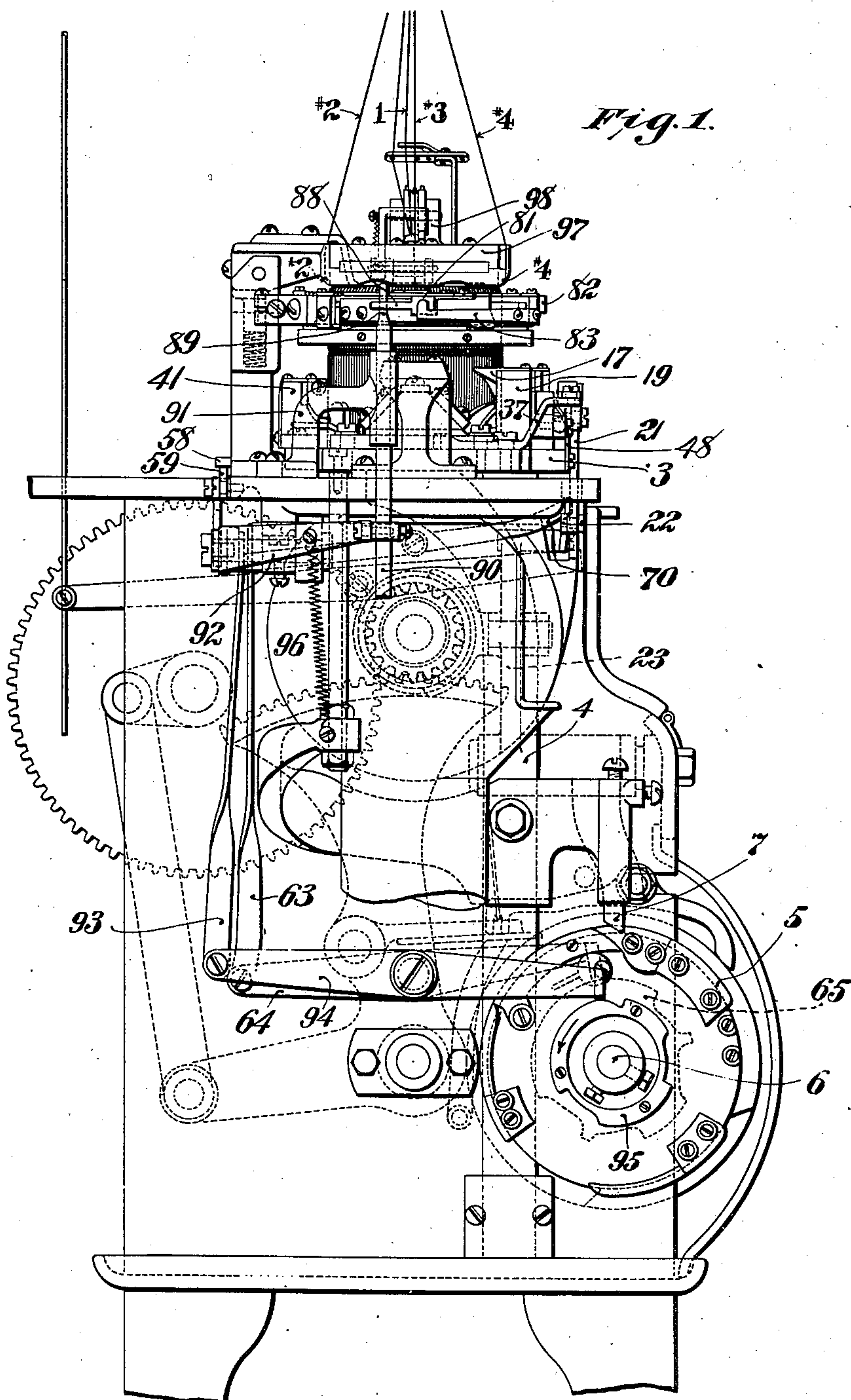


E. PAQUETTE.  
CIRCULAR KNITTING MACHINE.  
APPLICATION FILED MAR. 21, 1910.

999,853.

Patented Aug. 8, 1911.

6 SHEETS—SHEET 1.



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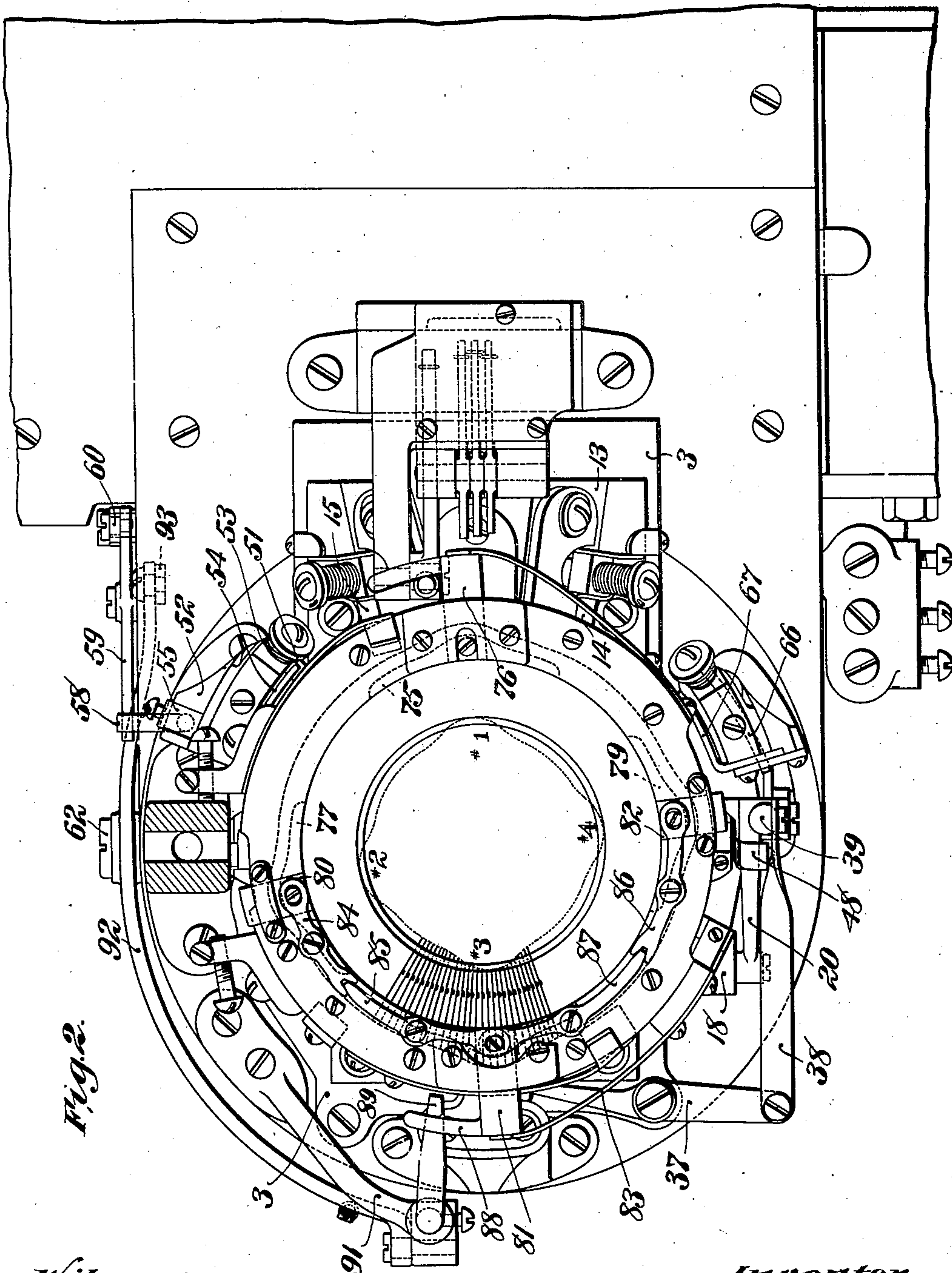
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6 SHEETS—SHEET 2.

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6 SHEETS—SHEET 3.

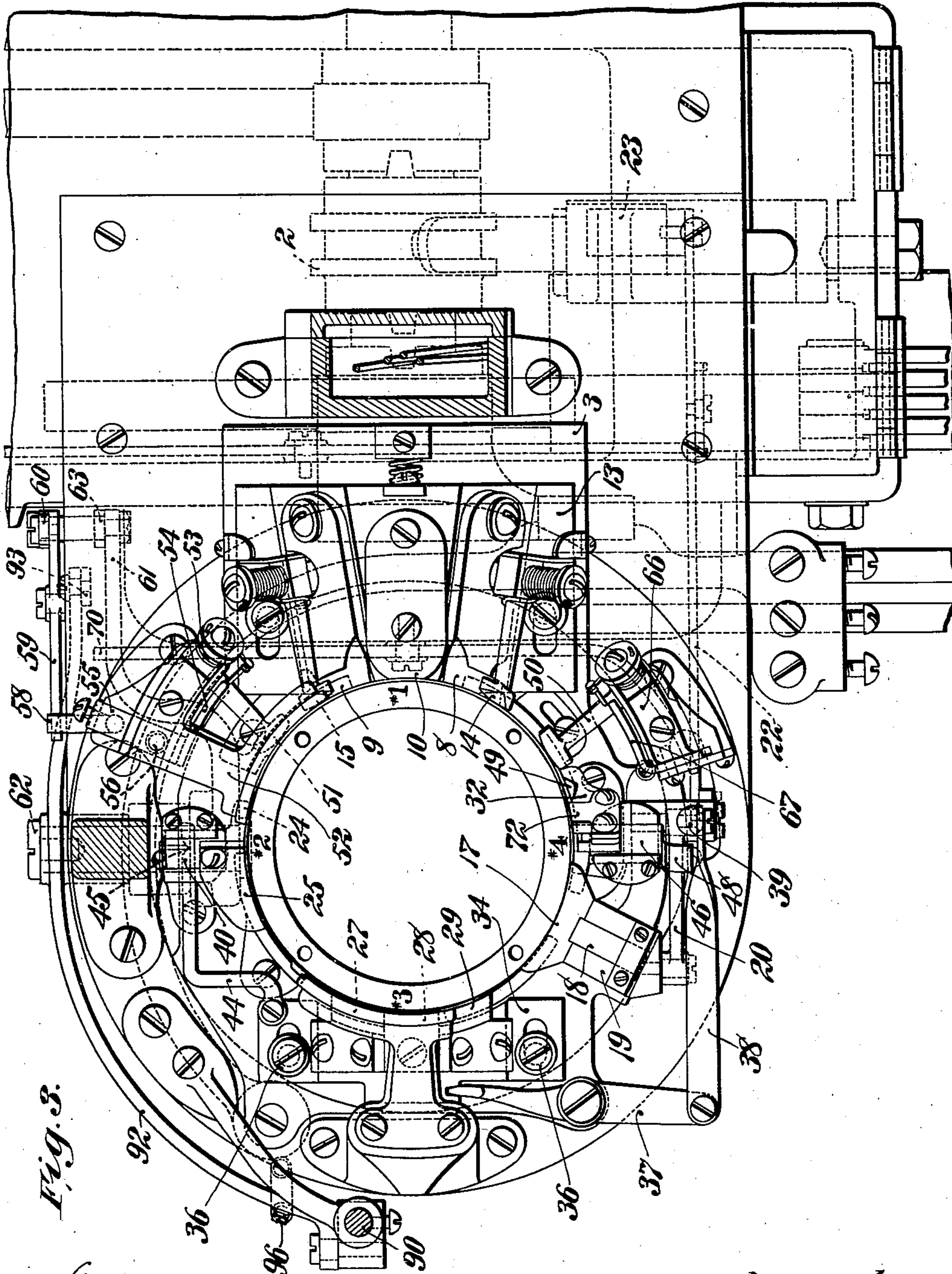


Fig. 3.

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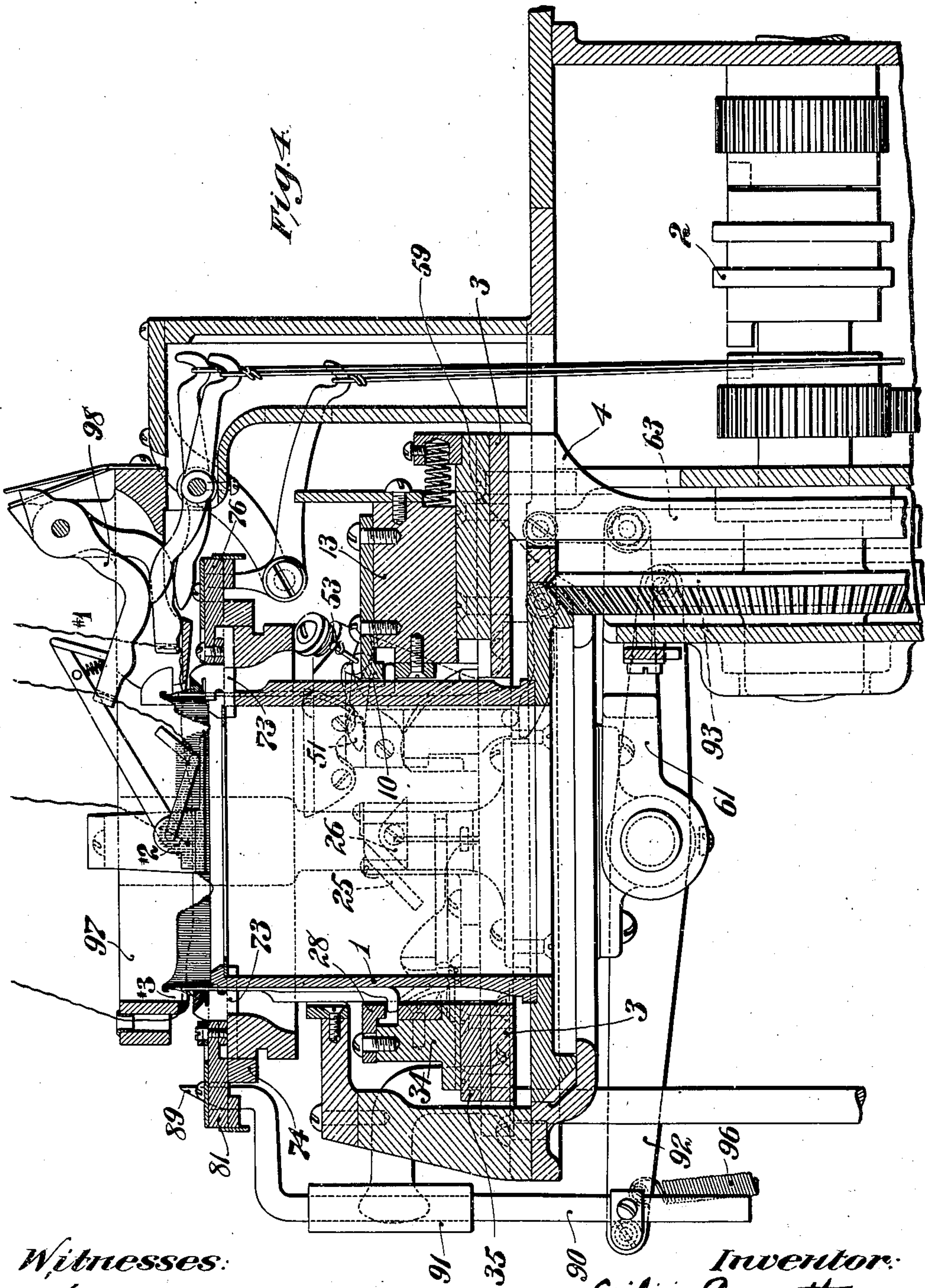


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6 SHEETS—SHEET 4.



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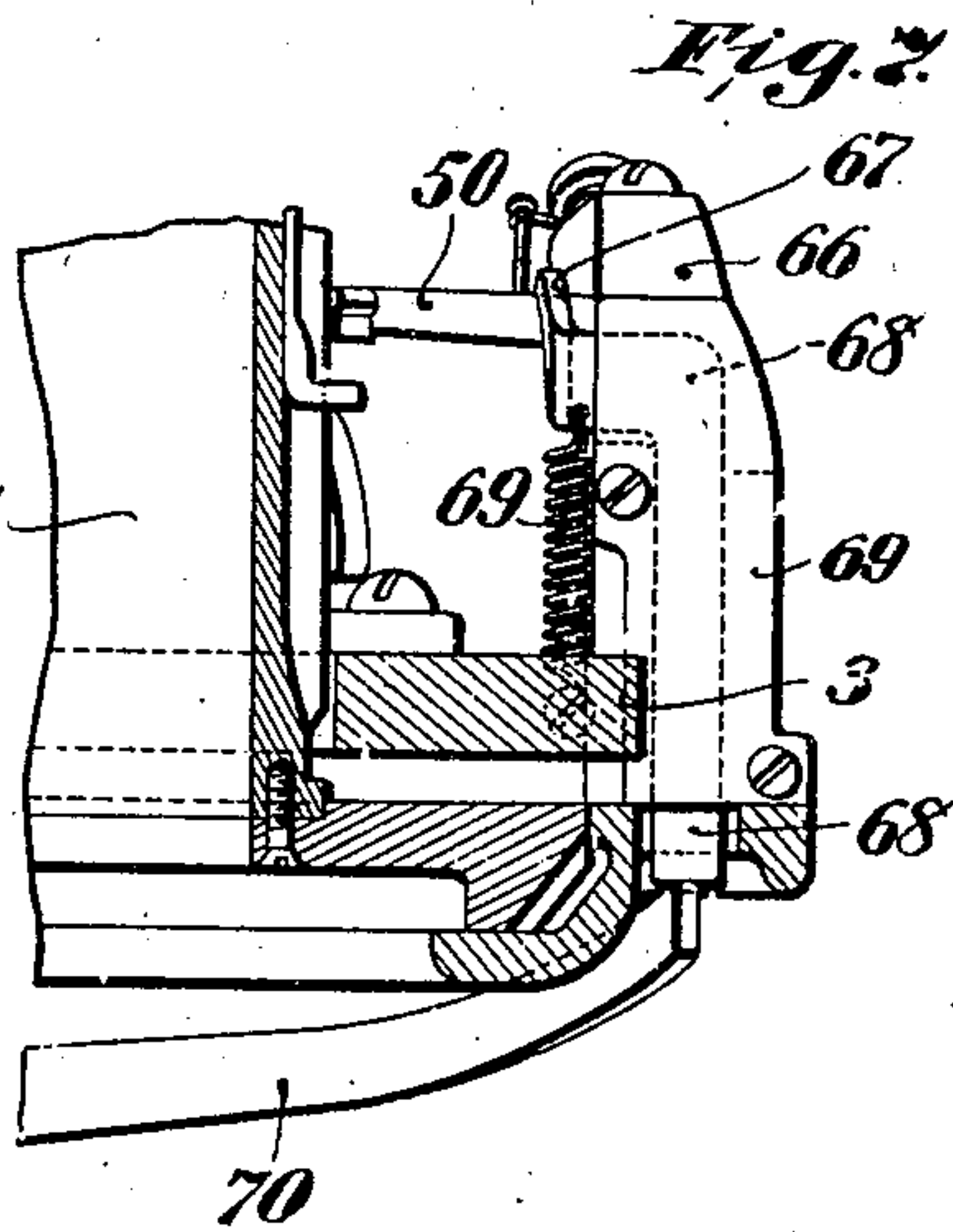
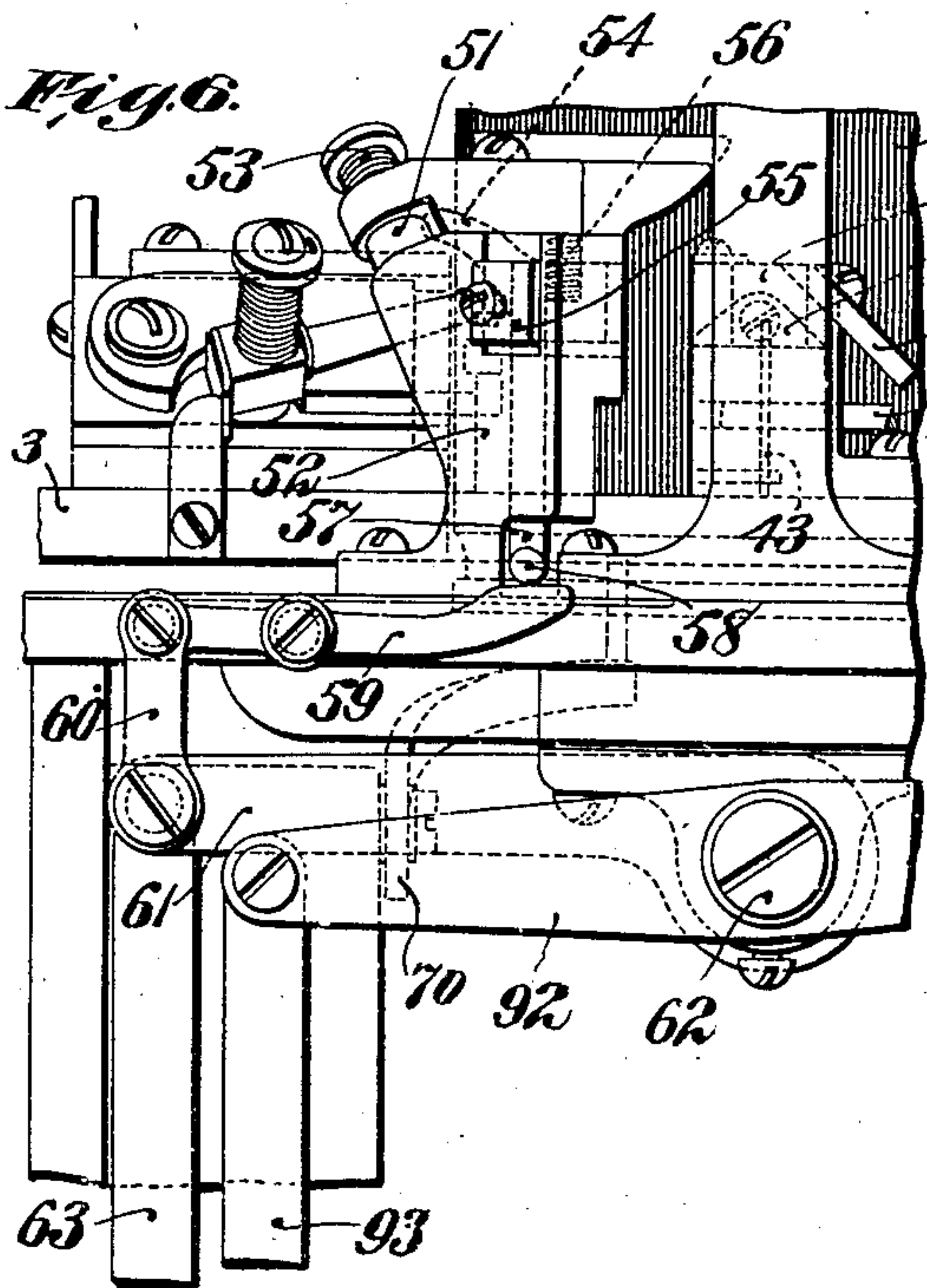
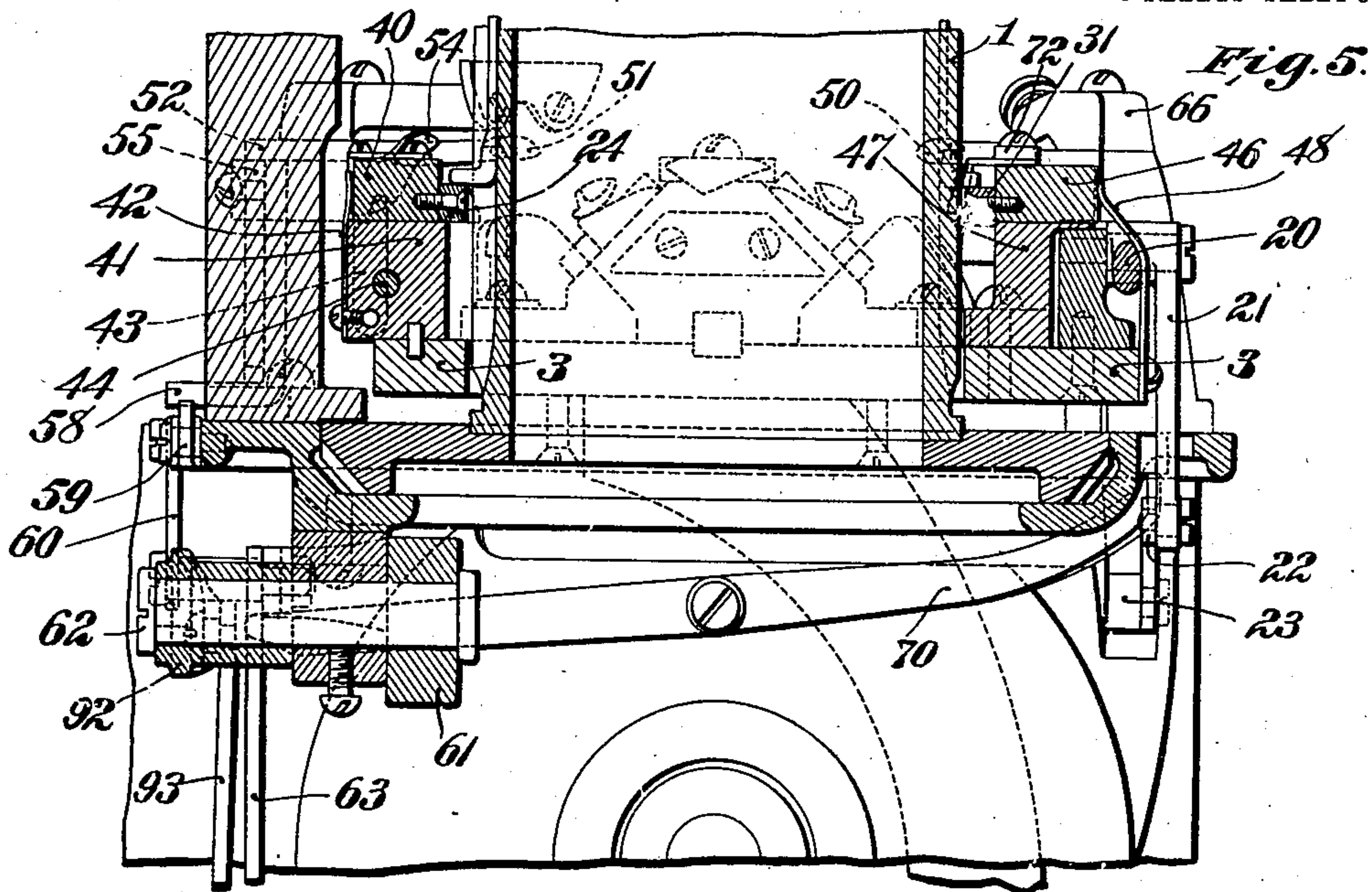
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6 SHEETS—SHEET 5.



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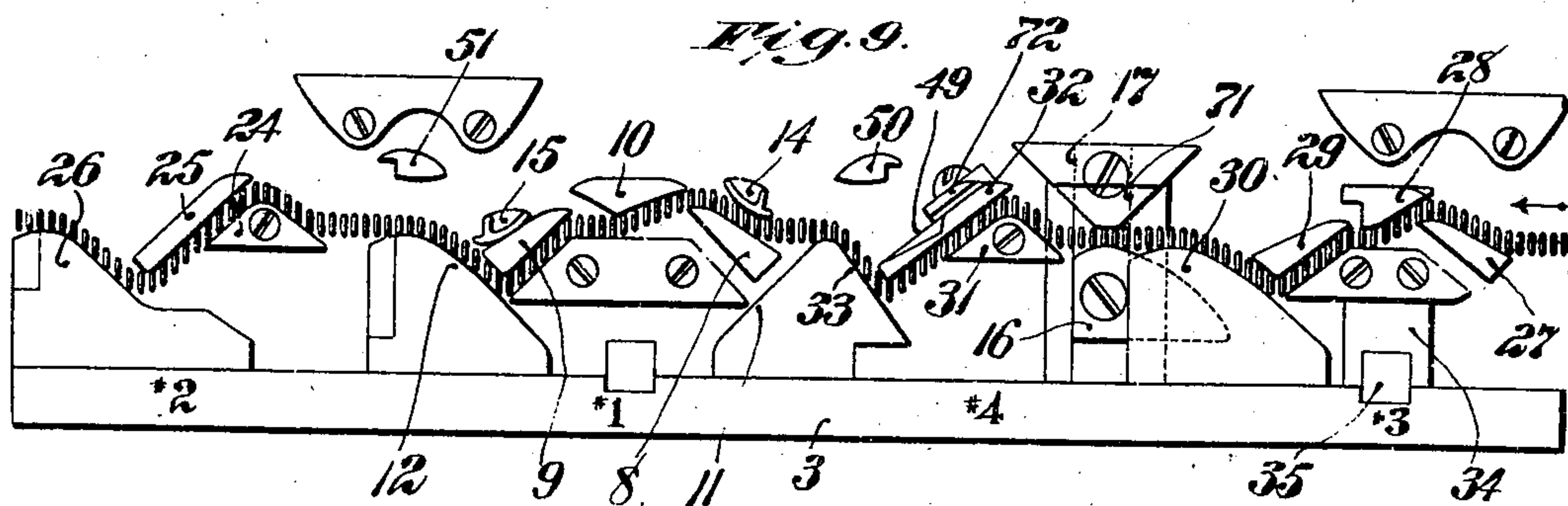
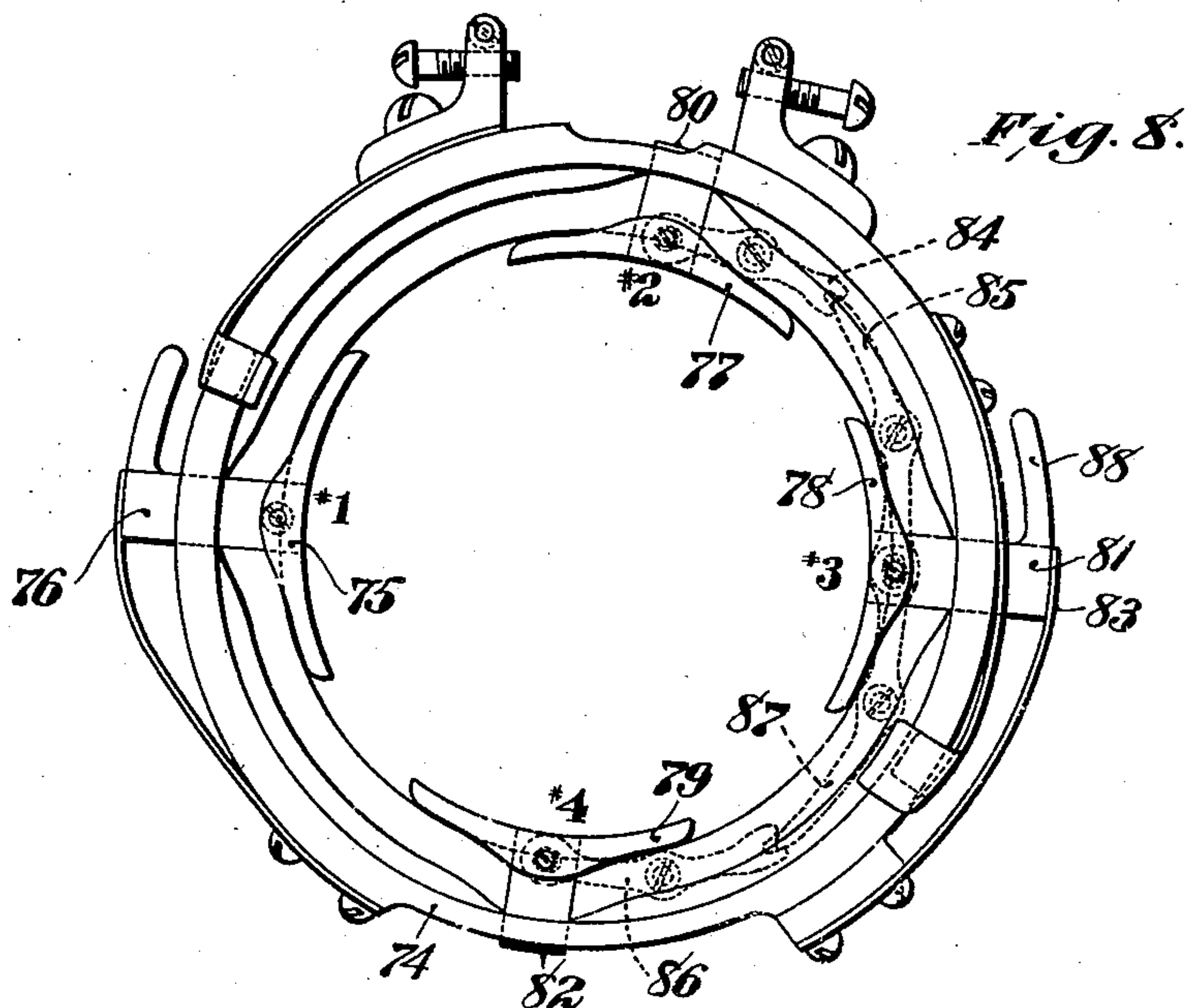
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APPLICATION FILED MAR. 21, 1910.

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6 SHEETS—SHEET 6.



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# UNITED STATES PATENT OFFICE.

EXILIAS PAQUETTE, OF LOWELL, MASSACHUSETTS, ASSIGNOR TO LAWRENCE MANUFACTURING COMPANY, OF LOWELL, MASSACHUSETTS, A CORPORATION OF MASSACHUSETTS.

## CIRCULAR-KNITTING MACHINE.

999,853.

Specification of Letters Patent.

Patented Aug. 8, 1911.

Application filed March 21, 1910. Serial No. 550,581.

*To all whom it may concern:*

Be it known that I, EXILIAS PAQUETTE, a citizen of the United States, residing at Lowell, in the county of Middlesex and State of Massachusetts, have invented certain new and useful Improvements in Circular-Knitting Machines; and I 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 circular knitting machines in which the needles are mounted in a needle cylinder and are operated upon by cams and controlling devices arranged about the cylinder, the relative movements between the needles and needle operating cams requisite for knitting a tubular fabric provided at intervals with heel and toe pockets being produced by rotary and reciprocatory movements of either the needle cylinder or the support or cylinder on which the needle operating cams and controlling devices are mounted.

The object of the invention is to provide a novel and improved construction and arrangement of the cams and devices for operating the needles and sinkers in this type of machine whereby a material increase in the production of the machine is secured.

The invention is intended primarily as an improvement on the machine shown and described in the patent to Hemphill, No. 933,443, patented September 7, 1909, and known as the "Banner" machine, although it will be understood that the invention is not limited in its application to this machine, and that the features of the invention may be embodied in other constructions and other forms of circular knitting machines for producing seamless hosiery.

The invention consists in the features and combinations hereinafter described and referred to in the claims, the advantages of which will be obvious to those skilled in the art.

The various features of the invention will be readily understood from an inspection of the accompanying drawings and the following detailed description of the machine illustrated therein.

In the drawings Figure 1 is a left-hand side elevation of a machine embodying the

various features of the invention in their preferred forms; Fig. 2 is a plan view of the machine, the latch ring and yarn feeding devices being removed for clearness; Fig. 3 is a plan view of the knitting head, the needle cylinder being removed; Fig. 4 is a vertical sectional view through the knitting head on a plane passing through the axis of the main driving shaft; Fig. 5 is a vertical sectional view through the knitting head on a plane at right angles to the plane of Fig. 4, and looking toward the right in Fig. 4; Fig. 6 is a detailed elevation showing the devices for controlling one of the widening cams; Fig. 7 is a sectional elevation showing the devices for controlling the other widening cam; Fig. 8 is a bottom view of the sinker cam ring; and Fig. 9 is a view showing an interior development of the cams and needle operating devices in position for rotary knitting.

In the drawings the invention is illustrated as embodied in a machine having many of its parts constructed and arranged, and operating in substantially the same manner as the corresponding parts in the Banner machine above referred to. The motion changing mechanism, the pattern mechanism for controlling the movements of the shaft carrying the controlling cams, and the yarn changing mechanism, are substantially the same as in the Banner machine. In addition to the knitting cams corresponding to the knitting cams of the Banner machine, which may for convenience be termed the main knitting cams, the machine illustrated in the drawings is also provided with three additional sets of knitting cams which may for convenience be termed supplemental knitting cams. The machine is also provided with three additional or supplemental thread guides through which yarns are fed to the knitting waves formed in the needles by the respective sets of supplemental knitting cams, so that during each revolution of the needle cylinder four circular courses of loops are formed, with a corresponding increase in the rapidity with which the leg or leg and foot of the stocking is knit. The supplemental knitting cams are thrown out of action at the beginning of the heel or toe, so that the main knitting cams are the only active knitting



cams during the knitting of the heel and toe. It is not essential that the machine should be provided with all three of the additional or supplemental feeds and knitting cams, and any one or any two of the feeds and sets of knitting cams may be omitted, so far as certain features of the invention are concerned.

The needles which are not used during the knitting of the heel and toe, and which may for convenience be termed the instep needles, are provided with the usual long butts, while the needles which are operated during reciprocatory knitting to knit the heel and toe, are provided with the usual short butts. The needles are carried in the needle cylinder 1 to which rotary and reciprocatory movements are imparted through the motion changing mechanism 2, like that of the patent above referred to, and connected with the needle cylinder through similar gearing.

The knitting cams are carried upon a plate 3 which is secured upon the upper end of a sliding bar 4, the vertical position of the plate being controlled by cams 5 carried on a cam shaft 6 and engaged by pins 7 secured in the lower end of the bar. The cam shaft 6 corresponds to the cam shaft of the Banner machine, and carries the various cams for controlling the movements of the needle cylinder and for controlling the cams and pickers which operate upon the needles. This cam shaft is intermittently operated through a pattern chain and actuating devices such as used in the Banner machine or in various other circular knitting machines.

The cam carrying plate 3 carries the main and supplemental knitting cams, and also the needle elevating and depressing cams which operate to throw the long butt or instep needles out of operation at the beginning of the narrowing and widening, and to return all the needles which are in the inactive series into operation at the end of the narrowing and widening. The main knitting cams which operate upon all the needles during rotary knitting, and upon the short butt needles during reciprocatory knitting, correspond in construction and arrangement to the knitting cams of the Banner machine. These cams comprise two stitch cams 8 and 9, a center switch cam 10, and two elevating cams 11 and 12. The elevating cams, which return the needles to normal position after they have been drawn down by the stitch cams, do not raise the needles high enough to carry the latches out of the loops on the needles. The knitting cams are therefore also provided with needle elevating or raising cams for raising the needles to draw the latches from the loops on the needles immediately before the yarn is fed to the needles and the needles are drawn down by the stitch cams. The upper sides of the stitch cams 8 and 9 form the needle elevating cams of the main knitting cams. The main knit-

ting cams are secured upon a block 13 which also carries the lifting pickers 14 and 15. These lifting pickers are constructed to lift a single needle, and correspond in construction and operation to the lifting pickers of the Banner machine.

The needle elevating and depressing cams for raising the long butt or instep needles to the inactive plane at the beginning of the heel or toe, and for directing all the needles in the inactive plane down into the active plane at the completion of the heel or toe, correspond in construction and arrangement to the needle elevating and depressing cams of the Banner machine. As shown, the needle elevating cam 16 and the needle depressing cam 17 are secured to a vertically movable slide 18 mounted in a standard 19 which is secured to the plate 3. The cam carrying slide 18 is moved vertically at proper intervals through a bell crank lever having a horizontal arm 20 connected with the slide 18, and a vertical arm 21, the lower end of which is connected by a link 22 with the clutch shifting lever 23 of the motion changing mechanism (Fig. 3). When the clutch is shifted to change the motion of the needle cylinder from rotary to reciprocating, the bell crank lever is moved to raise the slide 18, thus lifting the cam 16 into position to engage the long butt needles and direct them up into the inactive plane. When the motion changing clutch is shifted to change the motion of the needle cylinder back to rotary, the slide 18 is depressed, thus moving the needle depressing cam 17 into position to engage and direct the needles which are in the upper or inactive series down into the active series.

In addition to the main knitting cams, the plate 3 carries three additional sets of knitting cams, which are arranged to operate upon all the needles during rotary knitting, and are rendered inactive upon the short butt needles during the knitting of the heel and toe. For convenience I will refer to the set of main knitting cams as cams No. 1, and to the sets of additional or supplemental knitting cams as cams No. 2, No. 3, and No. 4 respectively. The same notation will be used in referring to the yarns fed to the different sets of cams, and to the sinker cams corresponding thereto. The set of supplemental knitting cams next in advance of the main knitting cams are designated No. 2, and comprise a needle elevating cam 24 for elevating the needles to draw the latches from the loops on the needles, a stitch cam 25, and a needle elevating cam 26. The supplemental knitting cams in advance of the cams No. 2 are designated No. 3, and comprise a needle elevating cam 27, stitch cams 28 and 29, and a needle elevating cam 30. The fourth set of knitting cams are indicated at No. 4, and comprise a



needle elevating cam 31, a stitch cam 32, and a needle elevating cam 33. Cams No. 2 and No. 3 are arranged to follow the main knitting cams and precede in the direction of the relative travel of the needles the cam 16 which raises the long butt needles into the inactive plane at the beginning of the heel or toe, while cams No. 4 are arranged to follow the needle elevating cam 16 and between it and the main knitting cams. The needle elevating cam 16 acts to raise the long butt needles during the last forward or rotary stroke of the needle cylinder in going upon the heel or toe. At the time the cam 16 is raised into active position, the knitting cams No. 2 and No. 3 are acting upon the long butt needles, and at this time they are rendered inactive upon the short butt needles by moving cams 24 and 25 and cams 27, 28 and 29 radially outward so that they will not engage the short butt needles, but will continue to engage the long butt needles. During the last rotary stroke of the needle cylinder, therefore, the cams No. 2 and No. 3 will continue to operate the long butt needles, but will not operate the short butt needles. During this stroke of the needle cylinder, therefore, yarns No. 2 and No. 3 will knit on the long butt needles, and will knit last upon the needle at the rear end of the series of long butt needles. During the knitting of the heel and toe, yarns No. 2 and No. 3 will lead from the rear long butt needle, and will wrap idly about the needles as the needle cylinder reciprocates. The cams No. 4 are arranged to follow the needle elevating cam 16, and when this cam is raised to act upon the long butt needles, cams No. 4 are acting upon the short butt needles. These cams therefore should not be rendered inactive upon the short butt needles at the time that the cam 16 is raised, but should continue to operate the short butt needles until the entire series of short butt needles has been operated upon, and should thereafter be rendered inactive upon the short butt needles. The knitting cams No. 4 are accordingly rendered inactive upon the short butt needles during the first reverse stroke of the needle cylinder. Yarn No. 4 therefore knits upon the short butt needles during the last rotary stroke of the needle cylinder in going upon the heel and toe, and knits last upon the needle at the rear end of the series of short butt needles, the long butt needles during this stroke having been raised into the inactive plane by the cam 16 before they reach the knitting cams No. 4. During the knitting of the heel and toe, therefore, the yarn No. 4 leads from the last short butt needle and wraps idly about the needles as the needle cylinder reciprocates.

The cams 27, 28 and 29 of knitting cams No. 3, and the cams 24 and 25 of knitting

cams No. 2, are moved radially into and out of position to operate upon the short butt needles by devices connecting them with the mechanism which raises and lowers the needle elevating cam 16. The cams 27, 28 and 29 are secured upon a block 34 which is guided upon a radially extending rib 35 secured to the plate 3, and is retained upon the plate by screws 36 passing through slots in the block. The block 34 is engaged by one end of a lever 37, the other end of which is connected by a link 38 with an arm 39 projecting upward from the bell crank lever which raises and lowers the cam 16. The cams 24 and 25 of knitting cams No. 2 are secured upon a block 40 which is mounted to slide radially in a groove formed in the upper end of a support 41 which is secured to the plate 3 (Figs. 3, 4, 5 and 6). The block 40 is forced yieldingly forward into position so that the cams 24 and 25 will engage both the long and short butt needles by a leaf spring 42 (Fig. 5). A lever 43 is pivotally supported in a vertical slot in the support 3, and its upper end engages the cam carrying block 40. A rod 44 is mounted to slide through the support 41, and is provided on its front face with a V-shaped notch 45 which is normally engaged by the lever 43 (Fig. 3). The rod 44 is connected to the slide 34 which carries the cams 27, 28 and 29 of the knitting cams No. 3. Through the connecting devices described the blocks 34 and 40 are moved radially outward when the needle elevating cam 16 is raised in going on to the heel and toe, and are moved radially inward when the cams 16 and 17 are lowered in passing from the heel or toe on to the foot or leg.

The cams 31 and 32 of the knitting cams No. 4 are secured upon a block 46 mounted to slide radially in a guiding slot formed in the upper end of a support 47 which is secured to the plate 3 (Figs. 3 and 5). During rotary knitting the block 46 is held in advanced position with the cams 31 and 32 in position to act upon the long and short butt needles by a leaf spring 48, the lower end of which is secured to the plate 3. The spring extends up outside of the arm 20 of the bell crank lever which raises and lowers the needle elevating and depressing cams 16 and 17, and bears against the outer end of the block 46. When the bell crank lever is operated to raise the needle elevating cams 16 in going on to the heel or toe, the arm 20 of the bell crank lever forces the spring 48 outward so that the block 46 is free to slide radially outward. During the first reverse stroke of the needle cylinder on the heel or toe, the butt of the needle at the end of the series of short butt needles strikes against a cam surface 49 on the cam 32, and forces the cam and block 46 radially outward, so that the short butt needles pass idly by in



front of these cams. When the bell crank lever is operated to move the cams 16 and 17 downward at the completion of the heel or toe, the arm 20 releases the spring 48 so that it bears against the end of the block 46 and tends to force the block radially inward. At this time the short butt needles are passing the cams 31 and 32, and the cams therefore ride along the ends of the butts until the short butt needles have passed, when the block 46 moves forward to bring the cams 31 and 32 into position to engage the short butt needles. The long butt needles which are directed down into the active plane by the cam 17 pass under the stitch cam 32 while the cam is still riding on the ends of the short butts, so that on the first rotary stroke of the needle cylinder in coming off of the heel and toe, the yarn No. 4 which during reciprocatory knitting has led from the last short butt needle, begins to knit upon the adjacent long butt needle at the front end of the series of long butt needles.

The needle depressing pickers 50 and 51 are constructed to engage two adjacent needles in the inactive series, and transfer them to the active series. These pickers are similar in construction and mode of operation to the depressing pickers of the Banner machine. The addition of the knitting cams No. 2 to the machine, however, necessitates a change in the position of the depressing picker 51, which acts during the reverse stroke of the needle cylinder, and the addition of the knitting cams No. 4 necessitates a change in the position of the picker 50, which acts during the advance stroke of the needle cylinder. If either or both of these sets of knitting cams are omitted, one or both of the pickers may be arranged as in the Banner machine. The change in the position of the widening pickers is necessary for the reason that the yarns No. 2 and No. 4 lead from the rear long butt needle and rear short butt needle respectively during the knitting of the heel and toe, and wrap around the other needles as the needles from which the yarns lead travel away from the thread eyes Nos. 2 and 4. It is necessary, therefore, that the picker 51 be arranged between the cams No. 2 and the main cams No. 1, and that the picker 50 be arranged between the cams No. 4 and main cams No. 1, in order that the latches of the needles depressed by the pickers may not engage the yarn No. 2 and yarn No. 4 which is wrapped idly about the needles, and thus interfere with the proper operation of the machine.

As shown, the picker 51 is mounted upon a support 52 secured to the base plate of the machine, and is forced yieldingly into position to engage the needles at the end of the inactive series by a coiled spring 53 (Figs. 3 and 6). The movement of the picker into and out of active position is effected by an

arm 54 carried by a block 55 which is guided in a vertical slot in the upper end of the support 52. The block 55 is forced downward or in a direction to hold the picker out of active position, by a spring 56. The block 55 is secured upon the upper end of a rod 57 which extends down through the support 52, and is provided with an offset lower end 58 which overlies one end of an operating lever 59. The other end of the lever 59 is connected by a link 60 with a lever 61 which is pivotally supported upon a stud 62. The lever 61 is connected by a link 63 with the rear end of a lever 64, the front end of which is arranged to engage and be operated by a picker controlling cam 65 on the cam shaft 6. The cam 65 corresponds substantially to the cam which controls the depressing pickers in the Banner machine. Through the connections described the cam 65 moves the controller arm 50 to throw the depressing picker 51 into and out of active position at proper intervals.

The depressing picker 50 is mounted in a support 66 which is secured to the base plate of the machine. The movement of the picker into and out of active position is controlled by an arm 67 projecting from a slide 68 which is mounted to move vertically in a guideway formed in the support 66 (Figs. 3 and 7). The slide 68 is moved in a direction to throw the picker out of active position by a spring 69. The slide is moved vertically against the tension of the spring 69 by a lever 70, one end of which engages the lower end of the slide 68, and the other end of which underlies the lever 61 (Figs. 5, 6 and 7). Through this lever the picker 50 is thrown into and out of action in unison with the picker 51.

In the Banner machine the change from reciprocating knitting to rotary knitting in passing from the heel or toe is made after the picker corresponding to picker 51 has depressed a short butt needle and the adjacent long butt needle at the end of the inactive series of needles. On the last reverse stroke of the needle cylinder, therefore, a long butt needle passes through the knitting cams and is operated to knit the yarn corresponding to yarn No. 1 into the fabric. This needle is elevated on the advance stroke of the cylinder (*i. e.* the first rotary revolution) by the elevating picker 14, so that it is not operated to knit until it is depressed by the cam which depresses all the inactive needles into the active series. The long butt needle which is thus actuated in the Banner machine is the needle corresponding to the long butt needle from which the yarns No. 2 and No. 3 lead in the present machine, and it is important to the successful operation of the machine that this long butt needle should not knit during the last reverse stroke of the needle cylinder. In the pres-



ent machine, therefore, the change from reciprocating to rotary knitting is effected after the picker 51 has depressed the two short butt needles adjacent to the long butt needles. These two short butt needles are operated by the main cams No. 1 to knit yarn No. 1 into the fabric during the last reverse stroke of the needle cylinder, and the short butt needle adjacent to the long butt needle is lifted by the picker 14 so that it is not operated by the cams No. 1, cams No. 2, or cams No. 3 during the first rotary revolution of the needle cylinder in passing from the heel or toe. In passing from the heel or toe, therefore, the cams No. 2 and cams No. 3 begin to operate upon the second short butt needle, and knitting is resumed with the No. 2 and No. 3 yarns upon the second short butt needle, instead of upon the needle which is adjacent to the long butt needle which was the last to knit the No. 2 and No. 3 yarn in going on to the heel or toe. This results in an improved fabric at this point in the stocking since the No. 2 and No. 3 yarns lie across a hole which would otherwise appear at this point in the fabric. The changing of the motion of the needle cylinder from reciprocating to rotary in the manner just described results in leaving three short butt needles at that end of the inactive series of needles which is acted upon by the depressing picker 50, which will be engaged and depressed by the needle depressing cam 17 during the first rotary revolution of the needle cylinder. These three short butt needles will be the three needles which are at the rear end of the series of short butt needles during rotary knitting. The presence of these short butt needles in the inactive series necessitates a change in the construction of the depressing cam 17 when knitting cams No. 4 are added to the machine. If these short butt needles were fully depressed into the active series by the cam 17, their latches would engage yarn No. 4, which at this time leads from the last short butt needle to the thread eye No. 4. The latches would be swung outward by engagement with the yarn No. 4, so that yarn No. 4 would loop about the latches as the needles pass thread eye No. 4, and would not be properly fed to the long butt needles upon which the cams 31 and 32 resume operation in passing from the heel and toe. The cam 17 is therefore cut away at 71, so that the short butt needles referred to are only partially depressed by the cam, the downward movement of the needles being insufficient to bring their latches into engagement with the yarn No. 4. In order that these three short butt needles may be depressed into the active series after they have passed the thread eye No. 4, a depressing cam 72 is secured upon the stitch cam 32 in such posi-

tion that it projects into the path of the butts of these needles while the cam 32 is riding upon the ends of the short butts. The cam 72 completes the depression of the three short butt needles above referred to, so that they are directed down into the active series at the rear end of the series of short butt needles without interfering with the proper feed of yarn No. 4. The long butt needles immediately following the short butt needles referred to are depressed into the active series by the cam 71, and pass through the knitting cams No. 4, so that knitting is resumed with yarn No. 4 upon the long butt needles adjacent to the rear short butt needle which was the last needle to knit with yarn No. 4 in going upon the heel or toe.

The web holding sinkers 73 are of usual construction, and are operated by cams carried on a sinker cam ring 74 which is mounted and operated in the same manner as the sinker cam ring of the Banner machine above referred to. The sinkers are withdrawn at the knitting point of the main knitting cams No. 1 by a sinker cam 75 secured upon a slide 76 which may be moved radially to render the sinker cam active or inactive in starting the machine, as fully described in the Hemphill patent above referred to. In addition to the sinker cam 75, the sinker cam ring is also provided with sinker cams 77, 78 and 79 for withdrawing the sinkers at the knitting points of knitting cams No. 2, No. 3 and No. 4 respectively. It is desirable that the sinkers should remain in advanced position during the knitting of the heel or toe, except at the point where yarn No. 1 is being knit into the fabric. This is desirable in order that the fabric may not slip up on the needles at the points where the sinkers might be withdrawn and pass above the sinkers so that the latches of the needles would not lift out of the loops on the needles when the needles are raised by the lifting cams just in advance of the knitting point. In order that the loops of the fabric may be held down upon the needles, except at the knitting point, during the knitting of the heel and toe, the sinker cams 77, 78 and 79 are so mounted in the sinker cam ring that they may be moved radially to throw them into and out of action, and are moved radially inward at the beginning of the heel and toe so that they are inactive upon the sinkers during the knitting of the heel and toe. As shown, the cams 77, 78 and 79 are secured upon slides 80, 81 and 82 respectively, which are mounted to move radially in the sinker cam ring. The slide 81 is forced radially inward by a spring 83, and the slides 80 and 82 are so connected with the slide 81 that all three slides move in unison. As shown, the slide 80 is connected



to one end of a lever 84, the other end of which is engaged by a lever 85 connected with the slide 81. The slide 82 is connected to one end of a lever 86, the other end of which is engaged by a lever 87 connected with the slide 81, as indicated in Fig. 8. The outer end of the slide 81 is provided with a circumferentially extending finger 88 by which the sinker cams are moved radially outward to render them active upon the sinkers at the completion of the heel or toe. The means for thus actuating the sinker cams comprises a wedge-shaped finger 89 arranged to pass between the finger 88 and the periphery of the sinker cam ring, as indicated in Figs. 2 and 4. The finger 89 is formed at the upper end of a rod 90 which slides vertically in a bearing 91 formed on a bracket which is secured to the bed plate of the machine. The lower end of the rod 90 is connected to one end of a lever 92, the other end of which is connected by a link 93 with the rear end of a lever 94 (Figs. 1, 2, 4 and 6). The front end of the lever 94 is arranged to bear upon a cam 95 secured to the cam shaft 6, and shaped to raise and lower the actuating finger 89 at the proper time. The lever 92 is forced in a direction to lower the finger 89 by a spring 96 (Fig. 4). During rotary knitting the end of the lever 94 rides upon one of the high parts of the cam 95 on the shaft 6, and the actuating finger 89 is raised to hold the sinker cams 77, 78 and 79 in retracted position so that they will withdraw the sinkers at the knitting points for yarns Nos. 2, 3 and 4. In going on to the heel or toe, the end of the lever 94 passes into one of the depressions in the cam 95, so that the finger 89 is lowered to allow the sinker cams to move radially inward so that they will not act to withdraw the sinkers. The sinker cams are thus moved after the knitting cams No. 2, No. 3 and No. 4 have ceased to actuate the needles to knit the yarns No. 2, No. 3 and No. 4 into the fabric. At the completion of the heel or toe, the end of the lever 94 again rides on to one of the high parts of the cam 95, retracting the sinker cams so that they withdraw the sinkers at the knitting points before the knitting cams resume action upon the needles.

The machine is provided with a latch guard 97 similar to the latch guard of the Banner machine, and is also provided with thread guides 98 for changing the yarn No. 1 and for feeding in a supplemental yarn to the knitting cams No. 1 which are constructed and actuated in the same manner as the corresponding thread guiding arms of the Banner machine. The latch guard is also provided with thread guiding eyes No. 2, No. 3 and No. 4 for feeding yarn to the knitting waves formed by the knitting cams No. 2, No. 3 and No. 4 respectively.

The yarns No. 1, No. 2, No. 3 and No. 4 are led through spring takeups (not shown) which operate in the usual manner to keep the yarns taut during the knitting of the heel and toe.

While it is preferred to embody the invention in a knitting machine in which the relative rotary and reciprocatory movements are secured by rotating and reciprocating the needle cylinder, since this construction is better adapted for feeding a plurality of yarns to the needles, it will be understood that in its broader aspects the invention is not limited to this construction of machine, but includes machines in which the relative rotary and reciprocatory movements are secured by movement of either the needle cylinder or the cam carrier or cylinder. It will also be understood that it is not essential that all of the yarn feeds and sets of knitting cams be employed in a machine embodying certain features of the invention, although the production of the machine will be increased by employing the four sets of cams shown and described. It will also be understood that it is not essential to certain features of the invention that the machine in which these features are embodied be constructed to produce the foot of the stocking by rotary knitting, and that such features of the invention may be embodied in machines in which the foot of the stocking is otherwise formed.

Having explained the nature and object of the invention, and specifically described one machine in which it may be embodied, what I claim is:—

1. A circular knitting machine, having, in combination, a needle cylinder provided with long and short butt needles, narrowing and widening devices, a needle elevating cam for raising the long butt needles at the beginning of the narrowing and widening, main knitting cams, two sets of supplemental knitting cams arranged to operate on all the needles during rotary knitting, and means for rendering said supplemental cams inactive upon the short butt needles while they are acting upon the long butt needles during the last course of rotary knitting, substantially as described.

2. A circular knitting machine, having, in combination, a needle cylinder provided with long and short butt needles, narrowing and widening devices, a needle elevating cam for raising the long butt needles at the beginning of the narrowing and widening, main knitting cams, two sets of supplemental knitting cams arranged to operate on all the needles during rotary knitting, mechanism for rendering one set inactive upon the short butt needles while they are acting upon the long butt needles during the last course of rotary knitting, and for rendering the other set inactive upon the



short butt needles after they have operated said needles during the last rotary course, substantially as described.

3. A circular knitting machine, having, in combination, a needle cylinder provided with long and short butt needles, narrowing and widening devices, a needle elevating cam for raising the long butt needles at the beginning of the narrowing and widening, main knitting cams, three sets of supplemental knitting cams arranged to operate on all the needles during rotary knitting, mechanism for rendering two sets inactive upon the short butt needles while they are acting upon the long butt needles during the last course of rotary knitting, and for rendering the other set inactive upon the short butt needles after they have operated said needles during said last rotary course, substantially as described.

4. A circular knitting machine, having, in combination, a needle cylinder provided with long and short butt needles, narrowing and widening devices, a needle elevating cam for raising the long butt needles at the beginning of the narrowing and widening, main knitting cams, a set of supplemental knitting cams arranged to operate on all the needles during rotary knitting, and mechanism for rendering said set of cams inactive upon the short butt needles after they have operated said needles to knit during the last course of rotary knitting, substantially as described.

5. A circular knitting machine, having, in combination, a needle cylinder, main knitting cams, narrowing and widening devices, devices for throwing the instep needles out of operation at the beginning of the narrowing and widening, two sets of supplemental knitting cams arranged to operate upon all the needles during rotary knitting, and means for causing said cams to operate only upon the instep needles during the last course of rotary knitting and to become inactive during the narrowing and widening upon the needles which are in operation during the narrowing and widening, substantially as described.

6. A circular knitting machine, having, in combination, a needle cylinder, main knitting cams, narrowing and widening devices, devices for throwing the instep needles out of operation at the beginning of the narrowing and widening, two sets of supplemental knitting cams arranged to operate upon all the needles during rotary knitting, and means for causing one set to act only upon the instep needles and the other set only upon the remaining needles during the last course of rotary knitting and for causing both sets to become inactive during the narrowing and widening upon the needles which are in operation during the narrowing and widening, substantially as described.

7. A circular knitting machine, having, in combination, a needle cylinder provided with semi-circular series of long and short butt needles, main knitting cams, means for rendering the long butt needles inactive at the beginning of reciprocatory knitting, a set of supplemental knitting cams arranged to operate upon all the needles during rotary knitting, and means operating during the first reverse stroke of reciprocatory knitting to throw said cams out of operation and means for relatively rotating and reciprocating the needle cylinder and knitting cams, substantially as described.

8. A circular knitting machine, having, in combination, a needle cylinder provided with long and short butt needles, main knitting cams, means for narrowing and widening, a needle elevating cam for raising the long butt needles at the beginning of the narrowing and widening, a set of supplemental knitting cams arranged to follow the needle elevating cam and between it and the main knitting cams, means for rendering the supplemental knitting cams inactive after they have operated the short butt needles to knit during the last course of rotary knitting, and means for throwing said cams into operation at the rear of the short butt needles during the first rotary course after the narrowing and widening, substantially as described.

9. A circular knitting machine, having, in combination, a needle cylinder provided with long and short butt needles, main knitting cams, means for narrowing and widening, a needle elevating cam for raising the long butt needles at the beginning of the narrowing and widening, a set of supplemental knitting cams arranged to follow the needle elevating cam and between it and the main knitting cams, means operated by the short butt needles on the first reverse stroke of reciprocatory knitting for rendering said supplemental cams inactive upon the short butt needles, and means for yieldingly forcing the cams forward into active position during the first rotary course at the end of the narrowing and widening, substantially as described.

10. A circular knitting machine, having, in combination, a needle cylinder provided with long and short butt needles, main knitting cams, two sets of supplemental knitting cams arranged to act upon all the needles during rotary knitting, elevating pickers, a needle elevating cam for raising the long butt needles at the beginning of the narrowing and widening arranged to follow said supplemental cams and between them and the main knitting cams, depressing pickers arranged on opposite sides of the main knitting cams and between them and the supplemental knitting cams, and means for throwing the supplemental cams out of operation



upon the short butt needles when the needle elevating cam is thrown into operation upon the long butt needles, substantially as described.

5 11. A circular knitting machine, having, in combination, a needle cylinder provided with long and short butt needles, main knitting cams, elevating pickers, a needle elevating cam for raising the long butt needles  
10 at the beginning of the narrowing and widening, two sets of supplemental knitting cams arranged on opposite sides of the needle elevating cam, depressing pickers arranged on opposite sides of the main knitting  
15 cams and between them and the supplemental knitting cams, means for throwing the supplemental knitting cams which are in advance of the needle elevating cam out of operation upon the short butt needles  
20 when the needle elevating cam is thrown into operation upon the long butt needles, and means for throwing the other set of supplemental knitting cams out of operation upon the short butt needles after they have  
25 operated the short butt needles to knit during the last course of rotary knitting, substantially as described.

12. A circular knitting machine, having, in combination, a needle cylinder provided  
30 with long and short butt needles, main knitting cams, a needle elevating cam for raising the long butt needles at the beginning of the narrowing and widening, elevating pickers constructed to engage a single needle, depressing pickers arranged to engage  
35 two needles, a set of supplemental knitting cams arranged to operate upon all the needles during rotary knitting, means for throwing said cams out of operation upon the short butt needles while acting upon the  
40 long butt needles during the last course of rotary knitting, and means for changing from reciprocatory to rotary knitting after two short butt needles adjacent to the long  
45 butt needles have been depressed by a depressing picker during a reverse stroke of reciprocatory knitting whereby the needle at the rear end of the series of long butt needles will be the last to be operated by the  
50 supplemental knitting cams during the last course of rotary knitting, and the second short butt needle will be the first needle to be operated by the supplemental knitting cams during the first course of rotary knitting after the narrowing and widening, sub-  
55 stantially as described.

13. A circular knitting machine, having, in combination, a needle cylinder, needles and web holding sinkers mounted therein,  
60 main knitting cams, supplemental knitting cams arranged to operate upon all the needles during rotary knitting, narrowing and widening devices, main and supplemental sinker cams corresponding to the main and  
65 supplemental knitting cams, means for

throwing the supplemental knitting cams out of operation during the narrowing and widening, and means for rendering the supplemental sinker cams inactive upon the  
70 sinkers during the narrowing and widening, substantially as described.

14. A circular knitting machine, having, in combination, a needle cylinder, needles and web holding sinkers mounted therein, main knitting cams, supplemental knitting  
75 cams, narrowing and widening devices, sinker cams corresponding to the main knitting cams, supplemental sinker cams corresponding to the supplemental knitting cams including a cam for withdrawing the sink-  
80 ers, and means for moving said cam radially inward at the beginning of the narrowing and widening, and radially outward at the end of the narrowing and widening, substantially as described. 85

15. A circular knitting machine, having, in combination, a needle cylinder, needles and web holding sinkers mounted therein, main knitting cams, a plurality of sets of supplemental knitting cams, narrowing and widening  
90 devices, main sinker cams corresponding to the main knitting cams, supplemental sinker cams corresponding to each set of supplemental knitting cams, means for throwing the supplemental knitting cams out of operation during the narrowing and widening  
95 and into operation at the end of the narrowing and widening, and means for rendering the supplemental sinker cams inactive upon the sinkers at the beginning of the narrowing and widening and active upon the sinkers at the end of the narrowing and widening, substantially as described. 100

16. A circular knitting machine, having, in combination, a needle cylinder provided  
105 with long and short butt needles, main knitting cams, needle elevating and depressing cams for raising the long butt needles into the inactive series and returning the needles in the inactive series to the active series, narrowing and widening devices, supplemental  
110 knitting cams arranged in advance of the needle elevating and depressing cams and between them and the main knitting cams, a cam surface with which the short butts engage on the first reverse stroke of reciprocatory knitting to move the supplemental cams radially outward, and means for forcing the  
115 cams yieldingly inward at the end of the narrowing and widening, substantially as described. 120

17. A circular knitting machine, having, in combination, a needle cylinder provided with long and short butt needles, narrowing and widening devices, a main knitting cam,  
125 a needle elevating cam for raising the long butt needles into the inactive plane, a needle depressing cam constructed to depress the long butt needles into the inactive series and to partially depress the short butt needles, 130



supplemental knitting cams in advance of the needle depressing cam, a thread eye for feeding yarn to the knitting wave formed by the supplemental knitting cams, and  
 5 means for completing the depression of the short butt needles into the active series after they have passed said thread eye, substantially as described.

18. A circular knitting machine, having,  
 10 in combination, a needle cylinder provided with long and short butt needles, main knitting cams, narrowing and widening devices, a needle elevating cam for raising the long butt needles into the inactive plane, a needle  
 15 depressing cam constructed to depress the long butt needles into the active plane and to partially depress the short butt needles, supplemental knitting cams arranged in advance of the needle depressing cam including a stitch cam, and a needle depressing  
 20 cam carried by the stitch cam for completing the depression of the short butt needles into the active plane, substantially as described.

25 19. A circular knitting machine, having, in combination, a needle cylinder provided with long and short butt needles, main knitting cams, a needle elevating cam for raising the long butt needles at the beginning  
 30 of the narrowing and widening, needle elevating and depressing pickers, a set of supplemental knitting cams arranged to oper-

ate upon all the needles during rotary knitting, means for throwing said cams out of operation upon the short butt needles while  
 35 acting upon the long butt needles during the last course of rotary knitting, and means for changing from reciprocatory to rotary knitting at the end of the widening, and devices coöperating with the motion chang-  
 40 ing means to leave at least one short butt needle in the inactive series adjacent to the long butt needle which is the last to be operated by the supplemental cams during the  
 45 last course of rotary knitting, substantially as described.

20. A circular knitting machine, having, in combination, a rotary needle cylinder provided with long and short butt needles, main  
 50 knitting cams, two sets of supplemental knitting cams, radially movable supports for the supplemental knitting cams, needle elevating and depressing cams, a vertically  
 55 movable slide carrying said elevating and depressing cams, and connections between the slide and the radially movable supports for moving the supports outward when the  
 slide is raised, and inward when the slide is depressed, substantially as described.

EXILIAS PAQUETTE.

Witnesses:

EDWARD MARTIN,  
 AUGUSTE JEAN.