(No Model.) 10 Sheets—Sheet 1.

E. W. GOURD.

CIRCULAR KNITTING MACHINE.

No. 521,284. Patented June 12, 1894.

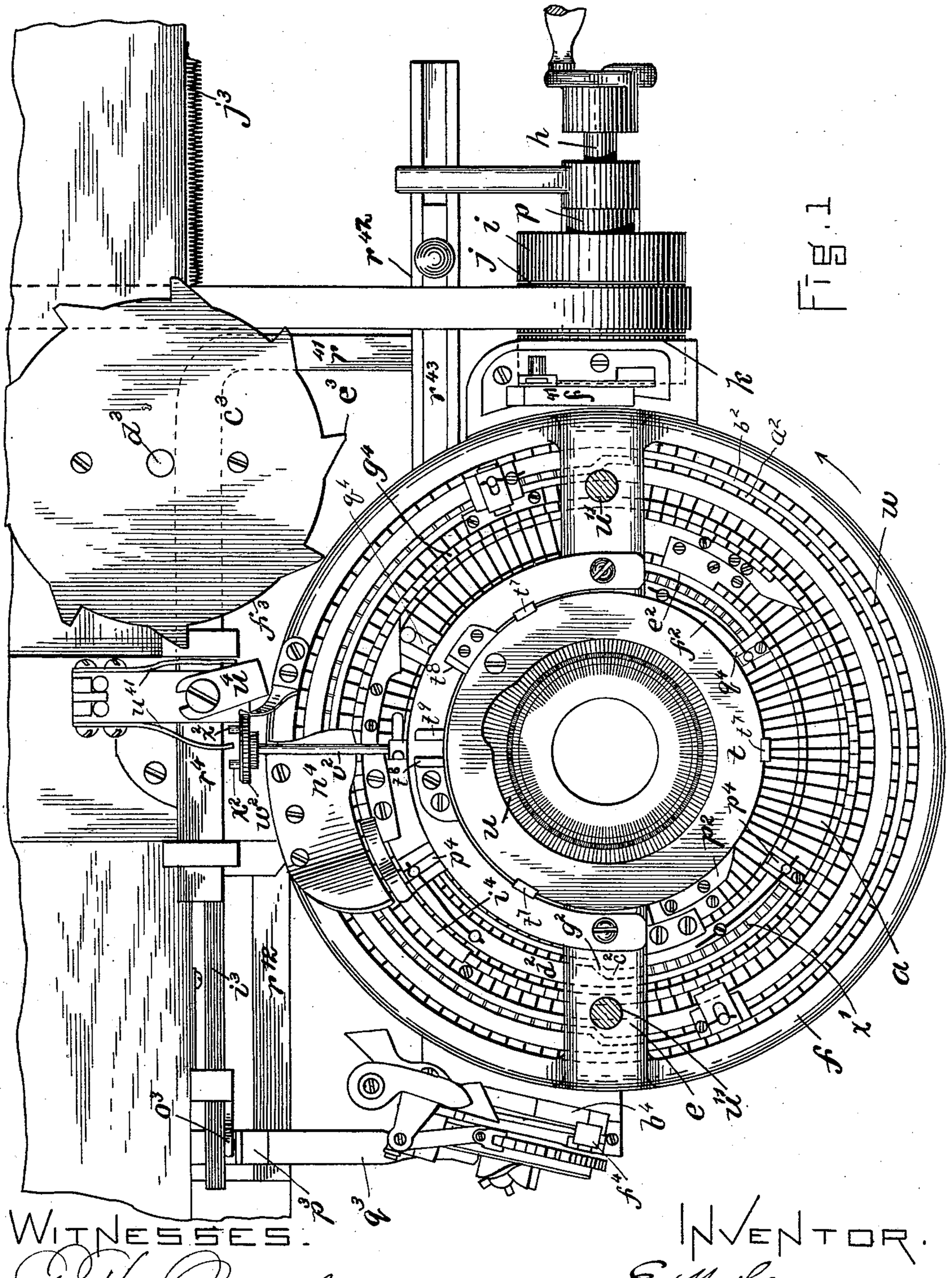

FIG. 1.

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A. D. Harrison.

INVENTOR.

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Wright, Brown & Quinby,

2 " Attys.

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Fig. 2.

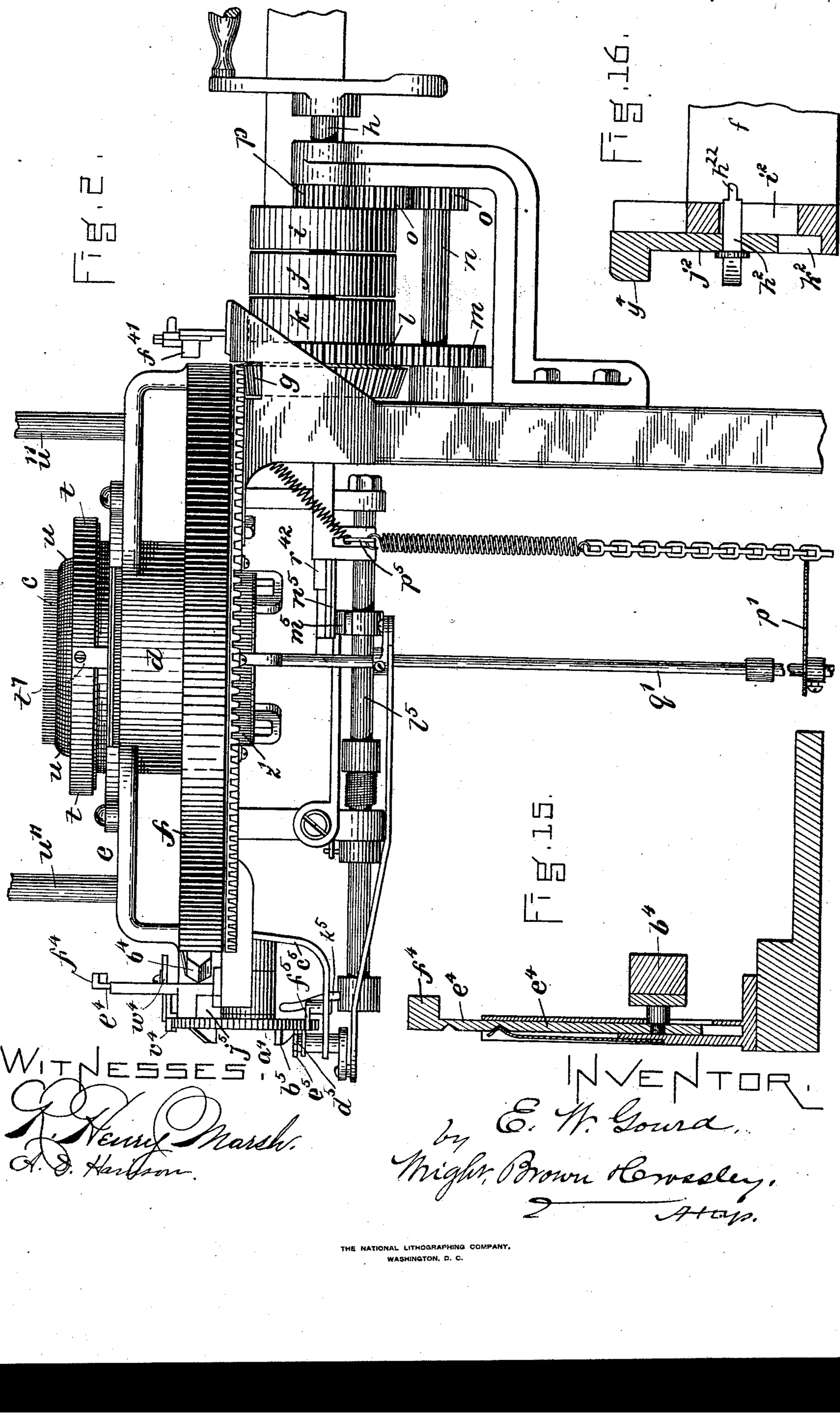

Fig. 16.

Fig. 15.

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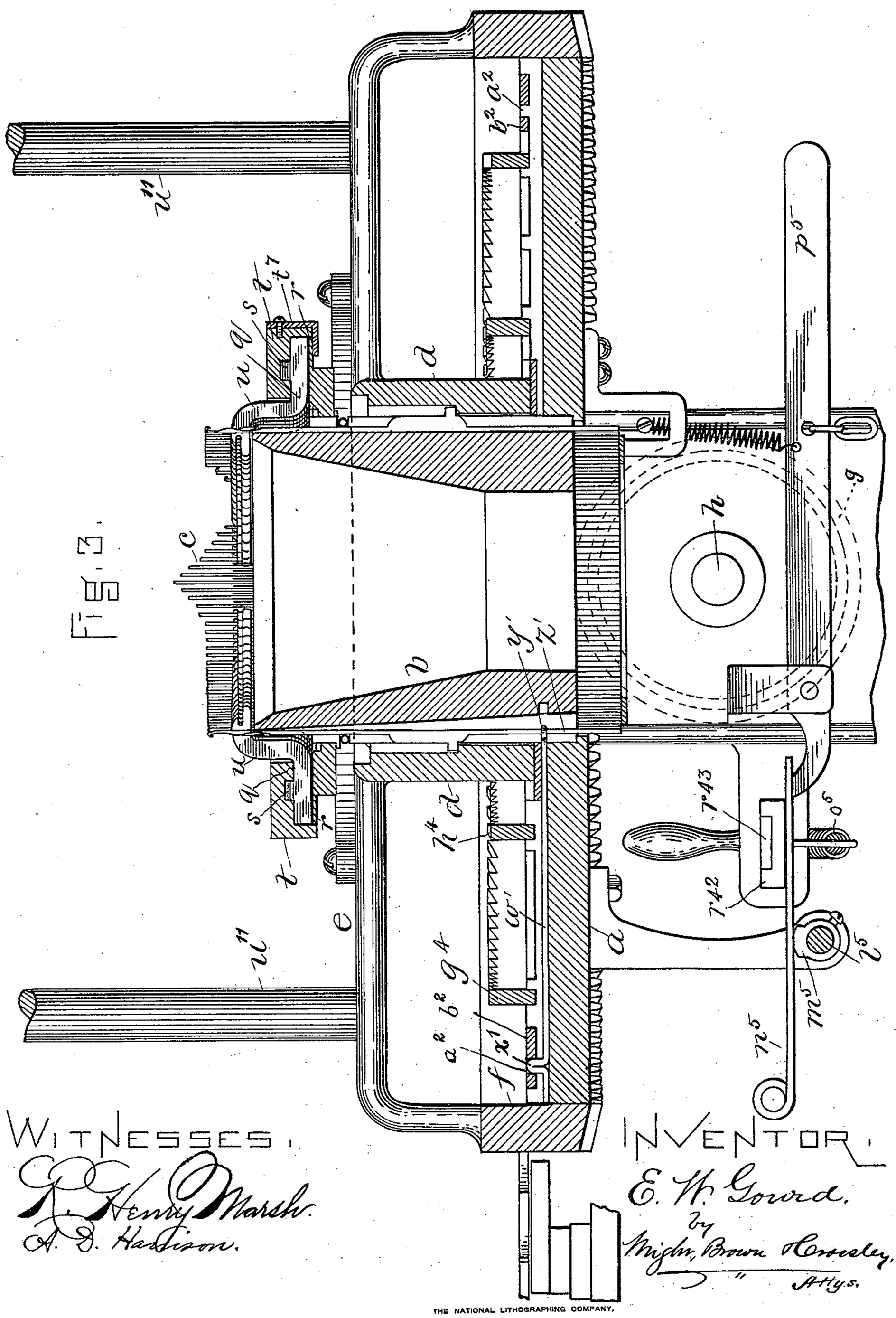

WITNESSES:

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FIG. 4.

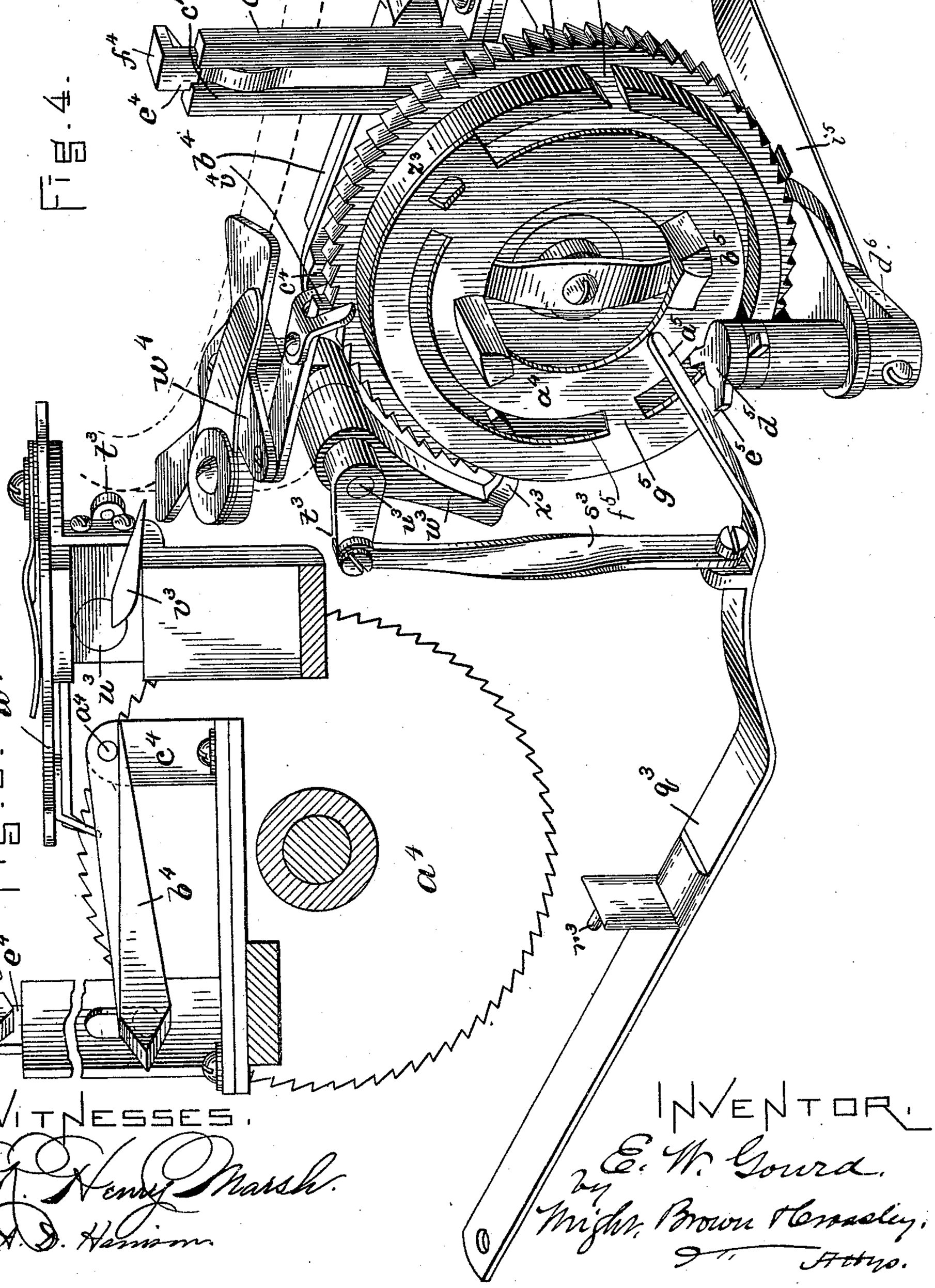

FIG. 5.

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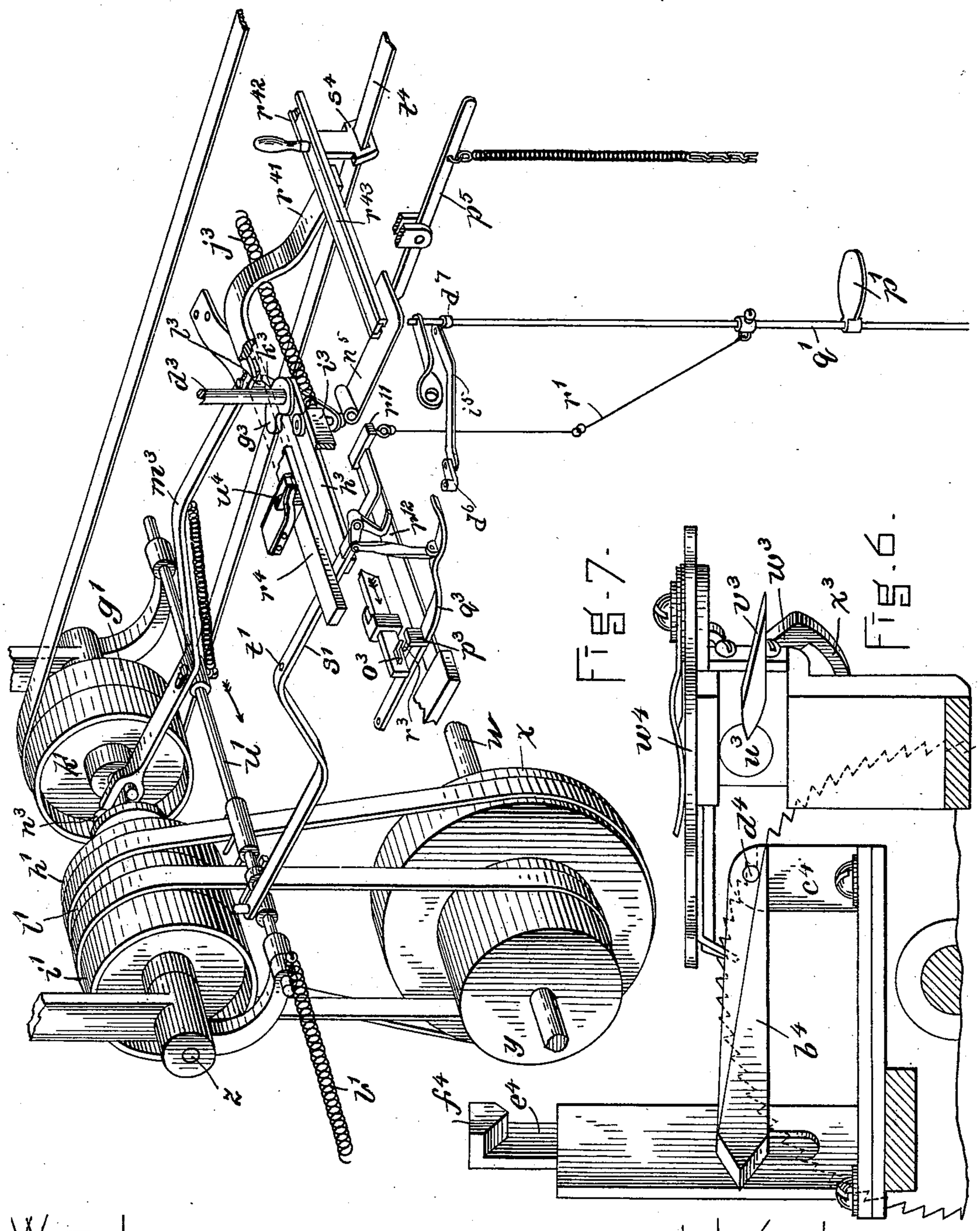

FIG. 7.

FIG. 6.

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E. W. GOURD.

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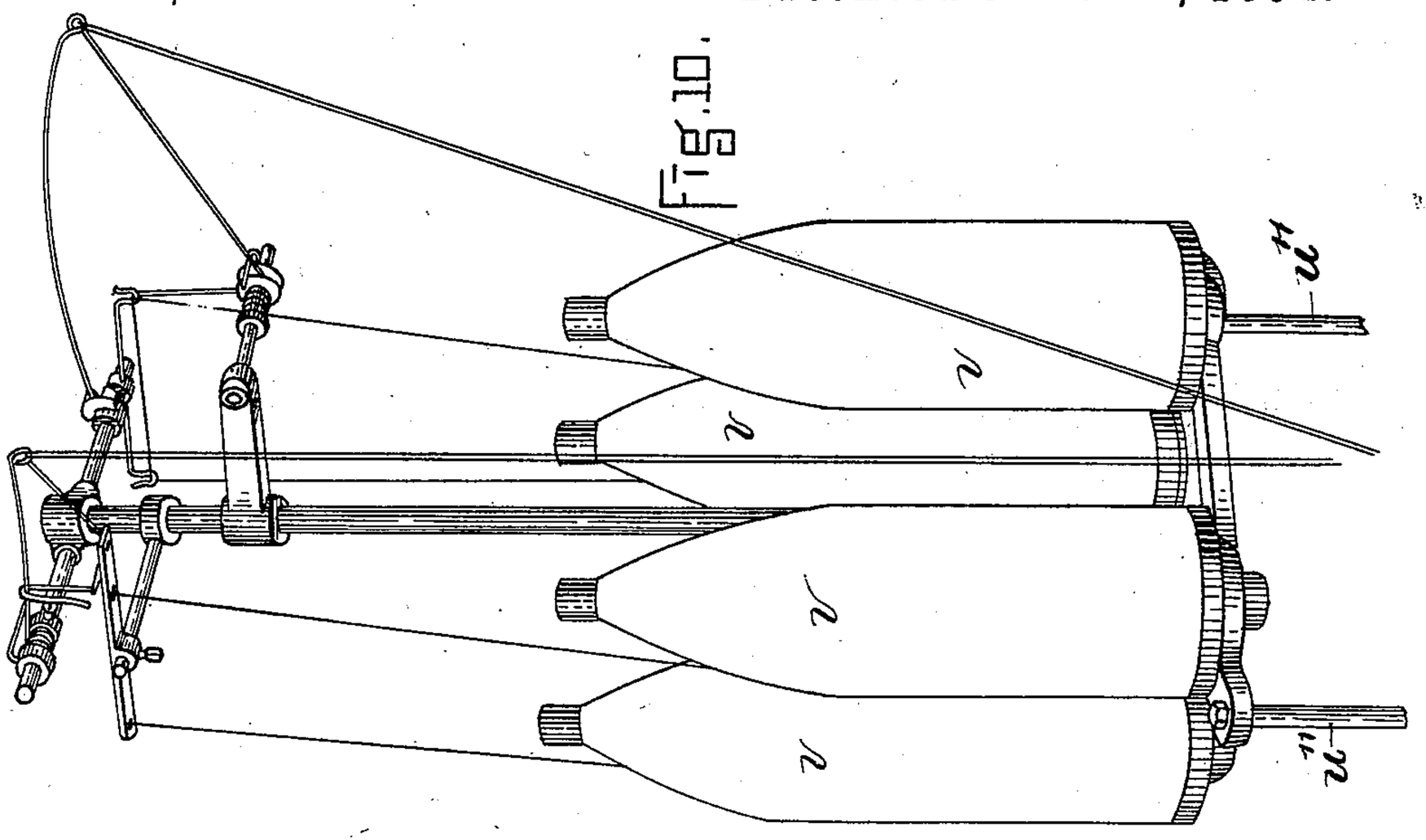


Fig. 10.

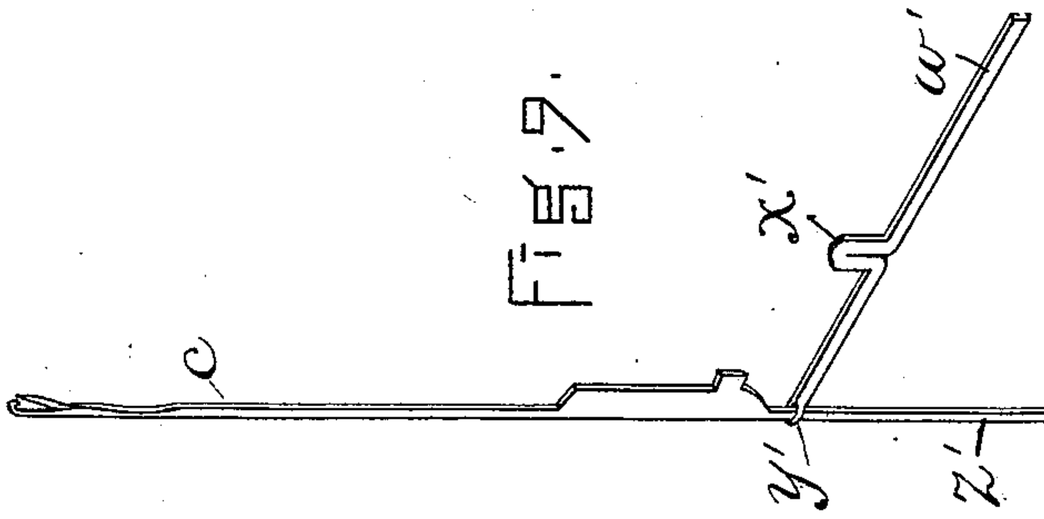


Fig. 7.

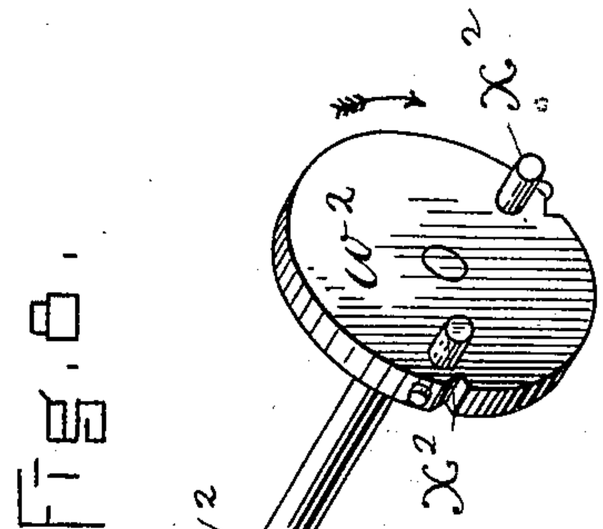
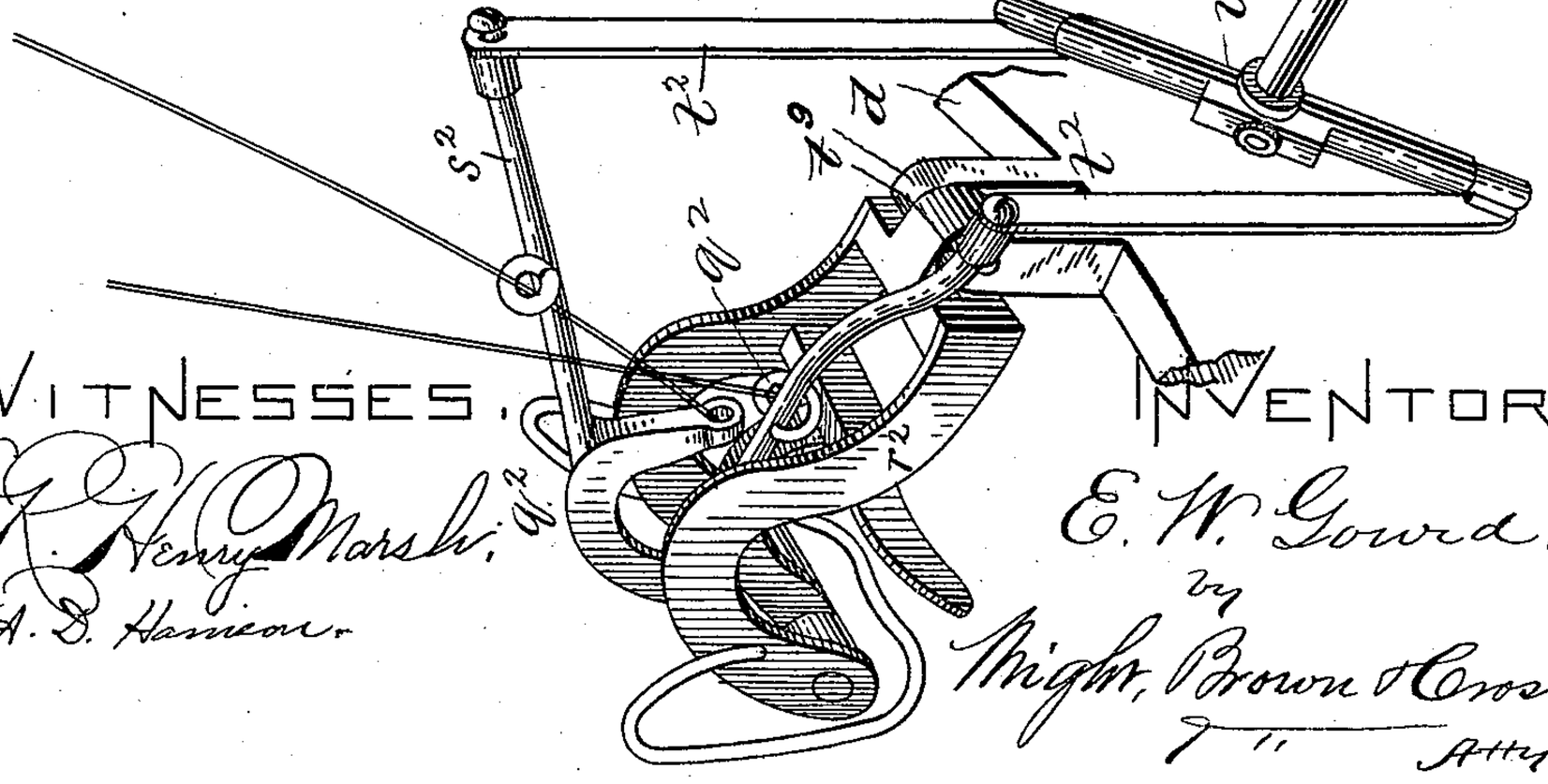


Fig. 8.



WITNESSES.

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E. W. GOURD.

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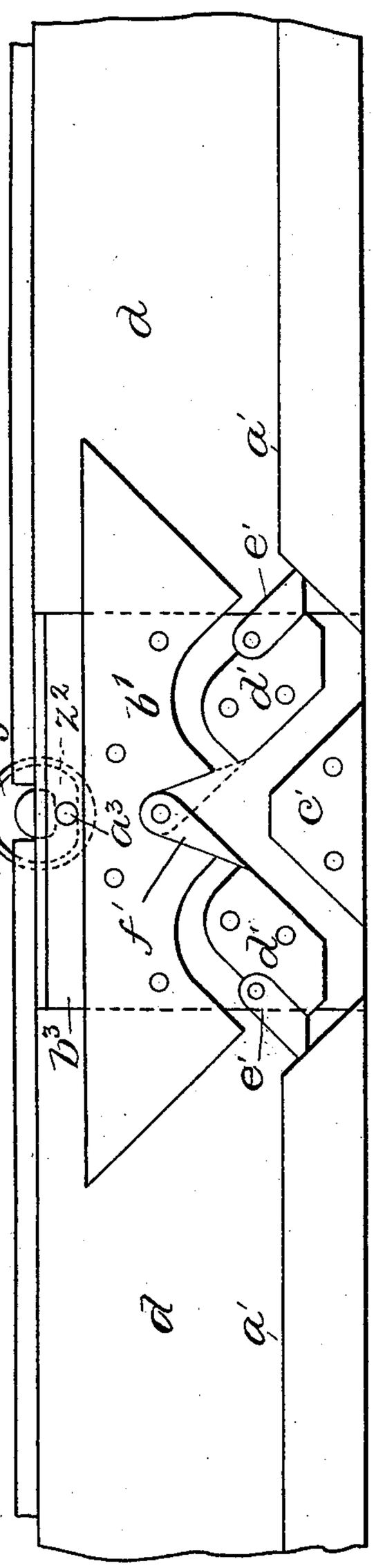

Fig. 11.

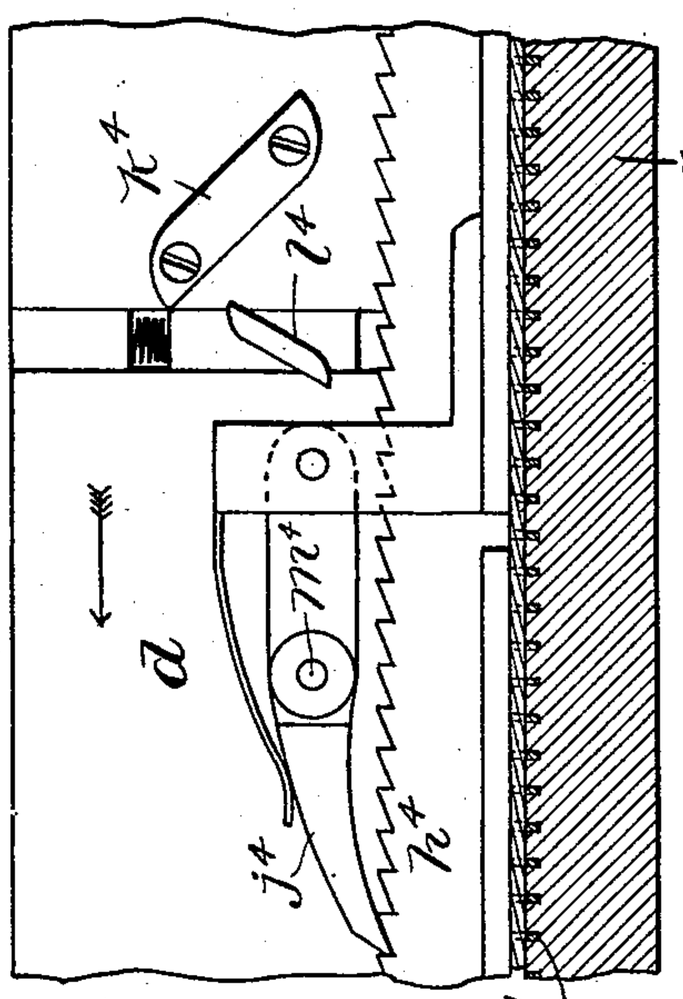

Fig. 13.

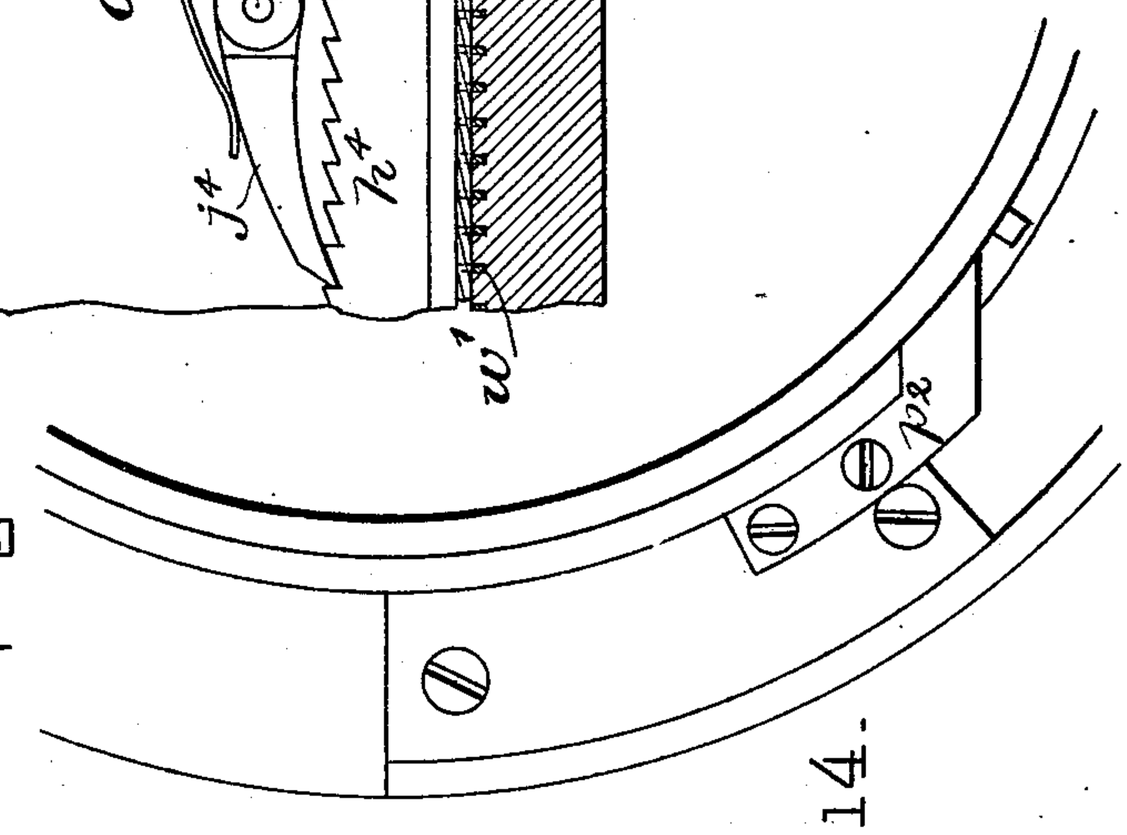

Fig. 14.

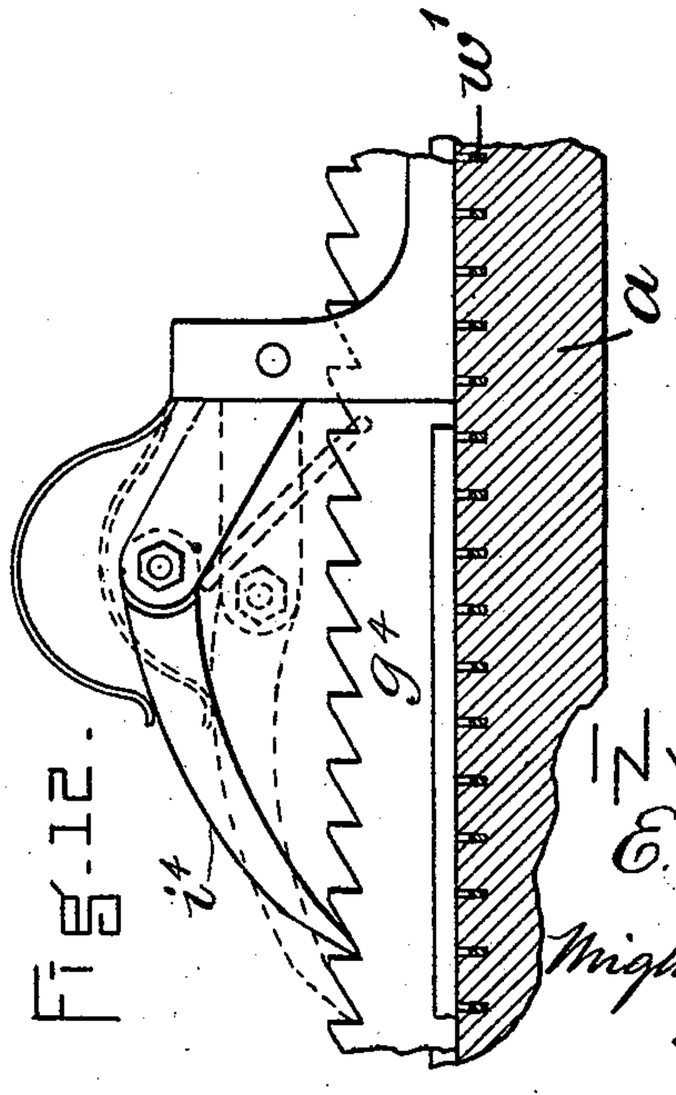

Fig. 12.

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E. W. GOURD.

CIRCULAR KNITTING MACHINE.

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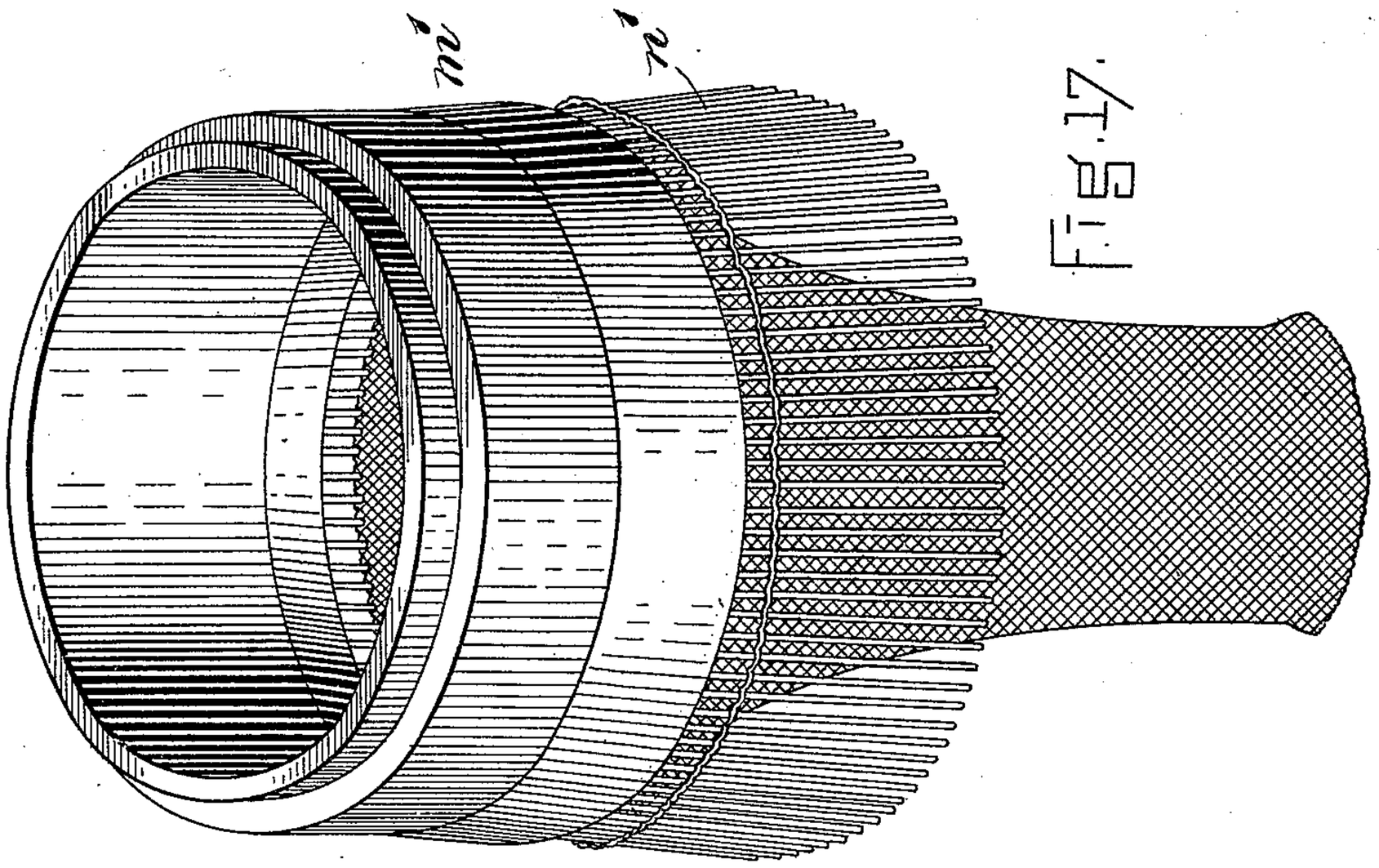

FIG. 17.

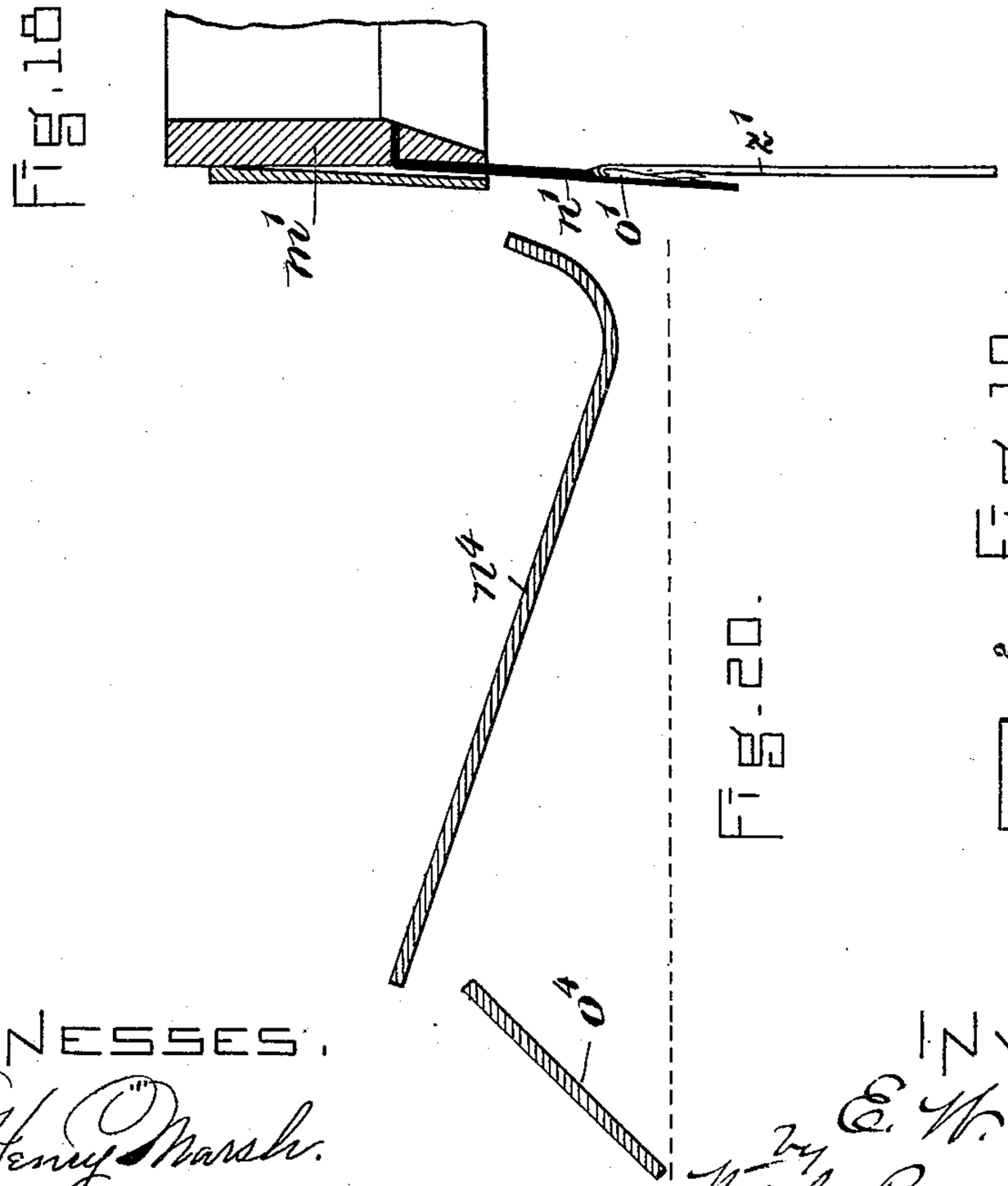

FIG. 18.

FIG. 20.

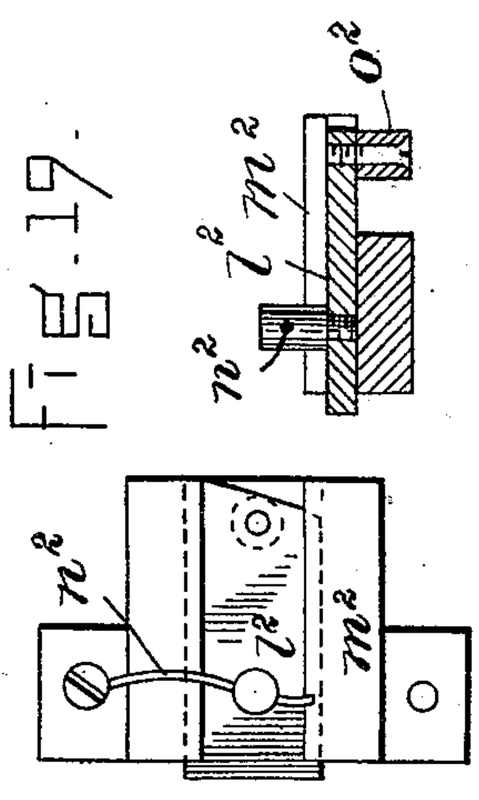

FIG. 19.

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E. W. GOURD.

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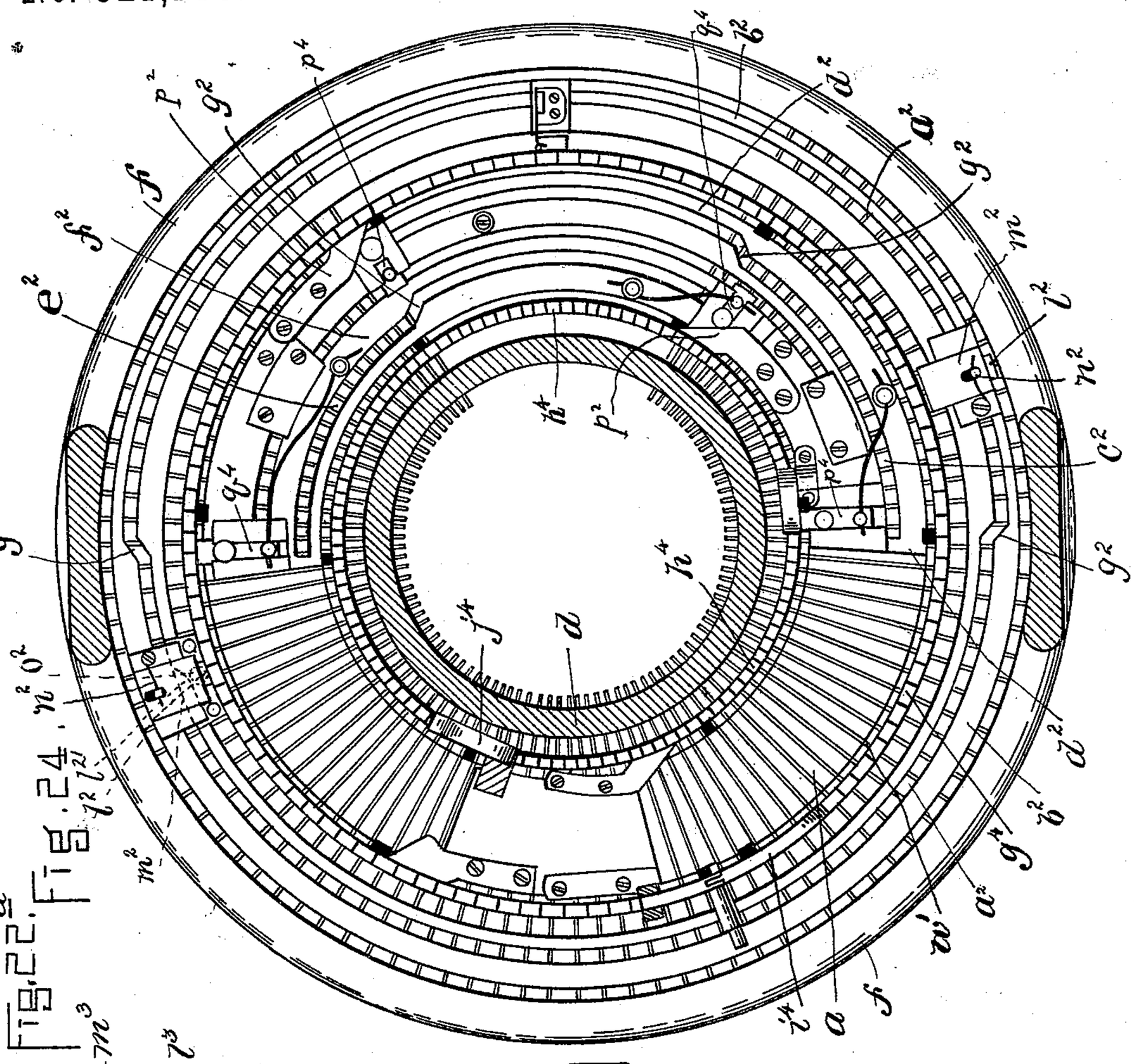


FIG. 22.

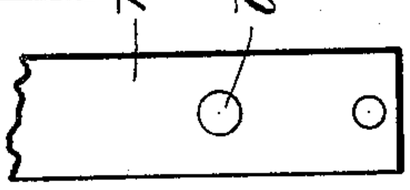


FIG. 22a.

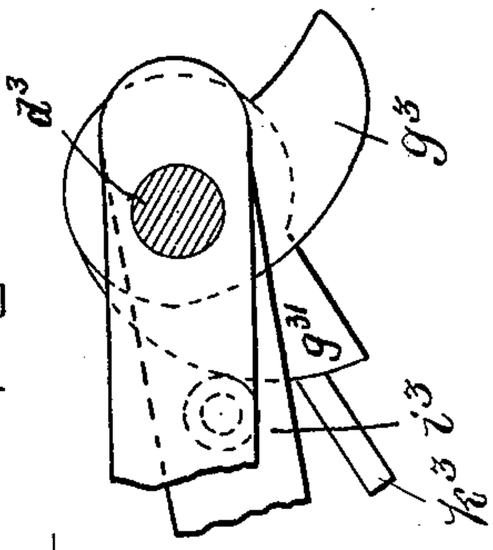


FIG. 23.

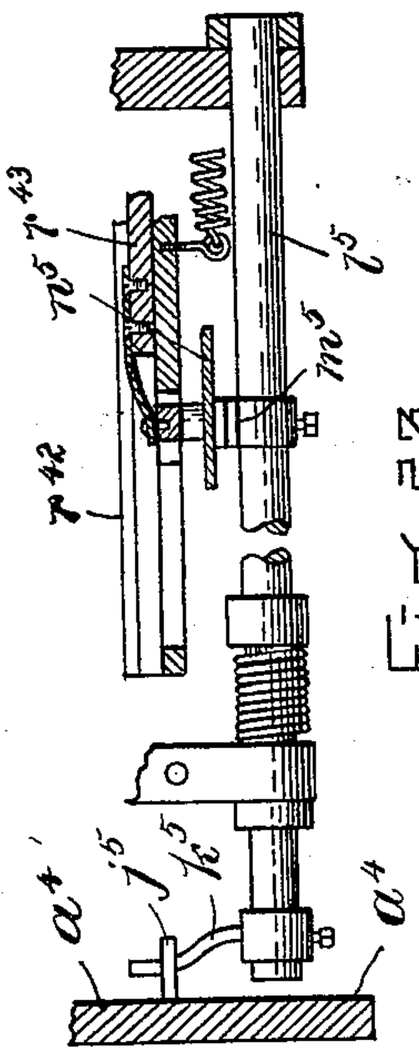
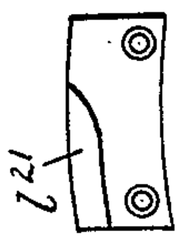


FIG. 21.



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E. W. GOURD.

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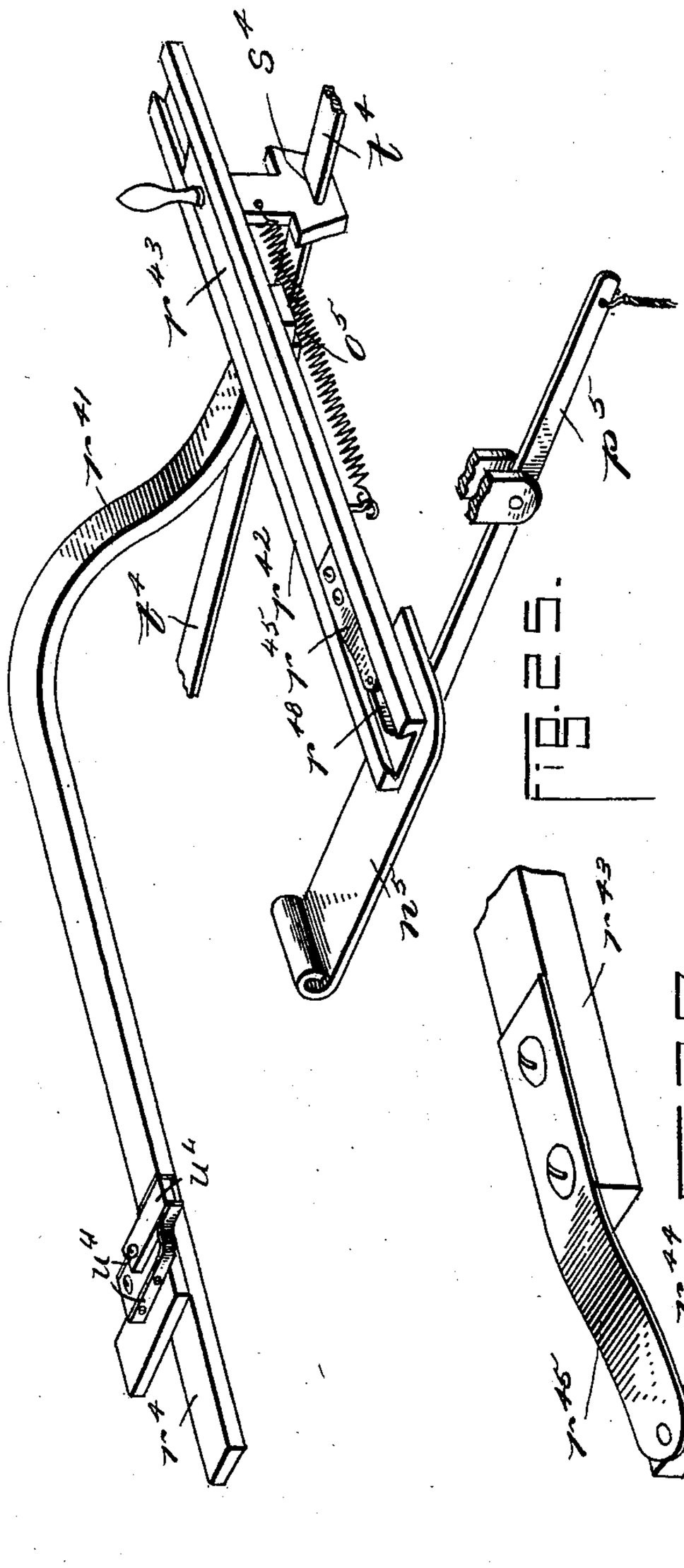

Fig. 25.

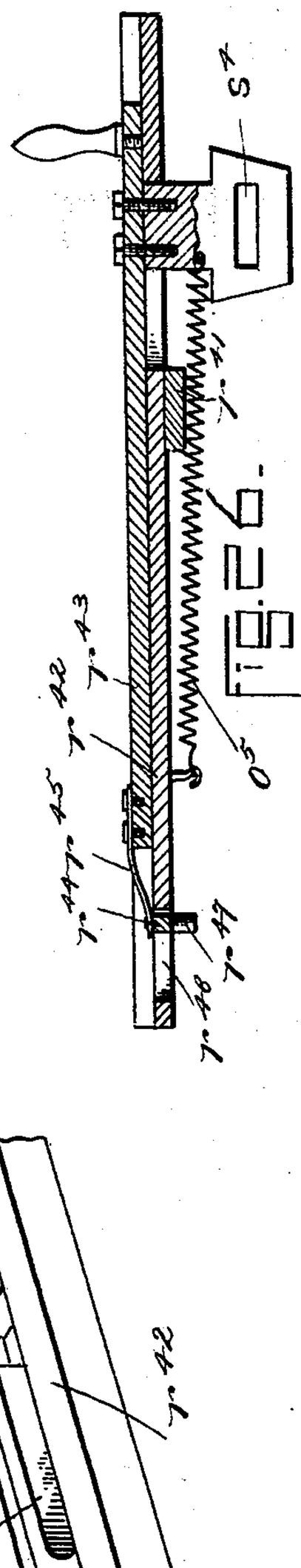

Fig. 26.

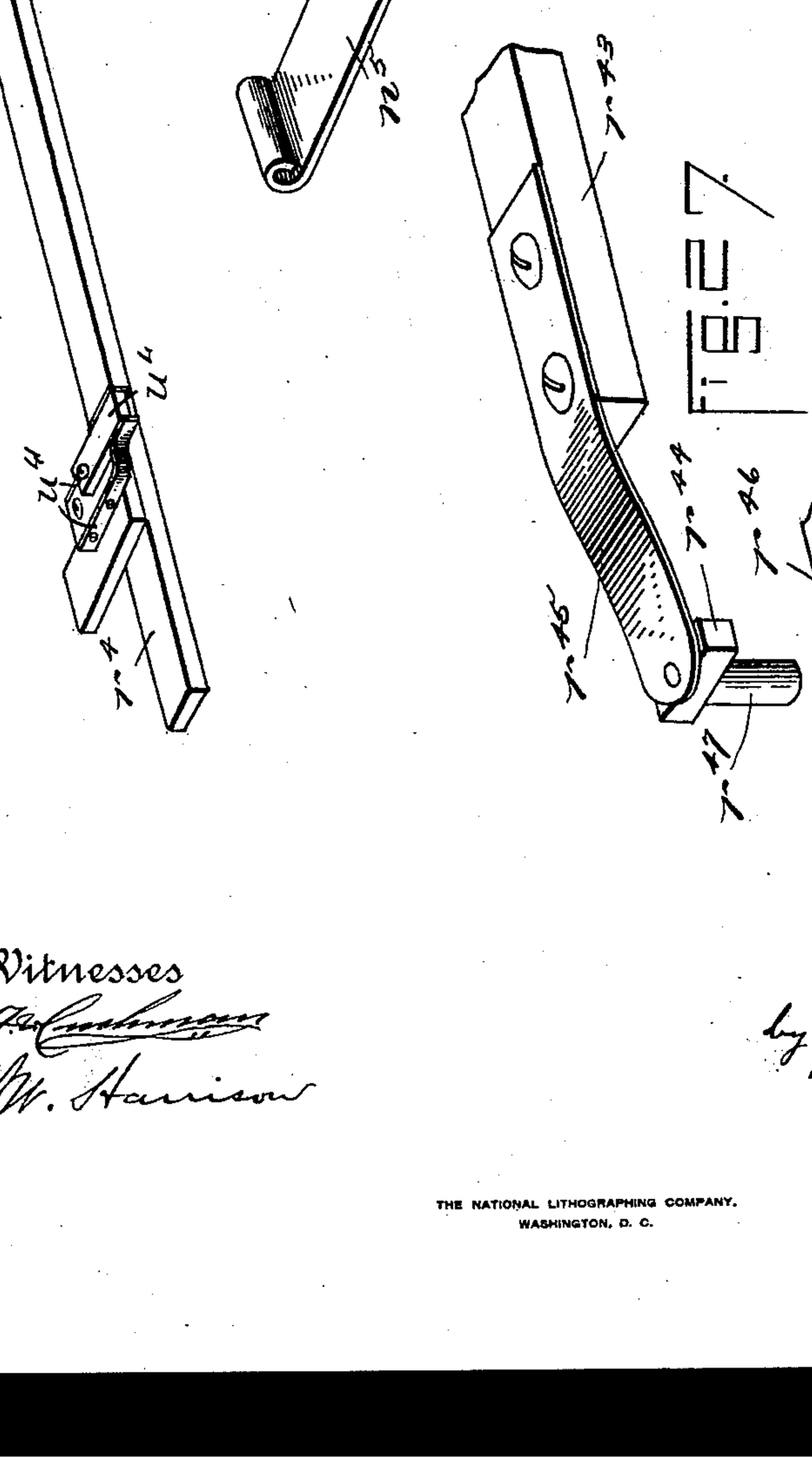

Fig. 27.

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A. W. Harrison

Inventor
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by Wright, Brown & Crosby
Attorneys.

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UNITED STATES PATENT OFFICE.

ERNEST W. GOURD, OF QUINCY, MASSACHUSETTS.

CIRCULAR-KNITTING MACHINE.

SPECIFICATION forming part of Letters Patent No. 521,284, dated June 12, 1894.

Application filed December 8, 1891. Serial No. 414,387. (No model.)

To all whom it may concern:

Be it known that I, ERNEST W. GOURD, of Quincy, in the county of Norfolk and State of Massachusetts, have invented certain new and useful Improvements in Circular-Knitting Machines, of which the following is a specification.

My invention has relation to circular knitting machines generally, and particularly to machines of the kind mentioned which are equipped with reciprocating latch needles, and are adapted to knit hose and half hose with round heels and toes.

It is the object of my invention to provide a circular knitting machine which shall be entirely automatic in the knitting of a stocking.

To this end my invention consists, first, of improved means for automatically changing the speed at which the machine is operated so that it can be "slowed down" in changing from circular knitting to heel-and-toe work, and "speeded up" in passing from heel-and-toe work back to circular knitting; second, of improved means whereby the yarns may be automatically changed in the beginning of the heel-and-toe work, and in passing from the latter to round-and-round knitting; third, of improved means for automatically throwing out of, and bringing into action the needles, in the knitting of heel-and-toe work; fourth, of improved means for securing a reciprocating movement of the cam ring or cylinder; fifth, of improved means for stopping the machine as hereinafter described and claimed; sixth, of improved parts and combinations of parts incidental to the foregoing.

Reference is to be had to the annexed drawings, and to the letters marked thereon, forming a part of this specification, the same letters indicating the same parts or features, as the case may be, wherever they occur.

In the drawings, Figure 1 is a top plan view of my improved machine, parts being represented as broken away, and the yarn guides and yarn supports and their immediate adjuncts being removed. Fig. 2 is a side view of the same. Fig. 3 is a vertical sectional view of the same. Fig. 4 is a perspective view of a portion of the contrivances whereby the machine is caused to change from round-and-round knitting to heel-and-toe work, and back again to circular work, to change the yarns, and to stop upon the completion of a stocking. Fig. 5 is a view from the inside, as it were, of the parts shown in Fig. 4. Fig. 6 is a view somewhat similar to Fig. 5, but showing the parts in a different position. Fig. 7 is a perspective view of a portion of the levers and other devices, through the medium of which the speed of the machine is changed, the reciprocation of the cam ring is effected, and the stoppage of the knitting operation is secured. Fig. 8 is a perspective view of the yarn-changing devices, and a portion of the means for changing the length of the stitch. Fig. 9 is a perspective view of a needle and needle-controller or shifter. Fig. 10 is a perspective view of the yarn supporters and yarn tension devices. Fig. 11 is an inside view of the needle-operating or stitch cams and their immediate adjuncts. Fig. 12 is a sectional side view of the means for actuating the outer ratchet ring, and its immediately-associated parts. Fig. 13 is a view similar to Fig. 12, though having reference to the inner ratchet ring. Fig. 14 is a top plan view upon an enlarged scale of one of the cams on the bed for operating a bolt connected with a needle-shifter ring to release it from a ratchet ring. Fig. 15 is a sectional view showing particularly the yarn-changing stop. Fig. 16 is a sectional detail view of a portion of the cam ring designed to show the construction and arrangement in the machine, of what I have herein termed the "king-bolt." Fig. 17 is a perspective view of the rib-top transferrer. Fig. 18 is a sectional detail of the latter, shown in connection with a needle. Fig. 19 shows a sectional and top plan view of a bolt employed in connection with a ratchet ring and a needle-shifter ring. Fig. 20 is a sectional detail of one of the cams for actuating a pawl to move one of the ratchet rings. Fig. 21 is a detail plan view of the cam l^{21} hereinafter referred to. Fig. 22 is a detail of the standard d^3 and its cams. Fig. 22^a is a detail side view of the slide bar m^3 and its pin l^3. Fig. 23 is a sectional elevation of a portion of the belt shifting mechanism. Fig. 24 is a sectional plan illustrating the position of parts when the machine is about to change from narrowing to widening. Fig. 25 is a de-

tail perspective of parts of the belt-shifting mechanism. Fig. 26 is a longitudinal sectional view of the belt-shifting bars. Fig. 27 is a detail perspective view of the ends of the bars at the left in Fig. 26, the said ends being separated from each other to more clearly show the construction.

In the drawings *a* designates the bed of the machine which is supported upon a suitable frame.

b is the needle-cylinder.

c designates the needles.

d is the cam cylinder which is connected by means of the yoke *e* with a toothed ring *f* arranged outside of the bed *a* and engaged by a bevel-gear wheel *g* on the driving shaft *h*.

i is a pulley fast on the shaft *h*, and *j k* are pulleys loose upon the said shaft, the pulley *k* being connected with a gear wheel *l*, also loose upon the shaft *h*, the said gear wheel meshing with a gear *m* fast on a counter shaft *n*, on the opposite end of which is a gear *o* engaged by an idle gear *o*, the latter being engaged by a gear *p* fast on the shaft *h*, by which construction and arrangement of parts the cam cylinder will when the belt is on the pulley *i*, be revolved in a direction contrary to that it will be when the belt is on the pulley *k*, as will be understood without further description.

q designates the web-holders which are supported in a grooved bed *r*, and are provided with heels *s* which are engaged and actuated by a cam groove formed in the under face of a ring *t* which is adapted to be rotated by the cam cylinder *d* by the mechanism presently described. The ring *t* is mounted to rest on the web-holders *q*, and is prevented from rising therefrom by clips t^7 secured thereto, (see Figs. 1, 2 and 3,) and extending down and under the bed *r*. The ring *t* is provided with two laterally projecting shoulders t^8, (see Fig. 1,) between which extends the standard t^9 rising from the cam cylinder *d*. The standard t^9 also supports the bracket r^2 of the yarn guides, as indicated in Fig. 8. During the movements of the cam ring, the standard t^9 engages one or the other of the shoulders t^8 and rotates or reciprocates the ring *t* with it, the object of the space between the shoulders being to permit sufficient lost motion so that the yarn guides will be carried in advance of the moving web-holders in either direction of movement of the cam ring and yarn guides. The web-holders are provided with necks *u* which extend upward from the inner ends of their bases, thereby enabling the ring *t* to be arranged well below the tops of the needles and so that its upper surface may be below the top of the needle-cylinder.

u'' are standards extending up from the yoke *e*, upon which the bobbins *v* and yarn-tension devices are supported.

w, (see Fig. 7) is the main shaft provided with the large high-speed pulley *x* and the small slow-speed pulley *y* which are belted to pulleys on the intermediate shaft *z*, other pulleys on the latter shaft being belted to the pulleys on the driving shaft *h*.

The needle-operating or stitch cams are shown in Fig. 11, wherein *a'* designates the ledge on the interior of the cam cylinder *d* whereon the heels of the needles ride before and after being actuated by the stitch cams.

b' designates the upper, and *c'* the lower stationary cams; and *d'*, the wing cams.

e' are swinging switch or bridge cams, operating between the outer points of the wing cams and the ledge *a'*.

f' is a swinging switch cam or tumbler pivoted between and above the wing cams so that its lower free point may be moved by contact with the heels of the needles from side to side and be brought to rest by contact with the inner points of the wing cams. The construction and arrangement of the cams insure the passage of the heels of all the needles which have been raised by one wing cam beneath the other.

g', *h'*, *i'*, and *k'* designate pulleys which are fast on the intermediate shaft *z*, and *l'* is a pulley loose upon the said shaft.

In Figs. 17 and 18 there is represented a transferring device by which a rib-knit top may be cast upon the needles, the said device consisting of a ring or cylinder *m'* in which are arranged in circular form a number of pins *n'* corresponding in position and arrangement with the needles in the needle cylinder. Each pin *n'* is provided on its inner side with a groove or depression *o'* to receive the hook and latch of the needle, as is clearly represented in Fig. 18. A top having been picked upon the pins *n'*, the transferrer will be placed over the needles, so that the latter shall engage the pins as shown in the figure last mentioned when the operator, taking hold of the free end of the top, which may extend through the needle-cylinder, and drawing down upon the same casts it upon the needles. A weight may now be attached to the free end of the rib-knit top, and with the machine belted as in Fig. 7, (the belt from the pulley *g'* passing around the pulley *i*,) it may be started, and will be run at a comparatively high rate of speed performing plain circular or round-and-round knitting, until the weight attached to the top shall have in its descent, reached the plate *p'* extending laterally from the rotary rod *q'* supported in suitable bearings. The said weight bearing upon the said rod will draw the latter downward pulling upon the wire or cord *r'* connected therewith and with the latch piece *r''* on the end of the spring latch bar r^{12} which is composed of a spring bar fastened to a suitable support, as the bench to which the machine is attached. The bar r^{12} normally keeps the shoulder or piece r^{11} in the position shown in Fig. 7 to prevent movement of the lever *s'* fulcrumed at *t'*. The opposite end of the said lever rests in a groove, or it may be between two collars on a shipping rod *u'*, with which a spring *v'* is connected tending to

draw the said rod in the direction of the arrow shown in close proximity thereto. When the forward end of the lever s' is released by drawing down the latch piece r'' in engagement therewith the belt-shipping rod u' will be released allowing the spring v' to move the said rod so as to ship the belt on the tight pulley h' to the loose pulley l' and the belt on the loose pulley l' to the tight pulley i', the effect of which will be to make the comparatively small pulley y, (instead of the large pulley x) the driving pulley, and operate the machine at a much slower speed, preparatory to the beginning of the knitting of a heel, it being understood that when the weight came to rest upon the plate p' a web had been knit of sufficient length to form the leg of a stocking.

In the knitting of heel-and-toe work it is understood that the cam cylinder will be reciprocated, substantially one-half of the needles having first been thrown out of action, and a portion of those left in action being gradually retired, as the cam cylinder is reciprocated, to narrow, and then gradually brought back into action, to widen, and this feature of the invention will be next described.

As will be seen by reference to Fig. 3, some of the grooves formed in the needle cylinder, in which the needles are reciprocated are gradually deepened from top to bottom, so that by moving the lower ends or tails of the needles inward toward the axis of the cylinder, the heels of the needles will be moved inward so as not to be engaged and actuated by the stitch cams shown in Fig. 11.

w' designates needle shifters, which may consist of lengths of wire, provided with heels x', similar to needle-heels and having a hole y' formed through their inner ends, through which the tails z' of the needles pass. See particularly, Figs. 3 and 9.

The needle-shifters are arranged so as to be reciprocated in radial grooves formed in the bed a, and substantially half of the needles in the circle, which are to be rendered inactive in commencing the knitting of a heel, are engaged by shifters the heels of which extend into a groove a^2 of a ring b^2 supported so as to be moved circularly on the bed a, and of the needles left in action which are to be gradually retired and again brought into action, those on one side are engaged by shifters the heels of which extend into the groove c^2 of a segment or it may be a ring d^2, and those needles on the other side are engaged by a groove e^2 of a segment or ring f^2. The grooves a^2, c^2, and e^2 of the ring and segments are divided so that a portion extends upon a greater radius than the remaining portion, the two portions being connected by an inclined portion g^2, (see Fig. 1.)

The construction and arrangement of the ring b^2 and segments or rings d^2 and f^2 are such that when circular work is to be performed the heels of the shifters will be in the portions of the grooves of greater radius, maintaining the needles in action. When, however, a heel or toe is to be knit, the ring b^2 will first be moved in its bearings to the extent of substantially a half revolution, carrying the heel of the shifters from the portion of the groove a^2 of greater radius to the portion of less radius, with the result of rendering the needles controlled by the shifters inoperative; and after this the segments d^2 and f^2 will as the needle-cylinder is reciprocated be moved step by step in one direction to gradually retire the needles from operation, and then be moved back in like manner to gradually bring the needles controlled by the shifters in the said segments, into operation again, the ring b^2 being again moved to the extent of a half revolution to bring the needles controlled by the shifters actuated by the said ring back into operation for the resumption of circular knitting, as in the formation of the foot portion of a stocking.

h^2 designates what I have, for the purposes of this specification elected to term a "king-bolt," which bolt extends through a slot i^2 in the ring f and is secured to a slide j^2 constructed and arranged to move vertically in a groove k^2 formed in the said ring. (See Fig. 16.)

The ring b^2 is equipped with two bolts or slides l^2 like that shown in detail in Fig. 19, wherein the said bolt l^2 is represented as being adapted to slide radially between guide pieces m^2 being pressed normally outward by a spring n^2. A stud o^2 projects downward from the inner end of the bolt l^2 and is adapted as the ring is moved or revolved in its bearings, to come into contact with a fixed cam or incline l^{21}, see Figs. 21 and 24, whereby the said bolt will be removed against the stress of the spring n^2. One of the bolts l^2 connected with the ring b^2 stands in a higher plane than the other, the arrangement being such, that when the king-bolt h^2 is in depressed position, it will be brought into contact or engagement with the bolt l^2 extending in the lower plane and when the king-bolt is raised, as is shown in Fig. 16, it will engage the other bolt l^2.

q^2 (Fig. 8.) designates the yarn-guides, constructed as levers pivoted upon the inner end of a bracket r^2 supported in proper position above the needles, from each of which yarn-guides there projects outwardly a rod or arm s^2, the outer end of which is pivotally connected with the upper end of a link t^2, the lower end being in like manner connected with the outer end of a cross arm u^2 upon the rock shaft v^2 supported in suitable bearings. On the outer end of the rock shaft v^2 is a disk w^2 from which project two pins x^2. The inner end of the said shaft is provided with a disk y^2, (see Fig. 11.) in the inner face of which is formed an eccentric groove z^2 into which projects a pin a^3 extending outward from the slide piece b^3 to which the knitting cams are attached, and which is adapted to slide vertically in suitable ways formed in

the cam cylinder. It will now be seen that if the rock shaft v^2 should be moved in the direction indicated by the arrow shown in close proximity to the disk w^2, the yarn guide q^2 shown as raised out of operative position would be lowered into position to have the yarn carried thereby fed to the needles, while the other yarn-guide would be raised out of operative position; and at the same time the disk y^2 would be moved so as to cause the eccentric groove z^2 to act upon the pin a^3 with the effect of lowering the slide piece b^3 and the knitting cams carried thereby, causing a longer stitch to be drawn.

c^3 designates a disk fixed upon a vertically arranged standard d^3, the said disk being provided upon its periphery with teeth e^3, the intervals between which are regular, excepting between two teeth, as at f^3 in which instance the interval is longer than in the other cases. This disk extends in a plane coincident with that of the king-bolt h^2 when the latter is in raised position, and when the long space f^3 is brought opposite the cam ring the king-bolt will pass the disk without engaging any of its teeth, but when the said disk is moved to bring one of its teeth opposite the cam ring, the said king-bolt will in each revolution of the cam cylinder, strike a tooth e^3 and revolve or move the said disk step by step until the long space f^3 is again brought opposite the cam ring. When the king bolt is depressed to make the heel, it does not move this ratchet. On the lower end of the standard d^3 is a cam g^{31}, see Fig. 22 similar to the cam g^3 shown in Fig. 7 as secured to the said standard above the bar h^3, which cam g^{31} is adapted to act upon a stud or roller g^{32} on the bottom of an extension of the bar i^3, which bar is adapted to be moved longitudinally and is held normally in backward position by a spring j^3. Extending out radially from the standard d^3 is a pin k^3, which is adapted to be engaged by a pin l^3 extending down from the inner end of a slide bar m^3, the forward end of which is forked and arranged astride of the intermediate shaft z so that when the shipping rod u' is moved by the spring v' the forked end of the bar m^3 which is pivoted upon the shipper rod u', will be brought into engagement with a cam n^3 on the intermediate shaft and moved so as to cause the pin l^3 to engage the pin k^3 on the standard d^3 and move the same, and consequently the disk c^3 so as to bring the tooth e^3 of the said disk, following the long space f^3 opposite the cam cylinder where it may be engaged by the king-bolt. On the outer end of the bar i^3 there is a ledge o^3 the inner end of which is downwardly inclined, and on a bracket p^3 connected with a lever q^3 is a laterally projecting stud r^3, over which the ledge o^3 is adapted to pass as the bar i^3 is moved in the direction of the arrow marked thereon, and when the said bar is moved by the spring j^3 in the opposite direction, the ledge will pass under the pin or stud r^3 and raise the lever k^3. The inner end of the lever q^3 (see Fig. 4.) is pivotally connected with the lower end of a link s^3, the upper end of which is in like manner connected with a crank arm t^3 secured upon a rock shaft u^3 journaled in a stationary bracket and having fixed upon its inner end a "lamb's-tongue" switch v^3, see Figs. 5 and 6. To the rock shaft u^3 is also fixed a dog w^3, the end of the curved finger x^3 of which is adapted, when out of the notches y^3, to rest upon the ledge z^3 formed on the side of the ratchet wheel a^4.

b^4 designates a switch cam pivoted upon a bracket c^4 at a^4, which pivot a^4 is in the same plane as the rock rod u^3. The opposite end of the said switch cam b^4 is pivotally connected with a vertically movable yarn-changing slide e^4, the upper end of which is provided with a projection f^4, with which the pins x^2 on the disk w^2 are adapted to come into contact.

g^4 and h^4 designate rings supported upon the bed a in suitable bearings so that they may be revolved. The upper edges of the said rings are provided with ratchet teeth. The teeth of the ratchet ring g^4 are engaged by a spring pressed pawl i^4 (see Fig. 12.) and those of the latter ratchet ring by a similar pawl j^4, (see Fig. 13.) each pawl being pivotally connected with a suitable bracket connected with the bed a.

Connected with the cam cylinder are a fixed inclined piece k^4 and a spring pressed inclined piece l^4, so arranged that when the cam cylinder is revolved in the direction opposite to that indicated by the arrow in Fig. 13, as it will be in the production of circular work, the roller stud m^4 extending out from the pawl j^4 will pass under the inclined piece l^4 without actuating the said pawl j^4, but when the cam cylinder is moved in the direction indicated by the arrow, (as it will be in one of its reciprocating movements,) the stud m^4 will ride upon the inclined piece l^4, and pass under the fixed incline k^4, causing the pawl to be actuated so as to move the ratchet ring h^4 to the extent of the distance between two teeth of the said rings.

In Fig. 20 are shown inclines or cams n^4 and o^4 which correspond respectively with the inclines k^4 and l^4, and are adapted to actuate the pawl i^4 in a similar manner so as to move the ratchet-ring g^4 to a similar extent. The full and dotted lines in Fig. 12 show how the pawls may be moved by their inclines to actuate their respective ratchet rings.

On the segment d^2 are bolts p^4 similar in construction and function to the bolt or slide l^2 shown in Fig. 19, and already fully described, and on the segment f^2 are similar bolts or slides q^4; and on the bed are cams p^2, q^2, suitably placed as shown to engage the studs o^2 so as to move the slides or bolts p^4 q^4 in a direction opposite to that exerted by the stress of their springs.

r^4 is a slide bar supported in suitable bearings and extended to form a bar r^{41}, which is

connected with a slide bar r^{42}, (see Figs. 1, 7, 25 and 26.) This bar r^{42} forms a guide-way for a slide bar r^{43}, which is provided with a guide-eye s^4, through which the driving belt t^4 passes, the connection of the guide-eye with the bar r^{43} being through a slot in bar r^{42}, as indicated in Fig. 26, so as to permit the bar r^{43} and its guide-eye to be moved independently of bar r^{42} by mechanism hereinafter described. The connection which causes movement of bar r^{42} to ordinarily move bar r^{43} with it, will also be hereinafter described. The bar r^4 (and consequently bars r^{42} and r^{43} when locked together), is moved by the following described mechanism:—A piece or block u^4 is pivotally connected with a block carried by the slide bar r^4 and is engaged on its opposite sides by springs u^{41}, the said block u^4 being thus yieldingly connected with the bar r^4. This block u^4 projects laterally from the bar r^4 in the plane of movement of the king-bolt n^2 when the latter is in depressed position, said king-bolt thus having the effect of moving the slide-bar from side to side, shifting the belt from the pulley i to the pulley k and reversing the movement of the cam cylinder.

v^4 designates a pawl, adapted to engage the teeth of the ratchet wheel a^4, (see Figs. 1, 4, 5 and 6) which pawl is pivoted upon the arm of a plate w^4, which plate is pivoted upon the bracket in which the rod u^3 is journaled. The said plate is provided with two other arms, which extend inward in the plane of travel of the outwardly projecting part y^4 on the upper end of the slide j^2 on which the king-bolt h^2 is fixed, when the said slide and king-bolt are in their lower position, while the cam cylinder is being reciprocated, and of course when the slide j^2 is down, the plate w^4 will be rocked upon its pivot, and the pawl v^4 will be actuated so as to move the ratchet wheel a^4 to the extent of one tooth each time.

Sufficient description has now been given of the construction and arrangement of parts entering into the organization of the machine to enable me to set forth its operation in changing from circular work to that of knitting a heel, in doing which the cam cylinder will be reciprocated.

As before stated, when the shipper rod u' is moved to change the speed from fast to slow, the bar m^3 will also be moved and be brought into contact with, and actuated by the cam n^3 so as to cause its pin l^3 to act upon the pin k^3 and move the standard d^3 to an extent sufficient to bring one of the teeth of the disk c^3 in position to be struck by the king-bolt in the revolution of the cam cylinder and ring f. As the disk c^3 and standard d^3 are rotated, the cam on the lower end of the standard, acting upon a stud or roller on the bar i^3 will move the said bar in the direction of the arrow marked thereon carrying the ledge o^3 over the pin r^3. When the cam on the standard passes the stud on the bar i^3, the spring j^3 will draw the said bar back in a direction contrary to that indicated by the arrow, and the stud r^3 will ride up on the ledge o^3, raising the lever q^3 and the free end of the switch v^3 and lifting the curved finger x^3 of the dog w^3 out of the notch y^3, so that the end of the said finger may rest upon the ledge z^3 of the ratchet wheel a^4. In the continuous revolution of the cam cylinder and ring, the outer projecting end of the king-bolt will pass under the free end of the switch v^3, (which will be in the position shown in Fig. 6) and be depressed thereby. The same end of the king-bolt will pass under the switch b^4 and raise it and the yarn changing slide e^4. The inner projecting end h^{22} of the king-bolt will now engage one of the bolts l^2 (the lower one) on the ring b^2 and carry said ring around until substantially half of the needles are thrown out of operation, as before described, when the stud o^2 coming into contact with the cam l^{21} will move the slide or bolt l^2 back out of contact with the king-bolt, leaving the ring at a standstill. One of the pins x^2 on the disk w^2 will be brought into contact with the yarn-changing stop f^4, the rock shaft v^2 will be moved, the yarns changed, and the knitting cams lowered so as to lengthen the stitch. The projecting part y^4 of the king-bolt when in depressed position coming into contact with the block u^4 will move the slide bar r^4 so as to ship the driving belt and reverse the motion of the cam cylinder, which, on its backward movement will cause the pawl j^4 and the pawl i^4 to be actuated through the medium of the inclines or cams, moving the ratchet rings h^4 and g^4, but in contrary directions owing to the arrangement of the pawls with respect to the ratchet rings upon which they operate. On the backward movement of the cam cylinder the part y^4 comes in contact with the other side of the block u^4, and thus, through the connections described, again reverses the motion of the cam cylinder. Upon the ends of the segments d^2 and f^2 are the bolts p^4 and q^4 similar to the bolt l^2 shown in Fig. 19, which bolts p^4 and q^4 on one end of the segments will be engaged by lugs on the ratchet rings g^4 and h^4, and so said segments will be carried around step by step, gradually retiring the needles controlled by the needle shifters actuated by the said segments, until all of such needles are retired, when the pin o^2 on the said bolts will be engaged by a cam p^2 and caused to move back out of contact with the lug on the ratchet ring by which it was engaged and moved. At this time the bolts p^4 q^4 on the opposite ends of the segments will be engaged with lugs on the opposite ratchet rings, and the segments will gradually be moved step by step back to their original positions gradually bringing the narrowing needles into operation and effecting widening. These lugs, which are shown in Fig. 24, in heavy black to make them more prominent, are carried by the walls of the ratchet rings at such proper height as to enable them to pass those bolts which they are not intended to operate.

When the segments reach their original positions, the bolts p^4 q^4 will be moved back, as has before been explained, so as to disengage the same from the ratchet rings. During this operation the ratchet wheel a^4 will have been moved as before described until the end of the curved finger x^3 on the ledge z^3 will have fallen into a notch y^3, the result of which will be to allow the lever q^3 to fall, rocking the rod w^3, and bringing the switch v^3 down from the position in which it is represented in Fig. 6 to that in which it is shown in Fig. 5. The outer end of the king-bolt will now be engaged by the switch v^3 and raised to the position shown in Fig. 16, and riding over the switch b^4 will lower the yarn-changing stop f^4, causing it to strike the other pin x^2 on the disk w^2 again changing the yarn-guides and stitch cams, bringing them back to original position. The inner end of the king-bolt will engage another bolt l^2 on the ring b^2 extending in a higher plane than that of the bolt first engaged, and carry the said ring back a half revolution, bringing the retired needles into operation again, when the said bolt l^2 will be disengaged from the king-bolt as before explained. The king-bolt being raised will again engage the teeth of the plate c^3 and turn the standard d^3 so that the cam g^3 will act upon the stud or roller z^4 on the bar h^3, which bar acting upon the shipper lever s' will move the same back against the stress of the spring l' shifting the belts back to the position in which they are represented in Fig. 7, and changing the speed of the machine from slow to fast. At the same time the latch piece r'' on the latch bar r^{12} will fall behind the free end of the lever s' and lock the same in position. The free end of the lever q^3 is extended and curved upward as at a^5, so that it may be brought into contact with the cams b^5 on the ratchet wheel a^4, and tip the said lever q^3 in order to throw the pin r^3 off the ledge o^3 after the end of the finger x^3 of the dog w^3 has been landed upon the ledge z^3 of the ratchet wheel a^4.

Supported in a suitable bracket or bearing c^5 (see Fig. 2.) is a short vertical shaft d^5 upon the upper end of which is a head provided with radial projections e^5 which project into grooves f^5 in the side of the ratchet wheel a^4 and are adapted as the said wheel is moved to engage the uncut-away parts g^5 and so rotate the said shaft. Upon the lower end of the shaft d^5 is a crank arm d^6 which is pivotally connected at its outer end with a pitman i^5 which is connected also to the outer end of a crank arm d^7 which is connected with the rotary rod q'. The parts are so constructed and timed that upon the completion of a heel the shaft d^5 will have been rotated so as to move the rod q' in its bearings to an extent sufficient to move the plate p' from under the weight connected with the fabric, and bring another plate similar to plate p', and below the same, on rod q', in position to be acted upon by the weight when a web of sufficient length has been knit for the foot of a stocking, and the machine is to be again changed from fast to slow speed, and operated to knit a toe. After a toe has been knit a pin j^5, (see Fig. 23) projecting laterally from the inside of the ratchet wheel a^4 will be brought into contact with a pin k^5 projecting radially from the end of the rock-rod 15 (see Fig. 2) and move the latter device in its bearings to an extent sufficient to cause a cam m^5 thereon, (see Fig. 3,) to lift a hinged plate n^5 which will act upon a pin or latch r^{47} connected with the slide-bar r^{43} and release the latter bar from the slide-bar r^{42} and allow a spring o^5 to move the slide-bar r^{43}, and ship the belt onto the pulley j, as shown in Fig. 1, and stop the machine. The mechanism for holding the bars r^{42} and r^{43} locked together is shown most clearly in Figs. 25, 26 and 27. As shown, the bar r^{43} has secured to it at one end a spring r^{45} carrying a block r^{44} and the pin r^{47}, while the bar r^{42} has an enlarged opening r^{46}, from one side of which extends a slot r^{48}. Normally, the block r^{44} is held in the enlarged opening r^{46} by the spring r^{45}, and the two bars are thus held locked together, while the pin r^{47} projects below the plane of the lower side of bar r^{42}. When, however, the plate n^5 is lifted by the action of cam m^5, or the lever p^5, presently described, the pin r^{47} is lifted so as to cause the disengagement of the block r^{44} from the opening r^{46}, and the spring o^5 then moves the slide-bar r^{43} and causes the eye s^4 to ship the belt.

p^5 is a lever (see Fig. 7), the inner end of which extends under the plate n^5. To the outer end of the lever p^5 is attached a chain or it may be a cord, which is suitably connected with the weight attached to the fabric, so that should the thread or yarn break or run out and the fabric run off the needles, the descent of the weight, drawing on the chain will operate the lever p^5, plate n^5, and slide r^{43}, to stop the machine The lever p^5 may also be employed to stop the machine by hand when desired.

The knitting of a toe of a stocking will be accomplished in the same way as the knitting of a heel, therefore that operation need not be repeated.

By the description it will be seen that I am enabled to fully accomplish all of the objects set out at the beginning of this specification; and it will be further observed that while I have been particular in the description of the construction and operation of the means shown in the drawings, I do not confine myself closely thereto, since the same may be varied in form and arrangement without departing from the nature or spirit of the invention.

As above stated the segments d^2 f^2 may be rings, and in either case, owing to the shape of their grooves c^2 e^2, they act as cams to positively advance or retract the shifters w'.

Having described the nature of my improvements and a form of means whereby the same

may be carried into effect, though without attempting to set forth all the ways in which the invention may be constructed or all of its modes of use, I declare that what I claim is—

1. A vertically arranged needle cylinder, provided with needle grooves, gradually deepened from their upper to their lower ends, and the needles therein, combined with a horizontally arranged needle shifter bed, needle shifters supported on the bed, and provided with heels, and oppositely movable cam rings for engaging the heels of the needle shifters to render the needles controlled by the shifters, operative and inoperative, ratchet rings, adapted to engage the cam rings for engaging the shifters to move the same, pawls for engaging the ratchets to move the cam rings, and means for operating the pawls, as set forth.

2. A vertically arranged needle cylinder, provided with needle grooves, gradually deepened from their upper to their lower ends, and the needles therein, combined with a horizontally arranged needle shifter bed, needle shifters supported thereon, and provided with heels, oppositely movable cam rings for engaging the heels of the needle shifters, to render the needles controlled by the shifters operative and inoperative, radially sliding bolts supported on said cam rings, ratchet rings, pawls for engaging the said ra'chet rings, means to operate said pawls, and cams on the bed to engage said bolts, and operate the same to disengage them from, the ratchet rings, as set forth.

3. The combination with the needle cylinder and its needles, of the cam cylinder and an independent cam-ring having a cam groove in two practically equal reaches, jacks corresponding to about half of the needles engaging with said reaches, driving mechanism, and tripping mechanism for causing the driving mechanism to engage the cam-ring and to be disengaged therefrom, whereby said ring is given a half revolution.

4. As a means for throwing substantially one-half of the needles of a circle out of, and bringing them into, action at the commencement and finish of heel and toe work, the combination with a vertically arranged needle cylinder provided with needle grooves, gradually deepened from their upper to their lower ends, of needles located in said grooves, a horizontally arranged needle shifter bed, needle shifters, provided with heels, adapted to engage the tails of the needles to be thrown out of, and brought into, action, the rotary cam ring or cylinder, the ring revolubly supported on the said bed, provided with a groove, one portion of which is described with a greater radius than the other portion, the two portions being connected by an inclined portion, the heels of the needle shifters being arranged to extend into said grooves, movable bolts on the said ring, cams on the needle shifter bed to move said bolts, and a vertically movable bolt on the cam cylinder, the construction and arrangement being such that when the bolt on the cam cylinder is raised, it may engage one of the bolts on the needle shifter ring, and when it is lowered it may engage the other bolt, as set forth.

5. The needle cylinder, needles, and cam cylinder, combined with needle shifters, provided with heels, the needle shifter bed, a ring provided with a groove, one portion of which is described with a greater radius than the other portion, the two portions being connected by an inclined portion, the heels of the needle shifters extending into said groove, sliding bolts on said ring, and means engaging said bolts to move the ring and cams on the bed, to move the bolts to disengage them from their moving means, as set forth.

6. The needle cylinder, needles, and cam cylinder, combined with a driving shaft, two pulleys on the driving shaft, connections whereby one pulley will revolve the cam cylinder in one, and the other, in the other direction, a belt for actuating the said pulleys, a belt shipping bar for shipping the belt from one pulley to the other, a projection on said bar, a movable bolt on the cam cylinder, and a switch for moving said bolt to position to be brought into, and moved out of contact with the said projection on the belt shipper bar, as set forth.

7. The combination, with the needle cylinder, needles, and cam cylinder, of the operating shafts, pulleys and belts connected therewith for operating the cam cylinder at fast and slow speeds, belt shipping mechanism for shipping the belts to run at either fast or slow speed, means for moving, locking, and tripping the belt shipping mechanism, a rod "q'" below the needle cylinder, provided with plates "p'" to receive a weight connected with the descending knit fabric, and connections between the said rod and tripping devices to release the belt shipping mechanism when the weight bears upon the said plates, as set forth.

8. The combination, with the needle cylinder, needles, and cam cylinder, of the operating shafts, pulleys and belts connected therewith for operating the cam cylinder at fast and slow speeds, belt shipping mechanism for shipping the belts to run at either fast or slow speed, means for moving, locking, and tripping the belt shipping mechanism, a rod "q'" below the needle cylinder, provided with plates "p'" to receive a weight connected with the descending knit fabric, and connections between the said rod and tripping devices to release the belt shipping mechanism when the weight bears upon the said plates, means to move the rod to carry one plate from beneath the weight, and bring another into position therebelow, as set forth.

9. The needle cylinder and needles combined with the revoluble cam cylinder, provided with a ledge "a'," a vertically movable slide piece "b^3," the knitting cams connected therewith, a rock shaft "v^2," and disk "y^2," provided on its inner face with an eccentric

groove "z^2," and a pin on the slide piece projecting into the eccentric groove "z^2," as set forth.

10. The needle cylinder, needles, and cam cylinder, in combination with the bracket "r^2," the yarn guides constructed as levers pivoted on said bracket, the rock rod "v^2," cross arm "w^2" connected with the said rod, and links "t^2" connecting the ends of the cross arm with the yarn guide levers, as set forth.

11. The needle cylinder, needles, and cam cylinder, in combination with the bracket "r^2," the yarn guides constructed as levers pivoted on said bracket, the rock rod "v^2," cross arm "u^2" connected with the said rod, and links "t^2" connecting the ends of the cross arm with the yarn guide levers, the slide piece "b^3," the knitting cams carried thereby, and disk "y^2" on rock shaft "v^2," provided on its inner face with an eccentric groove "z^2," and a pin on the slide piece projecting into the said eccentric groove, as set forth.

12. The needle cylinder, and needles, combined with the cam cylinder, movable knitting cams on the cam cylinder, movable yarn guides to change the yarn, a mechanism connected with both the yarn guides and knitting cams for moving the same in unison to simultaneously change the yarn and length of stitch, as set forth.

13. The needle cylinder, and needles, combined with the cam cylinder, movable knitting cams on the cam cylinder, movable yarn guides to change the yarn, rock rod "v^2," connections between the same, and the movable knitting cams and yarn guides, and disk "w^2," provided with pins "x^2" on the outer end of said rock rod, and a stop to engage said pins to rock the rod, for actuating the cams and yarn guides in unison, to simultaneously change the yarn and length of stitch, as set forth.

14. A machine for knitting stockings and half hose, comprising in its construction mechanism for automatically varying the speed to knit rapidly in the production of circular work, and slowly in the production of heel and toe work, a mechanism for automatically changing from circular to reciprocating knitting, and a mechanism for automatically varying the length of the stitch and changing the yarn when changing from circular to heel and toe work, and from the latter back to circular work again, as set forth.

15. The needle cylinder, and needles, combined with the cam cylinder, the needle cylinder being provided with needle grooves, gradually deepened from their upper to their lower ends, horizontally arranged needle shifter bed, the needle shifters arranged to be reciprocated thereon, a toothed ring "f" arranged to revolve around the periphery of said bed, and a yoke "e" connecting the ring with the cam cylinder, as set forth.

In testimony whereof I have signed my name to this specification, in the presence of two subscribing witnesses, this 19th day of November, A. D. 1891.

ERNEST W. GOURD.

Witnesses:
ARTHUR W. CROSSLEY,
A. D. HARRISON.