

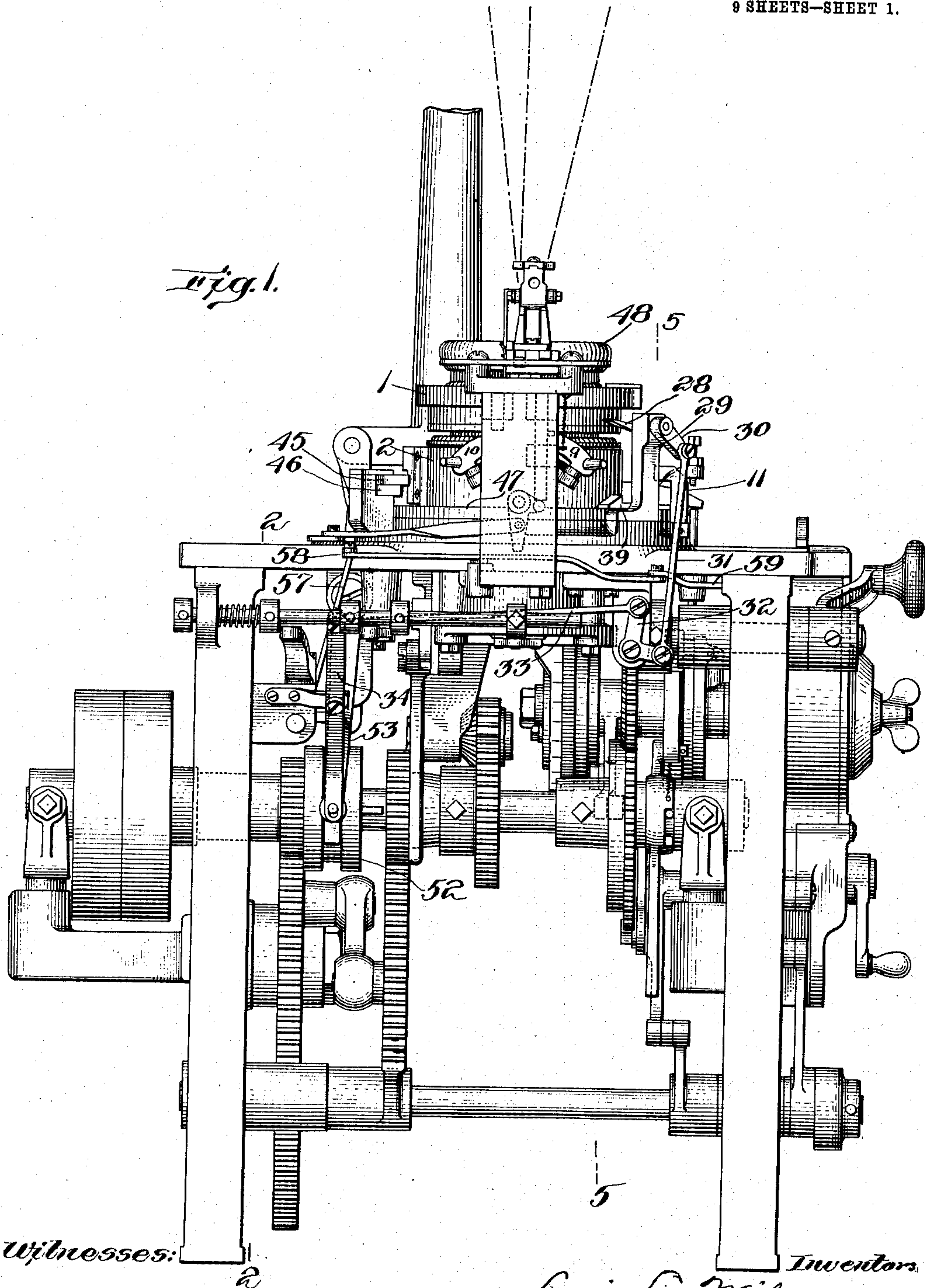
L. L. WILSON & E. PAQUETTE.
KNITTING MACHINE.

APPLICATION FILED JUNE 29, 1906.

928,165.

Patented July 13, 1909.

9 SHEETS—SHEET 1.



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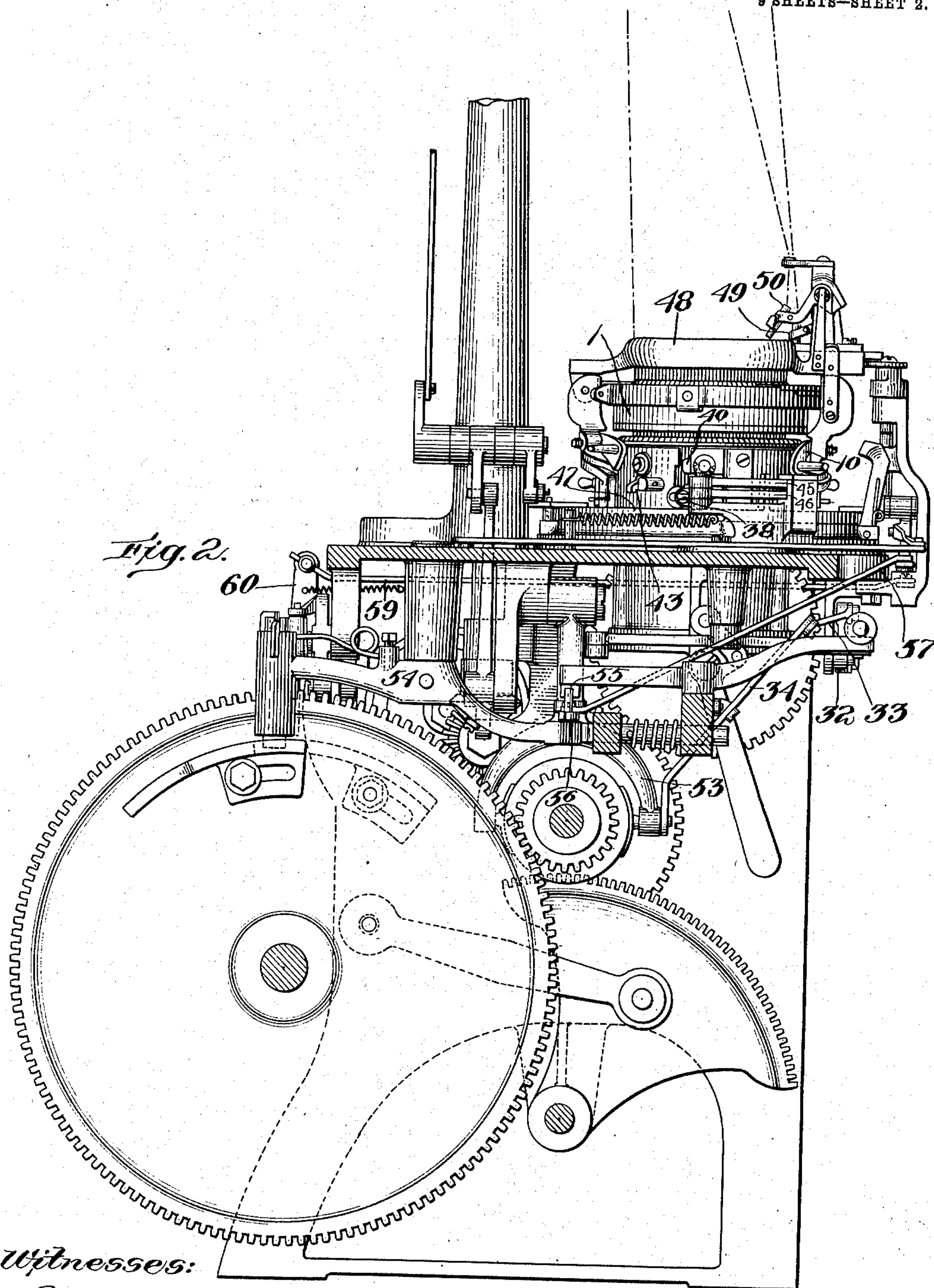
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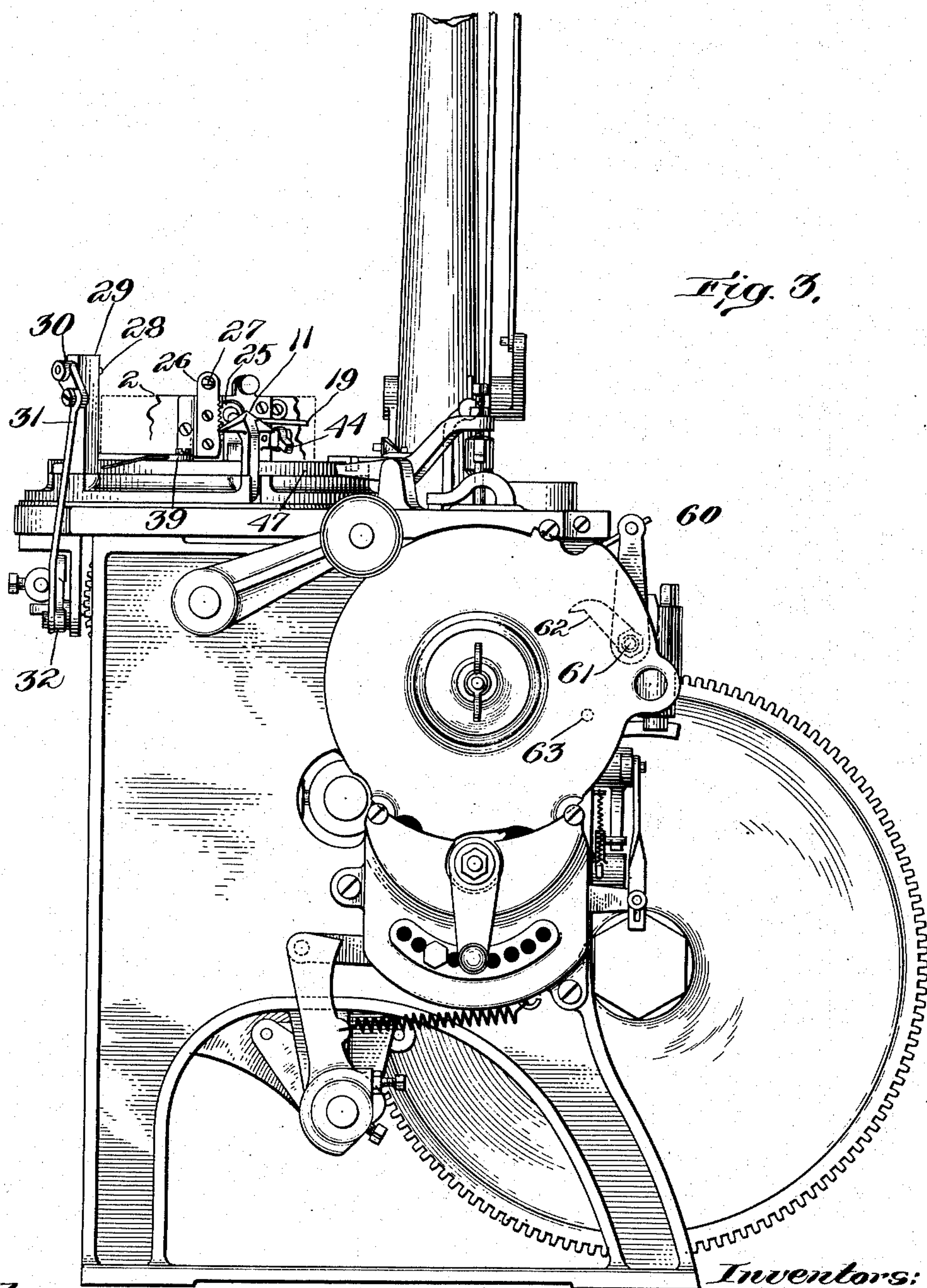
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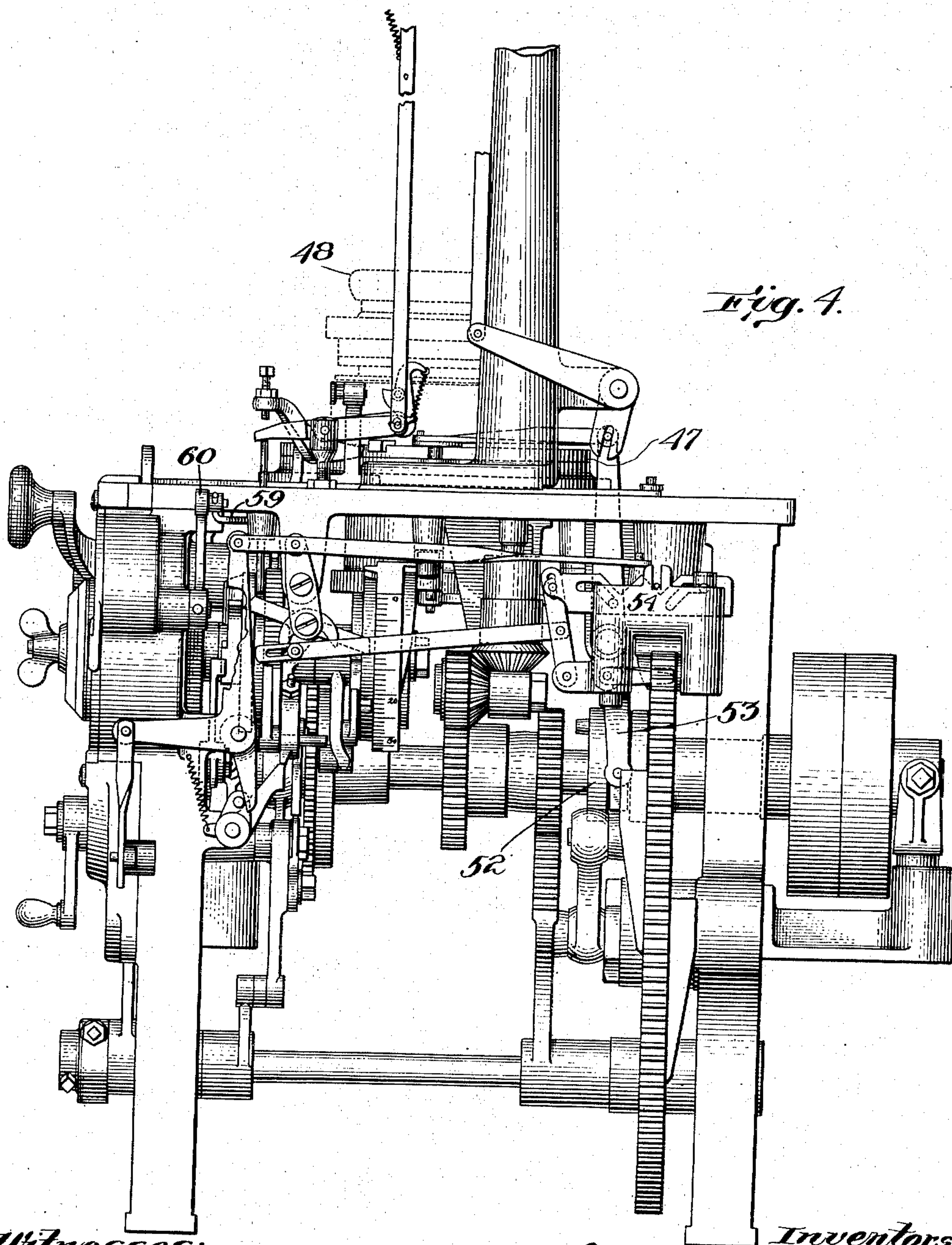
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9 SHEETS—SHEET 4.



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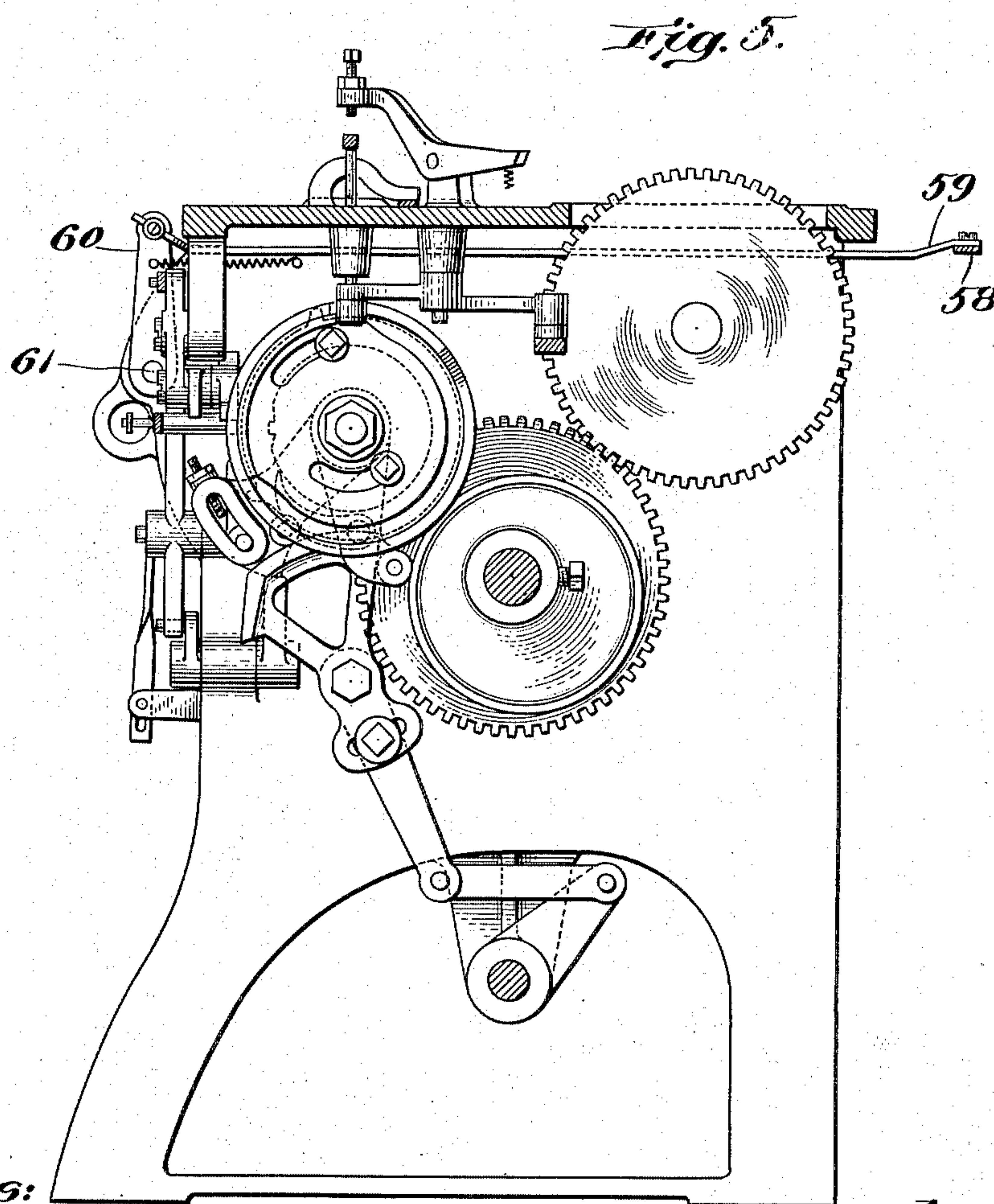
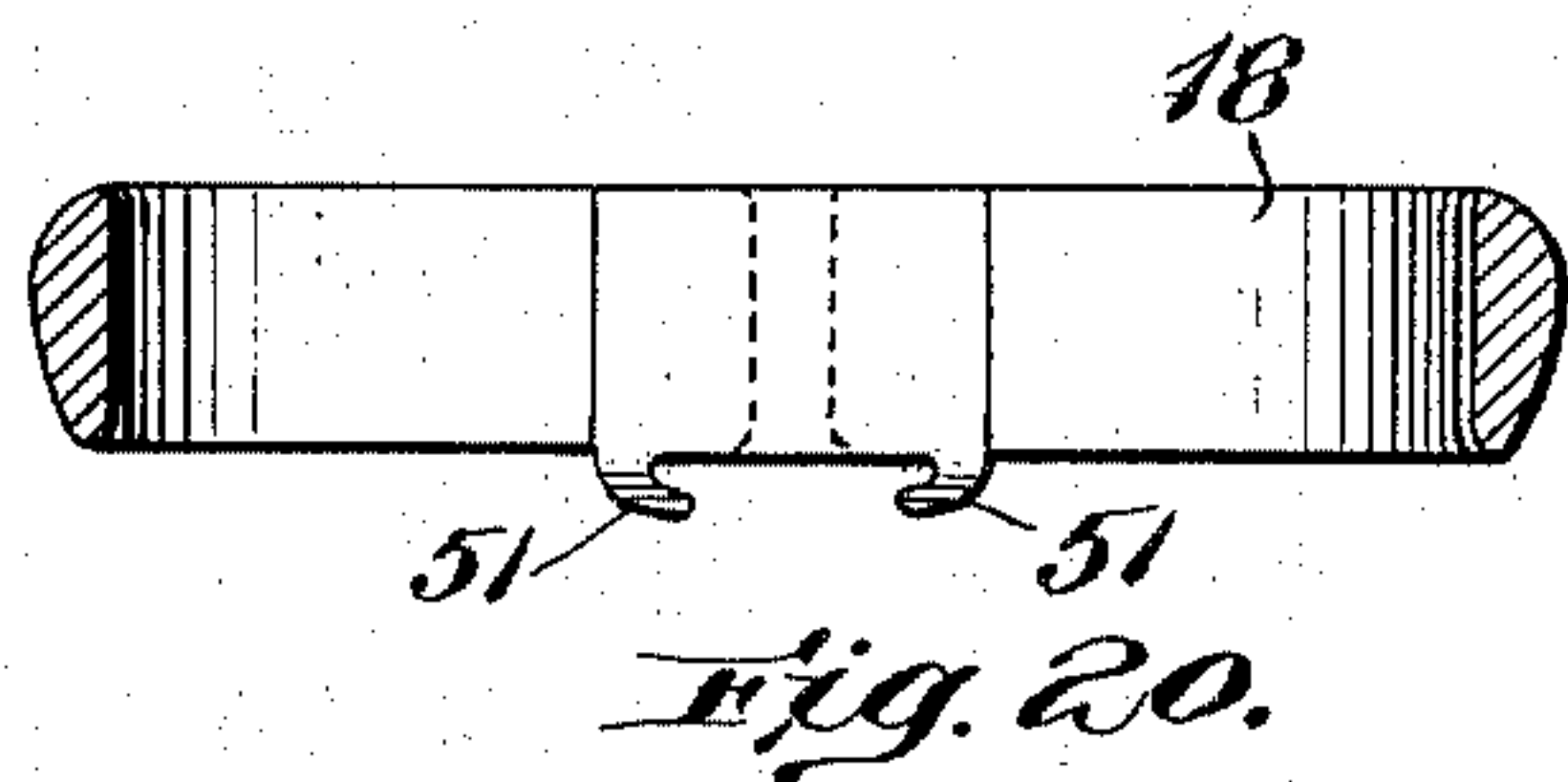
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9 SHEETS—SHEET 5.



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L. L. WILSON & E. PAQUETTE.
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9 SHEETS—SHEET 6.

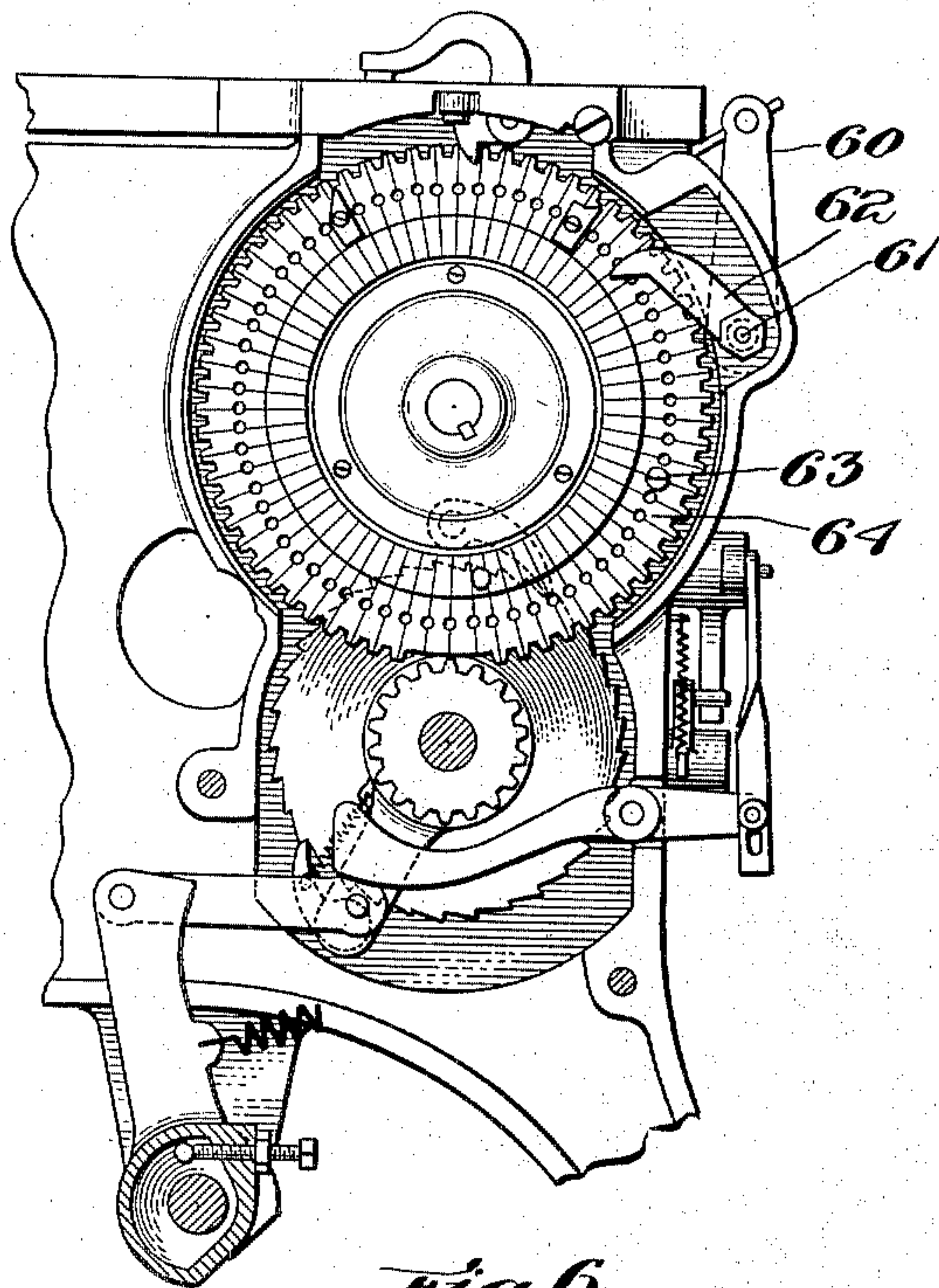


Fig. 6.

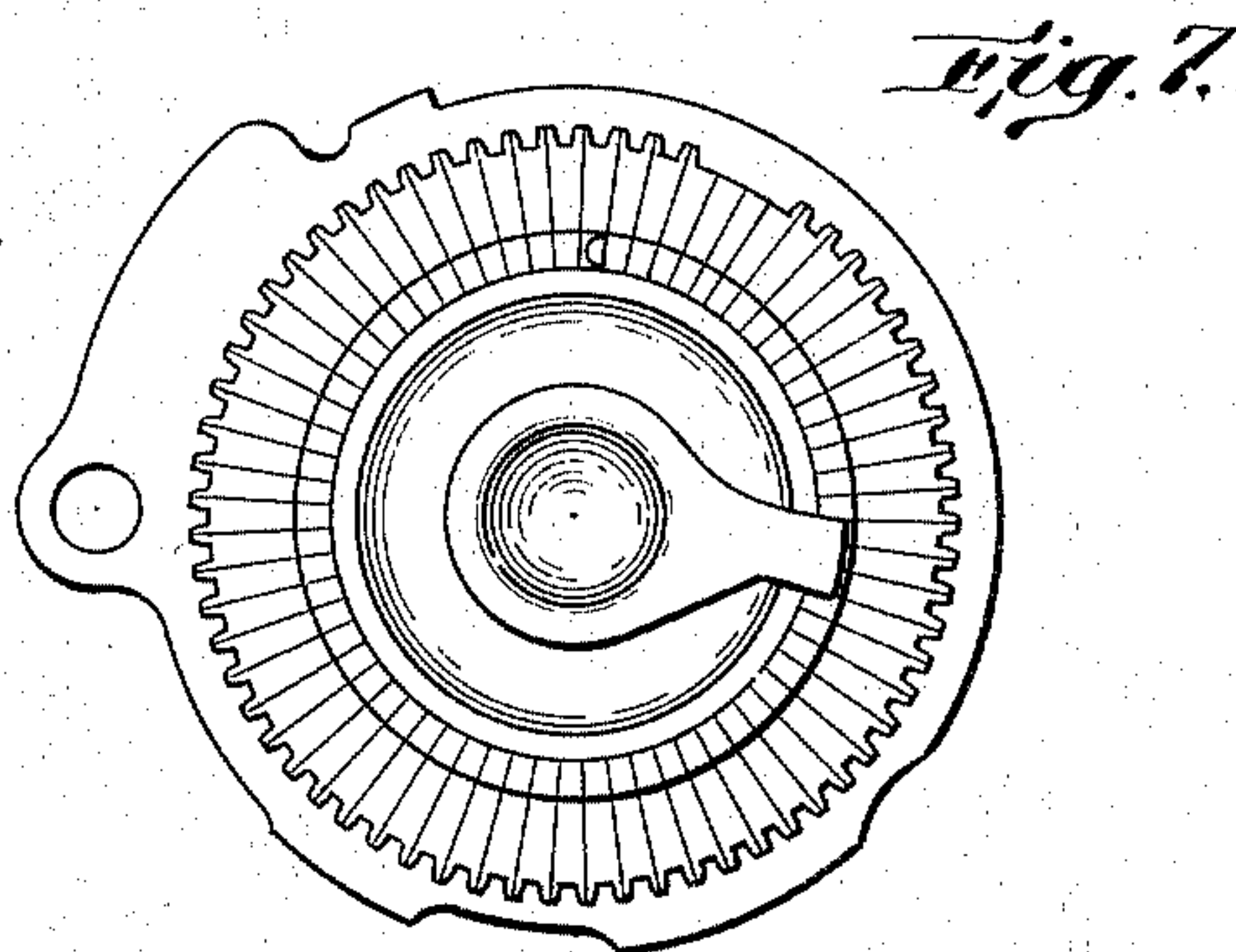


Fig. 7.

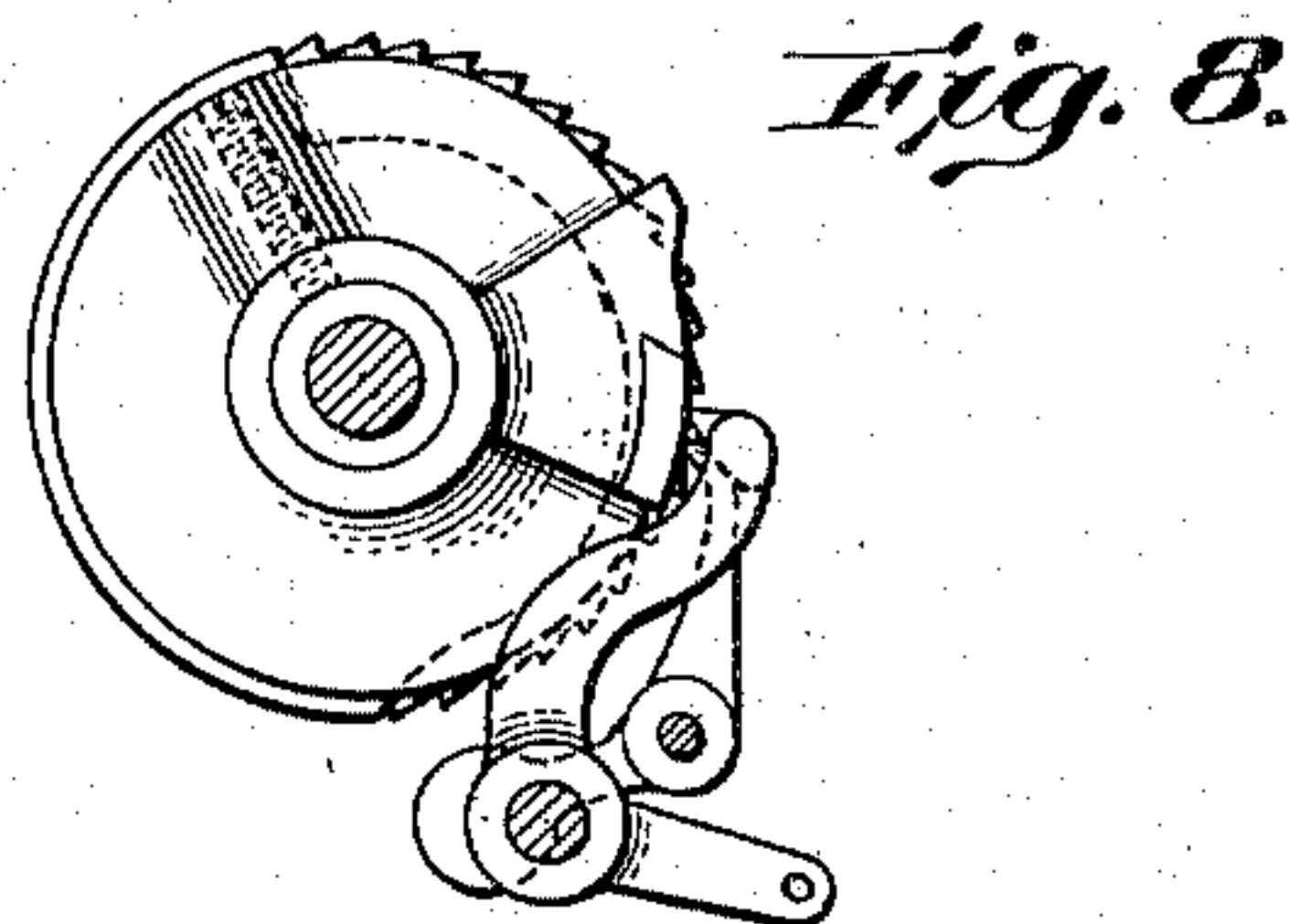


Fig. 8.

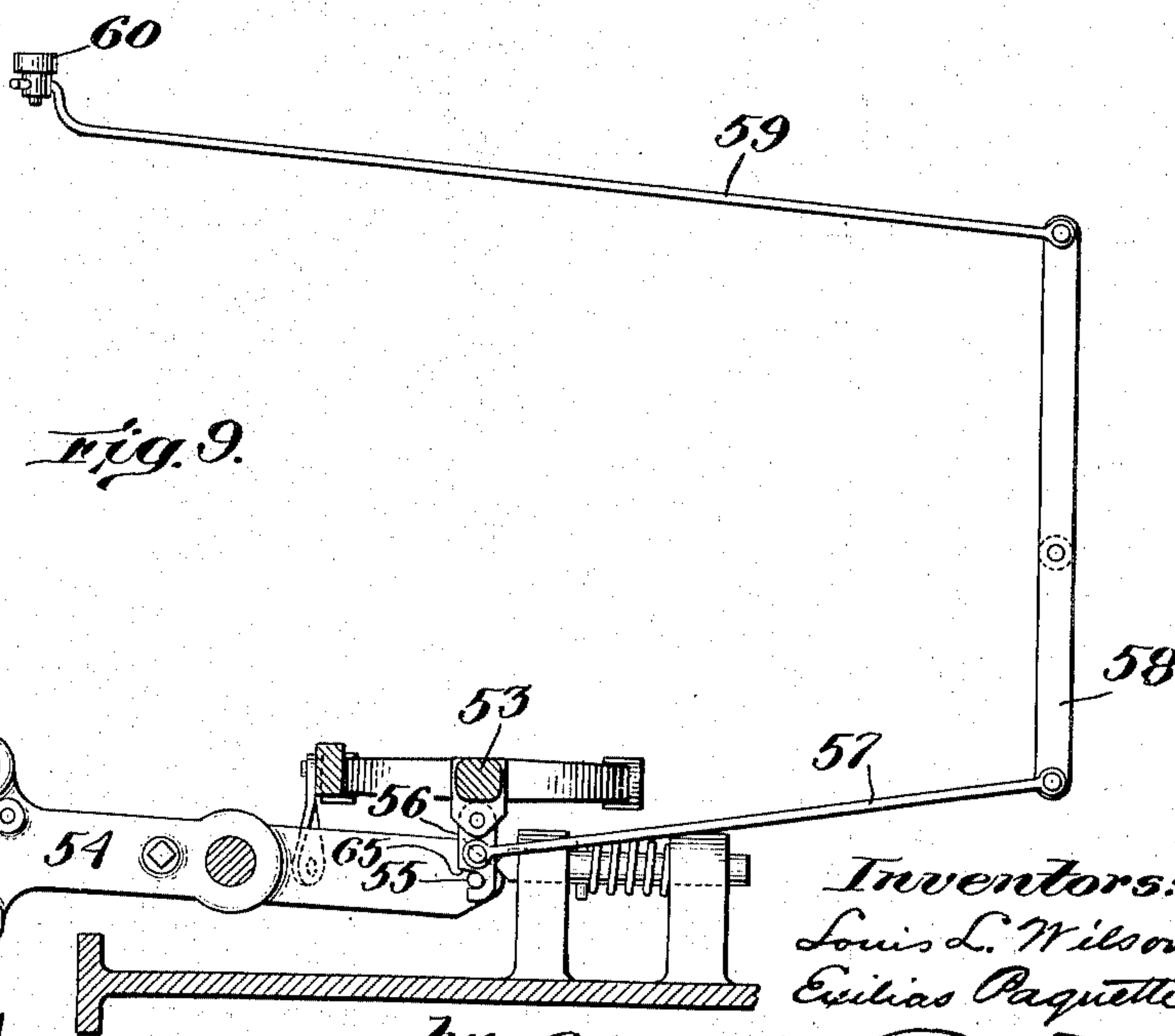


Fig. 9.

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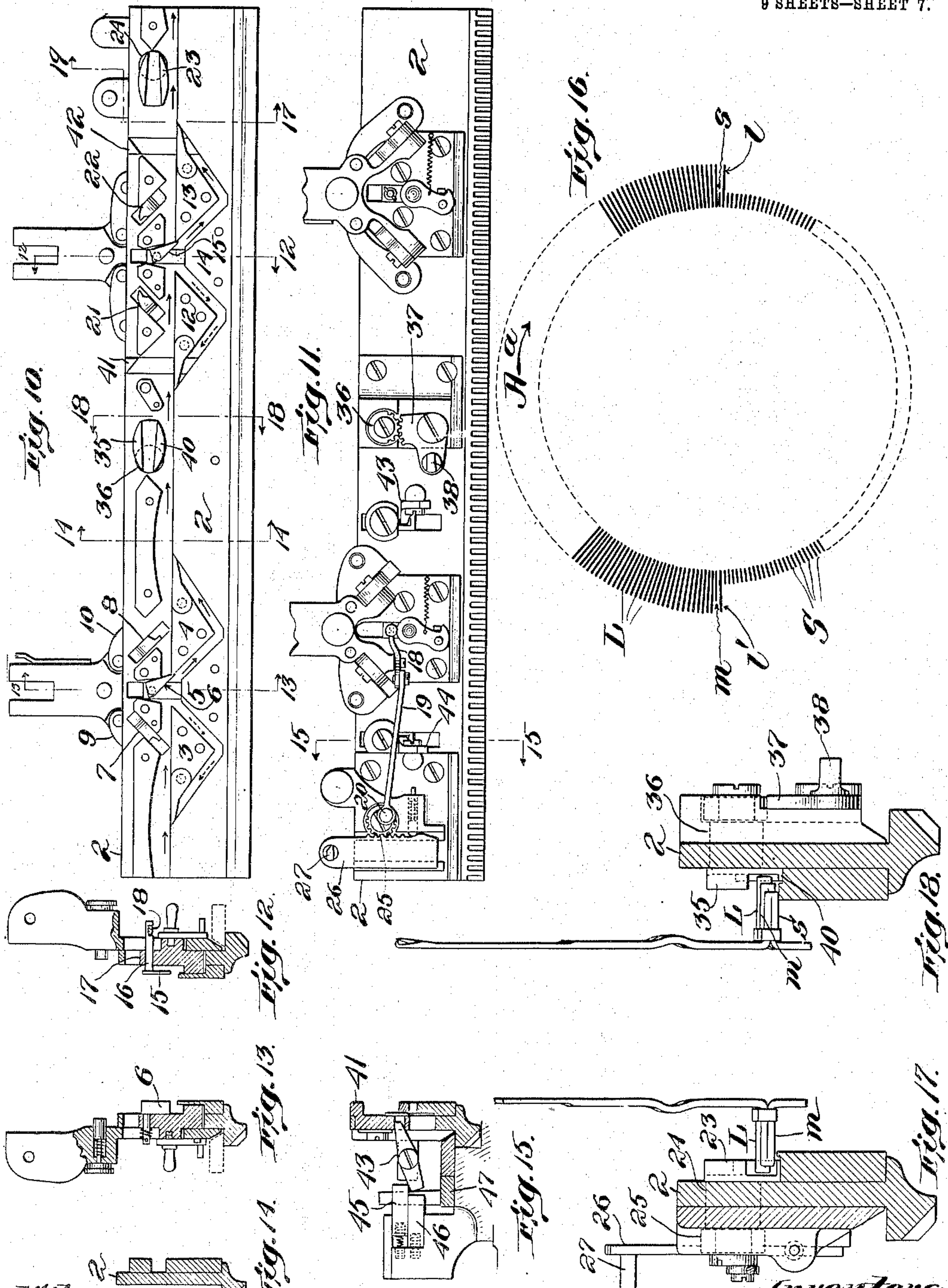
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Patented July 13, 1909.

9 SHEETS—SHEET 7.

928,165.



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L. L. WILSON & E. PAQUETTE.

KNITTING MACHINE.

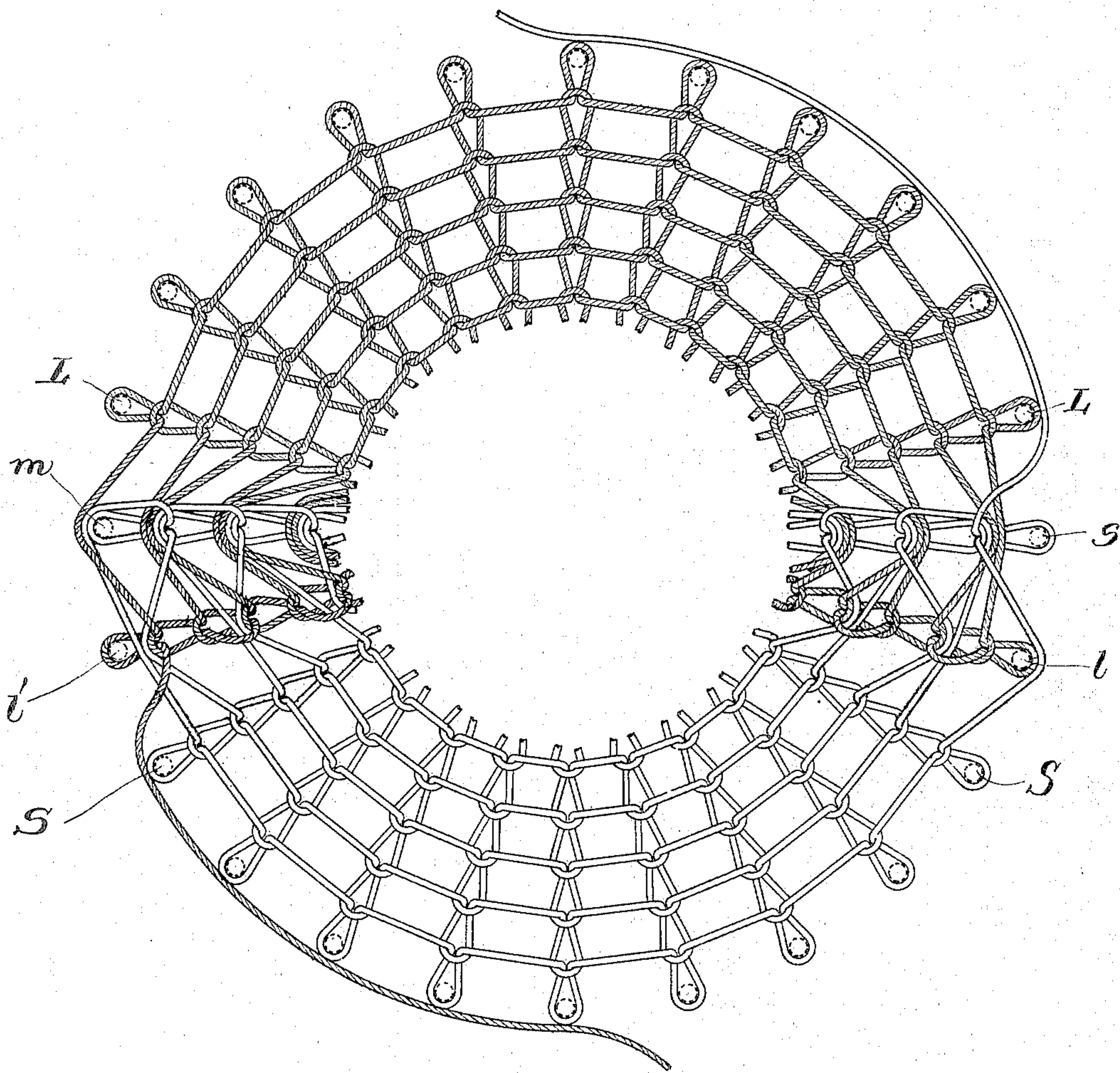
APPLICATION FILED JUNE 29, 1906.

928,165.

Patented July 13, 1909.

9 SHEETS—SHEET 8.

Fig. 19.



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L. L. WILSON & E. PAQUETTE.
KNITTING MACHINE.

APPLICATION FILED JUNE 29, 1906.

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Patented July 13, 1909.
9 SHEETS—SHEET 9.

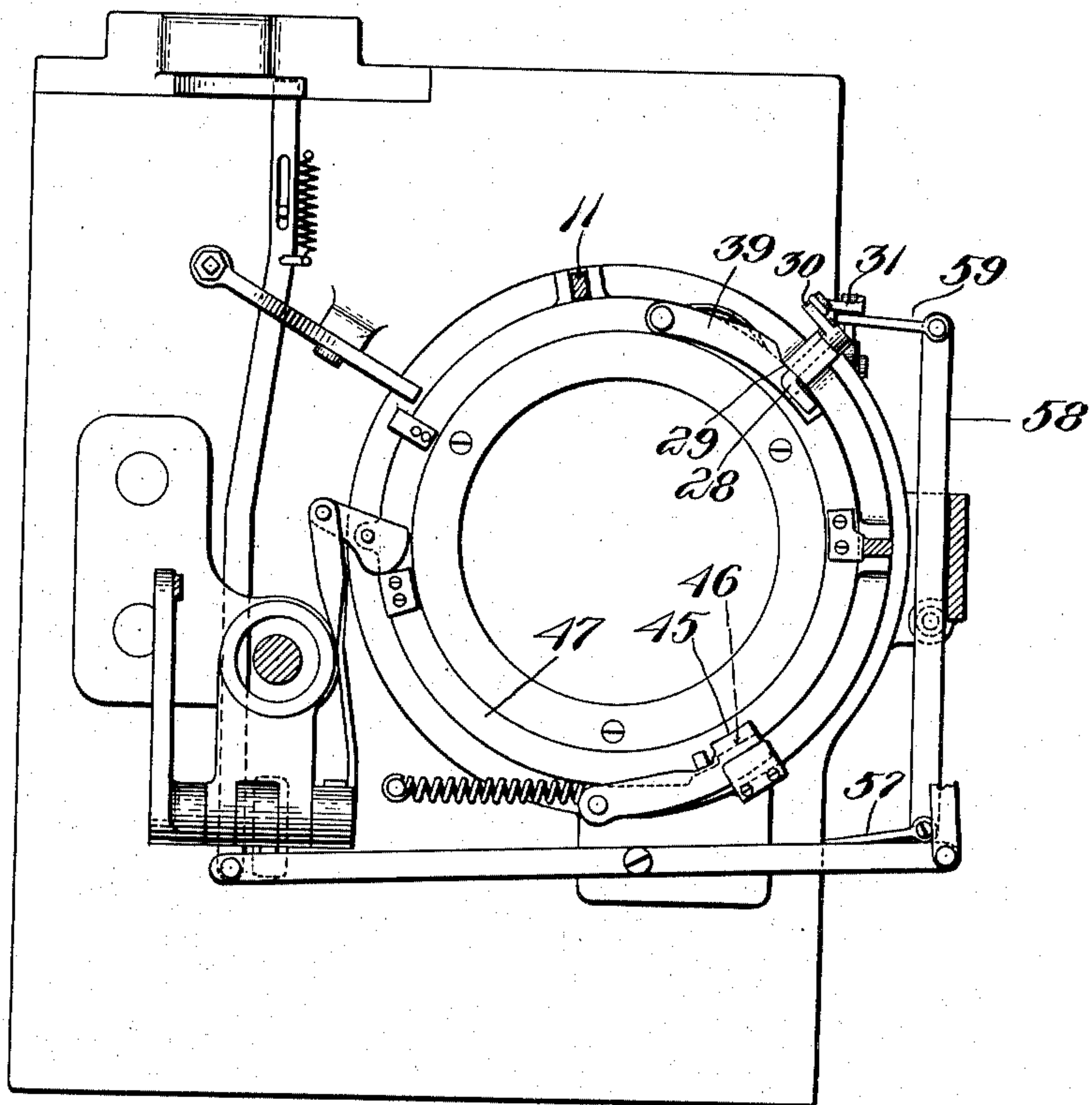


Fig. 21.

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UNITED STATES PATENT OFFICE.

LOUIS L. WILSON AND EXILIAS PAQUETTE, OF LOWELL, MASSACHUSETTS, ASSIGNORS TO
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KNITTING-MACHINE.

No. 928,165.

Specification of Letters Patent.

Patented July 13, 1909.

Application filed June 29, 1906. Serial No. 323,973.

To all whom it may concern:

Be it known that we, LOUIS L. WILSON and EXILIAS PAQUETTE, citizens of the United States, residing at Lowell, in the county of Middlesex and State of Massachusetts, have invented certain new and useful Improvements in Knitting-Machines; and we do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

The invention relates to that class of knitting machines in which the needles are mounted in a circular series, and are operated upon by cams and controlling devices arranged about the needles, relative movement between the needles and the needle-operating cams and devices being produced by rotary and reciprocatory movements of either the needle cylinder or the support or cylinder on which the needle-operating cams and devices are mounted.

The object of the invention is to effect certain improvements in the construction and operation of circular knitting machines, particularly of the latch-needle type, used for knitting stockings, by which the product of such machines may be modified and improved and the operation of the machines rendered more rapid.

Certain features of the invention are adapted particularly to enable the production upon a circular knitting machine of stockings of the kind in which the leg is knit of circular courses while the foot consists of two separate yarns of different colors forming the top of the foot and the sole respectively.

Other objects of the invention will be noted in connection with the description of the illustrated embodiment.

The invention consists in the improved knitting machine hereinafter described, as defined in the claims.

In the drawings Figure 1 is a front elevation of a knitting machine embodying the present invention; Fig. 2 is a section on line 2—2, Fig. 1; Fig. 3 is an elevation of the right side of the machine as shown in Fig. 1; Fig. 4 is a rear elevation of the machine; Fig. 5 is a section on line 5—5 Fig. 1 parts being removed for clearness; Figs. 6, 7 and 8 are detail views relating to the pattern mechanism of the machine; Fig. 9 is a detail view of the controlling mechanism for the shipper lever;

Figs. 10 and 11 are, respectively, an interior and an exterior development of the cam cylinder; Figs. 12, 13 and 14 are, respectively, sections on lines 12—12, 13—13, and 14—14 of Fig. 10; Fig. 15 is a section on line 15—15 of Fig. 11; Fig. 16 is a diagram illustrating the arrangement of the needles; Figs. 17 and 18 are, respectively, sections on lines 17—17 and 18—18, Fig. 10; Fig. 19 is a diagrammatic view of the new fabric produced by the machine; Fig. 20 is a detail view of the feed ring; and Fig. 21 is a plan view of the shifter ring and associated parts.

The invention is shown as embodied in a machine of the same type as the machine which is illustrated in the patents to Mayo, No. 474,671, May 10, 1892, and No. 745,449, December 1, 1903, and which will for convenience be referred to as the Mayo machine. In this machine the needles are of the latch type mounted in a fixed needle cylinder, and operated by cams carried by a rotary cam cylinder. The needle cylinder 1 is the same as in the Mayo machine, and is supported in the same manner. The needles are divided into two groups or series, long butt instep needles L, which are inactive during the knitting of the heel and toe, and short butt needles S which are active both during rotary and reciprocatory knitting. Between the last two long butt needles at one end of this series of needles is interposed a short butt needle s and at the other end of the series of long butt needles is interposed a medium butt needle m. The needles s and m and the end needles of the long butt group needles, l and l', comprise the suture needles. The function and operation of these suture needles will be hereinafter described. The cam cylinder 2 is provided with two sets of knitting cams, both of which act upon all the needles during rotary knitting, and one of which is rendered inactive during the knitting of the heel and toe, and is again rendered active when reciprocating knitting is continued during the knitting of the foot, or when rotary knitting is resumed. One set of knitting cams corresponds to the knitting cams commonly employed to reciprocate the needles during rotary and reciprocating knitting, and may be termed the main knitting cams. These cams comprise the stitch cams 3 and 4, the center cam 5, and the switch cam 6. The narrowing and widening devices for cooperating with these

cams in knitting the heel and toe comprise lifting pickers 7 and 8 and depressing pickers 21 and 22, which are similar in construction and mode of operation to the pickers of the Mayo machine. In the present machine, however, the cam post 11 which operates the latches 9 and 10 for the lifting pickers is fixed in operative position at all times. The second set of knitting cams, which may be termed the supplemental knitting cams, are arranged diametrically opposite the main knitting cams, and may be of similar construction. As shown, they comprise the stitch cams 12 and 13, the center cam 14, and the switch cam 15. The switch cam 15 is arranged to be moved radially inward so as to engage the butts of all the needles, or to be moved outward to a position where it will engage only the butts of the long butt needles so as to render the supplemental knitting cams inactive during the knitting of the heel and toe, and active upon only the long butt needles during reciprocatory knitting on the foot. It is mounted upon a pin 16 carried by the slide 17 and at its outer end the pin 16 is engaged by one end of a bell-crank lever 18, the other end of the bell-crank lever being connected, by means of a link 19, with an eccentric pin 20 hereinafter referred to. The elevating cam 23 for raising the long butt needles out of the path of the knitting cams in its form and location is the same as in the Mayo machine. It is mounted upon a rotatable rock shaft 24 supported in the cam cylinder, and the rock shaft carries upon its outer end a segmental pinion 25 engaged by a rack on the side of a vertical slide 26 supported in a vertical guideway on the outside of the cam cylinder, which slide 26 carries upon its upper end an outwardly projecting pin 27. The pin 27 is adapted to engage a switch point 28 having a shank journaled in the upper end of a post 29 supported upon the bed plate adjacent to the cam cylinder. The shank of the switch point is provided with an arm 30 to which is connected a link 31, the other end of which is attached to one arm of a bell-crank lever 32. The other arm of the lever is connected by a link 33 with a lever 34, pivoted upon a stationary part of the machine and connected at its opposite end to the clutch fork hereinafter referred to.

The eccentric pin 20, hereinbefore referred to in connection with the switch cam 15, is fixed in the outer end of the rock shaft 24 which carries the elevating cam 23. The radial movement of the cam 15 is therefore controlled by the movements of the elevating cam 23. A second elevating cam 35 is provided upon the opposite side of the supplemental knitting cams, symmetrically arranged with relation to the elevating cam 23. This elevating cam 35 is mounted upon a rock shaft 36 supported in the cam cylinder. The outer end of the rock shaft 36 is pro-

vided with a segmental pinion which is engaged, by a segmental bell-crank lever 37, the other end of which has an arm provided with a pin 38. The pin 38 is adapted to engage a cam arm 39 (see Fig. 21) pivoted upon the shifter ring 47 hereinafter referred to. A spring normally holds the cam arm 39 outwardly in engagement with the post 29, and the outer edge of the cam arm has a cam surface adapted to cooperate with the post 29 so as to move the cam arm in and out when the shifter ring is moved, as hereinafter described. When the cam arm is in its inner position it engages the pin 38, and through the means described throws the switch cam 35 into operative position. The lower lip 40 of the switch cam 35 is short and projects radially inward only far enough to engage the butts of the long butt needles. The cam 35 is returned to normal inoperative position by riding over the long butts when rotary knitting is resumed.

The lowering cams 41 and 42 are provided upon opposite sides of the supplemental knitting cams for lowering the needles from the high inactive plane to the low active plane. These lowering cams 41 and 42 are mounted upon vertical slides mounted in guides in the cam cylinder. The slide carrying the lowering cam 41 is engaged by a lever 43, and the slide carrying the lowering cam 42 is engaged by a lever 44. These levers 43 and 44 are pivoted on the outside of the cam cylinder, and their ends project outward and are adapted to be engaged by lowering-cam shifters 45 and 46. These lowering-cam shifters are similar in form and mode of operation to the shifters which operate the needle elevating and lowering cams of the Mayo machine, the lowering-cam shifter 45 operating to raise the lowering cams into operative position, and the lowering-cam shifter 46 operating to lower the lowering cams into their inoperative positions.

The shifter ring 47 hereinbefore referred to comprises the means for throwing the lowering cams out of and into operative position, for throwing the elevating cam 35 into operative position, and for throwing the depressing pickers 21 and 22 into and out of operation. This shifter ring 47 is mounted upon the bed of the machine, and it is actuated in the same manner and at the same times as in the Mayo machine.

A latch ring 48 is located above the needles and carries a yarn-changing device provided with yarn guides 49 and 50. The latch ring, the yarn-changing device, and the mechanism by which the latter is operated, are all similar to those of the Mayo machine.

In addition to the yarn feed above referred to, the present machine is provided with a supplementary yarn feed corresponding to the supplementary knitting cams. This is accomplished by perforating the latch ring

48, as shown in Fig. 20, at a point diametrically opposite the yarn-changing device, and providing the ring upon its lower edge with two hooks 51—51 which act alternately to guide the yarn as the ring rotates in one direction or another.

The present machine is arranged to knit parts of a stocking by a circular motion and other parts by a reciprocating motion of the cam cylinder, and the pattern mechanism by which the mode of operation of the cam cylinder is automatically changed at suitable times in the manufacture of a stocking, and by which the depressing pickers, the elevating cams, the lowering cams, and the other automatic knitting instrumentalities of the machine are automatically thrown into and out of operation at the proper times, is in general similar to that of the Mayo knitting machine. In order to enable reciprocatory knitting to be continued through the foot of the stocking, the present machine is provided with means for disconnecting the clutch from the clutch shipper mechanism at the completion of the heel, so that while the pattern mechanism operates as usual in other respects, it does not shift the clutch at this time. The clutch 52 is thrown, as in the Mayo machine, by a fork 53 actuated by a shipper lever 54 which is moved in the same manner and by the same mechanism as in the Mayo machine. In the present machine, however, the shipper lever is connected to the fork by means permitting these parts to be automatically disconnected at certain times in the operation of the machine. The shipper lever is provided at its forward end with a pin 55 adapted to be engaged by a hook 56 pivoted on the clutch fork 53. The hook 56 is connected by a link 57 with a lever 58 pivoted on the fixed part of the machine and connected at its other end by means of a link 59 with an arm 60 fixed to the outer end of a rock shaft 61 extending into the casing inclosing the pattern wheels, as shown in Fig. 6. A trip arm 62 is fixed on the inner end of the shaft and is provided with a beveled end adapted to be engaged by a trip pin 63 fixed on one of the leg-and-foot pattern wheels 64. When the pin 63 engages the trip arm 62 it swings the latter upwardly and operates through the connections above described to swing the hook 56 out of engagement with the pin 55. The hook is provided with a shoulder 65 which remains in position to engage the pin 55.

The operation of the machine above described, when arranged to knit a stocking having a leg of one color and a foot consisting of yarns of two colors, is as follows: Supposing it is desired to make the leg or upper part of the foot of black yarn while the sole of the foot is of white yarn; the auxiliary yarn feed is threaded with black yarn and the yarn tubes 49 and 50 of the yarn-

changing device are threaded with black and white yarns respectively. During the knitting of the leg of the stocking the yarn tube 49, containing the black yarn, is in operative position, so that two black yarns are fed simultaneously at opposite points to the needle. The switch cam 15 is in its inward position, so as to engage the butts of all the needles, and thus the stitch cam 13 operates in addition to the stitch cam, 4, and as the needle cylinder is rotated both black yarns are knit simultaneously by the two sets of knitting cams, so that at each rotation of the cam cylinder two courses of loops are knit, and thus the leg of the stocking is knit in half the number of revolutions required in knitting machines of the ordinary construction. The pattern mechanism is therefore adjusted to discontinue the rotary knitting after one-half of the usual number or rotations. This does not involve, however, any change in the construction of the pattern mechanism. Owing to the fixed position of the cam post for the lifting picker latches hereinbefore described, the lifting pickers are free from the latches 9 and 10 during the knitting of the leg of the stocking, and the picker 7 rests idly upon the butts of the needles, being inoperative, however, since the butts form a continuous series. At this time the relative travel of the needles with relation to the cams is in the direction of the arrows, Fig. 10, and the needle butts pass under the cam 4 and do not engage the picker 8 which rests on the top of this cam. Upon the completion of the leg of the stocking the pattern mechanism operates in the usual manner to actuate the shipper lever 54 and move the clutch 52 to change the motion of the cam cylinder from rotary to reciprocating. Simultaneously, by the means above described, the switch point 28 is moved to a position to throw the elevating cam 23 into operative position, so that during the last revolution of the cam cylinder in rotary knitting the long butt needles and the medium butt needle are raised to the high plane and their operation ceases. The lowering cams 41 and 42 are also moved out of operative position at this time. The connections between the elevating cam 23 and the switch cam 15 cause the latter to be drawn back at this time, for a purpose which will appear later. At the end of the last rotation the main knitting cams are in the position A, Fig. 16, and upon the first reciprocating movement, which is in the direction *a*, the first needle in the active series is the short butt suture needle *s*, which is, of course, not raised with the adjacent long butt needles *L*, owing to its short butt. This short butt needle *s* is not, however, caused to knit at this time, since it is first encountered by the picker 8 and is therefore raised to the high plane with the long needles so as not

to be actuated by the knitting cam 3. The medium butt needle *m*, having been raised with the long needles as above described, is not actuated with the short butt needles at this time, and thus an unbroken series of loops is formed, making the first course of the heel. The utility of the medium butt needle is apparent in this connection. If a short butt suture needle similar to the needle *s* were used in the place of the medium butt needle *m* this needle would be actuated with the short butt needle *S* upon this first reciprocating movement of the cam cylinder, and, since the suture needle *V* has been previously raised with the long butt needles *L*, a stitch would be missed at this point when the long butt needles come into action on the foot, leaving a hole in the stocking; but this is avoided by the use of the medium butt needle, which is adapted to operate with the long butt needles at this point in the operation of the machine, while acting with the short butt needles during the knitting of the foot, as will be herein-after described. The use of the short butt suture needle *s*, is permissible, however, since, as has been above pointed out, this needle is raised by the picker 8 before it can be actuated by the stitch cam 3.

At the same time that the clutch is shifted as above described the yarn changer is operated in the usual manner to substitute the white yarn in the yarn tube 50 for the black yarn used in the leg, so that the heel is knit with white yarn. The narrowing and widening of the heel are accomplished in the usual manner, the depressing pickers 21 and 22 being thrown into operation at the same time and by the same means as in the Mayo machine, to cause the widening of the heel. The elevating cam is also thrown into operative position by the movement of the shifter ring which throws the lifting pickers into operation. At the completion of the heel the shipper lever 54 is moved back as in the Mayo machine, and the shifter ring is returned to its original position, thereby throwing the depressing pickers out of operation, and returning the lowering cams 41 and 42 to operative position. The clutch fork 53, however, is at this time disconnected from the shipper lever 46 by the operation of the hook 56 and the mechanism connected therewith, the pin 64 being at this time in position to operate the trip arm 62 as above described, and therefore the clutch fork and all the parts actuated thereby are left in the same position as during the knitting of the heel. The cam cylinder, therefore, during the knitting of the foot, continues to reciprocate and the yarn changer is not shifted, but continues to feed a white yarn for the sole of the foot. Owing to the operation of the lowering cams 41 and 42, cooperating with the elevating cams 35 and 23, the supplemental

knitting cams now recommence to operate the long butt needles, for at each reciprocation of the cam cylinder the long butt needles and the medium butt needles are engaged and drawn down to the lower plane by one of the lowering cams, and the long butt needles are engaged by the switch cam 15 and directed to one or the other of the stitch cams 12 or 13, so that the needles are actuated thereby and caused to knit. After leaving the stitch cams 12 or 13 the long butt needles are again raised by the succeeding elevating cam 35 or 23 and thus directed out of the path of the main knitting cams. It is to be noted that during the reciprocation of the cam cylinder in the direction *a* the medium butt needle, after it has been drawn down by the lowering cam 42, is not engaged by the switch cam 15, owing to the retracted position of the latter, nor by the elevating cam 35, owing to the shortness of the lip 40, so that it is not actuated but remains on the lower plane and is knit with the short butt needles by the stitch cam 3. At the end of the reciprocation the medium butt needle is at the extreme right of Fig. 10 between the cam 23 and the picker 7 and in the active plane. During the reciprocation of the cam cylinder in the opposite direction the medium butt needle is raised by the picker 7 so that it does not knit, is lowered by cam 41, and is raised again to the high plane by the elevating cam 23, but this operation is functionless, resulting merely from the required form of the elevating cam 23, and does not interfere with the operation of the machine, since the medium butt needle is lowered again by cam 42, as above described, before it is necessary to actuate it to make a stitch. It is at this point in the operation of the machine that the arrangement of the suture needles has its utility. Owing to the interposition of the short butt needles *s* and the medium butt needle *m* between the long butt needles *L* and the long butt suture needles *V*, the courses of black and white yarn knit by the long butt needles and the short butt needles are interlooped at the edges.

During the knitting of the foot the elevating pickers 7 and 8 remain in action. During the reciprocation in the direction *a* the short butt needle *s* which, during the formation of this course, is the first needle in the group acted upon by the main knitting cams, does not knit, since it is raised out of action by the picker 8. The medium butt needle *m* which is the last needle in the group acted upon by the main knitting cams remains in active position after it has been lowered by cam 42 as above described, and knits during the formation of this course of stitches. During the reciprocation of the cam cylinder in the opposite direction the medium butt needle *m*, which is the first needle in the group acted upon by the main knitting cams

during the formation of this course of stitches, does not knit, since it is raised out of action by the picker 7. The short butt needle *s*, which is now the last needle in the group acted upon by the main knitting cams, having been previously lowered by the cam 42 during the reciprocation in the direction *a*, is operated during reciprocation in this direction, *i. e.* direction opposite to *a*, by cam 4, and takes part in the knitting. Thus the suture needles *s* and *m* are alternately rendered inactive, so that but one of these suture needles knits in each course, and the action of the needles is so controlled that the inactive suture needle is the first needle of the group in the knitting of each course. This results in a better joint at the edges of the two fabrics being knit than would be produced if both suture needles were operated during the formation of each course, and also eliminates imperfections due to the dropping of stitches by the suture needles. By this mode of operation the interlooping of the two fabrics formed upon the two groups of needles indicated in Fig. 19 is effected in a uniform and reliable manner. After the required number of courses to form the foot have been knit, the pattern mechanism operates again, as in the Mayo machine, to actuate the shipper lever 54. Since the clutch has remained, as above described, in the proper position for the knitting of the toe, it is not moved at this time, but the hook 56 again engages the pin 55, since the pattern wheel 64 has moved during the knitting of the foot and disengaged the pin 63 from the trip arm 62, so that upon the next succeeding movement of the shipper lever 54 the clutch is thrown in the same manner as in the Mayo machine. The movement of the shipper lever which occurs at the completion of the foot restores the parts to the positions occupied at the commencement of the heel, so that the toe is knit in the same manner as the heel and in the same manner in which it is knit in the Mayo machine. At the completion of the toe the shipper lever is again moved, as in the Mayo machine, thereby restoring the rotary movement of the cam cylinder, and all of the parts except the yarn changer are restored to their original position occupied during the knitting of the leg. A few courses are knit with the yarn guide 50 in operation so as to knit alternate courses of black and white yarn to form a margin or cutting strip, and the yarn changer is then restored to its original position and the machine commences to knit another leg.

Owing to the double feed during the knitting of the leg the machine may be arranged to knit a stocking having alternate courses of different colored yarns instead of making a leg of one solid color as above described. Thus a white yarn may be used in the supplementary feed in place of the black yarn,

thereby making a leg with alternate courses of black and white yarn. With this arrangement the foot, although knit in the manner above described, would be of solid white instead of having a black instep. Other combinations of yarn will readily suggest themselves by which stockings may be made having legs of black and white and feet either entirely black or with black soles and white insteps.

The invention has been described as embodied in a machine of a particular type, since this type of machine is well known, and in this manner a detailed description of so much of the pattern mechanism and actuating mechanism of the machine as are not essential to the invention is avoided. It will be understood, however, that the invention is applicable to and may be embodied in circular knitting machines of various types, the specific form of the devices employed being varied to suit the requirements of the type of machine in which the invention is embodied. The several features of the invention, moreover, are not necessarily used in conjunction; thus, the double feed, although it expedites the operation of the machine, is not necessarily used in connection with the mechanisms by which the circular knitting machine is adapted to knit the particular form of stocking produced by this machine.

The invention is not limited in general to the details of construction and operation of the illustrated embodiment, but may be embodied in other forms within the spirit and terms of the claims.

Having thus described the invention, what we claim is:

1. A circular knitting machine, having, in combination, a needle cylinder, needles therein comprising two segmental groups, main knitting cams, narrowing and widening devices, supplemental knitting cams, devices for directing one group of needles into the path of the supplemental cams and out of the path of the main knitting cams during reciprocatory knitting, and mechanism acting automatically to render the directing devices active upon the completion of the narrowing and widening, substantially as described.

2. A circular knitting machine, having, in combination, a needle cylinder, main knitting cams, a motion changing mechanism, narrowing and widening devices, supplemental knitting cams, devices for directing a segmental group of the needles into the path of said supplemental cams and out of the path of the main cams, and mechanism for automatically rendering said directing devices active upon the completion of the widening, substantially as described.

3. A circular knitting machine, having, in combination, a needle cylinder, needles

therein comprising two segmental groups, cams for operating each group of needles, narrowing and widening devices, means for rendering one group of needles inactive during the narrowing and widening, and mechanism acting automatically upon the completion of the narrowing and widening to render the operating cams for each group active upon its own group only during the continuance of reciprocary knitting, substantially as described.

4. A circular knitting machine, having, in combination, a needle cylinder, main knitting cams, a motion changing mechanism, narrowing and widening devices, supplemental knitting cams arranged to act upon all the needles during rotary knitting, devices for rendering said supplemental cams inactive upon the change from rotary to reciprocating knitting, and devices for directing a segmental group of the needles into the path of said supplemental cams and out of the path of the main cams after the completion of the widening, and during the continuation of reciprocary knitting, substantially as described.

5. A circular knitting machine, having, in combination, a needle cylinder, main knitting cams, a motion changing mechanism, supplemental knitting cams arranged to act upon all the needles during rotary knitting, and devices for rendering said cams active upon a segmental group of the needles only during reciprocary knitting, substantially as described.

6. A circular knitting machine, having, in combination, a needle cylinder provided with long and short butt needles, main knitting cams, a motion changing mechanism, supplemental stitch cams, a cooperating switch cam arranged to act upon all the needles during rotary knitting, means for withdrawing the switch cam into position to act upon the long butts only during reciprocary knitting, and devices for directing the long butts out of the path of the main knitting cams during reciprocary knitting, substantially as described.

7. A circular knitting machine, having, in combination, a needle cylinder having long and short butt needles, main knitting cams, motion changing mechanism, narrowing and widening pickers, supplemental knitting cams arranged out of the path of the short butts during reciprocating knitting, and elevating and lowering cams on opposite sides of the supplemental cams the elevating cams being arranged out of the path of the short butts, substantially as described.

8. A circular knitting machine, having, in combination, a needle cylinder having long and short butt needles, main knitting cams, supplemental knitting cams arranged out of the path of the short butts, elevating and lowering cams on opposite sides of the sup-

plemental cams the elevating cams being arranged out of the path of the short butts, substantially as described.

9. A circular knitting machine, having, in combination, a needle cylinder having long and short butt needles, main knitting cams, motion changing mechanism, supplemental knitting cams, elevating and lowering cams on opposite sides of the supplemental cams, and means for rendering the elevating and lowering cams active and inactive and for bringing the supplemental cams into and out of the path of the short butts, substantially as described.

10. A circular knitting machine, having, in combination, a needle cylinder provided with long and short butt needles, main knitting cams, motion changing mechanism, supplemental knitting cams arranged out of the path of the short butt needles, devices for directing the long butt needles into said cams and out of the path of the main knitting cams, and mechanism acting automatically to render said directing devices active and inactive, substantially as described.

11. A circular knitting machine, having, in combination, a needle cylinder, needles therein comprising two substantially semi-circular groups, suture needles interposed between two needles at the ends of one group, knitting cams arranged to operate all the needles during rotary knitting, narrowing and widening devices, and devices for rendering one group of needles and the suture needles inactive during the narrowing and widening, substantially as described.

12. A circular knitting machine, having, in combination, a needle cylinder, needles therein comprising a group of long butt needles, a medium butt suture needle interposed between two needles at the end of the long butt group, and an elevating cam constructed to act upon the long and medium butts only, substantially as described.

13. A knitting machine, having, in combination, a needle cylinder comprising a group of long butt needles, a short butt suture needle interposed between two needles at one end of the group of long butt needles, a medium butt suture needle interposed between two needles at the other end of the group of long butt needles, two sets of knitting cams, one set being arranged to engage the long butts only, an elevating cam arranged to engage the long and medium butts only, a lowering cam arranged to engage the long and medium butts, an elevating cam arranged to engage the long butts only, and a corresponding lowering cam, substantially as described.

14. A knitting machine, having, in combination, a needle cylinder, needles therein with long and short butts, two sets of stitch cams and two switch cams, means for relatively actuating the needle cylinder and cams

to knit the leg and foot of a stocking and means for moving one of the switch cams to cause it to engage only the long butts, or both the long and the short butts, according as the machine is knitting the foot or the leg of a stocking, substantially as described.

15. A knitting machine, having, in combination, a needle cylinder, needles therein comprising two distinct and contiguous sets and two suture needles interposed between the last two needles at the ends of one set, and cam mechanism for actuating the needles constructed and arranged to actuate all the needles successively to form the circular courses of a stocking leg; heel forming devices, and means for rendering one set of needles and the suture needles of the other set inactive during the knitting of the heel, substantially as described.

20 16. A knitting machine, having, in combination, a needle cylinder, needles therein comprising a group of long butt needles, a short butt suture needle interposed between the last two needles at one end of the group of long butt needles, a medium butt suture needle interposed between the last two needles at the other end of the group of long butt needles, two sets of stitch cams and two switch cams, one of the switch cams being operable to engage the long butts, an elevating cam operable to engage the long butts and the medium butt, an elevating cam operable to engage the long butts only, and lowering cams operable to engage both the long butts and the medium butt, substantially as described.

17. A knitting machine, having, in combination, a needle cylinder, short butt needles and long butt needles therein forming two substantially semicircular groups, two sets of stitch cams, two switch cams for directing the needle butts to the stitch cams of which one is long enough to engage only the long butts while the other is long enough to engage all the butts, means for raising the long butt needles shortly after their actuation by the short switch cam and the corresponding stitch cams and lowering them again into operative position shortly before the passage of such cams, and means for relatively reciprocating the cams and needle cylinder, substantially as described.

18. A circular knitting machine, having, in combination, a needle cylinder, needles therein comprising two substantially semicircular groups of needles, suture needles interposed between needles at the ends of one group, means for operating the groups of needles to effect the knitting, and means for rendering said suture needles alternately inactive whereby but one suture needle knits in each course of stitches formed by its group of needles, substantially as described.

19. A circular knitting machine, having, in combination, a needle cylinder, needles

therein comprising two substantially semicircular groups of needles, suture needles interposed between needles at the ends of one group, means for operating the groups of needles to effect the knitting, and means for rendering that suture needle inactive which is the first needle in its group in the knitting of each course of stitches by said group of needles, substantially as described.

20. A circular knitting machine, having, in combination, a needle cylinder, needles therein comprising two substantially semicircular groups, suture needles interposed between needles at the ends of one group, cams for operating each group of needles, motion changing mechanism, narrowing and widening devices, devices for rendering one group of needles inactive during the narrowing and widening, and means for rendering both suture needles inactive during the knitting of the first course of reciprocary knitting, substantially as described.

21. A knitting machine, having, in combination, a needle cylinder, needles therein comprising two substantially semicircular groups, cams for operating each group of needles, narrowing and widening devices, means for rendering the operating cams for both groups active upon all the needles during rotary knitting and the cams for each group active upon its own group only during reciprocating knitting, means for rendering one group of needles inactive during the narrowing and widening, a yarn feed corresponding to the cams for each group of needles, and means for changing the yarn delivered by the yarn feed corresponding to the operating cams for the group of needles which is active during the narrowing and widening, substantially as described.

22. A knitting machine, having, in combination, a needle cylinder, needles therein comprising two substantially semicircular groups, cams for operating each group of needles, narrowing and widening devices, means for rendering the operating cams for both groups active upon all the needles during rotary knitting, and the cams for each group active upon its own group only during reciprocary knitting, and means for rendering one group of needles inactive during the narrowing and widening, substantially as described.

23. A knitting machine, having, in combination, a needle cylinder, needles therein comprising two substantially semicircular groups, cams for operating each group of needles, narrowing and widening devices, mechanism acting automatically to render the operating cams for one group active upon all the needles during rotary knitting, and the cams for each group active upon its own group only during reciprocary knitting, and mechanism acting automatically to render one group of needles inactive during the nar-

rowing and widening, substantially as described.

24. A knitting machine, having, in combination, a needle cylinder, needles therein comprising two substantially semicircular groups, cams for operating each group of needles, narrowing and widening devices, mechanism acting automatically to render the operating cams for one group active upon all the needles during rotary knitting, and the cams for each group active upon its own group only during reciprocary knitting, mechanism acting automatically to render one group of needles inactive during the narrowing and widening, a yarn feed corresponding to the cams for each group of needles, and mechanism acting to automatically change the yarn delivered by the yarn feed corresponding to the operating cams for the group of needles which is active during the narrowing and widening, substantially as described.

25. A circular knitting machine, having, in combination, a needle cylinder, needles therein comprising two substantially semicircular groups, suture needles interposed between the needles at the end of one group, cams for operating each group of needles, narrowing and widening devices, devices for rendering one group of needles inactive during the narrowing and widening, and means for rendering that suture needle which is the last in its group inactive during the knitting of the first course of reciprocary knitting, substantially as described.

26. A circular knitting machine, having, in combination, a needle cylinder provided with substantially semicircular groups of long and short butt needles, a set of knitting cams arranged to actuate both the long and short butt needles to form stitches, a second set of knitting cams constructed and arranged to be brought into active relation with the butts of all the needles and to actuate them to form stitches, or into inactive relation to the butts of the short butt needles, and yarn feeding devices corresponding to each set of knitting cams, substantially as described.

27. A circular knitting machine, having, in combination, a needle cylinder provided with long and short butt needles, a set of knitting cams arranged to operate upon the butts of all the needles, a second set of knitting cams for actuating all the needles en-

gaged thereby to form stitches and including a switch cam mounted for movement into and out of the path of the butts of the short butt needles, and yarn feeding devices corresponding to each set of knitting cams, substantially as described.

28. A circular knitting machine, having, in combination, a needle cylinder, a set of knitting cams arranged to operate upon the needles during rotary knitting and during the narrowing and widening, narrowing and widening devices, a needle elevating cam for throwing the instep needles out of operation at the beginning of the narrowing and widening, a second set of knitting cams arranged to operate upon all the needles during rotary knitting, and means for throwing said second set of cams out of operation when the instep needles are rendered inactive, substantially as described.

29. A circular knitting machine, having, in combination, a needle cylinder provided with two substantially semicircular series of needles having long and short butts respectively, a set of knitting cams arranged to operate upon the butts of all the needles during rotary knitting, a second set of cams arranged to be brought into active relation with the butts of all the needles during rotary knitting, and out of active relation with the butts of the short butt needles during reciprocary knitting, substantially as described.

30. A circular knitting machine, having, in combination, a set of knitting cams arranged to operate upon the needles during rotary knitting and during the narrowing and widening, narrowing and widening devices, devices acting to automatically throw the needles not used during the narrowing and widening out of operation at the beginning of the narrowing and widening, a second set of knitting cams, and mechanism acting to automatically throw said second set of knitting cams out of operation during the narrowing and widening and into operation upon the return to rotary knitting, substantially as described.

In testimony whereof we affix our signatures, in presence of two witnesses.

LOUIS L. WILSON.
EXILIAS PAQUETTE.

Witnesses:

HORACE VAN EVEREN,
FARNUM F. DORSEY.