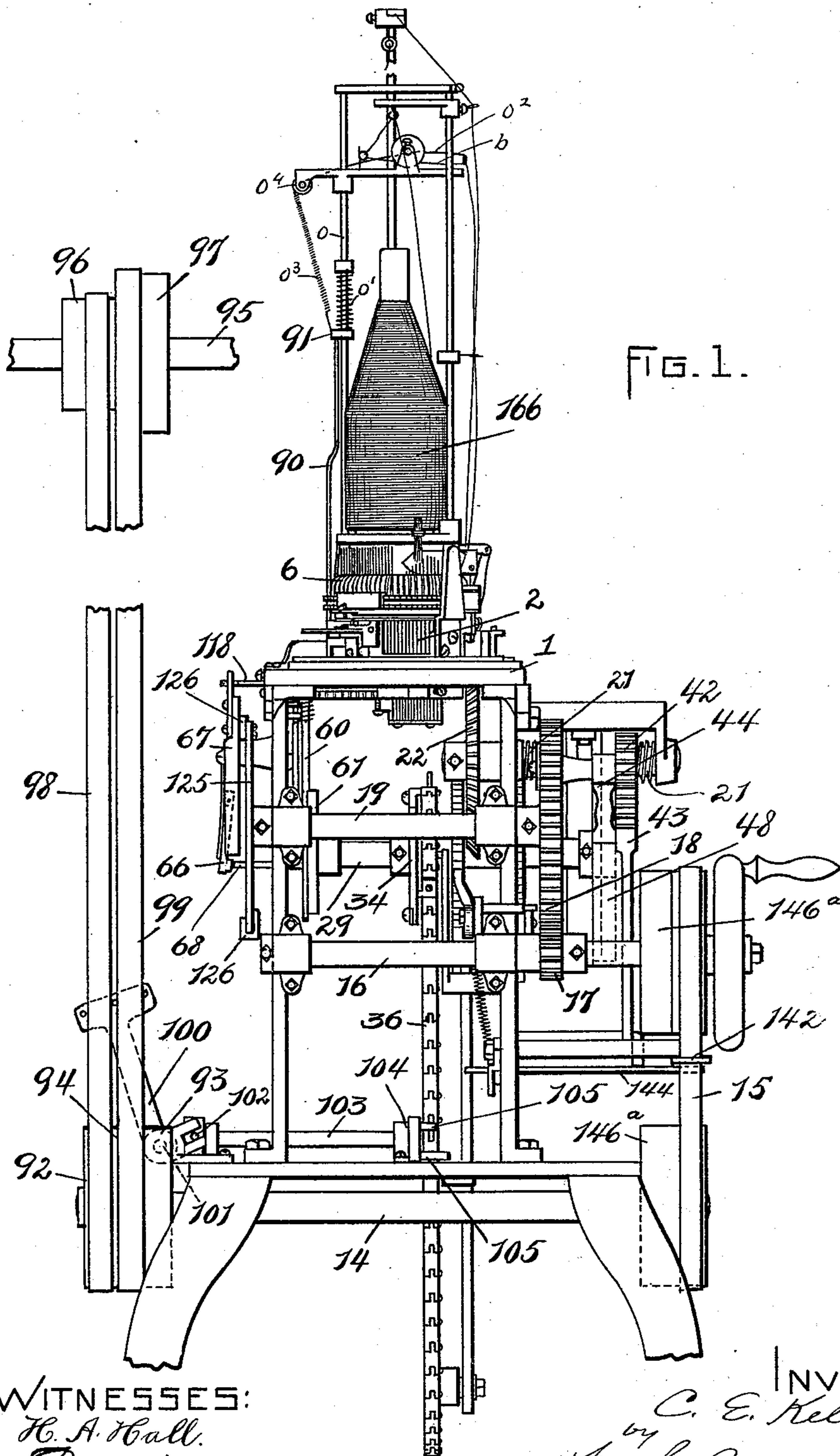


9 Sheets—Sheet 1.

No. 532,788.

Patented Jan. 22, 1895.



WITNESSES:

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INVENTOR:

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C. E. KELLEY.  
CIRCULAR KNITTING MACHINE.

No. 532,788.

Patented Jan. 22, 1895.

FIG. 2.

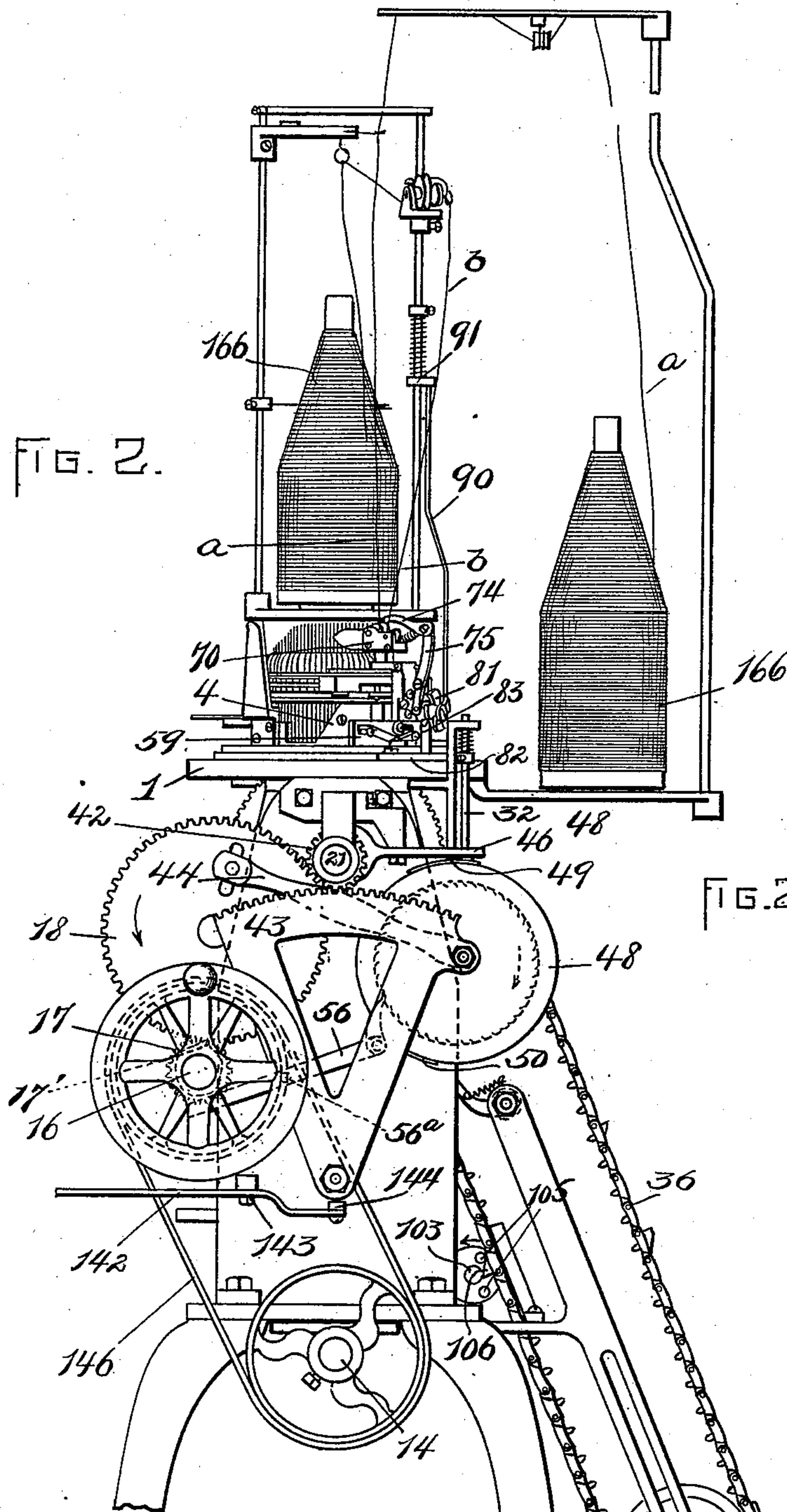
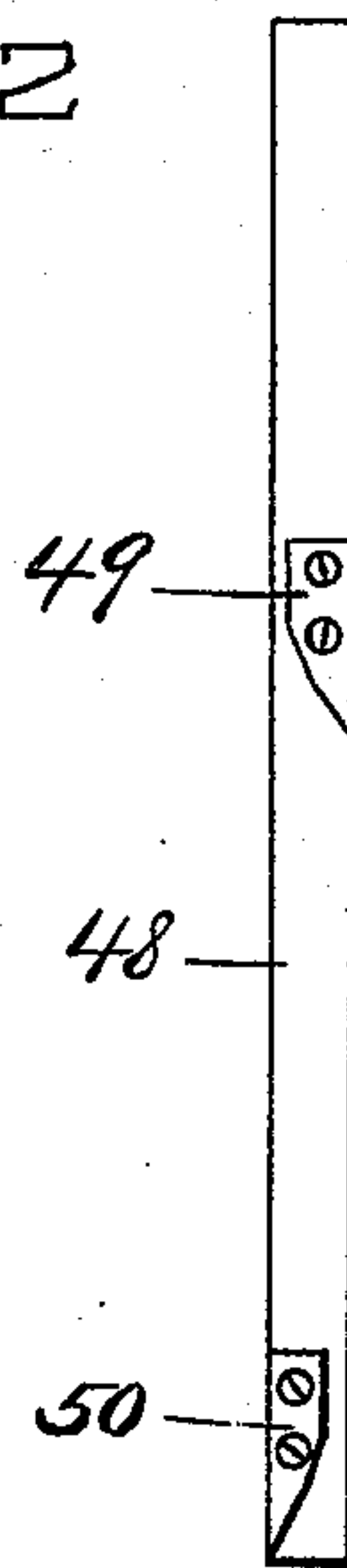


FIG. 22



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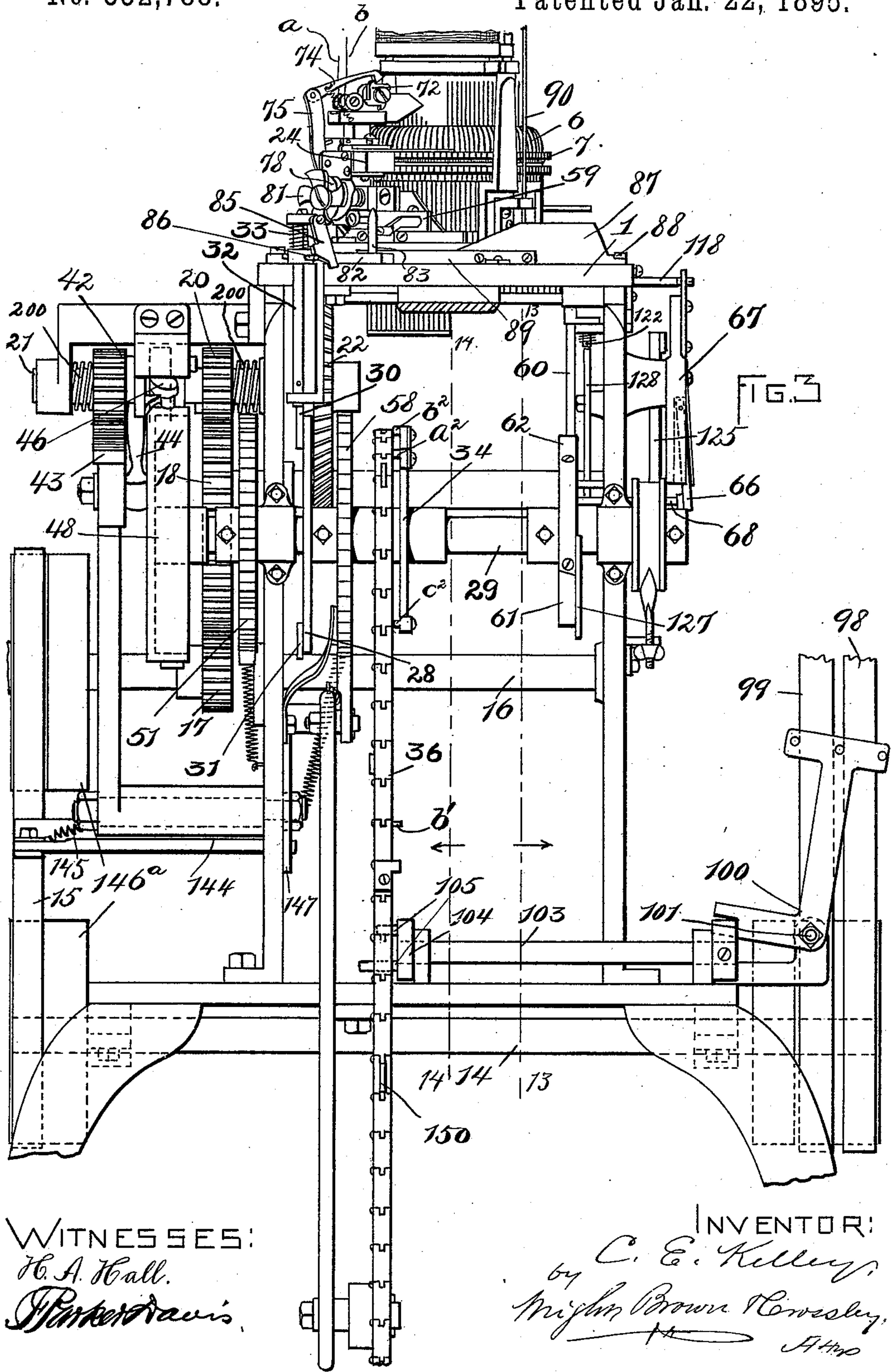
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9 Sheets—Sheet 3.

C. E. KELLEY.  
CIRCULAR KNITTING MACHINE.

No. 532,788.

Patented Jan. 22, 1895.



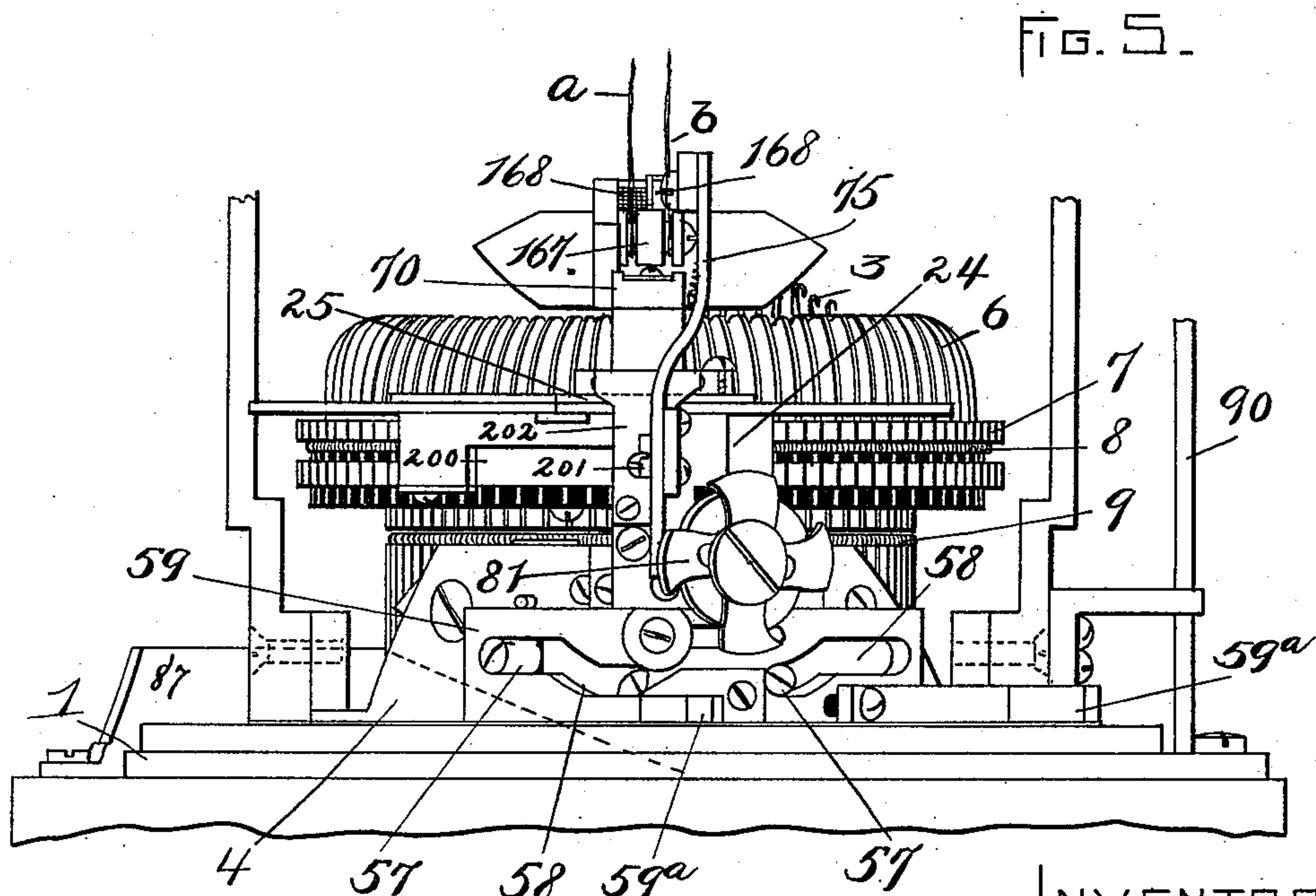
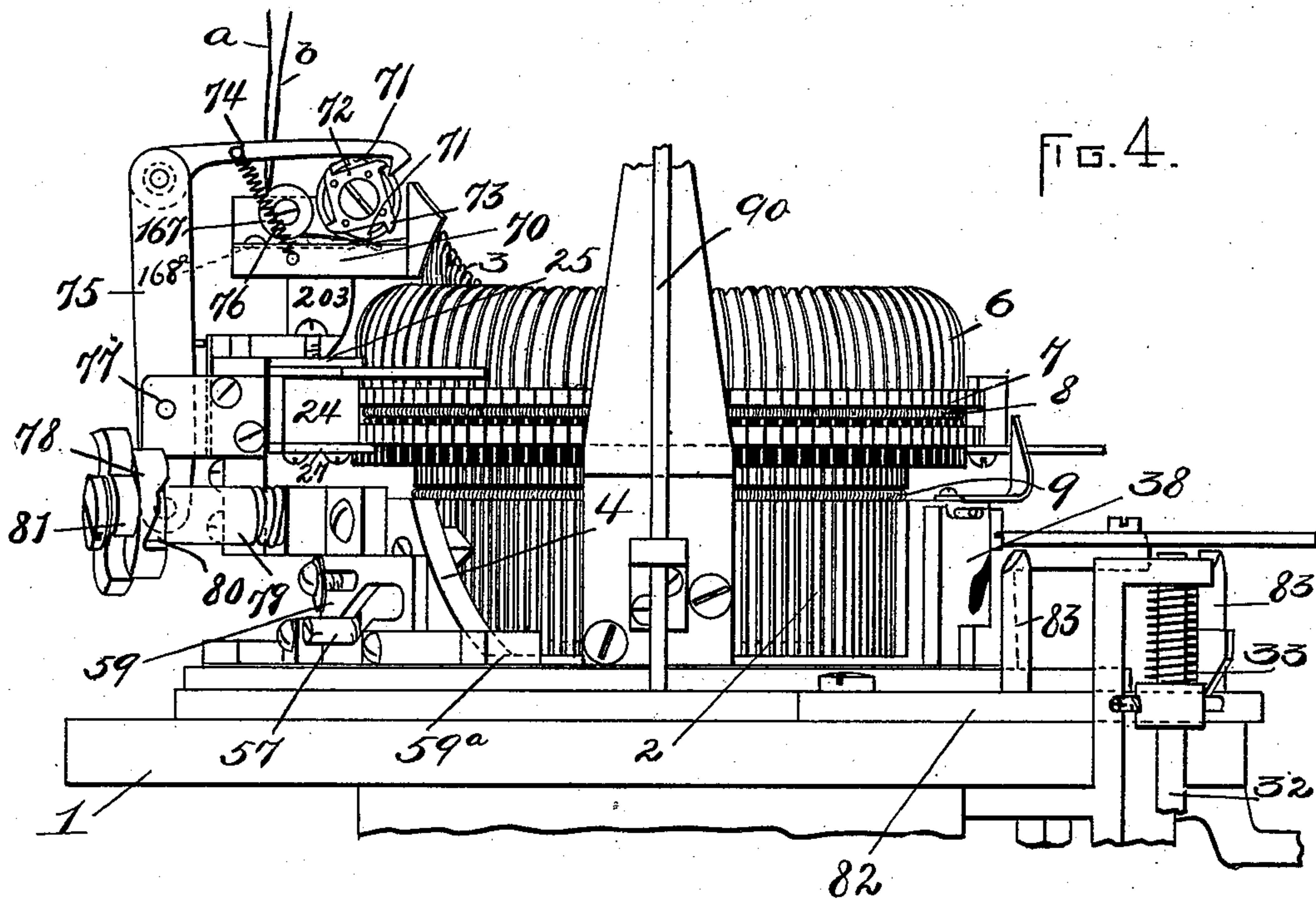
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Patented Jan. 22, 1895.



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H. A. Hall.  
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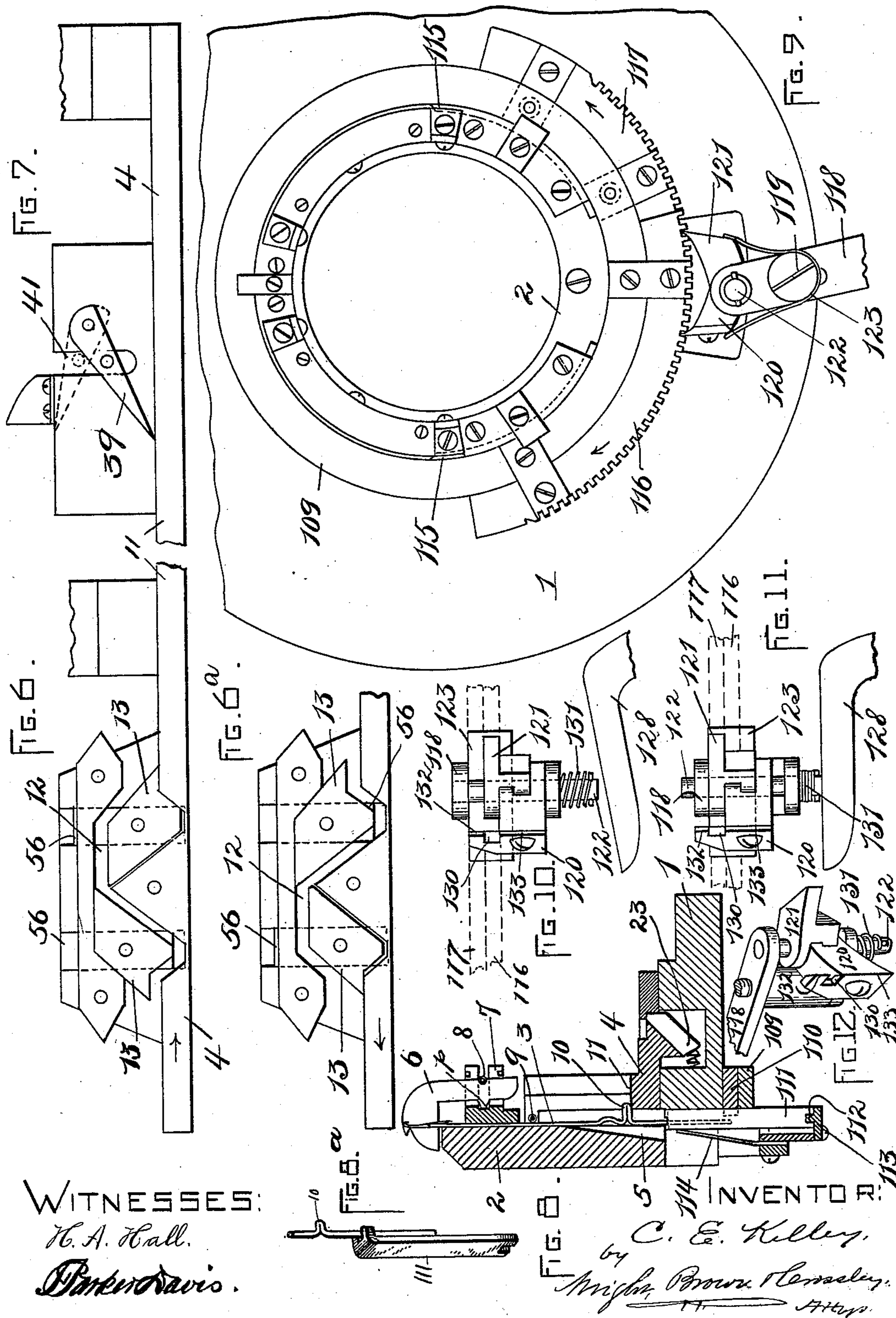
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9 Sheets—Sheet 5

No. 532,788.

Patented Jan. 22, 1895.



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

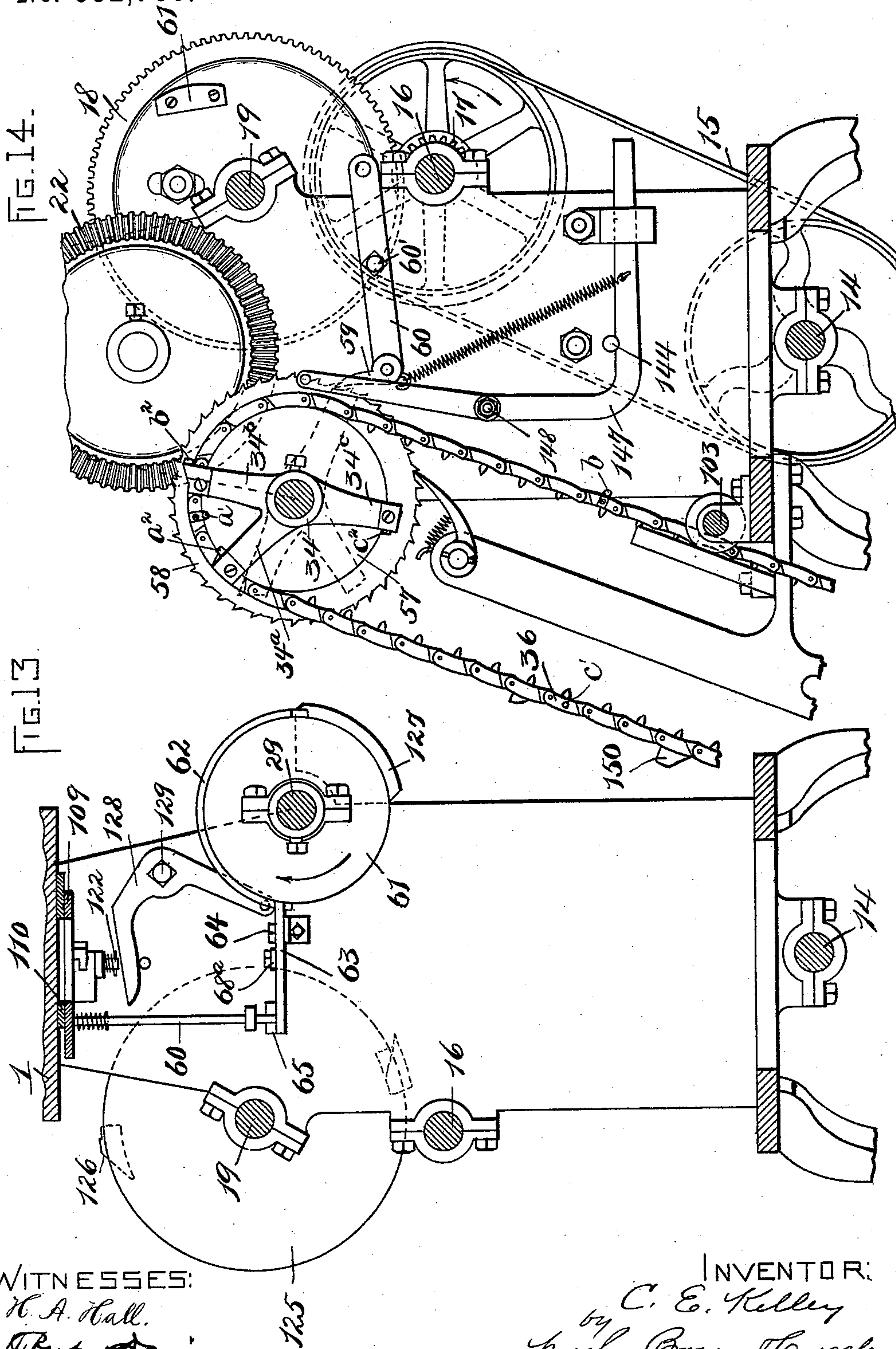
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C. E. KELLEY.  
CIRCULAR KNITTING MACHINE.

No. 532,788.

Patented Jan. 22, 1895.





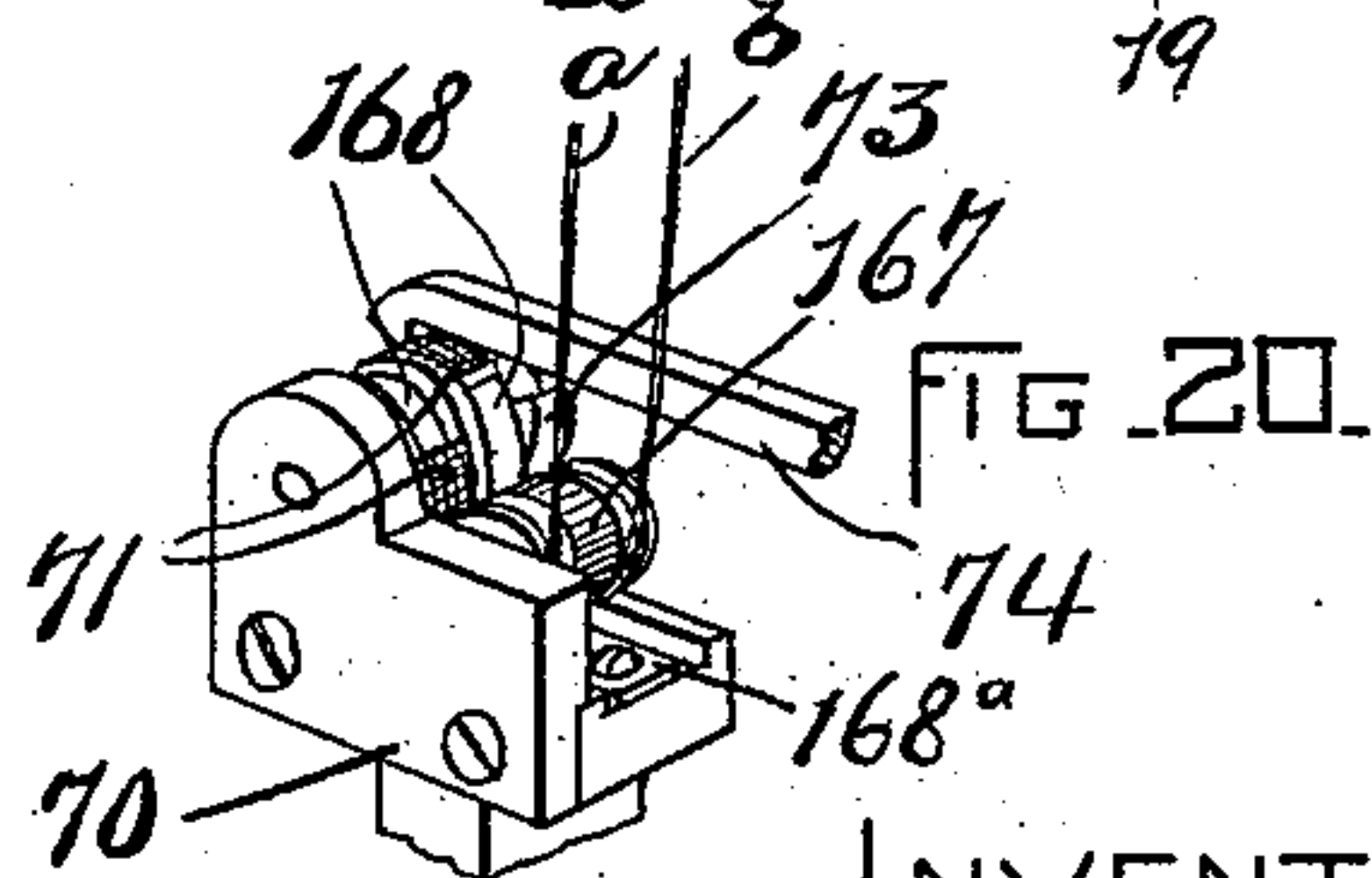
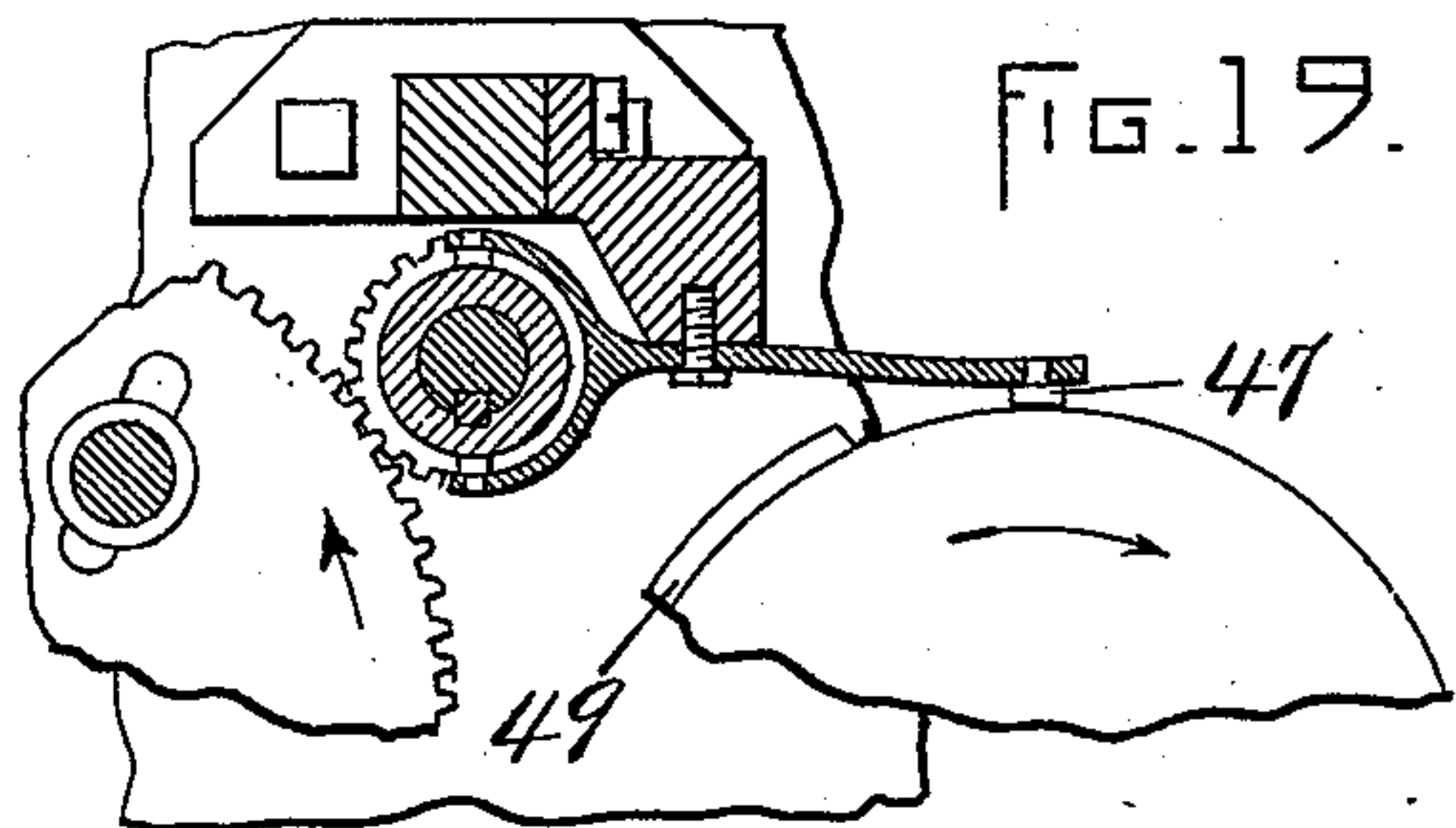
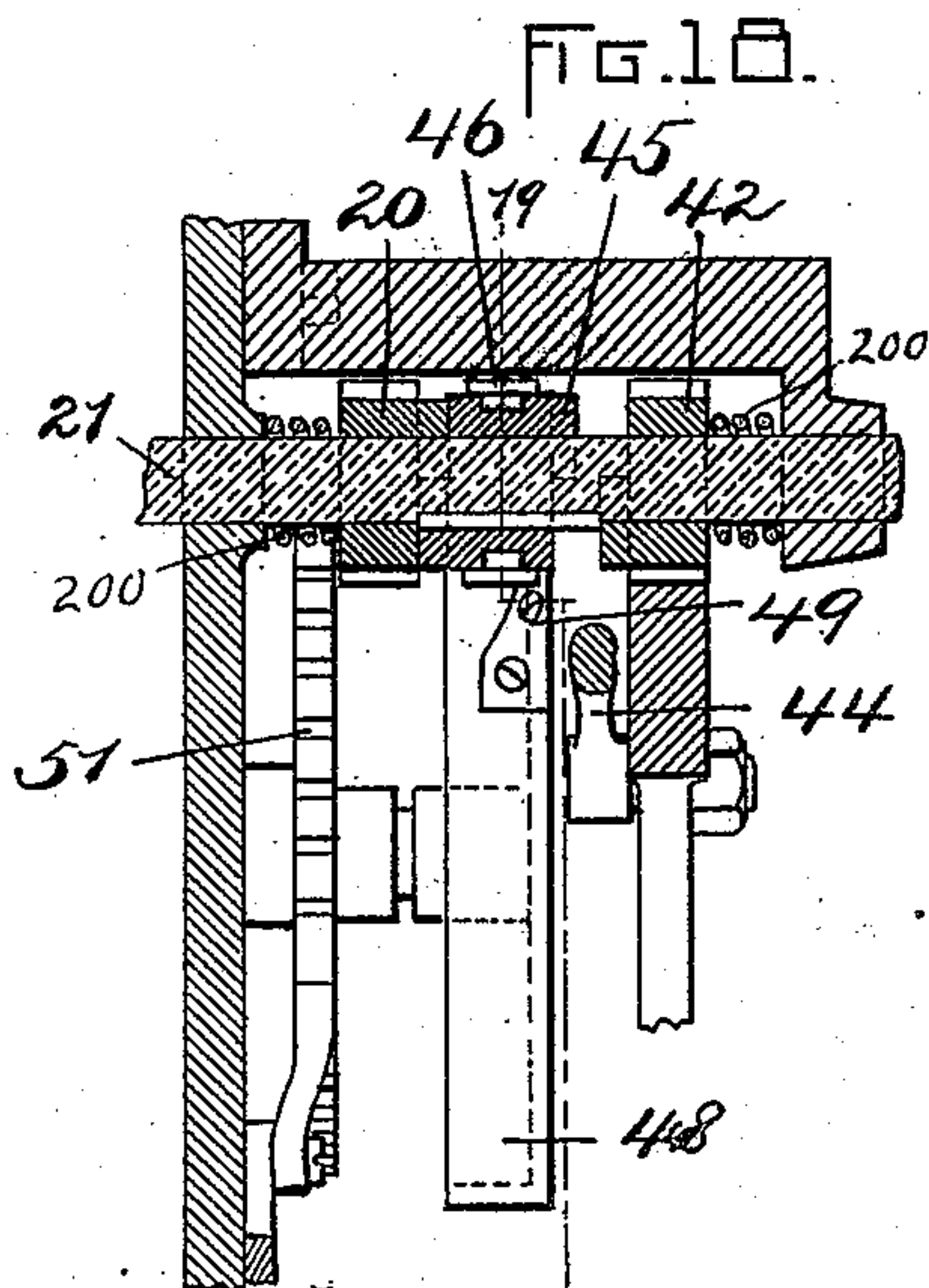
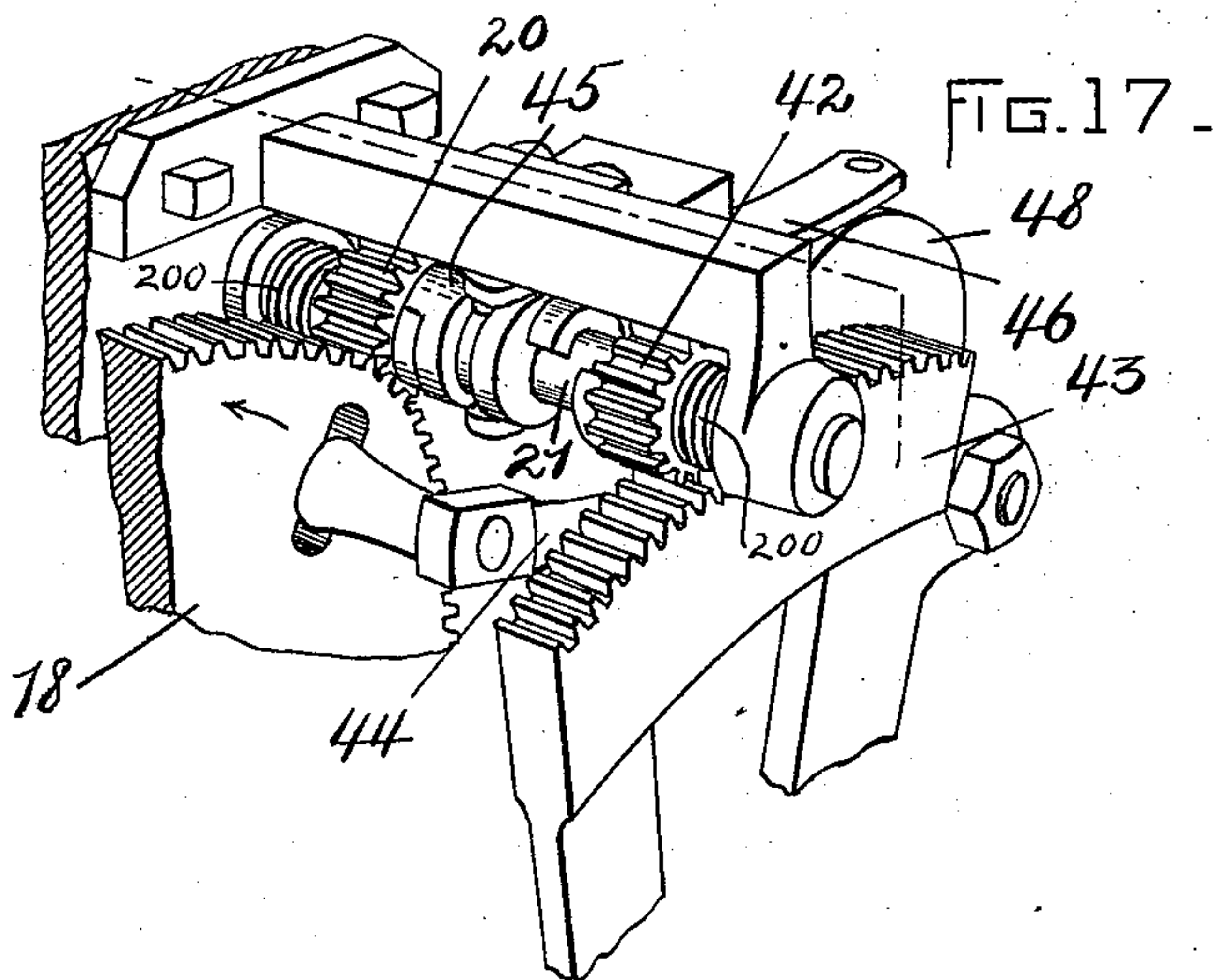
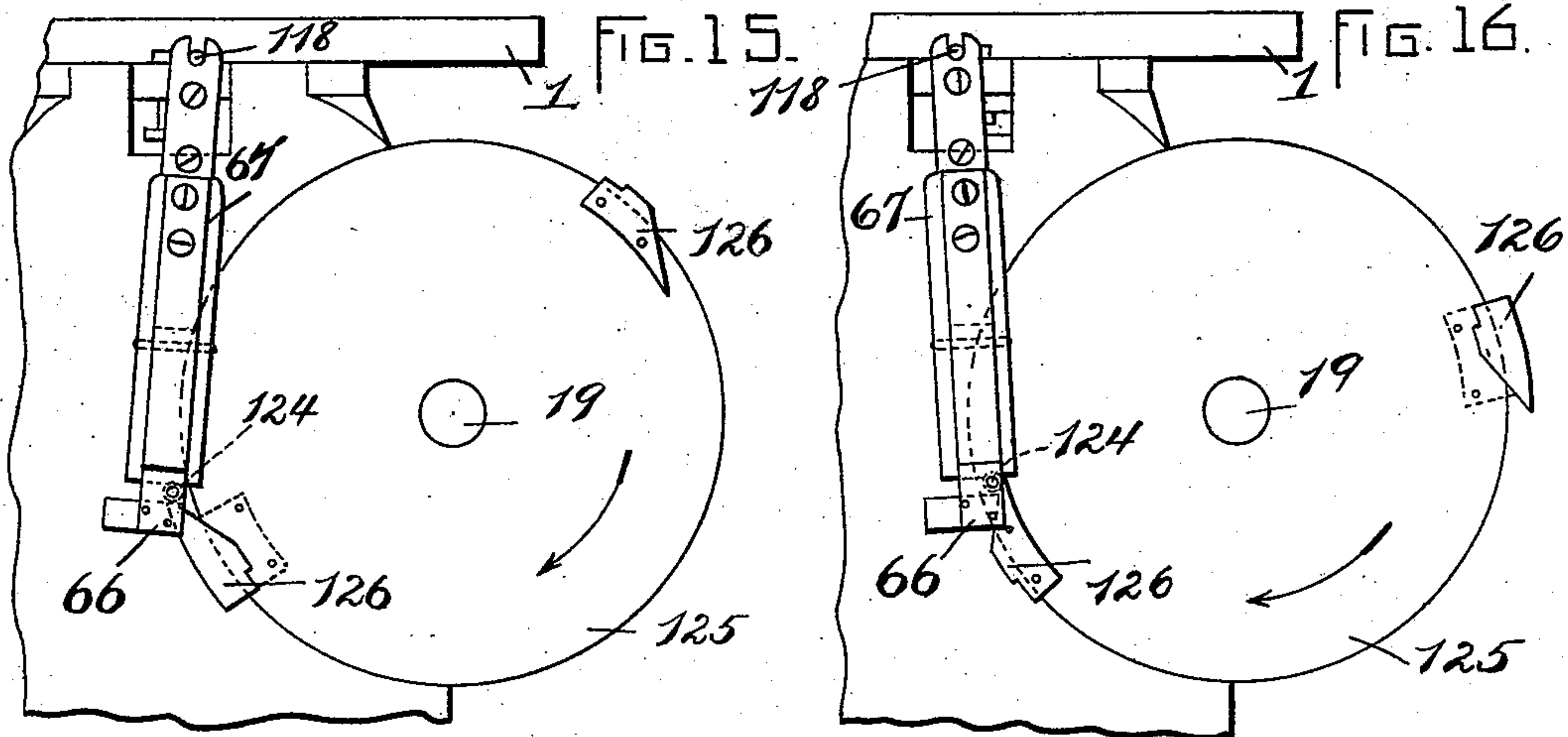
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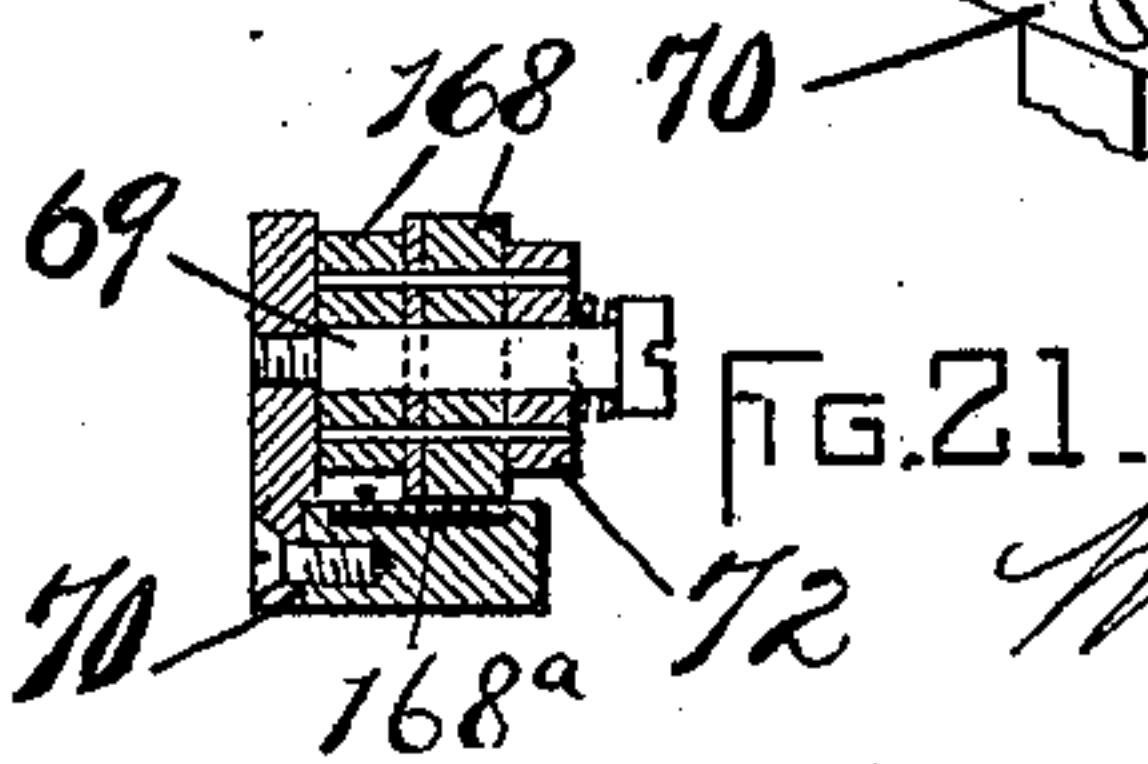
C. E. KELLEY.  
CIRCULAR KNITTING MACHINE.

No. 532,788.

Patented Jan. 22, 1895.



WITNESSES:  
H. A. Hall.  
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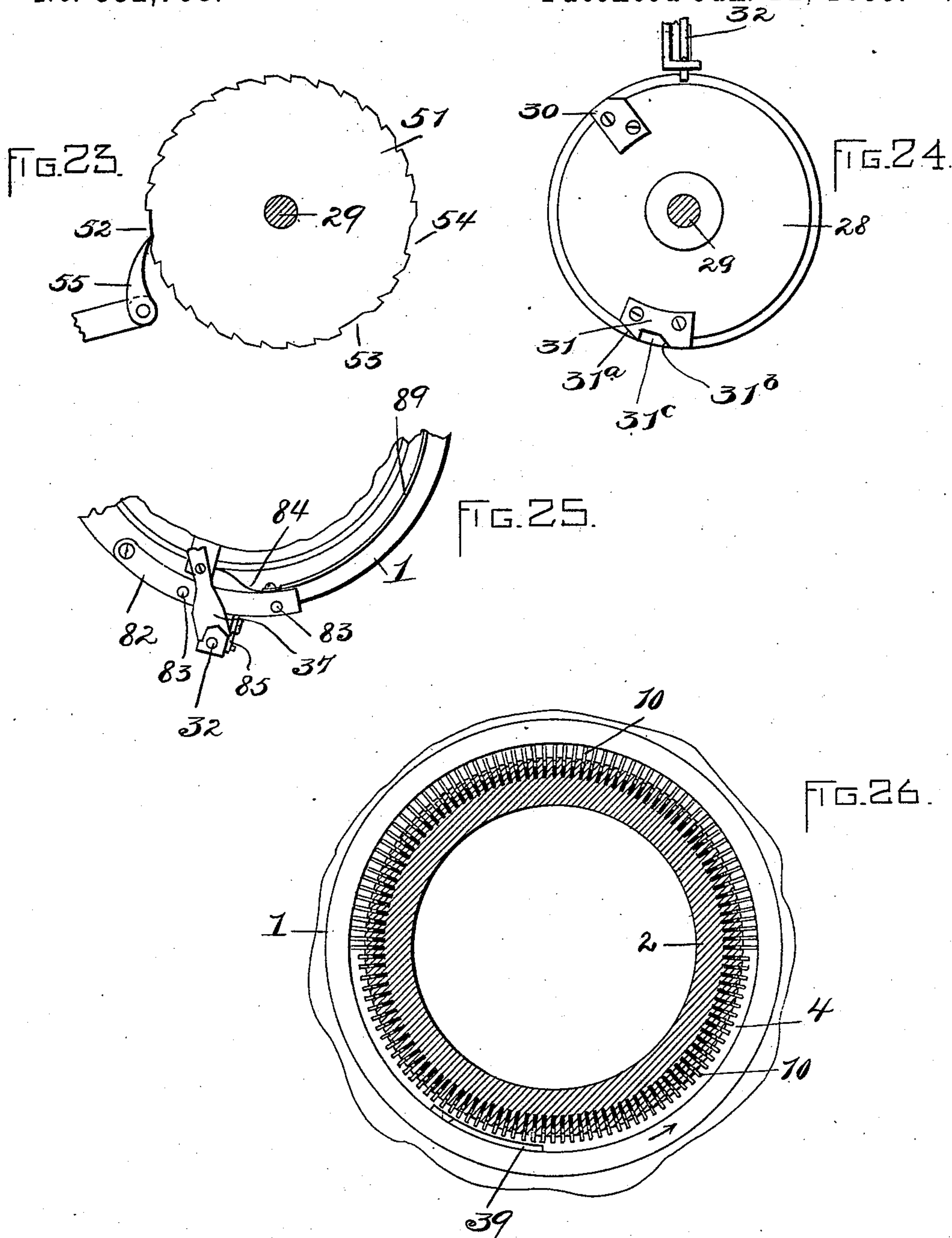
(No Model.)

9 Sheets—Sheet 8.

C. E. KELLEY.  
CIRCULAR KNITTING MACHINE.

No. 532,788.

Patented Jan. 22, 1895.



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(No Model.)

9 Sheets—Sheet 9.

C. E. KELLEY.  
CIRCULAR KNITTING MACHINE.

No. 532,788.

Patented Jan. 22, 1895.

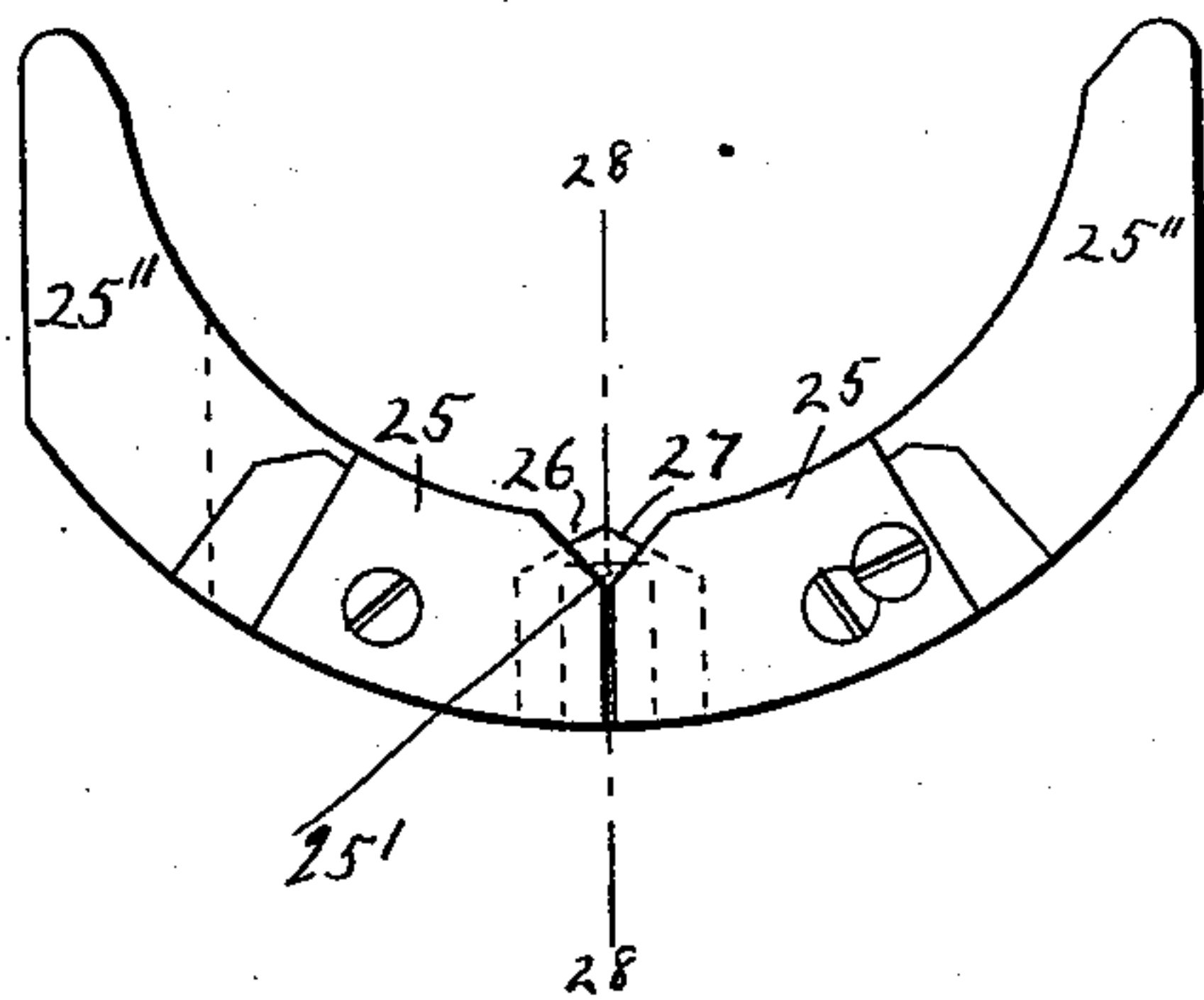


FIG. 27.

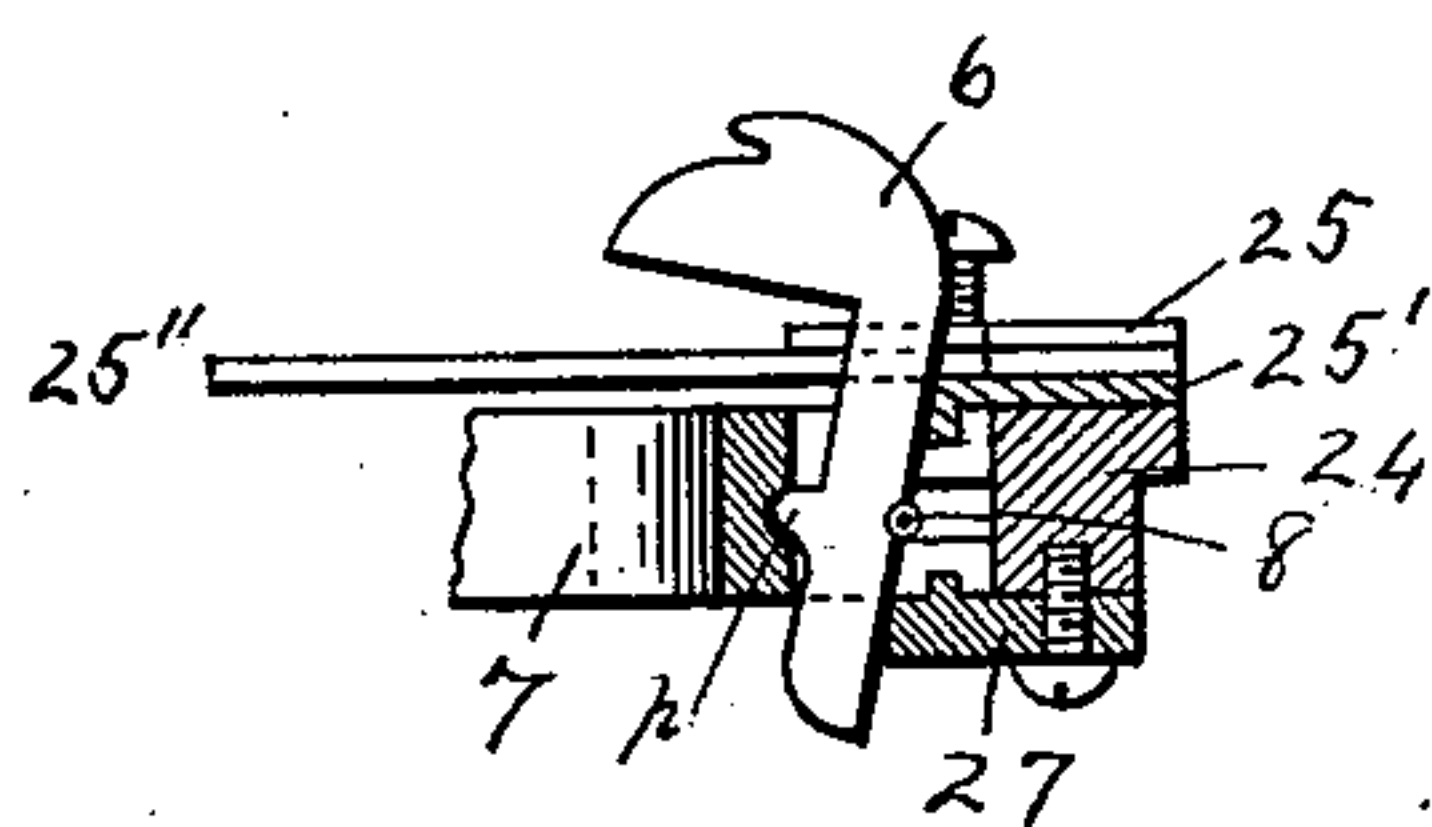


FIG. 28.

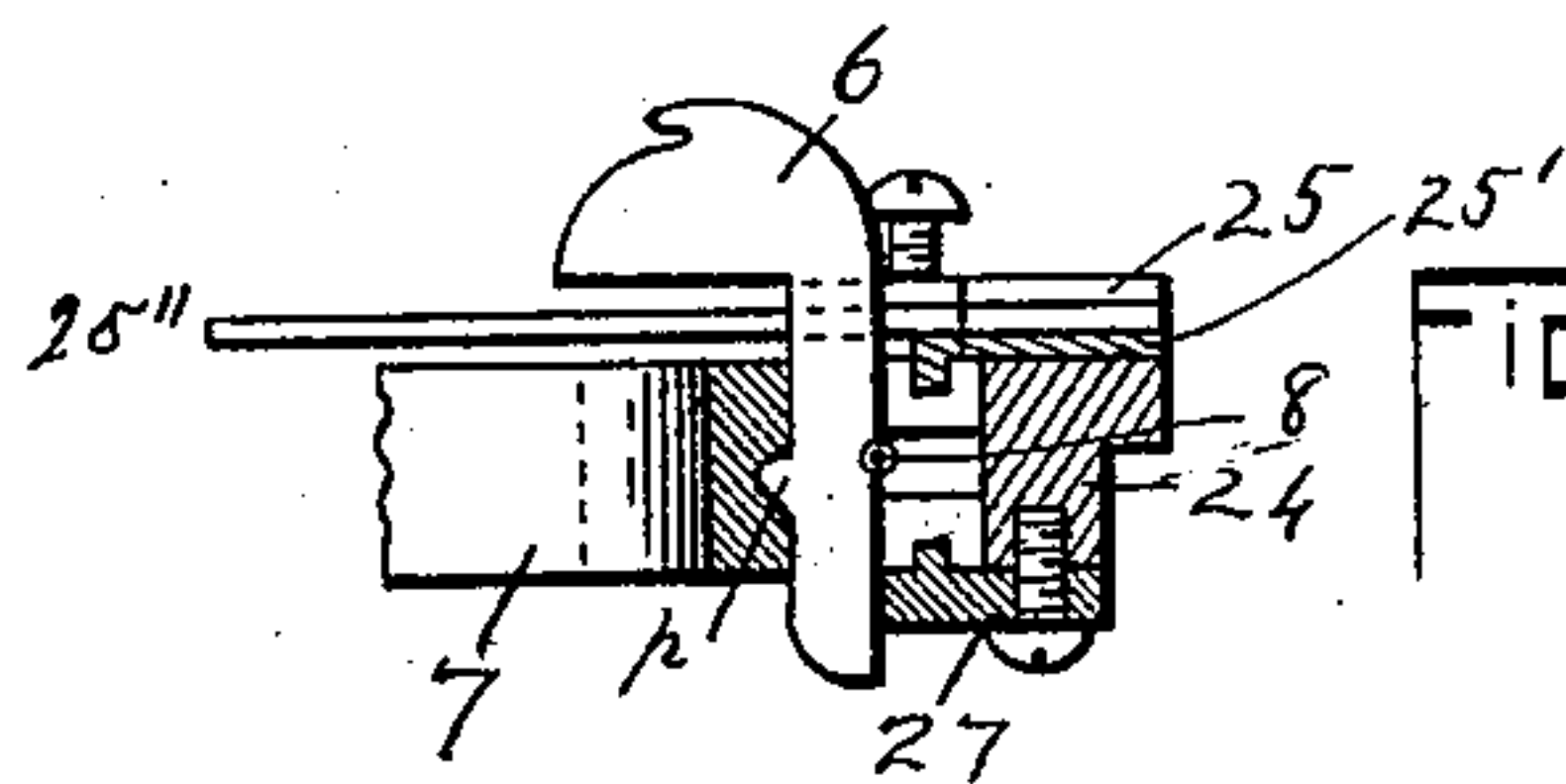


FIG. 29.

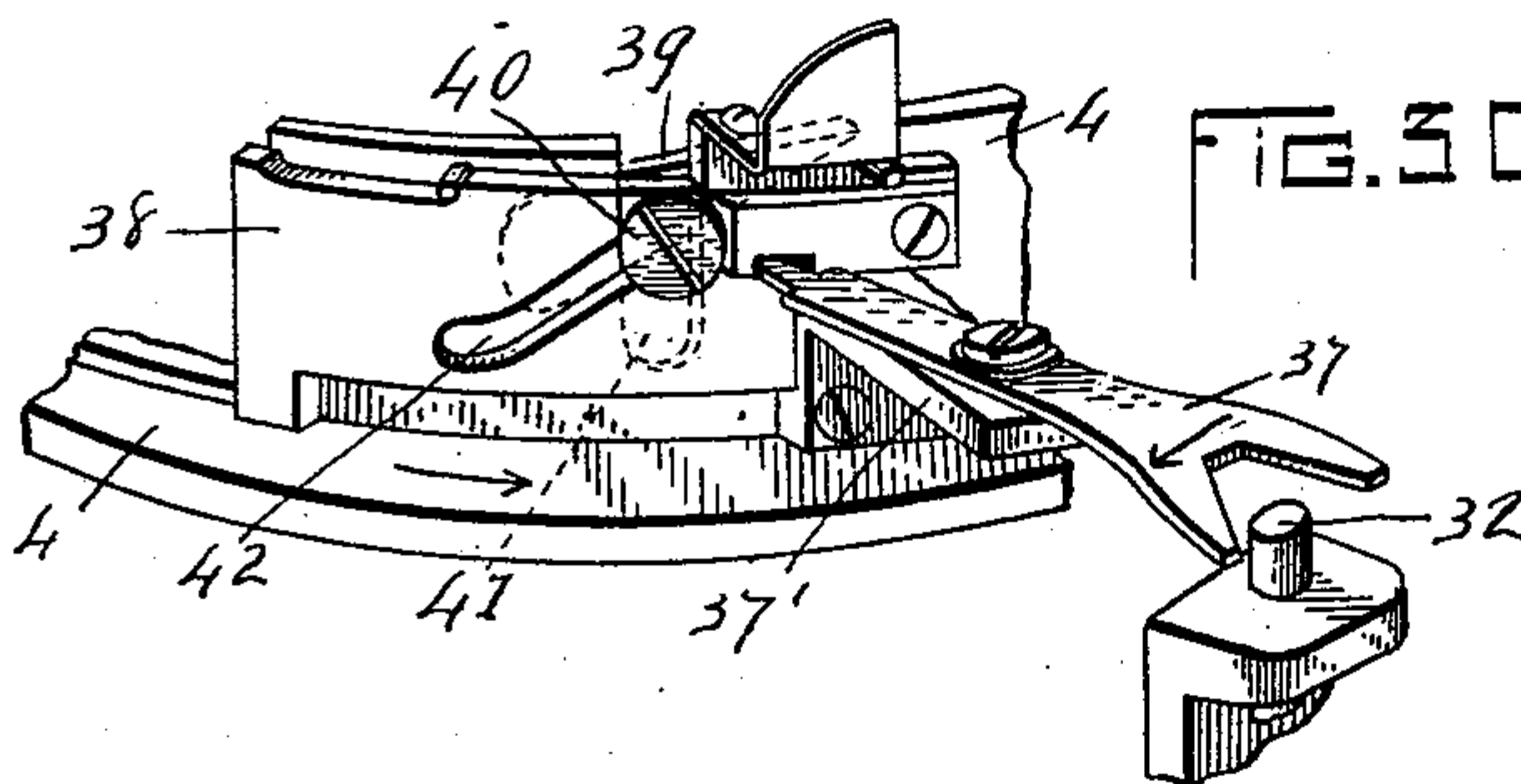


FIG. 30.

Witnesses  
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Inventor  
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by *Wright, Brown & Grosley*  
Attorneys

# UNITED STATES PATENT OFFICE.

CHARLES E. KELLEY, OF LACONIA, NEW HAMPSHIRE, ASSIGNOR, BY DIRECT AND MESNE ASSIGNMENTS, OF TWO-THIRDS TO J. A. BURLEIGH AND HENRY TUCKER, OF SAME PLACE.

## CIRCULAR-KNITTING MACHINE.

SPECIFICATION forming part of Letters Patent No. 532,788, dated January 22, 1895.

Application filed April 17, 1893. Serial No. 470,744. (No model.)

*To all whom it may concern:*

Be it known that I, CHARLES E. KELLEY, of Laconia, in the county of Belknap and State of New Hampshire, have invented certain new and useful Improvements in Circular-Knitting Machines, of which the following is a specification.

This invention relates to circular knitting machines of the class employing latch-needles.

10 The objects of the invention are as follows: To provide improved mechanism for throwing half the needles out of operative position when narrowing; to provide improved mechanism for changing the motion of the cam-cylinder from rotary to reciprocating; to provide improved mechanism for shifting the needle cam-blocks carried by the cam-cylinder, during the reciprocating movement of the latter; to provide improved yarn-changing mechanism; to provide improved mechanism for throwing the narrowing needles out of operative position one by one, and restoring them in the same manner, for narrowing and widening; to provide improved mechanism for varying the speed of the machine for the rotary and reciprocating motion of the cylinder; to provide an improved construction whereby a pattern chain of great length is dispensed with; to provide an improved take-up apparatus to operate when the yarn changes.

35 The invention therefore consists in the various novel features of construction and arrangement of parts which will be fully described hereinafter and pointed out in the claims.

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

Figure 1 shows a front elevation of the machine. Fig. 2 shows a side elevation, as viewed from the right of Fig. 1. Fig. 3 shows a rear elevation on a larger scale. Fig. 4 shows an enlarged elevation of the head and appurtenances, as viewed from one side. Fig. 5 shows an elevation of the same parts, as viewed from another side. Figs. 6 and 6<sup>a</sup> show the needle-cams developed and the two different

adjustments of which they are capable. Fig. 7 shows a development of a portion of the cam-cylinder where the pivoted cam, which throws half the needles out of action is located. Fig. 8 shows a vertical section, taken through one side of the head. Fig. 8<sup>a</sup> shows a perspective detail of one of the needle-jacks and a needle engaged therewith. Fig. 9 shows a bottom view of the head. Figs. 10, 11 and 12 show detail views of a double-pawl device appearing in Fig. 9. Fig. 13 shows a section on line 13—13 of Fig. 3, looking in the direction of the arrow crossing said line. Fig. 14 shows a section on line 14—14, looking in the direction of the arrow crossing said line. Figs. 15 and 16 show fragmentary end-views of parts appearing at the left-hand in Fig. 1. Figs. 17, 18 and 19 show details of a double clutch-mechanism, for changing the motion of the cam-cylinder from rotary to reciprocating, and vice versa. Figs. 20 and 21 show details of a yarn-controlling device. Fig. 22 shows a development of a cam-wheel which operates the double clutch illustrated in Figs. 17, 18 and 19. Fig. 23 shows a detail of a mutilated ratchet wheel and pawl which co-acts therewith. Fig. 24 shows a detail of a cam-wheel appearing in Fig. 3. Fig. 25 shows a top view of a fragment of the bed at the base of the head, illustrating the construction of a movable section of the rim thereof. Fig. 26 shows a horizontal section of the needle cylinder. Figs. 27, 28 and 29 show details of cam-devices for operating the sinkers. Fig. 30 shows a perspective detail of mechanism for throwing out half the needles when narrowing is to be done.

The reference figure 1 designates the bed-piece of the head of the machine; 2, the needle-cylinder formed with vertical grooves in the exterior to receive the needles; 3, said grooves receding at the lower part of the cylinder as indicated at, 5, in Fig. 8, for a purpose hereinafter explained; and 6, the sinkers located between the needles and supported in a ring or band 7 surrounding the needle-cylinder, said sinkers engaging slots in the band and fulcrumed by means of projections which bear in a groove of the band and are confined therein by a spring, 8, which



encircles the band. It will be observed that this construction permits the sinkers to be readily removed and replaced.

A similar spring, 9, encircles the needle-cylinder and has frictional bearing against the needles.

The needles are provided with heels, 10, which project over a horizontal surface, 11, of the cam-cylinder. The heels of one half of the needles are made longer than those of the other half as shown in Fig. 26, for a purpose which will be hereinafter explained.

4 designates the movable cam-cylinder mounted to travel around the needle-cylinder and carrying the cam devices which operate the needles and sinkers in the knitting operation.

The cam-groove, 12, on the inner side of the cam-cylinder which engages the heels, 10, of the needles and thereby raises and lowers the latter is formed in part by reversible blocks, 13. (See Figs. 6 and 7.)

The cam-cylinder co-acts with a block, 24, see Figs. 28 and 29, on whose upper side is secured a pair of curved plates, 25, to bear against the rear edges of the sinkers, a V-shaped opening, 26, being provided where said two plates meet, for the sinkers to recede into and allow the needle to draw down the yarn. A tapered or pointed cam, 27, is fastened to the under side of the block 24, and projects under the V-shaped opening, 26, so as to encounter the sinkers successively below their fulcrums and tilt them back into the V-shaped opening. The sinkers are righted by the inside surfaces of the plates, 25, engaging them. An auxiliary plate 25' fastened on top of block 24 and the cam, 27, have flanges which engage grooves in the band, 7, whereby they are guided, and the block 24 is supported, said block having an elongated recess 200 in its rear side (see Fig. 5) into which a screw 201 fastened in an upright 202 on the cam-cylinder, enters, and by abutting the ends of said recess carries the block along with the cylinder. The plates 25 are preferably fastened on under-plates 25'', which are secured to the block 24, and extend beyond the plates 25, and constitute means for holding up and guiding the sinkers.

Power is transmitted from the shaft, 14, to the cam-cylinder, as follows: Said shaft is connected by a belt, 15, with a shaft, 16, carrying a pinion, 17, which meshes with a gear, 18, fixed on a shaft, 19. Said gear, 18, meshes with a pinion, 20, adapted to drive a shaft, 21, carrying a bevel gear, 22, which meshes with gear-teeth, 23, formed on the under side of the cam-cylinder.

It will be understood that continuous rotary motion is imparted to the cam cylinder through the mechanism described, and it will also be understood that the rotary motion of the cam-cylinder actuates the needles and sinkers through the cam devices hereinbefore described as being carried by the cylinder, so as to knit the leg portion of the stock-

ing from the point where the ribbed top is picked on to the point where the heel is to be formed. When the heel is reached it is necessary to throw out one-half of the needles or thereabout and this is accomplished by the following mechanism: A cam-wheel, 28, (see Figs. 3 and 24) is fixed on a shaft 29, and carries two cams, 30, and, 31, which project from a peripheral surface of said wheel. When one half of the needles are to be thrown out preparatory to narrowing, the cam, 30, stands behind the lower end of a sliding rod or pin, 32, supported in suitable guides on the bed, 1, and pressed downward by a spring, 33. An arm, 34, is fixed on the shaft, 29, and a lug, as *a'*, on a pattern-chain, 36, encounters said arm when the heel is reached, and causes a movement of the shaft, which will turn the cam-wheel, 28, sufficiently to raise the rod or pin, 32, therewith. When the pin, 32, is thus moved upward, it will stand in the path of a forked lever, 37, which is pivoted to a support, 37' on the cam-cylinder, 4, see Fig. 30, and whose inner end engages a socket in a slide, 38, fitting against the exterior of said cylinder and movable back and forth thereon. A pivoted and tapered cam, 39, is carried on the inner side of the cam-cylinder, and a screw or pin, 40, is fastened in said cam and projects through a slot, 41, in the cylinder and engages an inclined slot, 42, in the slide, 38. When the forked end of the lever, 37, encounters the pin, 32, said lever is shifted in the direction indicated by the arrow in Fig. 30, and thereby moves the slide, 38, and causes the screw, 40, to move to the bottom of the slot, 41, and carry the cam, 39, downward until its pointed end rests on the surface, 11. See Fig. 7. The cam rides under the long heels, 10, of the needles which are provided with them, and throws said needles out of operative position, leaving only those needles which are provided with the shorter heels in operative position. See Fig. 26. The lever 37 being forked as shown is adapted to be moved in either direction by the pin 32. When one arm of the fork encounters the pin, the other arm is carried into a position where it will encounter the pin under reverse movement of the cylinder, as hereinafter explained. At the same time that the needles are thrown out in this way preparatory to narrowing for the heel the yarn is changed, and this is accomplished as follows: The two yarns *a* and *b* are carried from the bobbins, 166, through suitable tension and take-up devices, to a grooved roller, 167, under which they separately pass. See Fig. 20. This roller is supported in a head, 70, which is carried by the cam-cylinder, being carried by an arm 203 fastened to the upright 202 and a pair of rotatable dogs, 168, are mounted on a spindle, 69, fastened in said head. Each dog has two diametrically opposite teeth, 71, arranged to bind the yarn against a flat spring 168<sup>a</sup> on the bottom of the head, 70, while between said teeth the pe-



riphery of the dog is so formed as to permit free passage of the yarn when the dog is turned to bring such portions of its periphery over the bottom of the head, 70. The two dogs are fastened together, as seen in Fig. 21, so that the teeth of one have position equidistant between the teeth of the other. Each yarn passes under one of the dogs, and therefore when one dog is biting one yarn, the other yarn is free to pass under the other dog.

*a*, designates the yarn used in knitting the leg portion of the stocking and, *b*, the yarn used in knitting the heel. When the heel is to be knitted, the dogs, 168, are given a quarter turn, which causes one of them to bite the yarn, *a*, and break it off, and the other to feed the yarn, *b*, to the needles, and leave it free to be drawn in. A ratchet, 72, is fast with the dogs and has four equidistant teeth, 73, see Fig. 4, and a pawl, 74, is pivotally connected with a vertical lever, 75, and held in engagement with the ratchet, 72, by a spring, 76. The lever, 75, is pivoted at, 77, and its lower end carries a pin engaging the side of a cam, 78, mounted on a shaft, 79, and having two oppositely-located depressions, as 80. The spring 76 also holds the lever 75 against the cam 78. A four-armed wheel, 81, is fast with the cam, 78. A rim of the bed, 1, has a pivoted section, 82, carrying two upstanding pins, 83, and pressed outward by a spring, 84. See Fig. 25. A latch, 85, (see Fig. 3,) having an inclined underside, is pivotally hung from a stationary support, and the rod or pin, 32, has a lateral arm, 86, arranged to act against the inclined underside of the latch, 85, when the said rod or pin rises, and thereby push the pivoted section, 82, inward, thereby bringing the pins, 83, in the path of the four-armed wheel, 81. An arm of said wheel strikes the first of said pins and the wheel is turned through a quarter of a revolution and the corresponding movement of the cam, 80, actuates the lever, 75, which, through the pawl, 74, turns the ratchet, 72, and the cam is so formed as shown and the lever so pivoted as to produce an eighth of a revolution of said ratchet. This movement serves to cause the dog, which has been holding the yarn, *b*, to feed said yarn into the needles and release it before the other dog breaks off the yarn, *a*, allowing both yarns to knit together the space of three or four needles. After the wheel, 81, passes the first pin, 83, it encounters the other pin and is turned through another quarter revolution, and motion is imparted to the dogs as before, and the yarn, *a*, is locked and broken off.

When the pivotal section, 82, is moved inward it moves in with it a cam, 87, which is pivoted at, 88, to the bed, 1, and has an arm, 89, secured to it and projecting behind the said pivotal section, 82, and fastened thereto. (See Figs. 3 and 25.) When moved inward the cam, 87, stands in the path of a vertical rod, 90, which is connected to a take-up device, engaging the yarn, *b*. The rod, 90, rides up on the cam and the take-up device oper-

ates to produce a slack in the yarn so that the dog may readily draw it into the machine.

The take-up device comprises a collar 91, connected with the rod 90, and adapted to slide on an upright *o*, and actuated downward by a spring *o'*. A pivoted arm *o''*, whose outer end engages the thread *b*, is actuated upward to produce a tension on the thread by a spring *o'''*, attached at one end to a circular head *o''''* on the pivot of the arm *o''*, and at the opposite end to the collar 91. When the rod 90 rides up on the cam 87, the collar 91 is pushed up and the tension of the spring *o'''* removed, and hence the arm *o''* ceases to produce a tension on the thread.

As soon as half of the needles have been thrown out in the manner above described, the motion of the cam cylinder must be changed from rotary to reciprocating, and this is accomplished by the following mechanism: The pinion, 20, see Fig. 17, and another pinion, 42, are both loosely mounted on the shaft, 21. The pinion, 20, as before stated meshes with the gear, 18, and is continuously rotated thereby, and the pinion, 42, meshes with a sector, 43, pivoted to the machine frame and connected by a pitman, 44, with the gear, 18, whereby a reciprocating motion is imparted to it. A double clutch member, 45, is splined to the shaft, 21, and is constructed to interlock with the loose pinions, 20, and, 42. A shipper, 46, is pivoted to a stationary support, and at one end engages the double clutch member, while its opposite end carries a roller, 47, standing over the periphery of a cam-wheel, 48. Two cam-blocks, 49, and 50, are fastened on the periphery of this cam-wheel and they have reversely inclined edges as seen in Fig. 22, where the cam-wheel is shown developed. The said cam-wheel is fixed on the shaft, 29, and when one half the needles have been thrown out of operative position in the manner described, the cam-block, 49, is in a position to act on the roller, 47, upon further movement of the shaft, 29. Motion is transmitted to the shaft as follows: A mutilated ratchet, 51, is fixed on the shaft, a single tooth being omitted at three different points, 52, 53 and 54, see Fig. 23, and a pawl, 55, engages said ratchet, and receives motion from the pinion, 17, which carries a cam 17', (indicated in broken lines in Fig. 2) to act upon a lever, 56, pivoted at 56<sup>a</sup>, and to which the pawl is pivoted. See Fig. 2. The pattern-chain passes over a wheel, 57, and is driven step-by-step through a ratchet, 58, fast with said wheel, and engaged by a pawl, 59, mounted on the end of a lever, 60, pivoted at 60', and which carries a pin at the opposite end in the path of a cam-block, 61, on the side of the gear, 18. During the knitting of the leg-portion of the stocking, the pawl, 55, is in the mutilated space, 52, and hence does not move the ratchet. When the lug on the pattern-chain acts on the arm, 34, as previously explained, and moves the shaft, 29, a tooth of the ratchet, 51, moves under the pawl, 55, and the latter then acts



to rotate said ratchet step-by-step. The movement imparted to the ratchet by the pawl acting against the first tooth causes the cam, 49, to shift the shipper, 46, and change the motion of the cam-cylinder from rotary to reciprocating. Spiral springs, 200, are placed on the shaft, 21, behind each of the pinions, 20 and 42, and the latter may yield when the clutch member encounters them, and, as the pinion continues to move, the spring behind it will throw it into engagement with the clutch member. At the end of each stroke during the reciprocating movement, the cam-blocks 13 must be reversed, as illustrated in Fig. 6, so that the cam-groove will have the same effect on the needles during the movements of the cam-cylinder. This intermittent reversal of the cam-blocks is accomplished by the following mechanism: The cam-blocks are mounted on slides, 56, fitting vertical slots in the cylinder, and pins, 57, are fastened in said slides and engage angular slots, 58, (see Fig. 5) in a curved slide, 59, fitting against the exterior of the cylinder, the said angular slots being so arranged that when one of the pins, 57, is at the upper part of one of said slots, the other pin is at the lower part of the other slot. It will be seen therefore that by shifting this slide, the cam-blocks may be reversed. Said slide carries a pair of outward projecting stops, 59<sup>a</sup>, one of which is adjustable. A sliding pin or rod, 60, see Fig. 3, is arranged to be projected into the path of the stops, 59<sup>a</sup>, so that when the cam-cylinder reciprocates, the stops alternately encounter said pin and the slide, 59, is shifted and the cam-blocks 13, reversed at the end of each stroke. The pin, 60, is projected as follows: A cam-wheel, 61, Figs. 3 and 13, is fixed on the shaft, 29, and has a band, 62, extending part way around its periphery, and terminating abruptly at one end and having an incline at the other end. A horizontal lever, 63, is pivoted at 64, to a stationary support and one end is adapted to bear against one side of the band, 62, and the other end carries an inclined cam-block, 65, upon which the rod or pin, 60, is adapted to ride. The lever, 63, is held against the band, 62, by a spring-pressed pivotal member, 66, of a lever, 67, bearing against a rod, 68, which is connected with the lever, 63, at 68<sup>a</sup>. (See Figs. 3, 13, 15 and 16.) When the shaft, 29, is moved by the engagement of the pawl, 55, with the tooth of the ratchet, 51, which adjoins the space, 52, the corresponding movement of the cam-wheel, 61, moves the end of band, 62, past the lever, 63, whereupon the latter springs inward and its cam-block, 65, projects the rod, 60.

It is desirable that the speed of the machine be reduced while the ratchet, 51, is working, so as to make the changes from reciprocating to rotary motion, and vice versa, easier, and this is accomplished as follows: The shaft, 14, carries two loose pulleys, 92 and 93, and a tight pulley, 94, between them (see Fig. 1),

and a driving shaft, 95, carries a small pulley, 96, and a larger pulley, 97, both of sufficient width for the belts to shift upon them. Two belts, 98 and 99, connect the pulleys on the driving shaft, 95, with those on the driving shaft, 14, one of said belts engaging the small pulley, 96, and the other one engaging the large pulley, 97. When the belt, 99, is on the tight pulley, 94, as shown in Fig. 1, the machine is driven at higher speed, and during the rotary movement of the cam cylinder this adjustment is maintained.

A shifter, 100, engages the belts, and is in the form of a bell-crank lever, pivoted at, 101, and having a bifurcated short arm, which is engaged by a pin, 102, projecting laterally from a head on a rock-shaft, 103, in bearings in the machine frame and carrying a head, 104, with two pins, 105, projecting in the path of beveling lugs, 106, on the pattern-chain. When the motion is changed for narrowing, one of the lugs, 106, see Fig. 2, having such a bevel as to move the rock-shaft, 103, in the direction of the arrow in Fig. 2, encounters one of the pins, 105. This movement of the rock-shaft actuates the shifter, 100, which shifts the belts so as to throw the belt, 98, upon the tight pulley, 94, and the belt, 99, upon the loose pulley, 93. Now the parts are driven from the small pulley, 96, and the speed is slower, during the change from rotary to reciprocating motion of the cam-cylinder. When the change of motion has been effected, the belts, 98, 99, are restored to their former position by a beveled lug on the pattern-chain encountering the other one of the pins, 105, and the machine runs at a high speed again. The lower pin 105 is made longer than the upper one, so that the lug which acts against it to restore the faster speed, will clear the upper pin, said lug being suitably located on the chain to accomplish this. Otherwise the same lug which acts on the lower pin would immediately thereafter act on the upper pin.

To produce the narrowing effect in knitting the heel, the needles in action are reduced one by one, and the mechanism employed to effect this will next be described.

A pair of flat rings or plates, 109, and, 110, are supported one upon the other on the under side of the head, see Figs. 8 and 9, and are arranged to slide one upon the other.

It will be observed that each needle throughout a portion of its length above the heel lies in contact with the base of the groove in the cylinder, and is confined rigidly at this part by the ring 7 while the lower part of the needle stands away from the base of the groove by reason of the receding portion of the groove. This construction permits the needle to be flexed at the angle of the groove, and its lower part having the heel to be sprung back into the receding portion of the groove and its heel 10 moved out of the path of the cam-groove of the cam-cylinder.

The lower ends of the needles employed in



narrowing are supported in jacks as, 111, said needles engaging notches in the upper ends of the jacks and extending down alongside the same. The said jacks have a loose engagement with a rib, 112, formed on a portion, 113, of the bed, and the jacks are held by springs as, 114, against a vertical surface of the bed, 1. The rings, 109, and, 110, are each provided with a cam-strip, 115, to engage the jacks, 111, and move them inward against the pressure of the springs, 114, and the spring of the needles and thereby move the needles inward sufficiently to throw their heels out of the path of the cam-groove of the cam-cylinder. The recesses, 5, permit his inward movement of the needle and the needles are sufficiently resilient to allow it.

The position maintained by the above parts during the circular knitting is illustrated in Fig. 9, where it will be observed that the cam-strips, 115, are withdrawn so as to be included in that half of the circle of the cylinder where the needles not used in narrowing occur, thus leaving all the needles free to operate.

The rings, 109, and 110, carry overlapping racks, 116, 117, and a lever, 118, pivoted at, 119, carries two pawls, 120, and 121, pivoted on the same center, one of them being affixed to a pivot pin 122, and the other loosely mounted thereon and both held in engagement with the racks by a flat spring, 123. The said pawls are so mounted that one engages one rack and one the other, and when the narrowing takes place the pawl, 120, engages the upper rack, while the other pawl, 121, engages the lower rack (see Fig. 10) but the pawls are vertically movable and this condition may be reversed as illustrated in Fig. 11.

A reduced end of the lever, 118, engages a notch in the upper end of the lever, 67, see Figs. 3, 15, and 16. It will be remembered that this lever, 67, has a pivoted and spring actuated member, 66, and that this member is held out by a rod, 68, connected with a lever, 63, which bears against the band, 62. The member, 66, carries a roller, 124, and a cam-wheel, 125, is mounted on the continuously rotating shaft, 19, and carries two oppositely inclined cam-blocks, 126. When the member, 66, moves inward by reason of the end of the band, 62, passing the lever, 63, the roller, 124, is brought into the path of the cam-blocks, 126, so that as the cam-wheel, 125, rotates, the lever, 67, will be vibrated back and forth. This motion is transmitted through the lever, 118, to the pawls, 120, and, 121, and it will be observed that the racks, 116, and, 117, and the rings, 109, and, 110, will be alternately moved around in opposite directions, tooth by tooth of the racks. The cam-strips, 115, act upon the needle jacks, 111, and throw out the needles one by one. A needle at one end of the narrowing row is thrown out each time the cam cylinder arrives at that end of a stroke opposite this end of the row of needles. This operation continues until the num-

ber of operative needles is reduced to the limit. At this time, a cam, 127, see Fig. 13, on the wheel, 61, encounters a bell-crank-lever, 128, pivoted at, 129, and extending under the pivot-pin, 122, of the pawls, 120, and 121. The bell-crank lever pushes said pivot-pin up and moves the pawls to a position where the pawl, 120, will act on the lower rack, 116, and the pawl, 121, will act on the upper rack, 117. Now the vibrations of the lever, 118, cause the rings, 109, and, 110, to move step by step in the reverse directions to what they were before moved, whereby the needles are released one by one which produces the widening in the heel. The needles are restored by their inherent resiliency aided by the springs 114.

The construction of the pawls, 120, and, 121, is best illustrated in Figs. 10, 11 and 12. The engaging edge of the pawl, 120, is of such an extent that different portions of it, designated as, 132, and, 133, may engage the two racks, and a notch, 130, is provided between these two engaging portions to permit the rack actuated by the pawl, 121, to pass. The engaging edge of the pawl, 121, has an extent equal to that of the notch, 130, and is in alignment with said notch. When the needles are being thrown out one by one, the parts are in the positions shown in Fig. 10. The pawls are supported by a spring, 131, and the edge of the pawl, 121, is in position to engage the lower rack, 116, while the upper section, 132, of the edge of the pawl, 120, is in position to engage the upper rack, 117. When the pawls are pushed up as before explained, the edge of the pawl, 121, takes position to engage the upper rack, see Fig. 11, while the section, 133, of the edge of the pawl, 120 takes position to engage the lower rack.

In the operation of the machine thus far described, the narrowing and widening necessary to the formation of the heel has been completed and the machine is about to resume circular knitting to form the foot-portion of the stocking.

It will be remembered that when the lug on the pattern chain encountered a branch of the arm, 34, and moved said arm, the ratchet, 51, was moved so as to allow the pawl, 55, to engage its teeth. This pawl being constantly in motion, impels the ratchet and all the parts which are fast with the shaft, 29, step-by-step, until the pawl reaches the lost tooth space, 53, when the motion will be stopped as the pawl will simply reciprocate in said space.

The branch, 34<sup>a</sup>, of the arm, 34, is the particular branch which the lug on the pattern chain encountered, the construction being such that said lug passes the branch, 34<sup>b</sup>. The movement of the shaft, 29, is four times as fast as that of the pattern-chain wheel, in view of the fact that the former is driven from the pinion, 17, and the latter from the gear, 18, and hence the arm, 34<sup>a</sup>, will move ahead faster than the lug on the pattern



chain. The quarter turn or thereabout given to the shaft, 29, brings the arm, 34, to the dotted position shown in Fig. 14, and the wheel, 28, to a position where the cam, 31, is behind the rod, 32. While the pawl plays in the space, 53, the narrowing of the heel goes on, until another lug on the pattern chain encounters the arm, 34<sup>b</sup>, and moves the same sufficiently to carry a tooth of the ratchet under the pawl. The latter then actuates the ratchet the length of three teeth and the pawls, 120, and, 121, are reversed in the manner described, and the widening of the heel takes place while the pawl plays in the space, 54. Another lug on the pattern chain encounters the arm, 34<sup>c</sup>, and starts the ratchet and in so doing moves the cam, 31, under the end of the rod, 32, and the latter is projected into the path of the forked lever, 37, so that the said lever encounters the rod and is shifted thereby in a direction to move the slide, 38, and thereby throw up the cam, 39, into the position shown in broken lines in Figs. 7 and 30. The needles which were thrown out of action during the narrowing are now moved again into operative position as the said cam, 39, encounters them. The cam, 31, is formed with two bevels, 31<sup>a</sup> and 31<sup>b</sup>. When the first bevel, 31<sup>a</sup>, operates the rod, 32, as just explained, the cam-cylinder is on its last backward movement, and the forked lever, 37, is shifted at the extremity of the throw of said cylinder. Therefore the pin, 32, must drop out of operative position immediately, so as not to shift said forked lever back again when the cam-cylinder returns. The construction of the cam, 31, permits this, the rod, 32, dropping into the depression, 31<sup>c</sup>, between the two inclines of the cam. After the forked lever passes, the pin, 32, is again projected by the second bevel, 31<sup>b</sup>, of the cam, 31, so as to change the yarns.

As the pawl, 55, operates on the ratchet 51, the cam, 50, on the wheel, 48, moves the shipper, 46, and the motion is changed from reciprocating to rotary. As this takes place the speed is decreased momentarily by shifting the belts, 98, 99, through the mechanism before described,—an inclined lug, 106, on the pattern-chain acting against one of the pins, 105, carried by the rock-shaft, 103. Simultaneously with the operation of the clutch, the wheel, 61, brings the beveled end of the band, 62, against the end of the lever, 63, and moves said lever allowing the rod, 60, to lower, and also moving the member, 66, of the lever, 67, outward and the roller, 124, thereby out of the path of the cams, 126. The machine now knits the foot-portion of the stocking while the pawl is moving the ratchet and while it plays in the space, 52. The narrowing for the toe is accomplished in precisely the same manner as in the formation of the heel.

When the stocking is completed, the machine is thrown wholly out of operation by means of a shipper, 142, which engages the belt, 15, and is pivoted at, 143, and has its end

connected with a rod, 144, which runs through the side of the machine and is actuated by a spring, 145, which tends to draw the rod inward and shift the belt on to a loose pulley, 146<sup>a</sup>. A bell-crank lever, 147, is pivoted at, 148, and has one arm in engagement with a notch in the rod, 144, whereby the latter is held inward against the spring and the belt is held on the tight pulley. The upper end of the lever, 147, has a pin which stands in the path of a lug 150 on the pattern-chain so that said lug will move it and thereby release the shipper-rod, 144, and throw the machine out of operation. The shipper may also be operated by hand.

It will be seen that, by my improved arrangement of mutilated ratchet-wheel and appurtenances, a much shorter pattern-chain may be employed than otherwise would be possible, as the lost tooth spaces allow time for the knitting to take place.

In further explanation of the three-armed device and pattern-chain, illustrated in Figs. 3 and 14, it is remarked that each branch of said arm is provided with a lug, located to stand in the path of a corresponding lug in the pattern-chain, and the lugs on the arms are located out of alignment with each other, as are likewise the lugs on the pattern-chain. For instance, the arm, 34<sup>a</sup>, is actuated by the lug, *a'*, on the pattern-chain, and this lug, *a'*, is located at the inner part of the chain-link, and the lug, *a*<sup>2</sup>, on the arm, 34<sup>a</sup>, is in the path of said lug, *a'*. The next lug on the pattern-chain, which lug is designated, *b'*, has location at the outer part of the chain-link, and the lug, *b*<sup>2</sup>, on the arm, 34<sup>b</sup>, has position in the path of the lug, *b'*. It will thus be seen that the lug, *a'*, may pass the arm, 34<sup>b</sup>, without encountering the lug, *b*<sup>2</sup>. The third lug, *c'*, in the pattern-chain, is at the middle of the chain-link, and encounters a corresponding lug, *c*<sup>2</sup>, in the arm, 34<sup>c</sup>, while it may pass either of the other arms without encountering their lugs.

I disclaim the following:

First. A yarn-changer consisting of a pair of rotary dogs having provisions in virtue of which when one is biting one yarn the other allows the other yarn to pass it, and means for actuating said dogs.

Second. A yarn-changer consisting of a pair of rotary dogs having oppositely located teeth to engage the yarns, the teeth of one dog having position between those of the other dog, and means for periodically turning said dogs.

Third. A yarn-changer comprising a pair of rotary dogs having provisions in virtue of which when one is biting one yarn the other allows the other yarn to pass it, a spring between which and the acting portions of the dogs the yarns are held, and means for actuating said dogs.

Fourth. A yarn-changer comprising a pair of rotary wheels having non-registering segments removed therefrom, a yielding plate at



the perimeters of the wheels, and means to actuate the same intermittently.

Having thus explained the nature of the invention and described a way of constructing and using the same, although without attempting to set forth all of the forms in which it may be made or all of the modes of its use, it is declared that what is claimed is—

1. A circular knitting machine, comprising in its construction a needle-cylinder carrying the needles which are provided with heels, the heels of a number of the needles being longer than those of the other needles, a cam-cylinder having a cam-groove to actuate the needles, a pivoted cam arranged to engage the longer needle-heels, a slide having a cam-way co-acting with said pivoted cam and a lever engaging said slide, mechanism for actuating the cam-cylinder, and means for automatically shifting the said lever.

2. A circular knitting machine, comprising in its construction a needle-cylinder carrying the needles which are provided with heels, the heels of a number of the needles being longer than those of the other needles, a cam-cylinder having a cam-groove to actuate the needles, a pivoted cam arranged to engage the longer needle-heels, a slide having a cam-way co-acting with said pivoted cam and a forked lever engaging said slide, mechanism for actuating the cam-cylinder, a pin and means for periodically projecting the same into the path of the forked lever, substantially as and for the purpose described.

3. A circular knitting machine, comprising in its construction a yarn-changer, consisting of a pair of rotary dogs having oppositely-located teeth to engage the yarns, the teeth of one dog having position between those of the other dog, a ratchet fast with said dogs, a pawl engaging said ratchet, a lever carrying said pawl, a cam to vibrate said lever, and means for periodically moving the cam.

4. A circular knitting machine, comprising in its construction a yarn-changer, consisting of a pair of rotary dogs having oppositely-located teeth to engage the yarns, the teeth of one dog having position between those of the other dog, a ratchet fast with said dogs, a pawl engaging said ratchet, a lever carrying said pawl, a cam to vibrate said lever, a multiple-armed wheel fast with said cam, pins carried by a movable section of the machine bed, and means for periodically moving said pins into the path of the said wheel.

5. A circular knitting machine, comprising in its construction a needle-cylinder carrying the needles which are provided with heels, the heels of a number of the needles being longer than those of the other needles, a cam-cylinder having a cam-groove to actuate the needles, a pivoted cam arranged to engage the longer needle-heels, a slide having a cam-way co-acting with said pivoted cam and a lever engaging said slide, a yarn-changer consisting of a pair of rotary dogs having oppo-

sitely-located teeth to engage the yarns, the teeth of one dog having position between those of the other dog, a ratchet fast with said dogs, a pawl engaging said ratchet, a lever carrying said pawl, a cam to vibrate said lever, a multiple-armed wheel fast with said cam, pins carried by a movable section of the machine bed, a pin arranged to be projected into the path of the first-mentioned lever, means actuated by said pin for moving the pins on the movable section of the machine-bed into the path of the multiple-armed wheel, and means for periodically projecting said pin, substantially as described.

6. A circular knitting machine, comprising in its construction a needle-cylinder, a cam-cylinder movable around the same, a shaft in gear with the cam-cylinder, two pinions loose on said shaft, a rotary gear in mesh with one of said pinions, a sector in mesh with the other pinion and connected by a pitman with said rotary gear, a double clutch splined on the shaft between the pinions, a shipper-lever engaging the said clutch, a cam-wheel co-acting with said shipper-lever, a pattern-chain, and suitable connections between the same and the cam-wheel for periodically moving said cam-wheel.

7. A circular knitting machine, comprising in its construction a needle-cylinder, a cam-cylinder movable around the same and having reversible cam-blocks forming in part the cam-groove which actuates the needles, said blocks being mounted on slides and the slides carrying pins, a slide on the exterior of the cam-cylinder and having angular slots which receive said pins, said exterior slide having projections, a pin arranged to be projected into the path of said projections whereby the cam-blocks may be reversed at the end of each stroke of the cam-cylinder when reciprocating, and means for projecting said pin.

8. A circular knitting machine comprising in its construction a needle-cylinder having needle-receiving grooves with receding lower portions, heel-provided needles lying in said grooves against the bottom thereof throughout a portion of their length above the heels and standing away from the bottoms of the receding portions of said grooves, the angles of the grooves constituting fulcra about which the needles are adapted to be bent, means for holding said needles rigidly to the bottoms of the grooves above the heels, a cam-cylinder for engaging the heels of the needles, and means acting against the lower portions of the needles to flex them at the angles of the groove-bottoms and press their lower portions back into the receding portions of the grooves and thereby move their heels out of the path of the engaging portions of the cam-cylinder.

9. A circular knitting machine, comprising in its construction a needle-cylinder having grooves for the needles, said grooves having recessed lower portions, vertical needles engaging the grooves and having heels, verti-



cally extending jacks engaging the lower ends of the needles, a cam-cylinder having a cam-groove to actuate the needles by engaging the heels thereof, a pair of overlapping plates having cam-portions adapted to engage the outer sides of the needle-jacks and thereby push them inward and the needles back into the recessed portions of the grooves and their heels out of operative position, and means for moving said plates step by step whereby the needles may be thrown out of operative position one by one, for the purpose described.

10. A circular knitting machine, comprising in its construction a needle-cylinder having grooves for the needles, said grooves having recessed lower portions, needles engaging the grooves and having heels, jacks engaging the lower ends of the needles, a cam-cylinder having a cam-groove to actuate the needles by engaging the heels thereof, a pair of overlapping plates having cam-portions adapted to engage the needle-jacks and thereby push the needles back into the recessed portions of the grooves and their heels out of operative position, said plates each having a rack, a lever carrying a pair of pawls which engage said racks, a lever engaging said last-named lever and having a movable member with a cam-roller, a continuously-rotating cam-wheel carrying cam-blocks, and means for moving the roller on the movable member of the second lever into the path of the cams on said wheel.

11. A circular knitting machine, comprising in its construction a cam-cylinder having reversible cam-blocks, means for reversing said blocks, means for throwing out the narrowing needles one by one, and a cam-wheel controlling both the means for reversing the cam-blocks and the means for throwing out the narrowing needles.

12. A circular knitting machine, comprising in its construction a cam-cylinder having reversible cam-blocks, means for reversing said blocks, a pin controlling said reversing means, a lever having a cam to act on said pin and a rod projecting from it, a cam-wheel engaging said lever, means for throwing out the narrowing needles one by one, a lever for actuating such means and having a pivoted and spring-pressed member engaging the rod of the first-named lever and carrying a cam-roll, and a continuously-rotating cam-wheel arranged to act on said cam-roll, all arranged substantially as described.

13. A knitting machine, comprising in its construction a shaft, carrying cam-wheels to bring about the various operations of parts required, a mutilated ratchet-wheel having a plurality of lost tooth spaces, and an arm having a plurality of branches; a pattern-chain having lugs to act on the several branches of said arm; a pawl engaging the mutilated ratchet; and means for actuating said pawl.

14. A knitting machine, comprising in its construction a driving-shaft having a large

and a small pulley, a driven shaft having loose and tight pulleys, belting connecting said pulleys, a shifter engaging the belts, a rock-shaft having a projection at one end in engagement with the shifter and a pair of pins projecting from the opposite end; and a pattern-chain having inclined lugs adapted to act on the pins of said rock-shaft.

15. A circular knitting machine, comprising in its construction a take-up device for the yarn, a vertically sliding rod co-acting with said take-up device, a spring-held cam pivoted on the bed of the machine, and means for moving said cam into the path of the said rod.

16. In a circular knitting machine, a mechanism for throwing the narrowing needles out of operation one by one, the same comprising a pair of overlapping plates having racks, a lever arranged to be vibrated during the narrowing and widening operations, a pair of pawls carried by said lever on a pivot-pin common to both and engaging the racks, one of said pawls having two engaging sections separated by a notch and the other one of said pawls having an engaging edge in alignment with said notch, and means for automatically moving the pivot-pin and thereby shifting the pawls when the narrowing is completed, substantially as described.

17. In a circular knitting machine, a mechanism for throwing the narrowing needles out of operation one by one, the same comprising a pair of overlapping plates having racks, a lever arranged to be vibrated during the narrowing and widening operations, a pair of pawls carried by said lever and engaging the racks, said pawls mounted on a sliding pivot and being shiftable, *i. e.*, so arranged that either may engage either of the racks while the other engages the other rack, a bell-crank lever arranged to act on the pawl-pivot, and a cam-wheel to actuate said bell-crank lever.

18. A circular knitting machine, comprising in its construction a pair of sliding plates having cam-portions adapted to throw the narrowing needles out of operative position one by one and provided with racks, a lever carrying shiftable pawls which engage said racks, means for vibrating the lever, means for shifting the pawls, and a cam-wheel controlling both said means, substantially as described.

19. A circular knitting machine, comprising in its construction a cam-cylinder having reversible cams, means for reversing said cams, sliding plates having cam-portions arranged to throw the narrowing needles out of operative position one by one and provided with racks, a lever carrying shiftable pawls which engage said racks, means for vibrating said lever, means for shifting the pawls, and a cam-wheel controlling the reversal of the cam-blocks, the vibration of the lever and the shifting of the pawls.

20. A circular knitting machine, compris-



ing in its construction a needle-cylinder, a  
cam cylinder movable around the same, a  
shaft in gear with the cam-cylinder, two pin-  
ions loose on said shaft, springs on said shaft  
5 and acting against the said pinions, a rotary  
gear in mesh with one of said pinions, a sec-  
tor in mesh with the other pinion and con-  
nected by a pitman with said rotary gear, a  
double clutch splined on the shaft between  
10 the pinions, a shipper-lever engaging the said  
clutch, a cam-wheel co-acting with said ship-

per-lever, and mechanism for periodically  
moving said cam-wheel.

In testimony whereof I have signed my  
name to this specification, in the presence of 15  
two subscribing witnesses, this 21st day of  
March, A. D. 1893.

CHARLES E. KELLEY.

Witnesses:

J. A. BURLEIGH,  
A. C. MOORE.