are alternately engaged with and disengaged from the driving shaft, and a connection between one of said last-named transmitting mechanisms and mechanism first-named together with a belt shipper, and means for operating the same to transfer the belt from one pulley to the other at predetermined intervals, substantially as described.

10. The combination, with the needle cylinder, its needles, the cam cylinder and its cams, of the driving shaft, gearing between the same and the cam cylinder, the fast and loose pulleys on said shaft, a pinion thereon adjacent to the loose pulley, a clutch device adapted to engage or disengage said pinion and pulley, a second shaft, a fixed spur wheel thereon in gear with said pinion, an adjacent loosely-mounted spur wheel on said shaft, a transmitting device between said spur wheels, a second pinion mounted on the driving shaft and geared with said loose spur wheel, a sprocket wheel on said driving shaft, a clutch device between the same and said second pinion, means for operating said clutch device, a sprocket wheel on the said second shaft, and a chain connecting the two sprocket wheels, substantially as described.

11. In a knitting machine, the combination, with the driving shaft, and the fast and loose pulleys thereon, of the belt-shipper frame, a supporting shaft therefor, a bodily movable frame in which said latter shaft is mounted, means for retracting the shipper frame to maintain the shipper normally adjacent to the loose pulley, a power transmitting device adjacent to the loose pulley, means to connect said device with the loose pulley, a rock-shaft, a driven shaft provided with means for operating the rock-shaft, provisions whereby said driven shaft is connected with the said power transmitting device, an arm on said rock-shaft, and a head on the shipper frame supporting shaft in the path of said arm, substantially as described.

12. In a knitting machine, the combination, with the driving shaft, the fast and loose pulleys thereon, the pattern chain and means for supporting and operating it, of the belt shipper frame, its shaft, a vibratory support for the latter, said support being constructed to be operated by the pattern chain, means for retracting the shipper shaft to maintain the shipper normally adjacent to one of the pulleys, a rock-shaft, means for operating the same, and co-acting devices on said rock and shipper shafts adapted to effect the movement of the shipper to the other pulley, substantially as described.

13. In a knitting machine, the combination, with the driving shaft, and the fast and loose pulleys thereon, of a belt shipper frame, its

shaft, a vibratory support for the said shaft, means for retracting the shipper shaft to maintain the shipper frame normally adjacent to the loose pulley, means for maintaining said frame adjacent to the fast pulley, and a lever, one arm of which is constructed and arranged to raise the shipper shaft bodily and release the same when the lever is operated during tubular knitting, substantially as described.

14. In a knitting machine, the combination with the driving shaft, of a block or head affixed thereto, a sliding clutch bolt on said head, power transmitting mechanisms adjacent to the respective ends of said head, a double inclined cam fixed on said bolt, a stud or projection arranged fixedly in the path of one of the inclines of the cam, a stud movable into and out of the path of the other incline of the cam, a guide for the latter stud and means for operating said movable stud at predetermined intervals, substantially as described.

15. In a knitting machine, the combination, with the driving shaft, of an intermittently rotatable shaft adjacent thereto, pattern mechanism on said latter shaft, the two outer ratchet wheels fast on the shaft, and the two inner wheels connected by a sleeve which is loosely mounted on the shaft, all said wheels having a corresponding number of similarly-pitched teeth, but the inner loosely mounted wheels being larger in diameter than the others, the alternate teeth of one of the inner wheels being deepened so as to register with the corresponding teeth in the adjacent outer wheel, and two diametrically-opposite teeth of the other inner wheel being deepened to register with the proximate teeth of the adjacent outer wheel, the pawls co-acting with said wheels, as described, eccentrics on the driving shaft operatively connected with said pawls, a rock-shaft provided with means adapted to move one of the pawls periodically out of action and provided with means by which the shaft is controlled by the pattern chain, substantially as described.

16. In a knitting machine, the combination, with the needle cylinder, its needles, the cam cylinder and its cams, of the needle-controlling step-device, and means for supporting the same, a shaft, provisions whereby it is geared with said step-device, a pair of oppositely-pitched ratchet wheels on said shaft, levers on said shaft provided with pawls adapted to engage the ratchet wheels respectively, a cam shaft, its cams, arms actuated by said cams, means whereby said arms are operatively connected with the pawl-bearing levers, a lever on said first-named shaft provided with cams on its respective arms constructed to act upon the pawls to render them idle and active alternately, and means for operating said cam lever at predetermined intervals, substantially as described.

17. In a knitting machine, the combination with the needle cylinder, its needles, the cam

cylinder and its cams, of the needle-controlling step device, and means for supporting the same, a shaft, provisions whereby it is geared with said step-device, a pair of oppositely-pitched ratchet wheels on said shaft, levers on said shaft provided with pawls adapted to engage the ratchet wheels respectively, toothed sectors geared with said levers provided each with forked or yoke-like arms, a shaft adjacent to said arms, a cam on said shaft co-acting with the arms, means for rotating said shaft at predetermined intervals, and means for rendering the respective pawls idle and active alternately, substantially as described.

18. In a knitting machine, the combination, with the needle cylinder, its needles, the cam cylinder and its cams, of the needle controlling step-device and means for supporting the same, the rack depending from the said step device, a shaft, means for rotating the same in opposite directions at predetermined intervals, a pinion engaged with said rack, a clutch device adapted to lock or release the pinion on the shaft, and means for turning the pinion independently of the shaft, substantially as described.

19. In a knitting machine, the combination, with the needle cylinder, its needles, the cam cylinder and its cams, of the needle-controlling step-device and means for supporting the same, an intermittently rotatable shaft, provisions whereby it is geared with said step-device, a driving shaft, means whereby it is geared with the cam cylinder, mechanism intermediate the driving shaft and said first-named shaft adapted to impart the requisite movements thereto, oppositely-acting transmitting devices on said driving shaft, an intermediate clutch bolt, the support therefor, a double inclined cam on said bolt, a fixed stud in the path of one of the inclines of the cam, a stud movable into and out of the path of the other incline of the cam, a rock-shaft, provisions whereby it is connected with said movable stud, a pawl on said rock-shaft, and a peripherally notched wheel mounted on the first named shaft and engaged by said pawl, substantially as described.

20. In a knitting machine, the combination, with the needle cylinder, its needles, the cam cylinder and its cams, of a tension regulating shaft provided with gear teeth, its support, a depending portion on the needle cylinder provided with gear teeth that are engaged by those on the shaft, and means whereby said shaft is automatically operated at predetermined stages of the knitting operation, substantially as described.

21. In a knitting machine, the combination, with the needle cylinder, its needles, the cam cylinder and its cams, of a tension regulating shaft, its support, provisions whereby said shaft is operatively connected with the needle cylinder to effect longitudinal adjustment of the latter, an arm on said shaft, a rock-shaft, an arm thereon, a rod connecting said

arms, and means for automatically operating said rock-shaft at predetermined stages of the knitting operation, substantially as described.

22. In a knitting machine, the combination, with the needle cylinder, its needles, the bit cylinder, its bits, the cam cylinder and its cams, of a tension-regulating shaft provided with gear teeth constructed to engage corresponding teeth in the bit cylinder, a fixed support for said shaft, an arm thereon, a rock-shaft, an arm thereon, a rod connecting said arms, and means for operating said rock-shaft at predetermined stages of the knitting operation, substantially as described.

23. In a knitting machine, the combination, with the needle cylinder, its needles, the cam cylinder and its cams, of a tension regulating shaft, its support, provisions whereby said shaft is operatively connected with the needle cylinder to effect longitudinal adjustment of the latter, an arm and a handle on said shaft, a sector adjacent to the handle, a rock-shaft, an arm thereon, a rod connecting said arms, means whereby one end of the rod is adjustably connected with the proximate arm, and means for operating said shaft at predetermined intervals, substantially as described.

24. The combination of a guide for the main knitting thread, a guide tube for an additional thread, said tube being provided with a lateral opening through which the threads extend, and means for reciprocating said tube, substantially as described.

25. The combination of a guide for the main knitting thread, a horizontally disposed guide tube for an additional thread, said tube being provided with an inclined slot near the forward end thereof, through which slot the threads extend, and means for reciprocating said tube, substantially as described.

26. The combination of a guide for the main knitting thread, a guide tube for an additional thread, said tube being provided with a lateral opening through which the threads extend and means for reciprocating said tube, together with means for severing the additional thread, substantially as described.

27. The combination of a guide for the main knitting thread, a guide tube for an additional thread, means for reciprocating said tube and a collar or clamp member fixed in advance of said tube, and adapted to receive the nose of the latter to clamp the extending end of the additional thread, substantially as described.

28. The combination of a guide for the main knitting thread, a guide tube for an additional thread, means for reciprocating said tube, and a collar or clamp member fixed in advance of said tube, and adapted to receive the nose of the latter to clamp the extending end of the additional thread, together with means for severing the additional thread when the tube is advanced, substantially as described.

29. The combination of a guide for the main knitting thread, a guide tube for an additional thread, said tube being provided with a lateral opening through which the threads ex-

tend, and a collar or clamp member fixed in advance of said tube and adapted to receive the nose of the latter so as to clamp the extending end of the supplemental thread, substantially as described.

30. The combination of an arm provided with a thread guide, a take-up lever, supported on the arm, a reciprocative thread guide tube on said arm, means for reciprocating said tube, and means for operating the take-up lever simultaneously with said tube, so as to reduce the tension upon the main thread when the tube is projected, and the converse, substantially as described.

31. The combination of an arm provided with a thread guide, a take-up lever supported on the arm, a reciprocative thread-guide tube on said arm, means for reciprocating said tube, and means for operating the take-up lever simultaneously with said tube, so as to reduce the tension upon the thread when the tube is projected, and the converse, together with the trap-lever through which the thread extends on its way to the take-up lever, substantially as described.

32. The combination of the vertical post, the arm thereon, the reciprocative guide tube, the collar, its support, the co-acting blades, means whereby they are actuated by the movements of the tube, a bell-crank lever pivoted to the post and linked with said tube,

a vertically-reciprocative rod linked with said lever, the lever 160 connected with said rod, and the take-up lever linked with the lever 160, substantially as described.

33. The described pattern chain for knitting machines, the links of the chain comprising a series of curved plates provided with lateral lugs on their under or concave sides and with appropriate risers on their outer or convex sides, the upper ends of the risers being rounded and the lower ends thereof extended and cut under and the meeting ends of the respective links being detachably connected, the ends of the succeeding risers overlapping each other and the upper ends of all the risers curving inwardly beyond the adjacent curved plates of the respective links, whereby the meeting ends of the risers present an uninterrupted surface when the chain is flexed and whereby when a riser succeeds a plane or plate portion of the link such portion when the chain is flexed overlaps the riser, substantially as described.

In testimony whereof I have hereunto affixed my signature in the presence of two subscribing witnesses.

WILLIAM H. ZELLERS.

Witnesses:

JOHN R. NOLAN,
A. V. GROUP.