

No. 726,178.

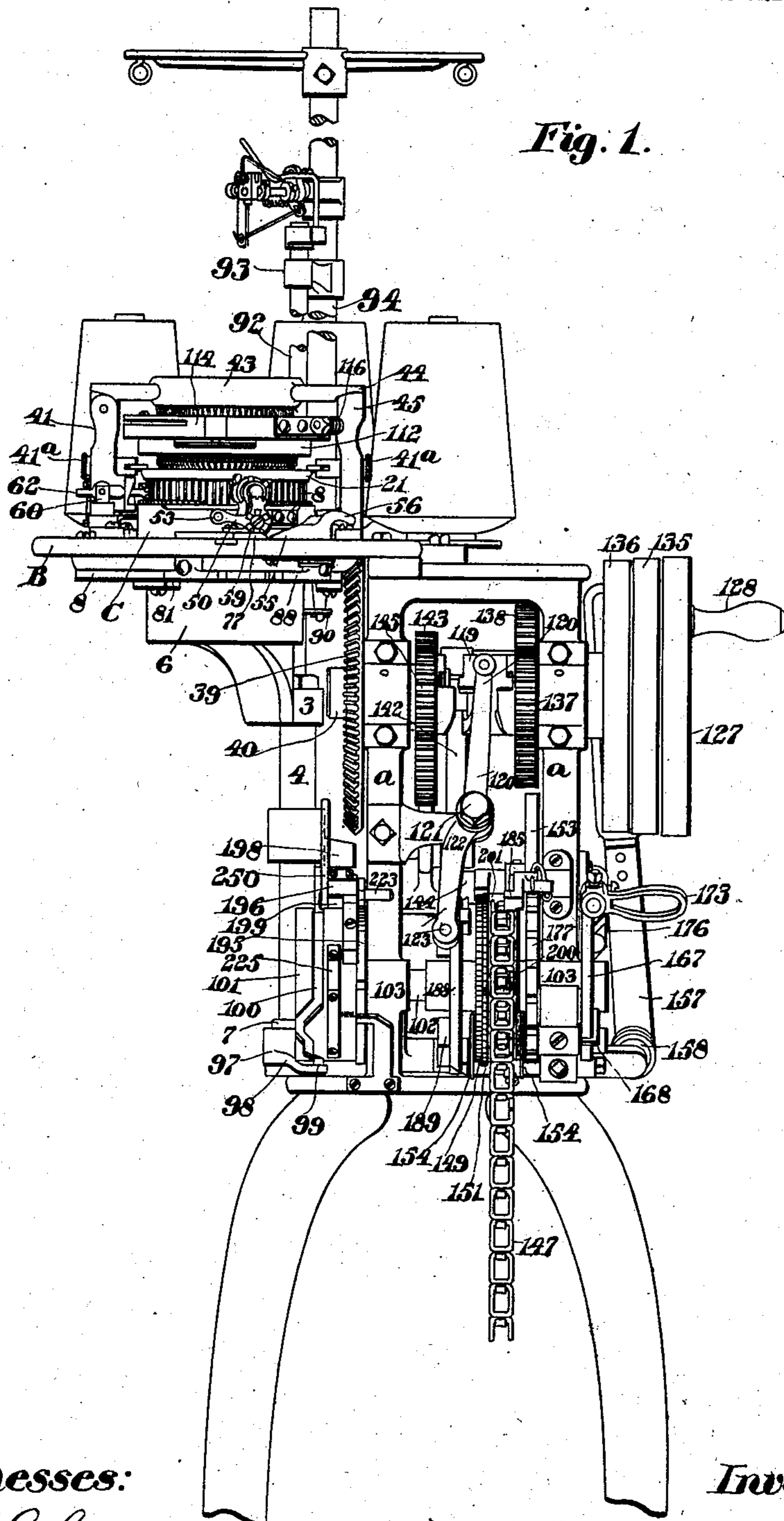
PATENTED APR. 21, 1903.

G. D. MAYO.
KNITTING MACHINE.

APPLICATION FILED DEC. 4, 1902.

NO MODEL.

16 SHEETS—SHEET 1.



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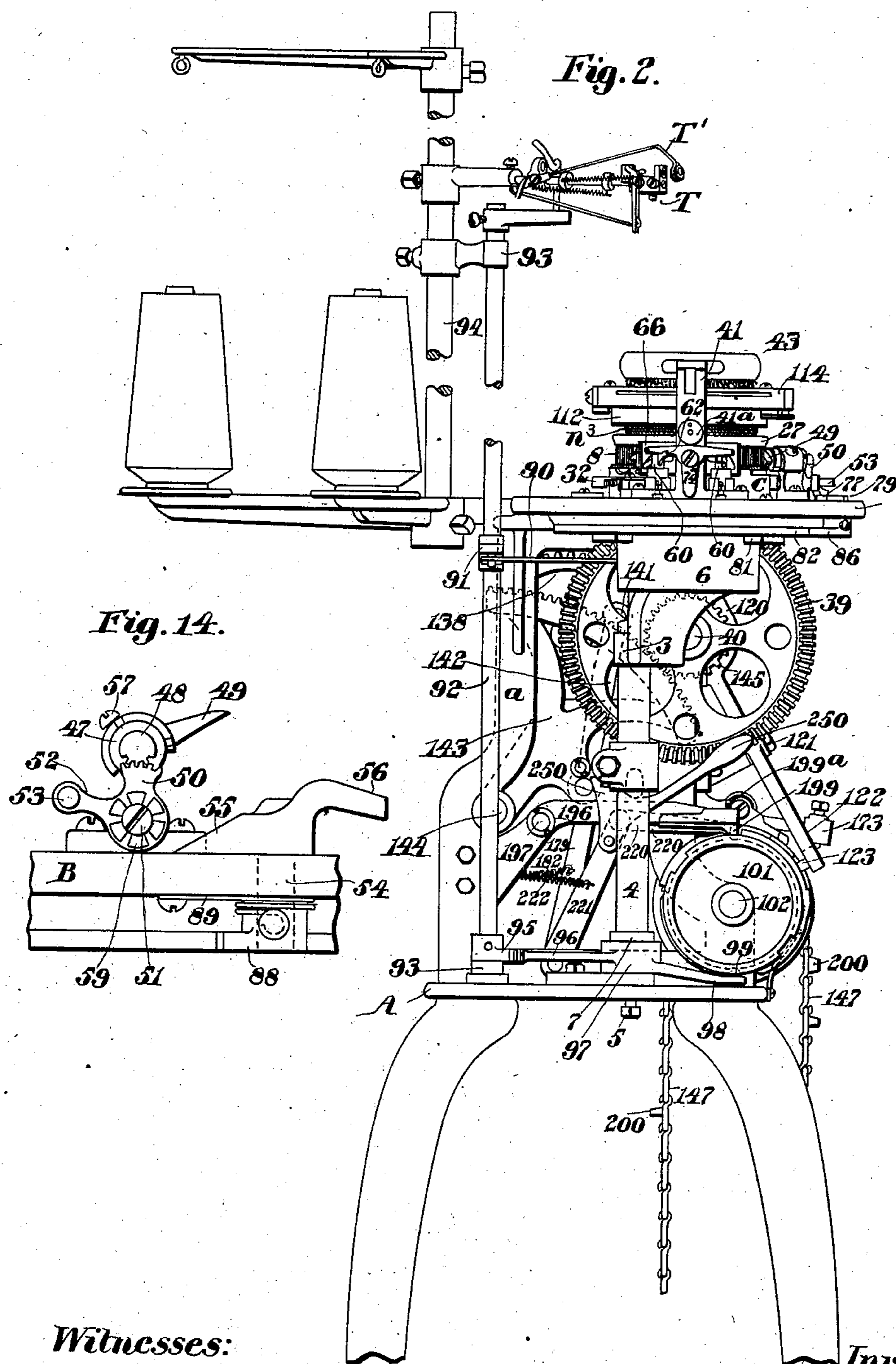
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16 SHEETS—SHEET 2.



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16 SHEETS—SHEET 3.

Fig. 3.

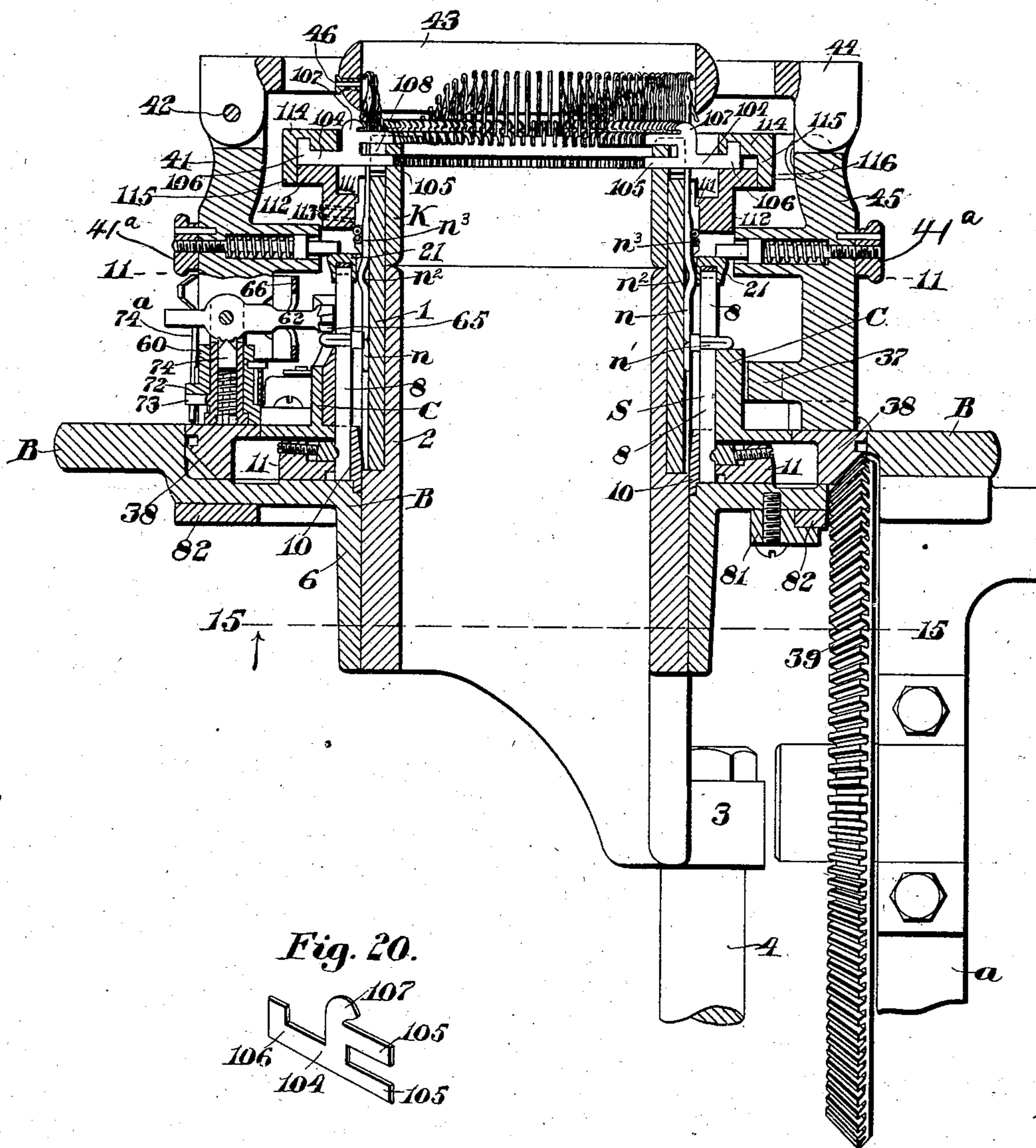
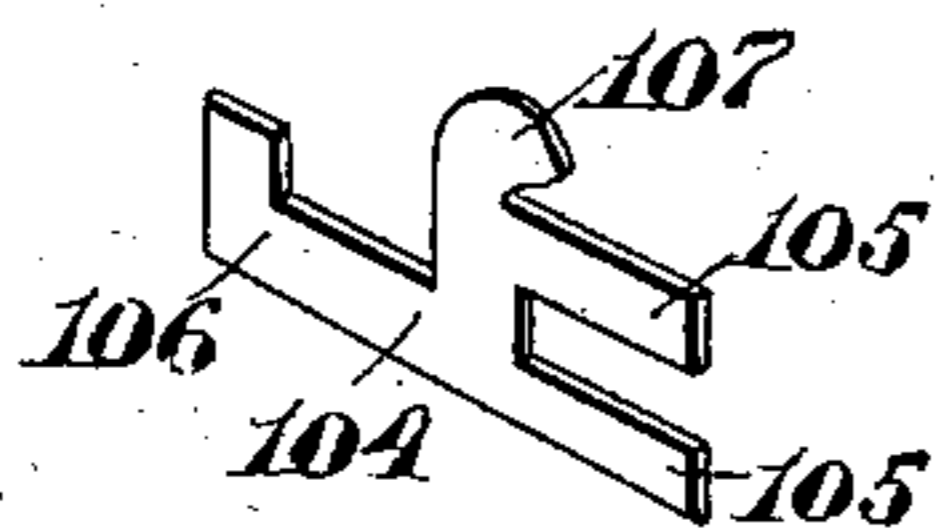


Fig. 20.



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16 SHEETS—SHEET 4.

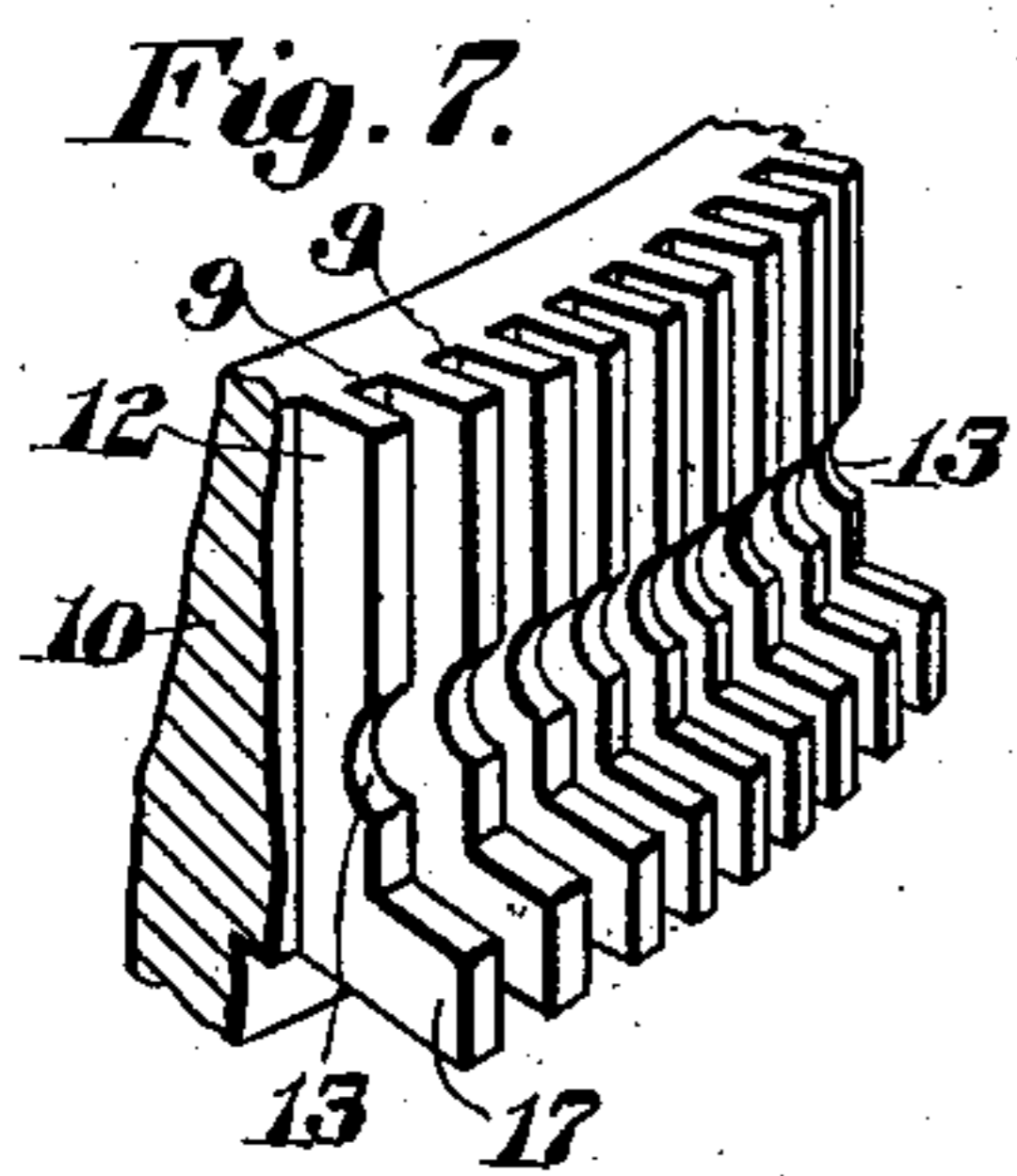
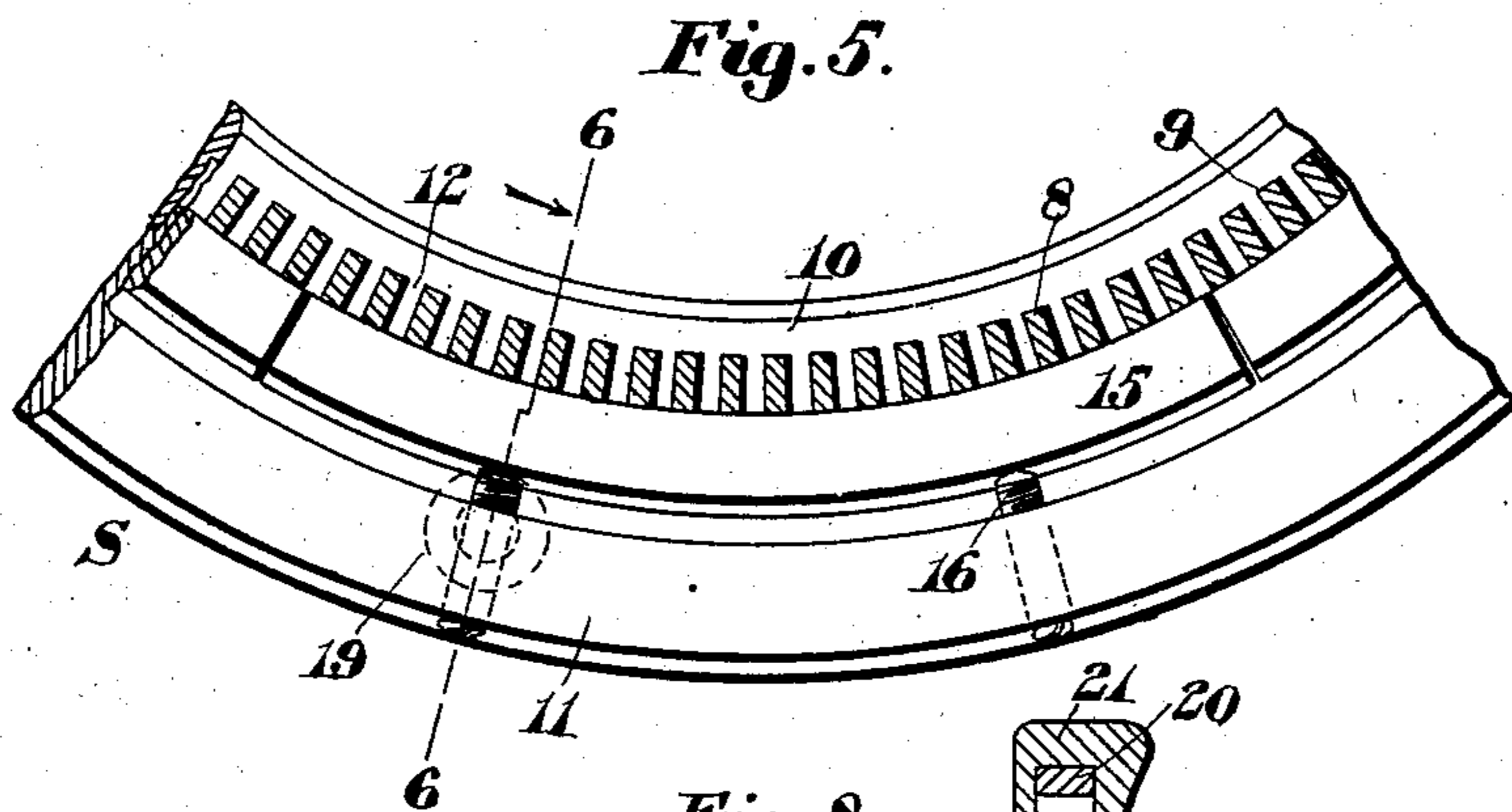
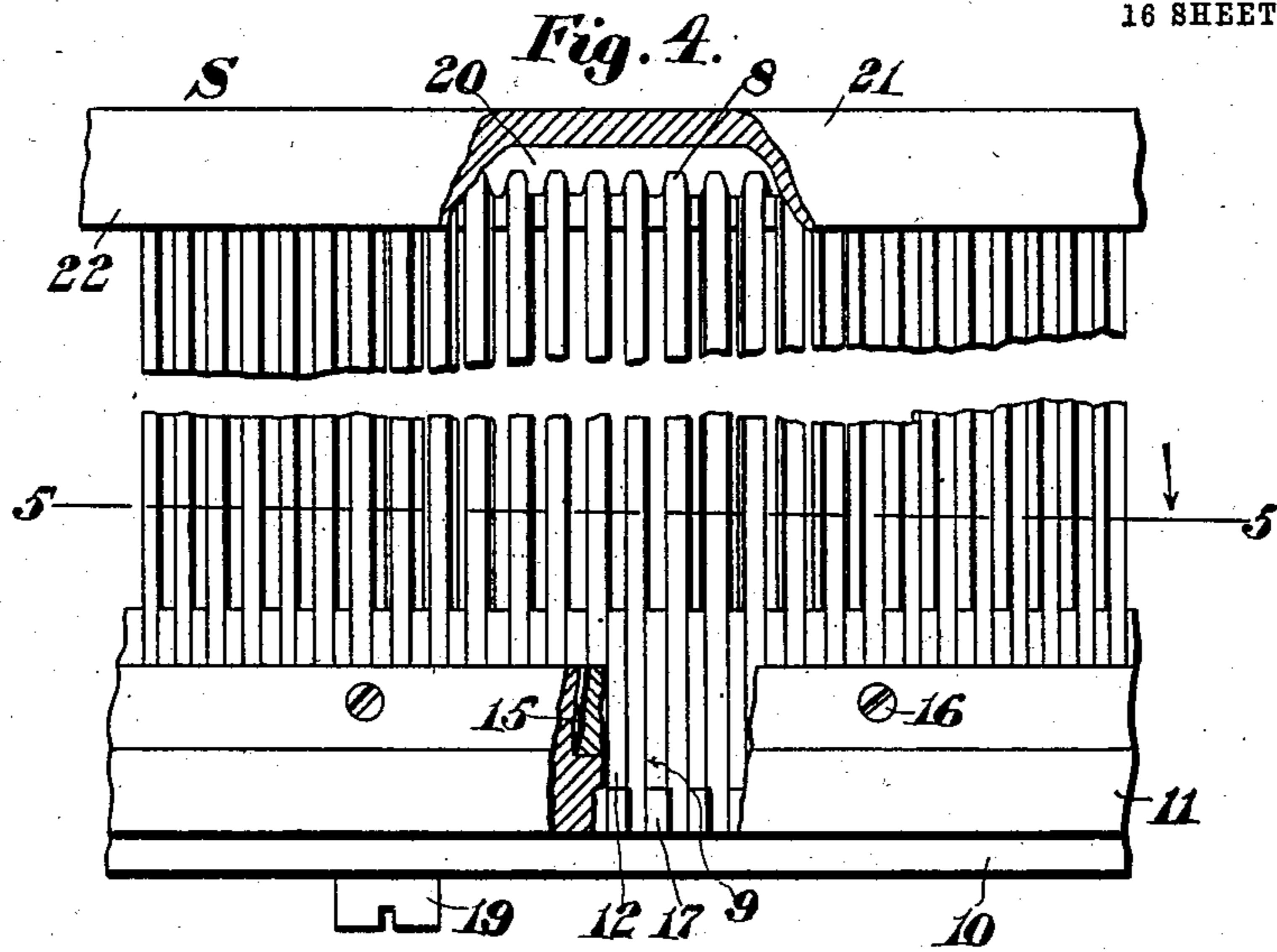
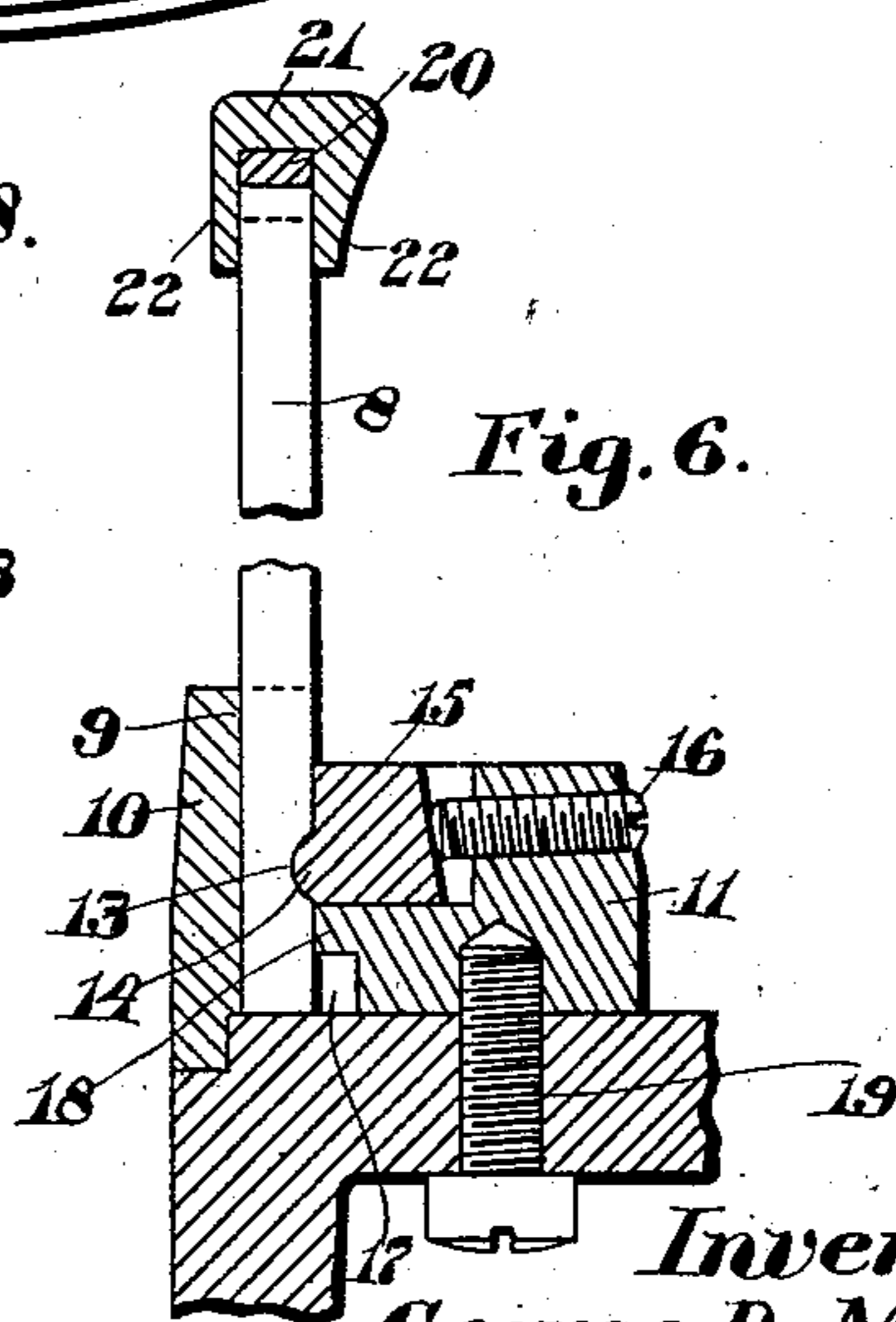
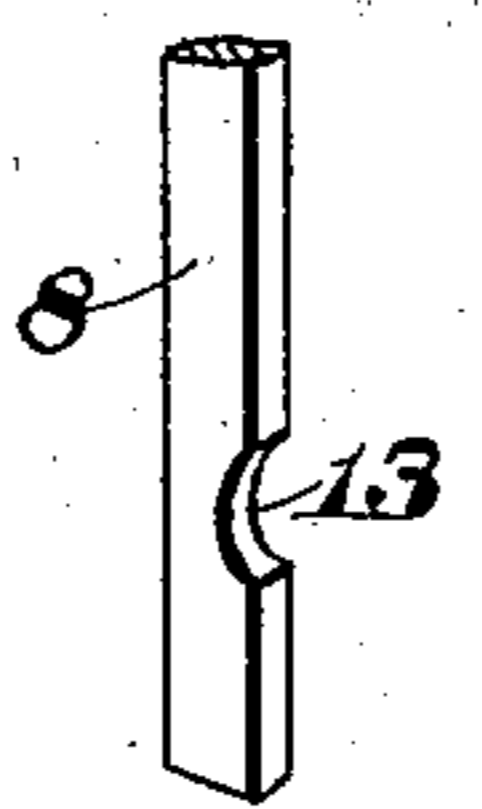


Fig. 8.



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16 SHEETS—SHEET 5.

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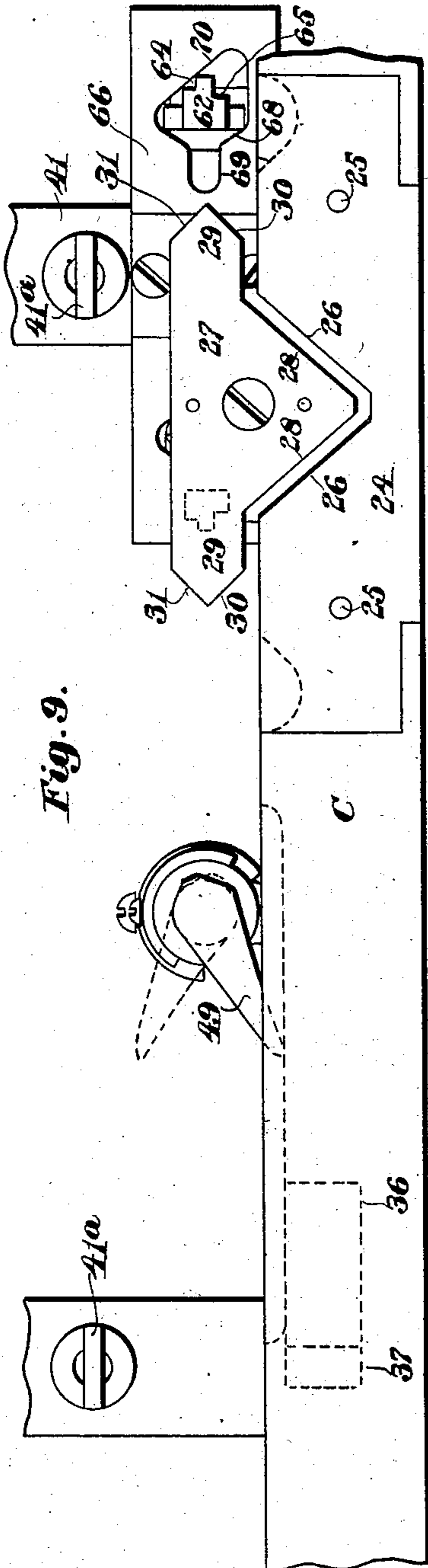


Fig. 9.

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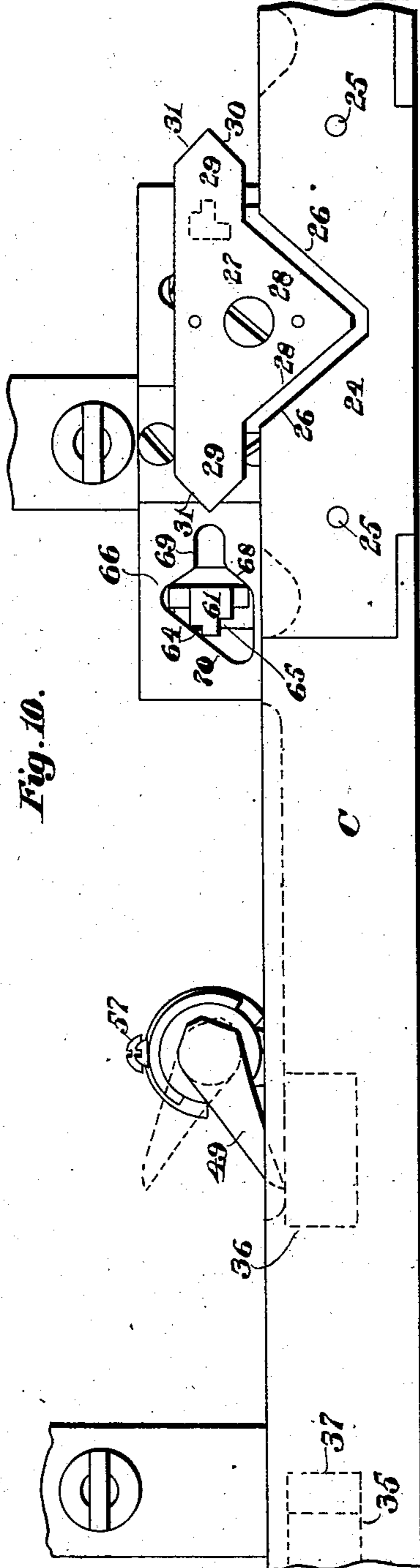


Fig. 10.

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16 SHEETS—SHEET 7.

Fig. 12.

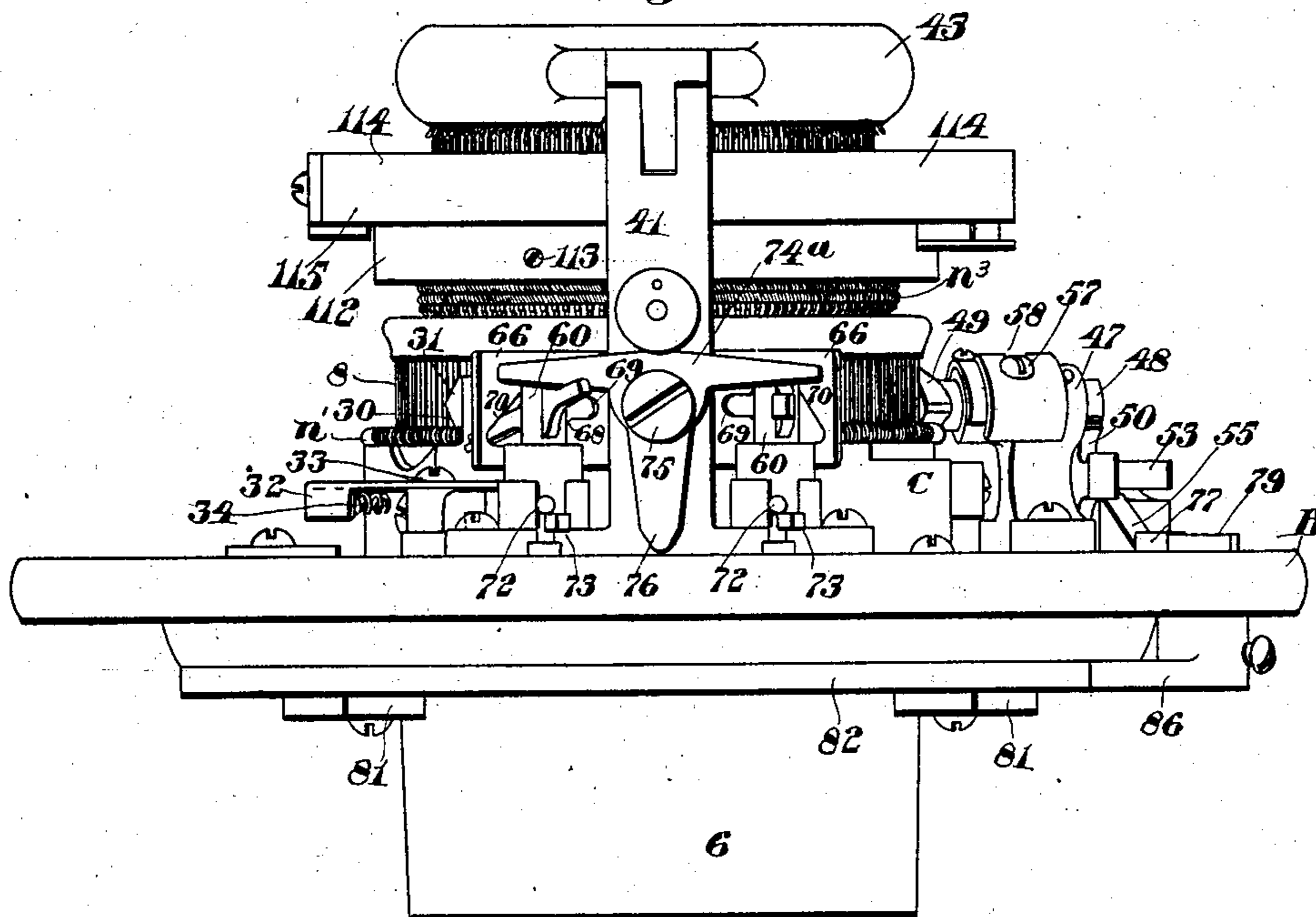
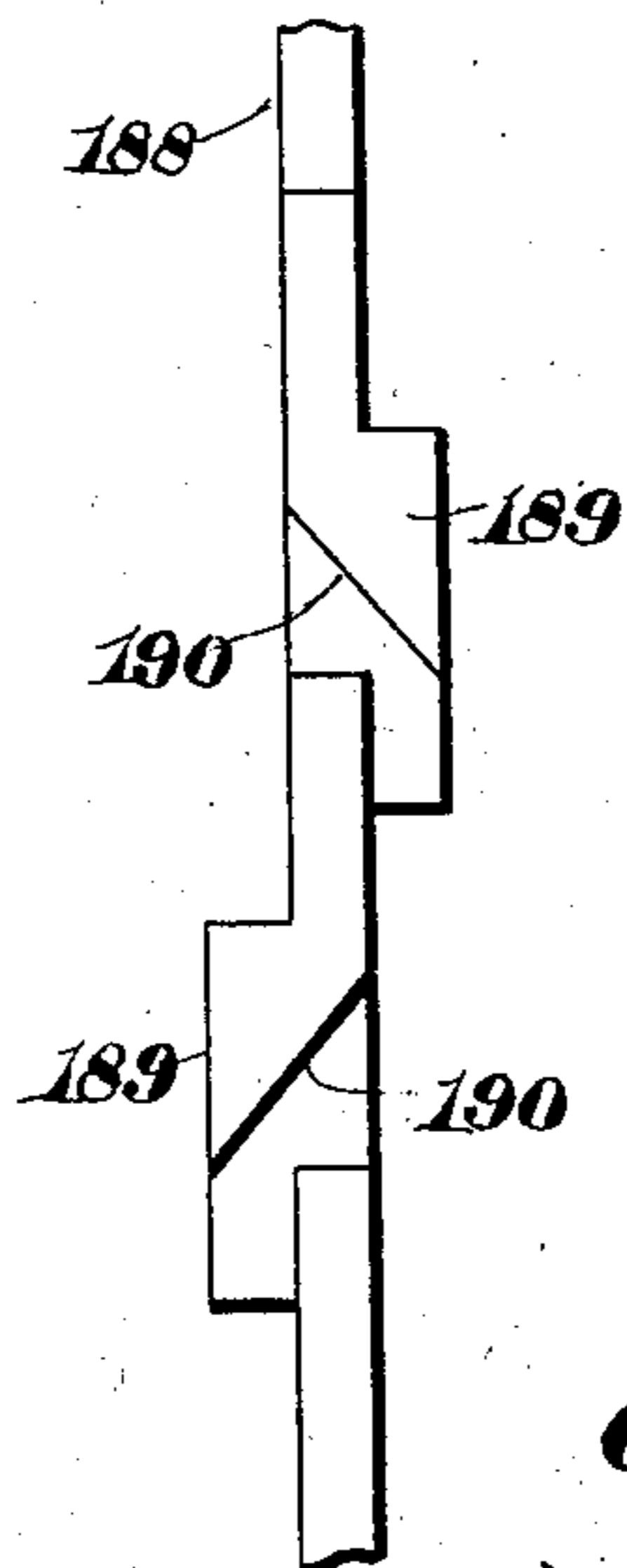


Fig. 31.



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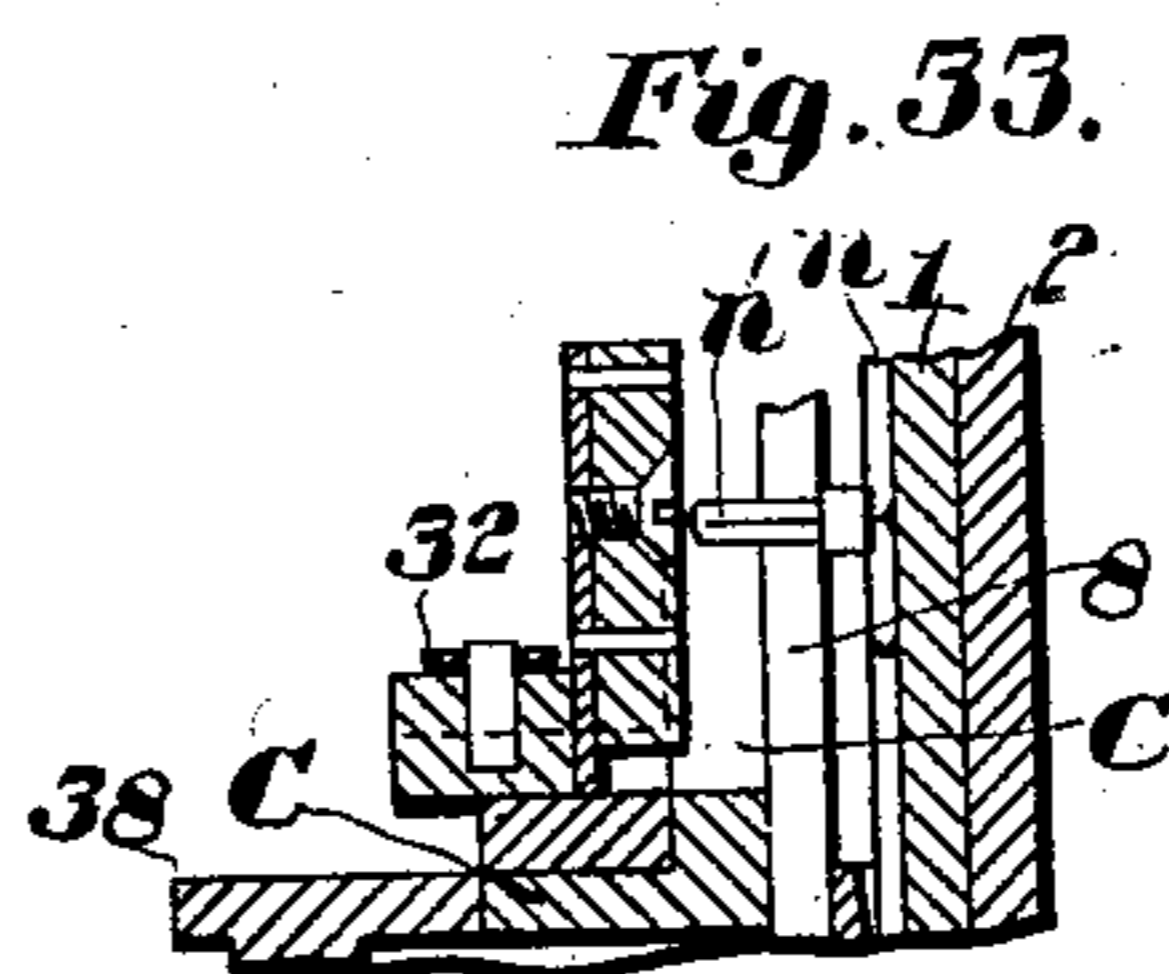
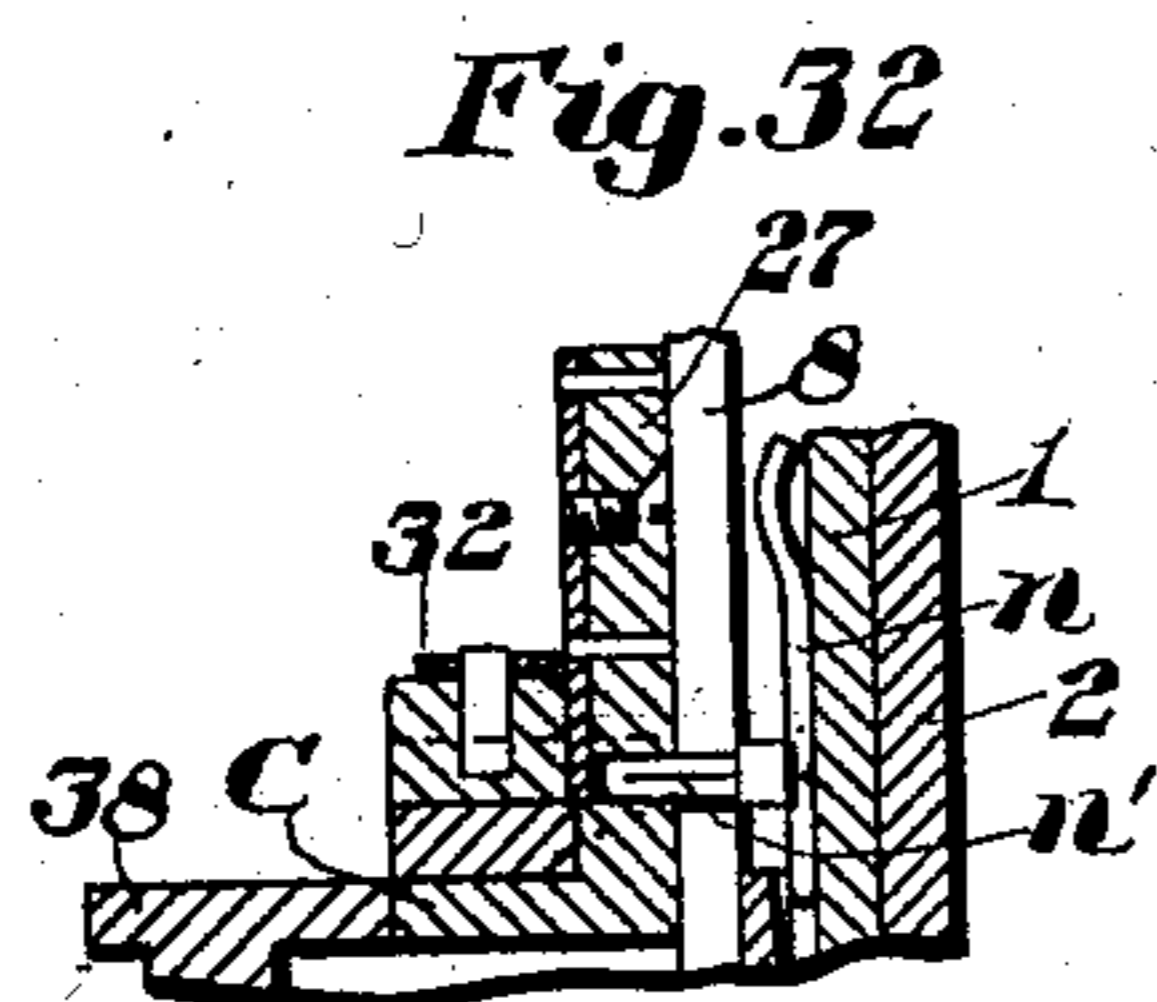
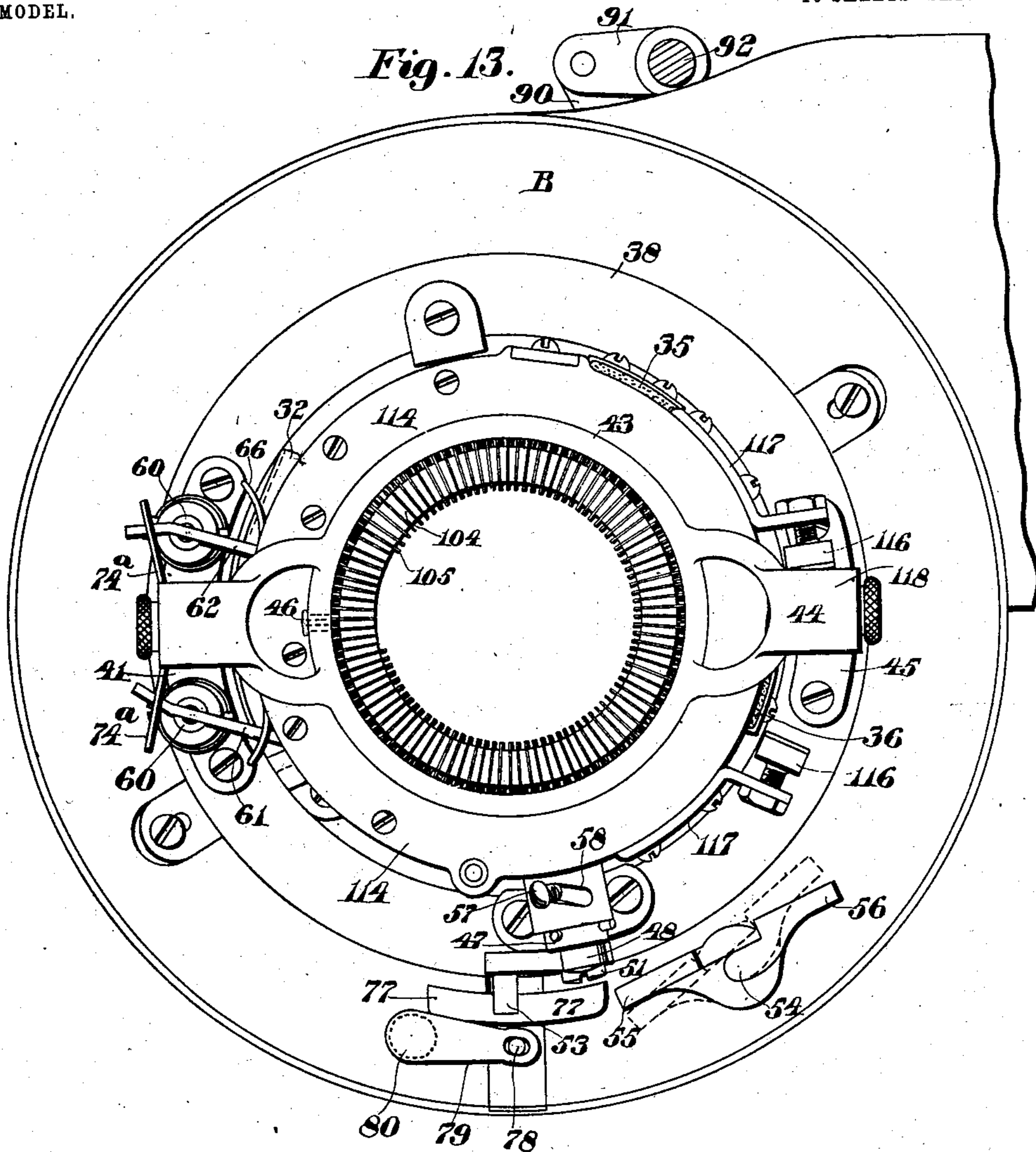
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16 SHEETS—SHEET 8.



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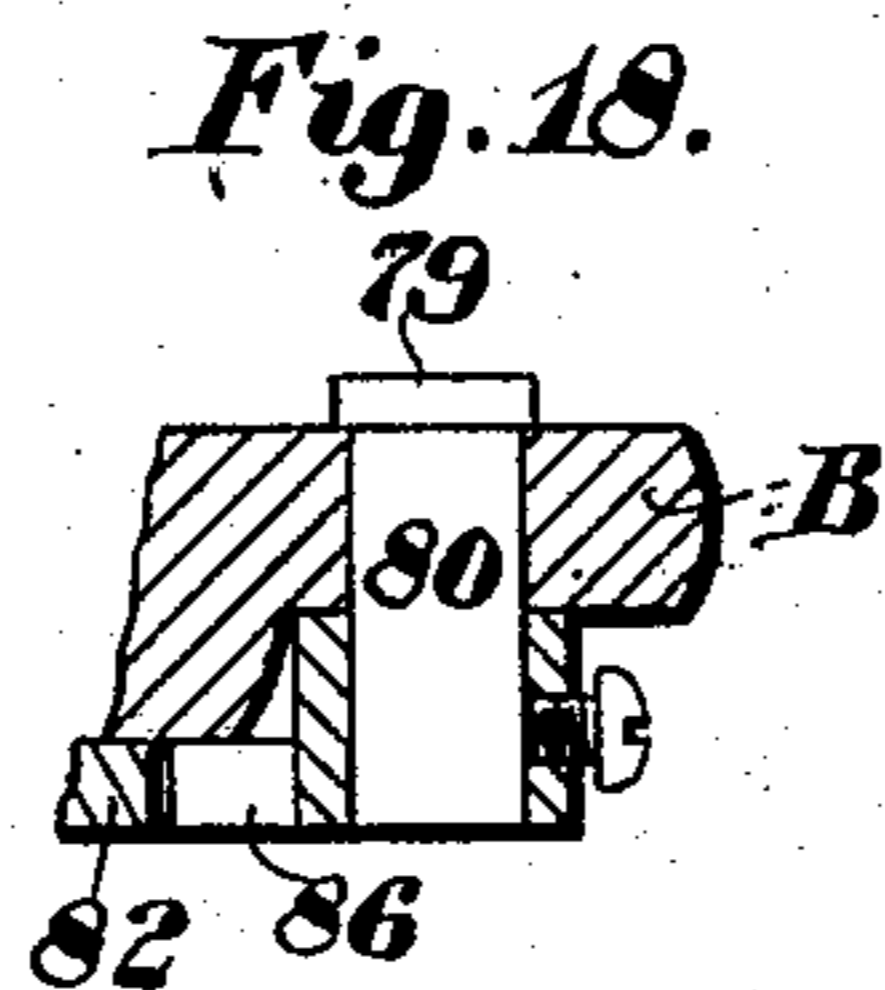
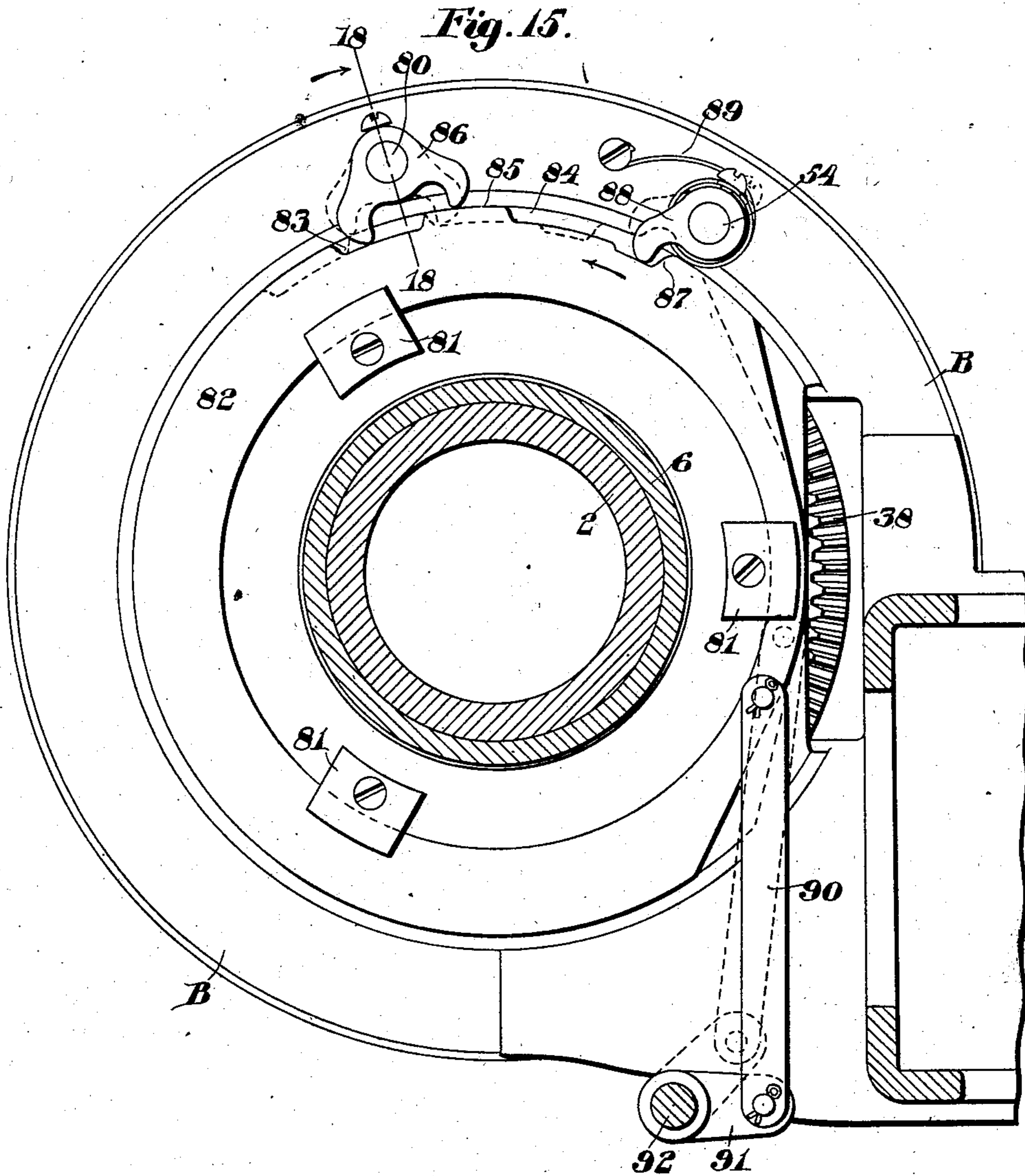
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NO MODEL.

16 SHEETS—SHEET 9.



Witnesses:
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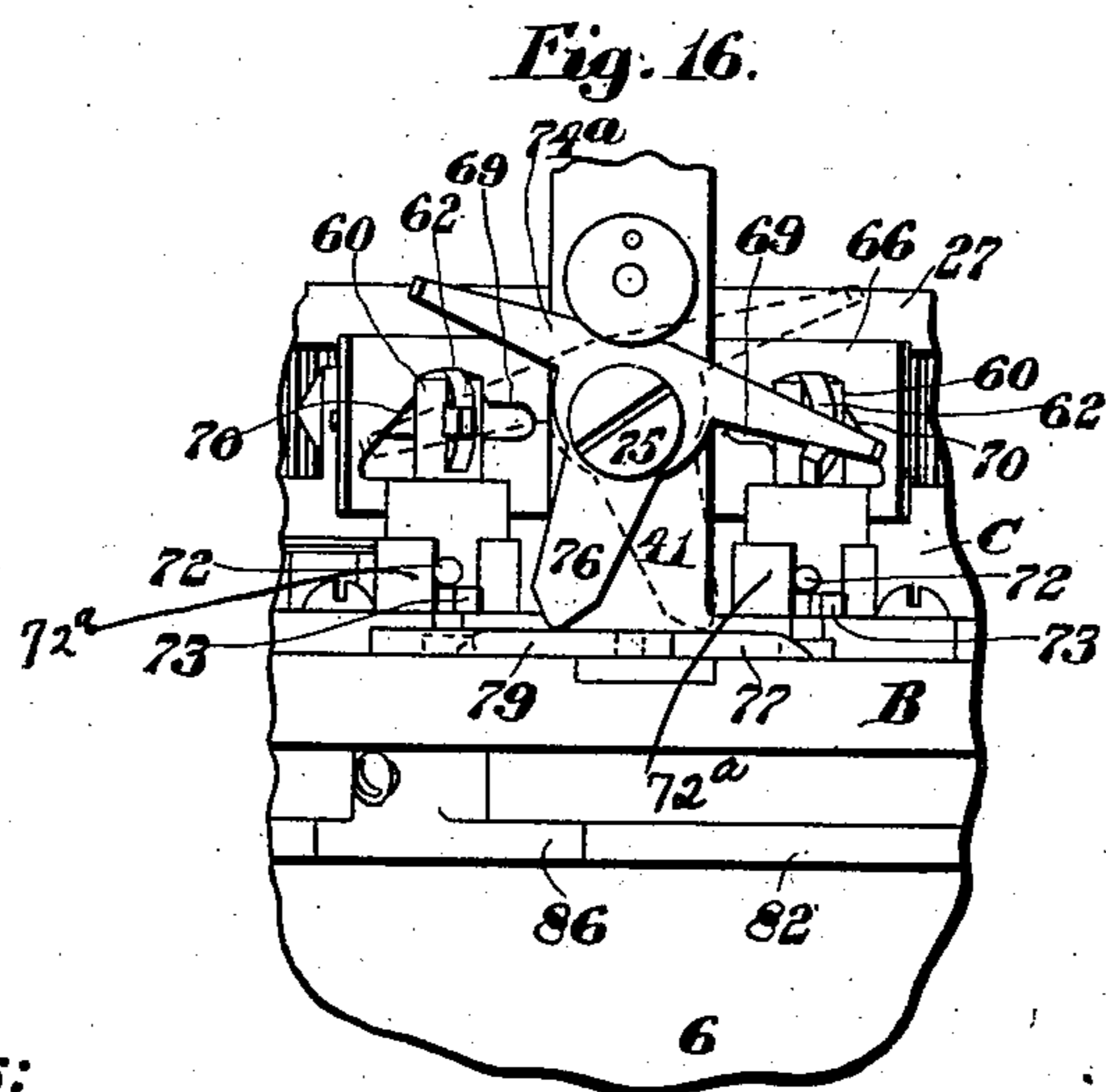
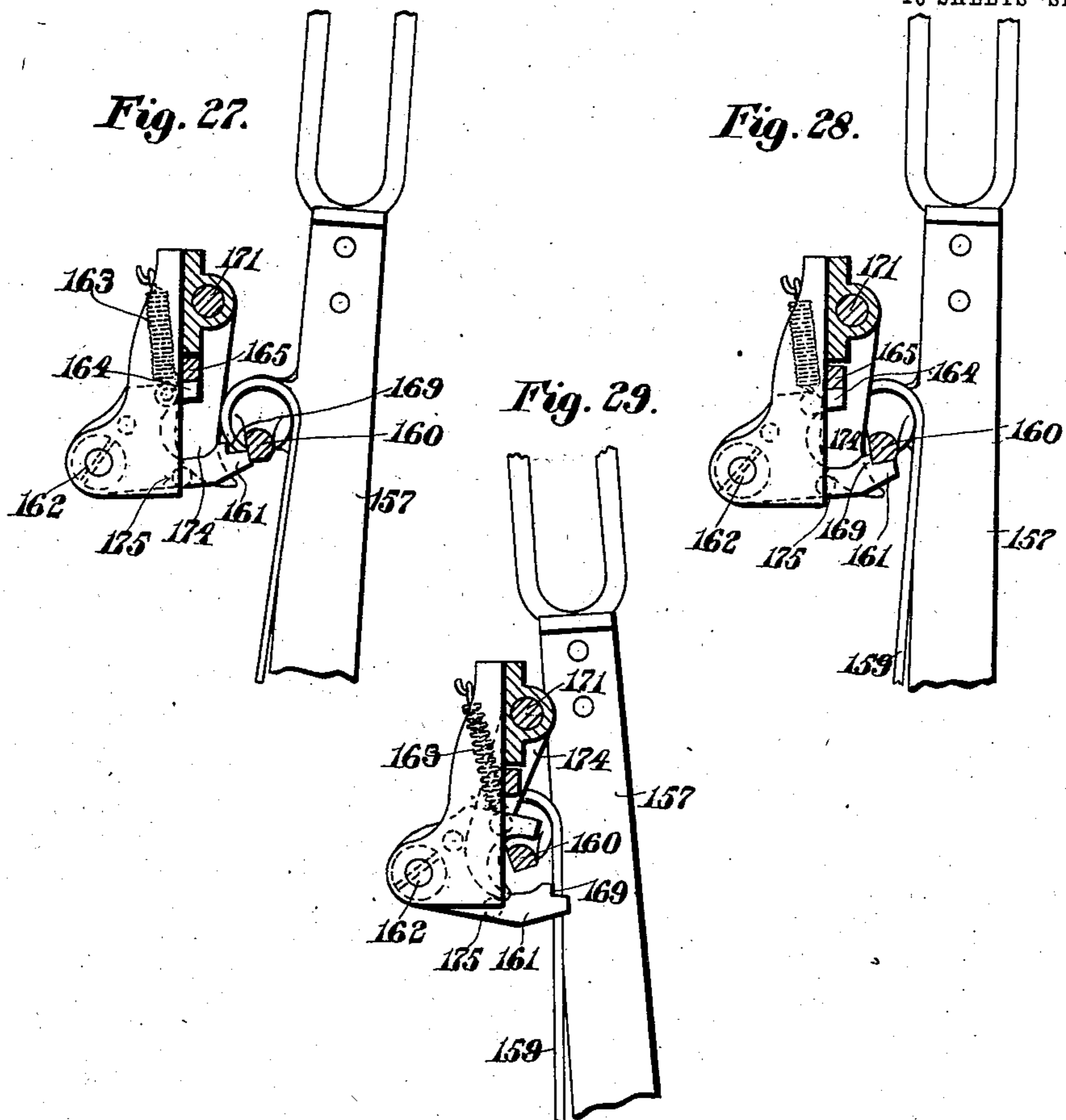
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16 SHEETS—SHEET 10.



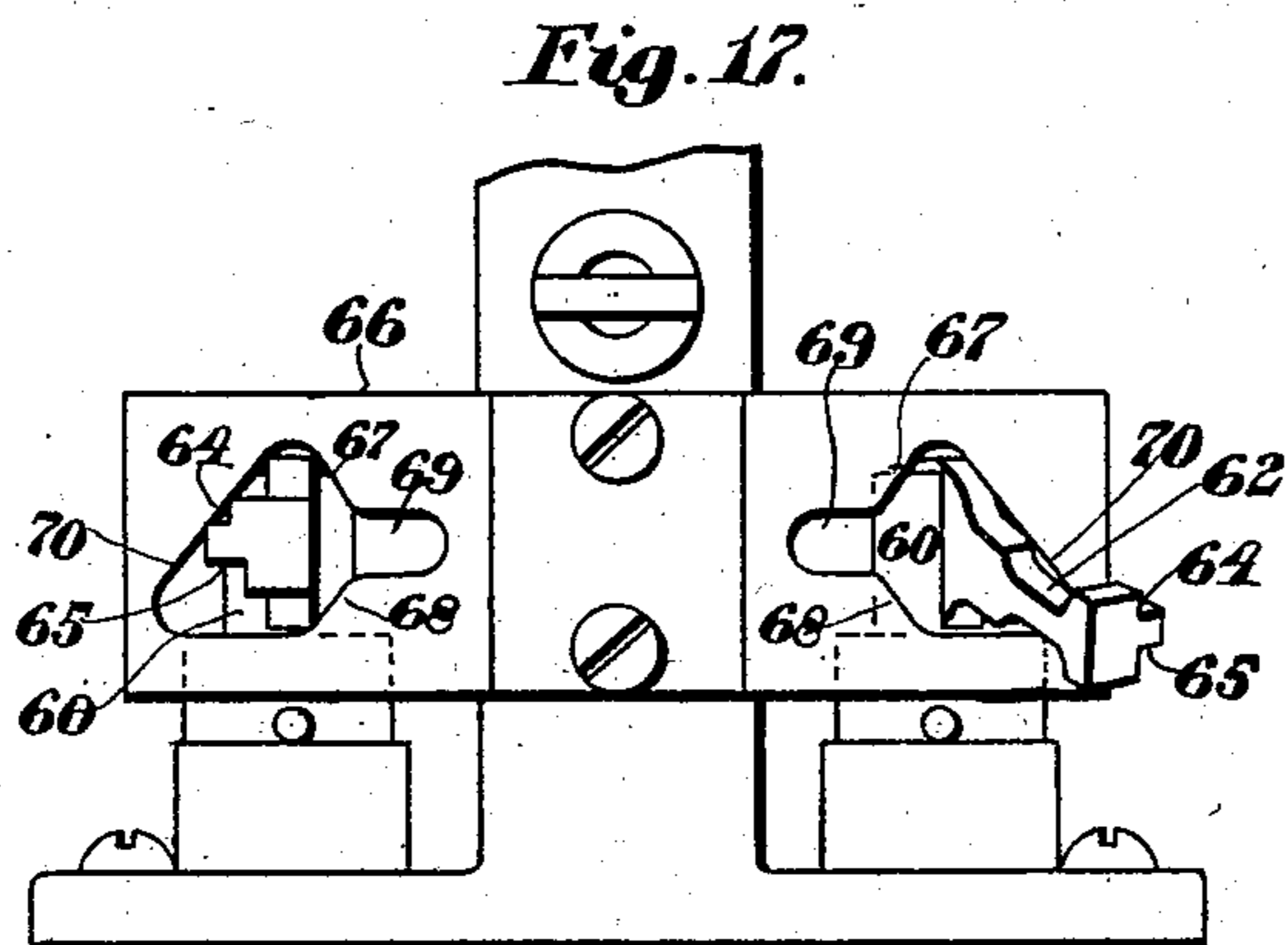
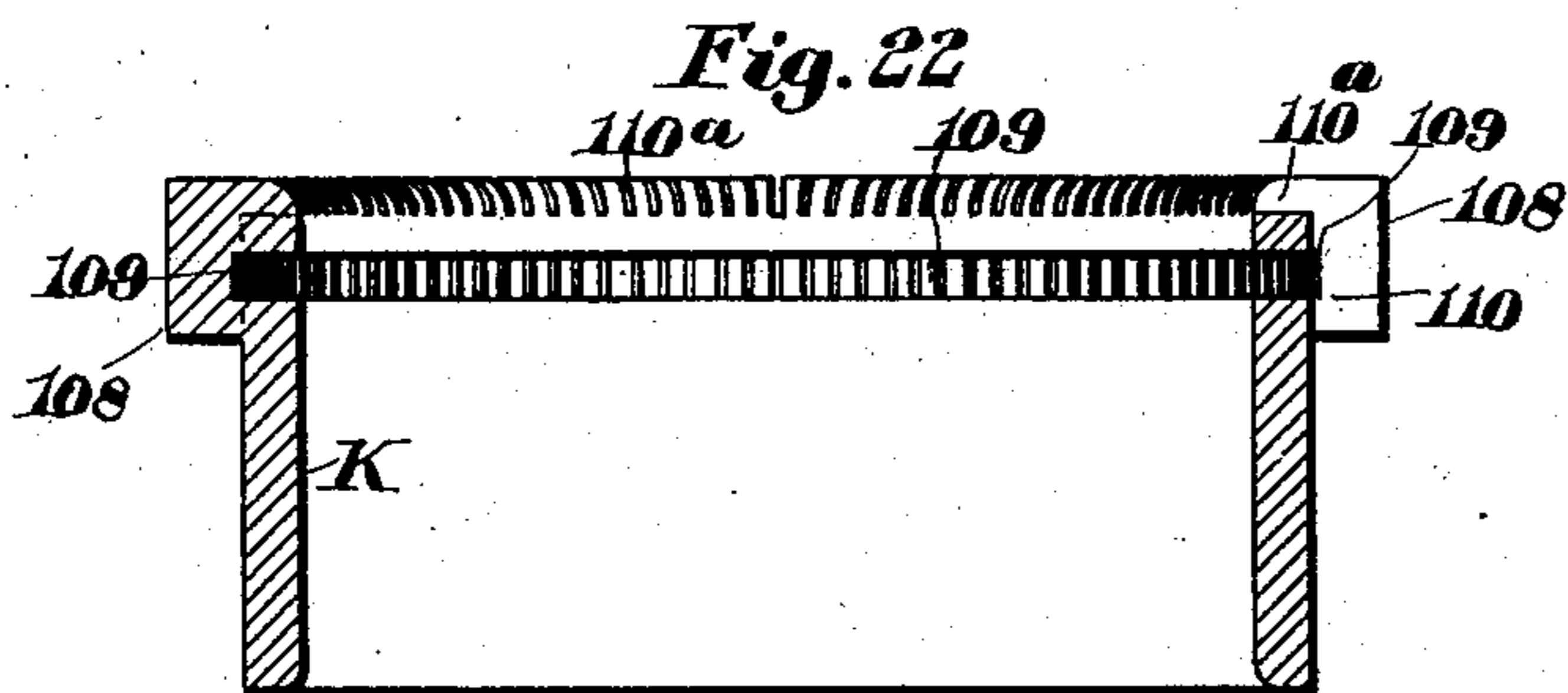
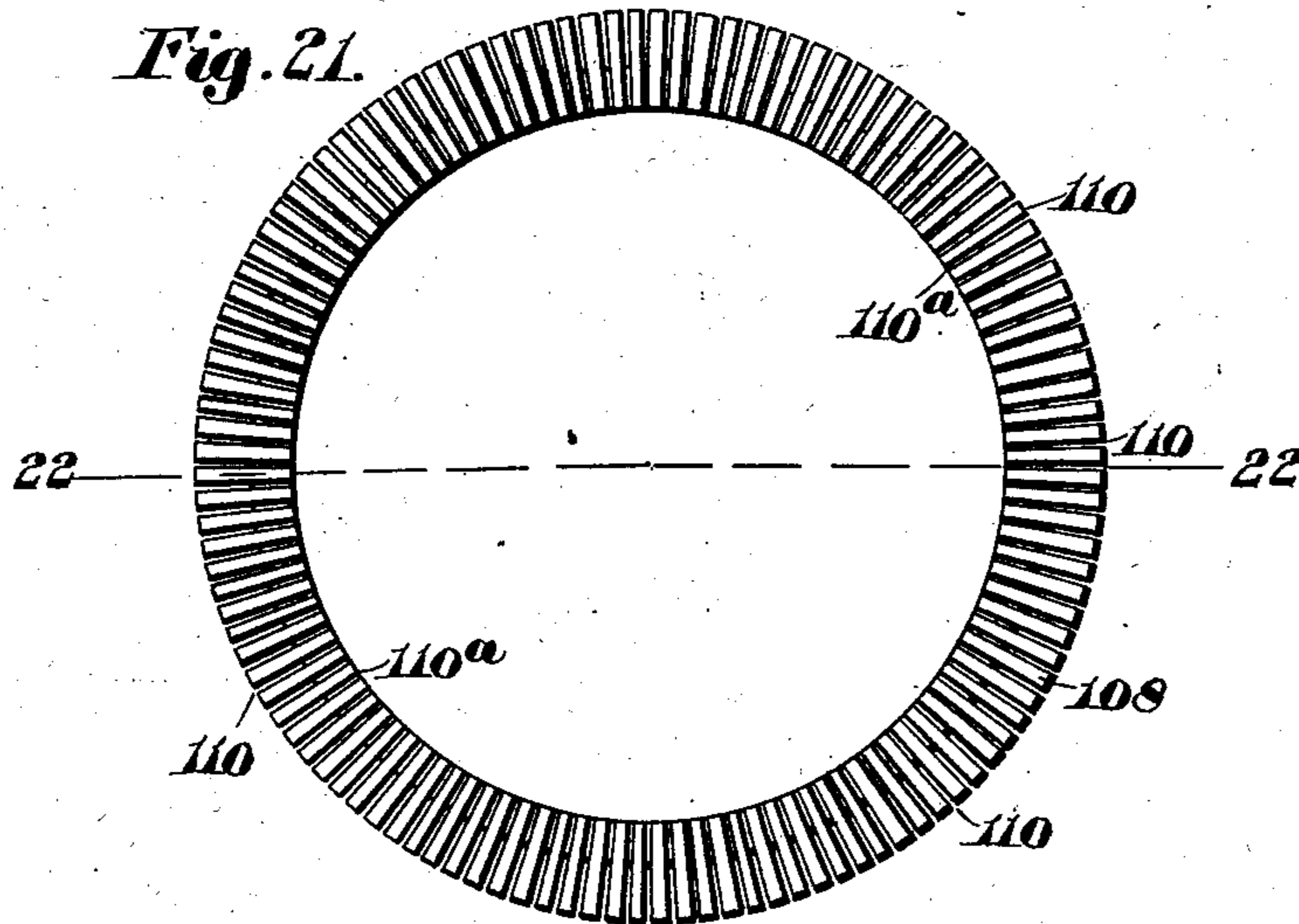
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NO MODEL.

16 SHEETS—SHEET 11.



Witnesses:
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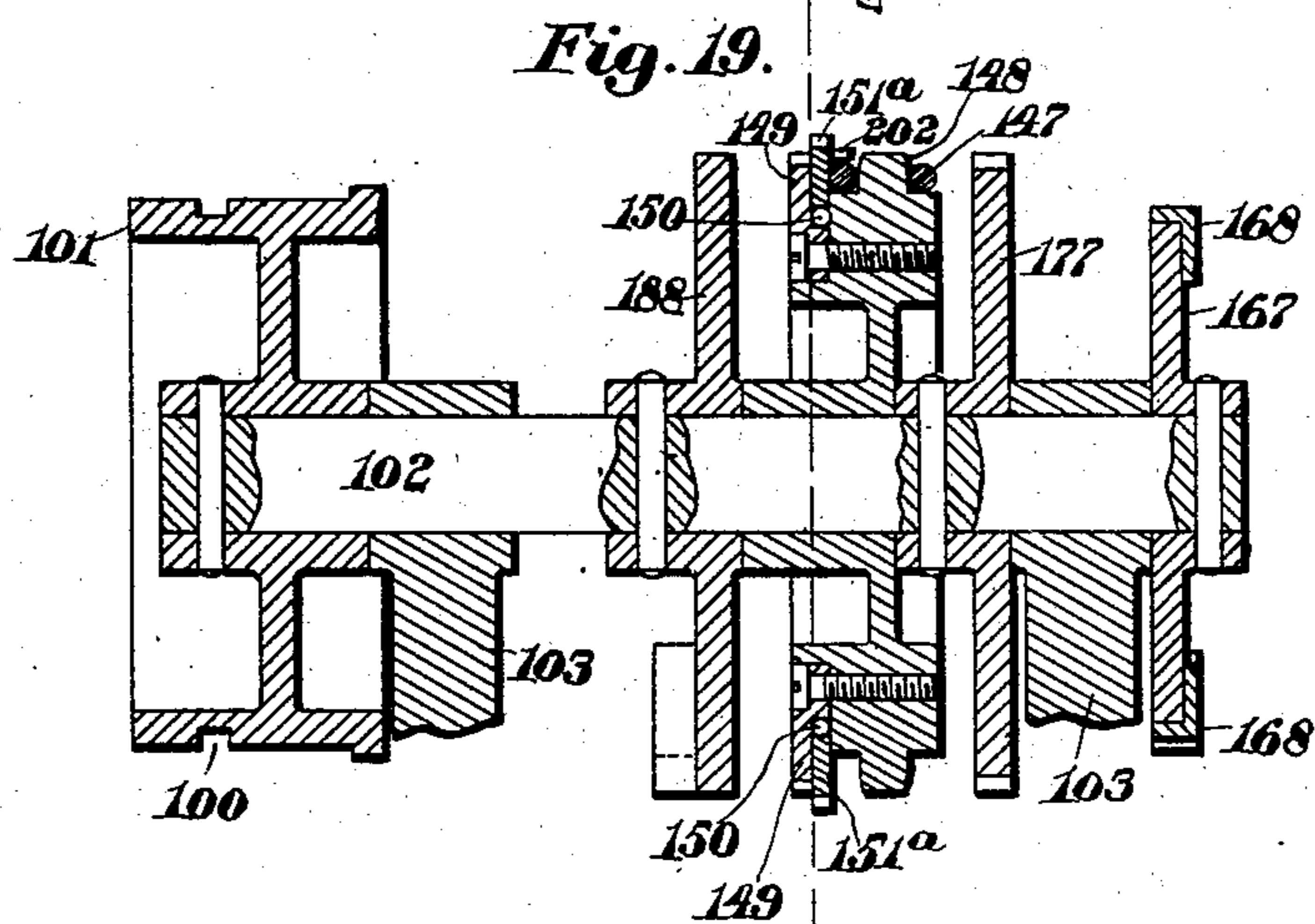
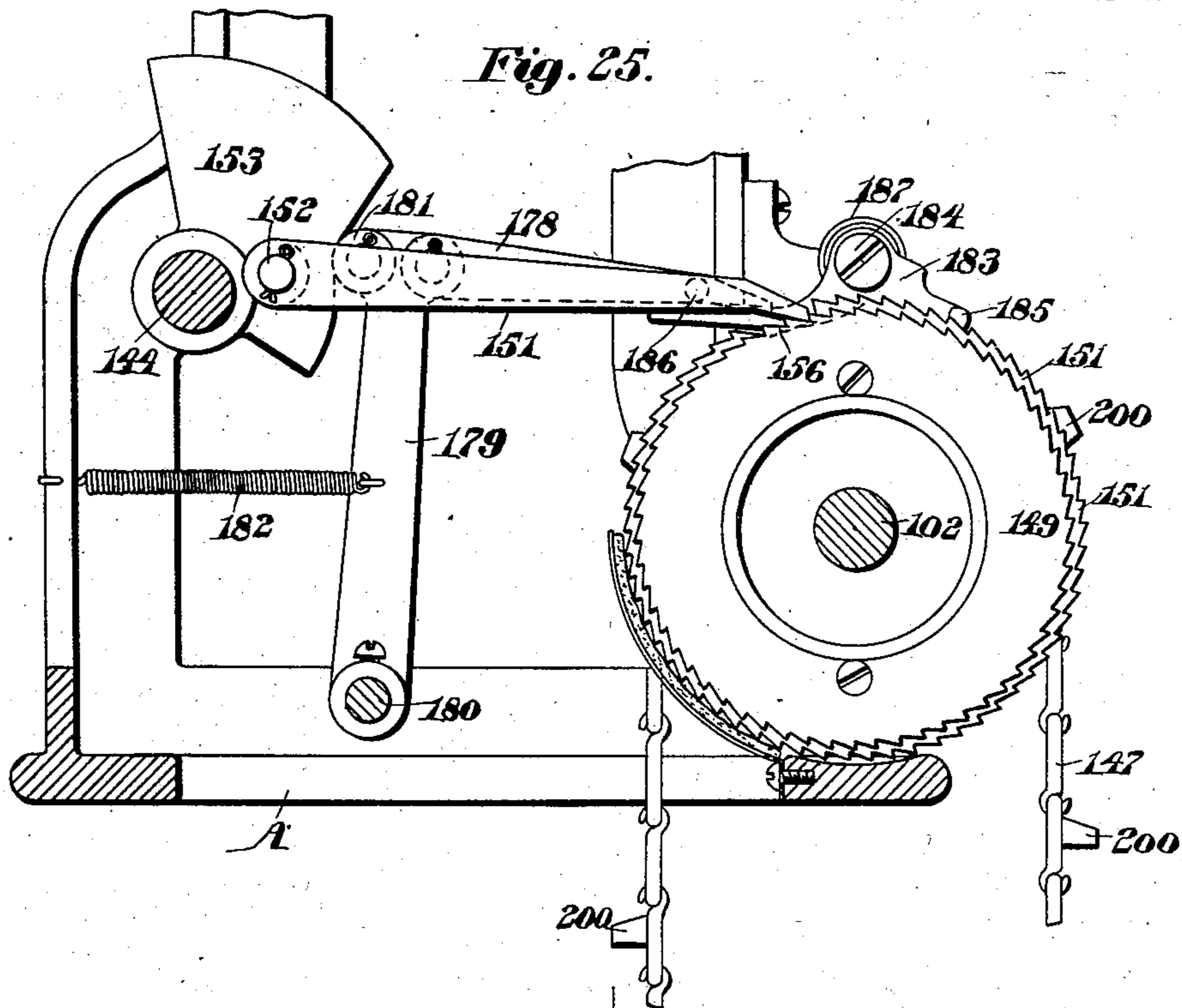
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NO MODEL.

16 SHEETS—SHEET 12.



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NO MODEL.

16 SHEETS—SHEET 13.

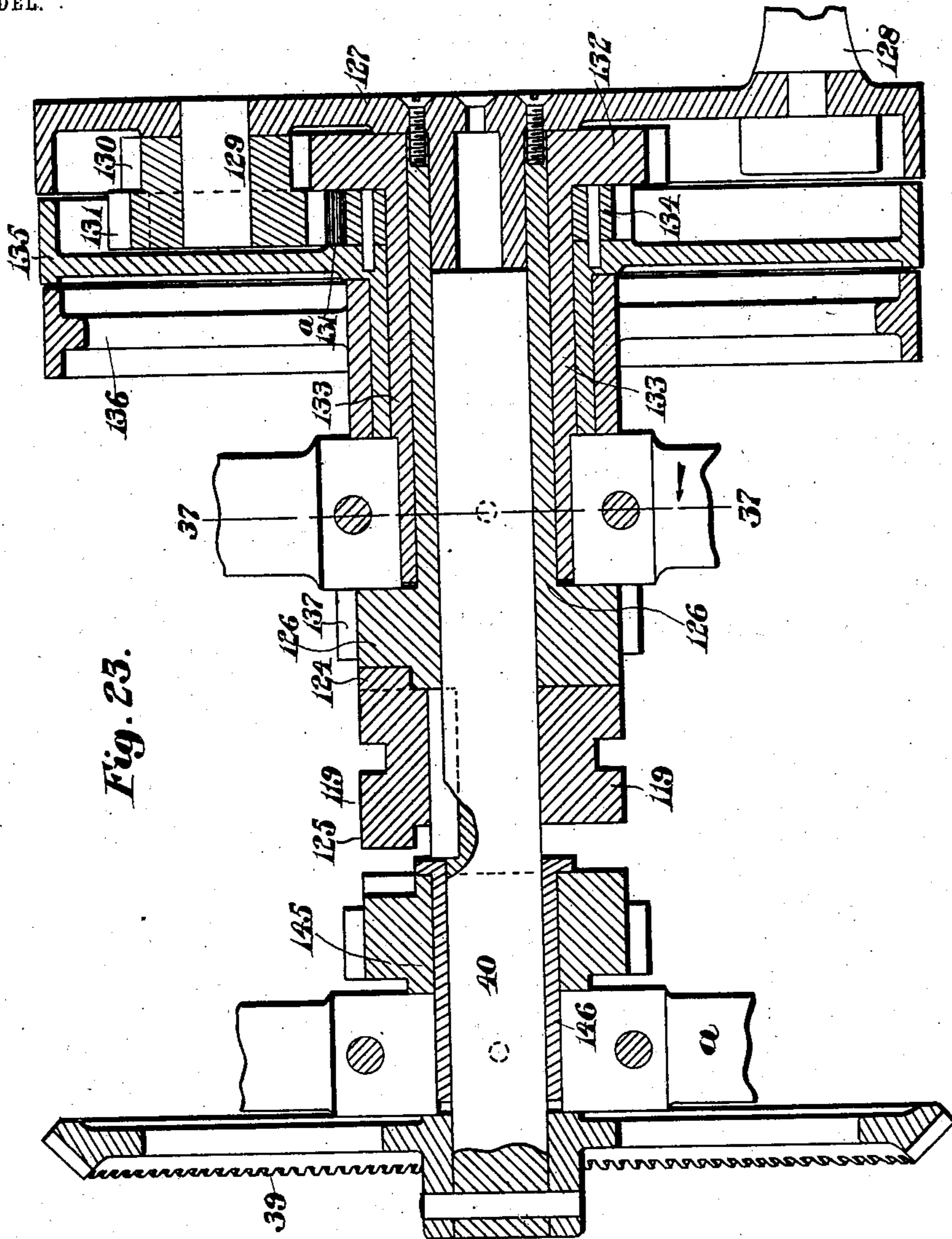


Fig. 23.

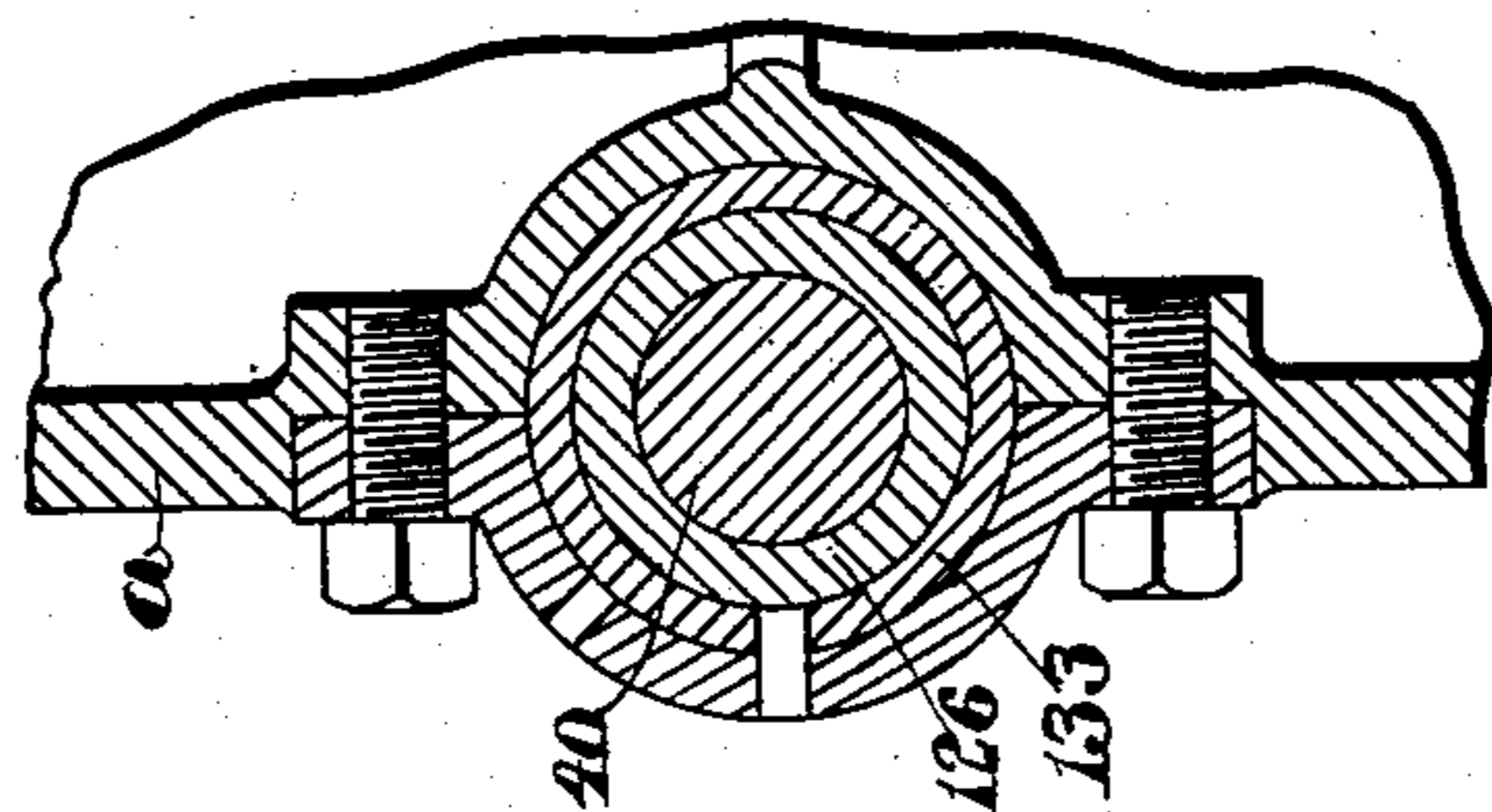


Fig. 37.

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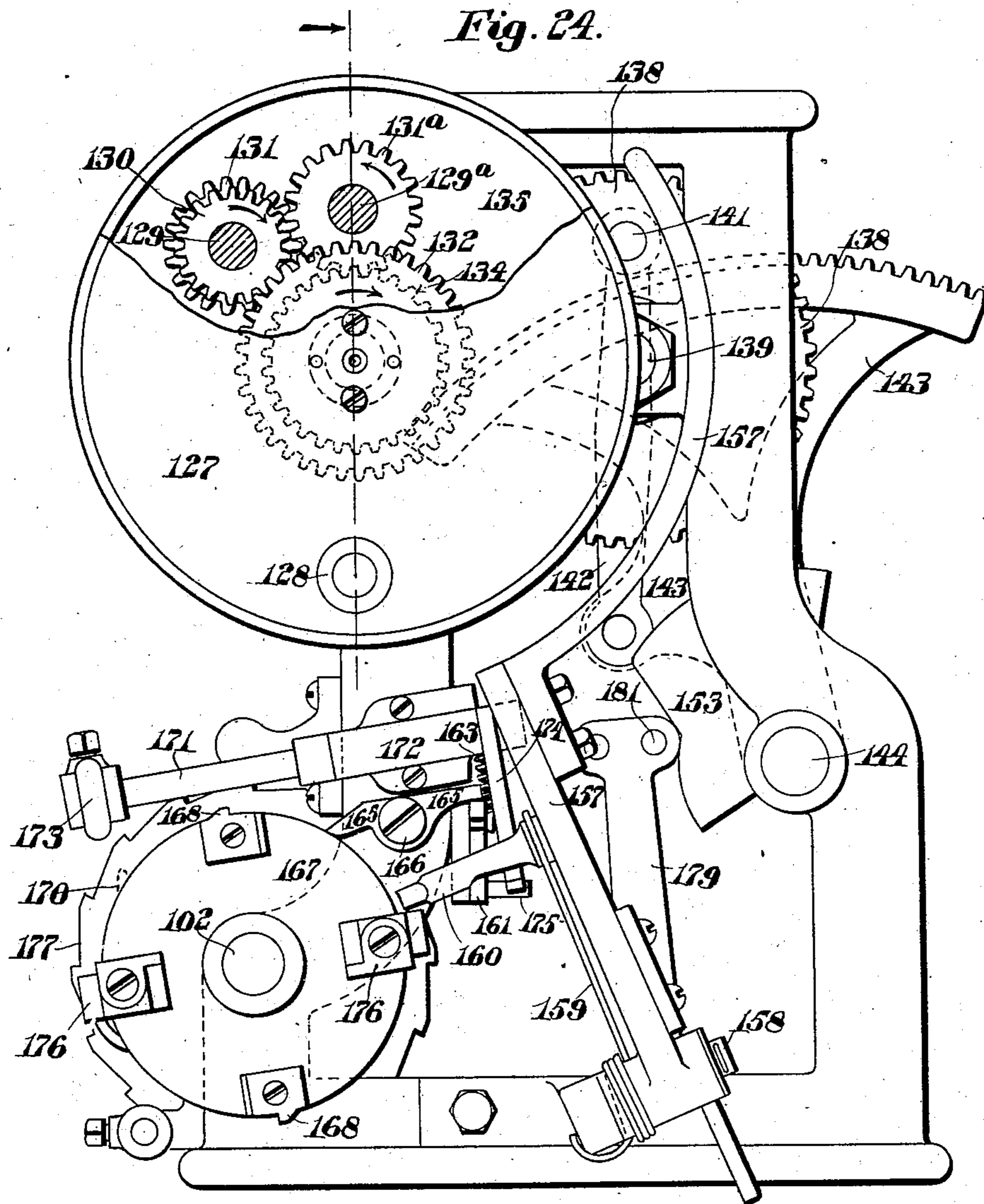
G. D. MAYO.

KNITTING MACHINE.

APPLICATION FILED DEC. 4, 1902.

NO MODEL.

16 SHEETS—SHEET 14.



Witnesses:

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PATENTED APR. 21, 1903.

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NO MODEL.

16 SHEETS—SHEET 15.

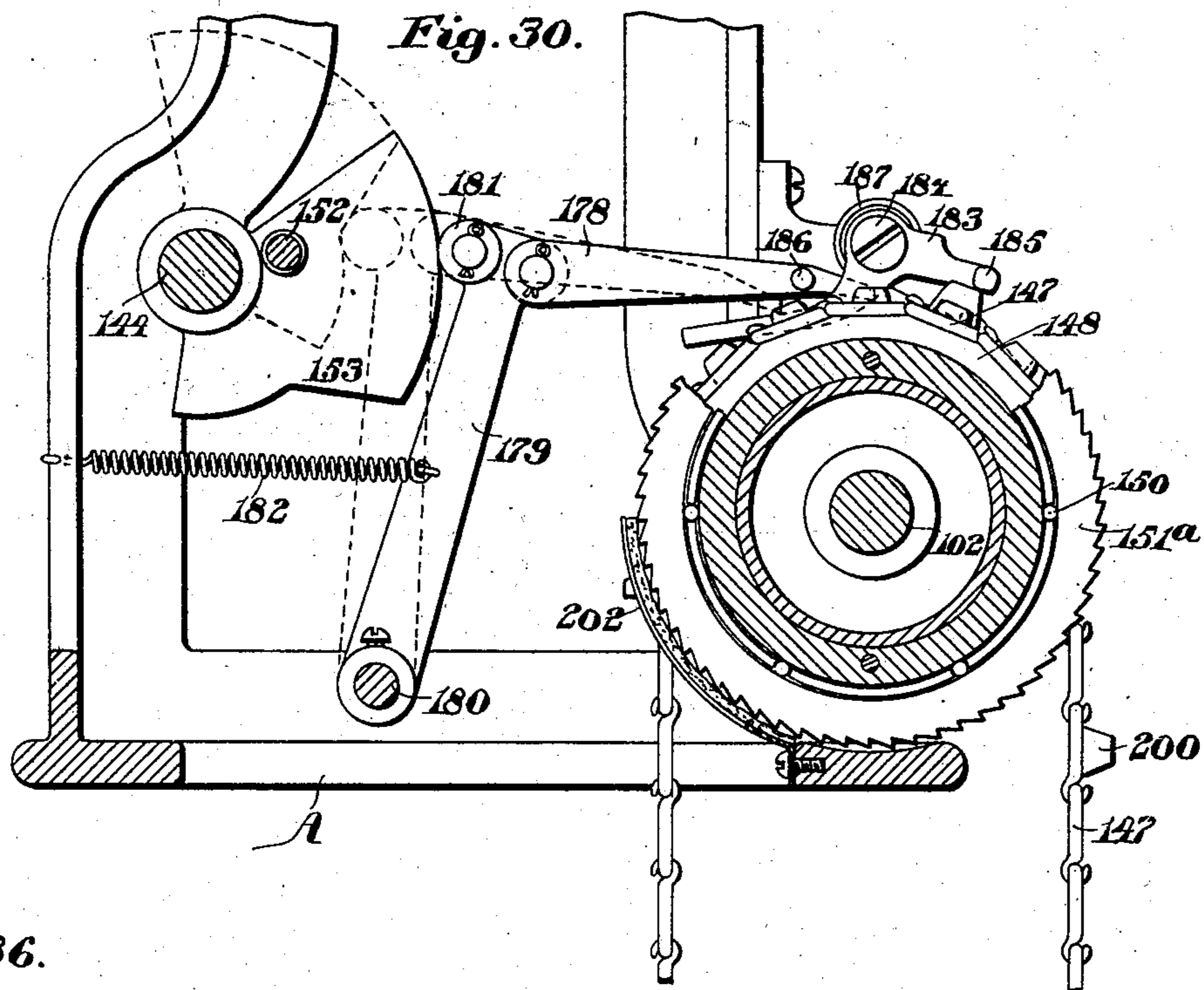


Fig. 36.

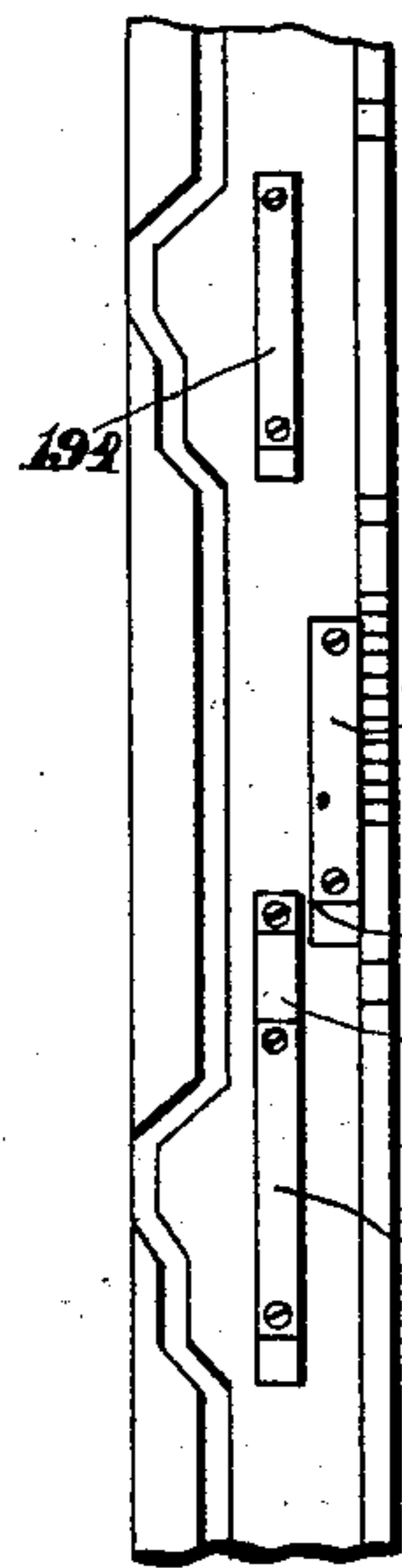


Fig. 35.

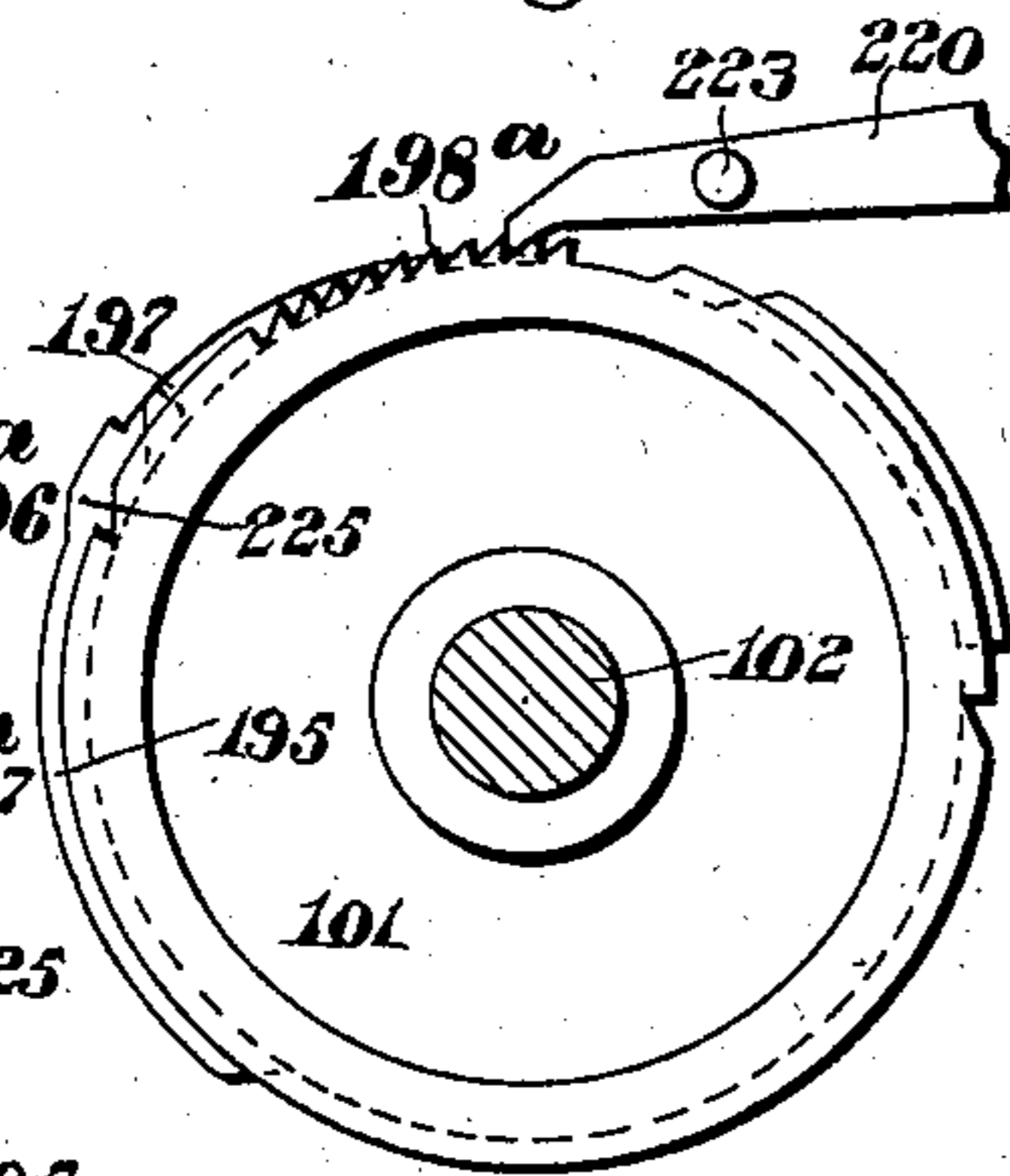
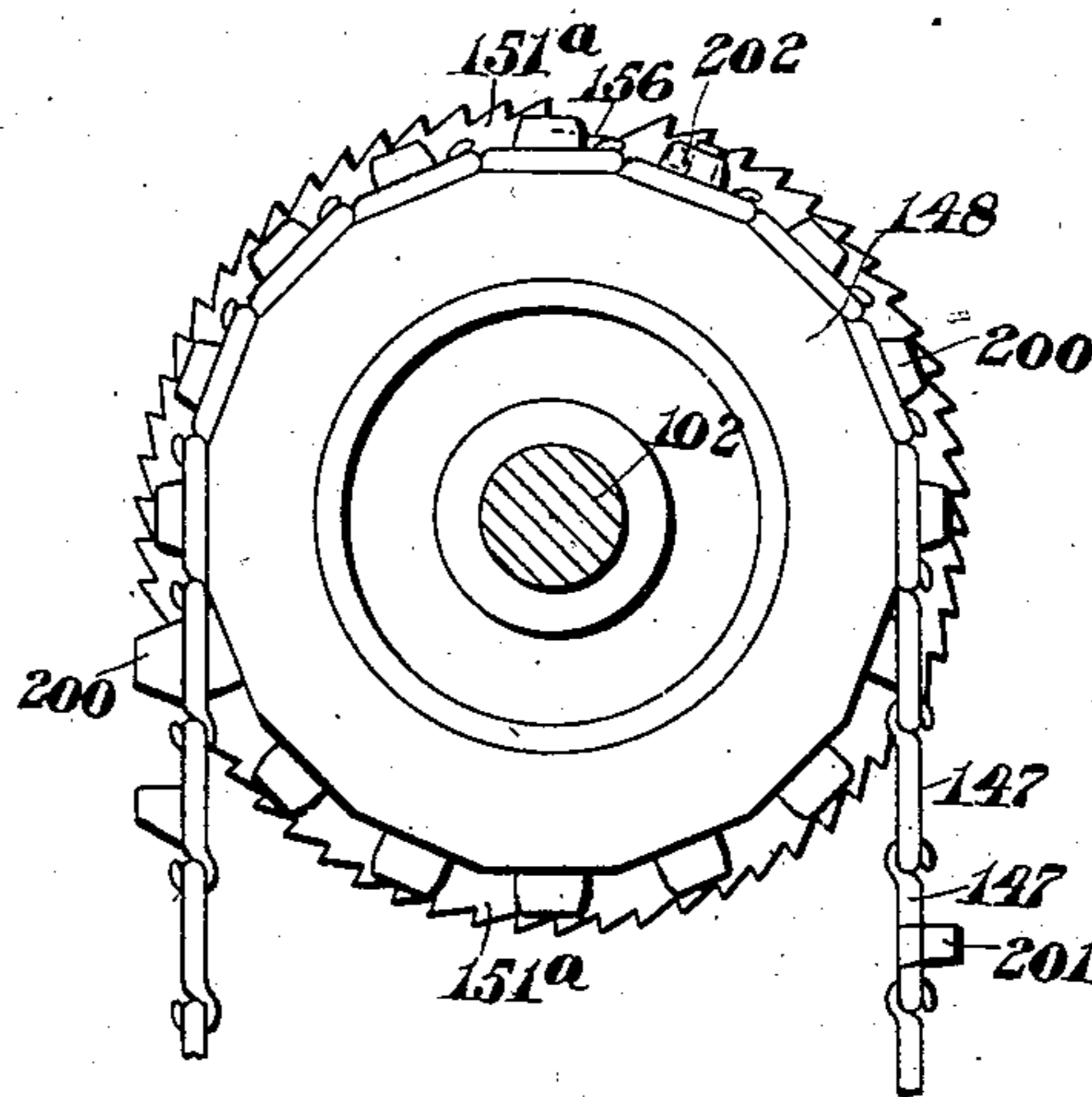


Fig. 34.



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No. 726,178.

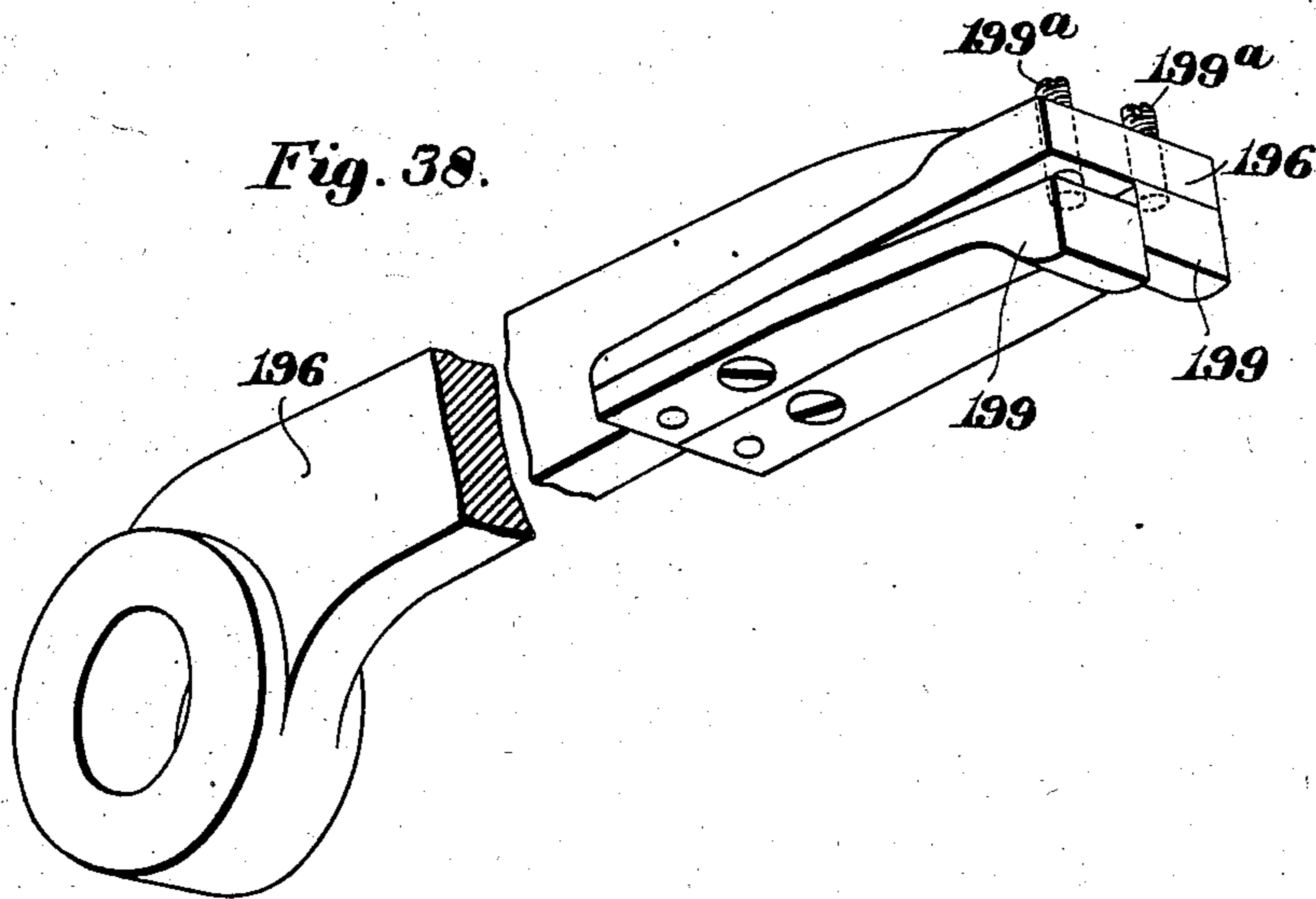
PATENTED APR. 21, 1903.

G. D. MAYO.
KNITTING MACHINE.

APPLICATION FILED DEC. 4, 1902.

NO MODEL.

16 SHEETS—SHEET 16.



Witnesses:
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Susan E. Haynes

Inventor:
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by *Maude L. Emery* *Atty.*

UNITED STATES PATENT OFFICE.

GEORGE D. MAYO, OF FRANKLIN, NEW HAMPSHIRE.

KNITTING-MACHINE.

SPECIFICATION forming part of Letters Patent No. 726,178, dated April 21, 1903.

Application filed December 4, 1902. Serial No. 133,823. (No model.)

To all whom it may concern:

Be it known that I, GEORGE D. MAYO, a citizen of the United States; residing at Franklin, in the county of Merrimack and State of New Hampshire, have invented an Improvement in Knitting-Machines, of which the following description, in connection with the accompanying drawings, is a specification, like characters on the drawings representing like parts.

My invention aims to simplify and improve knitting-machines, the invention being particularly useful in connection with circular-knitting machines employed in the knitting of seamless hosiery.

To enable my invention to be understood, I will first describe, in connection with the accompanying drawings, a machine illustrating one embodiment thereof, it being understood, however, that my invention is not to be limited to the particular embodiment disclosed.

In the annexed drawings, Figure 1 is a front elevation of a circular-knitting machine, illustrating one embodiment of my invention, the legs of the machine, also the supports for the thread-guides and tension device, being broken out to economize space upon the drawings. Fig. 2 is a left-hand side elevation of Fig. 1. Fig. 3 is an enlarged vertical section of the knitting-head of the machine, showing the needle, skeleton, and sinker cylinders, the cam-carrier, and the immediate associated parts. Fig. 4 in side elevation, partially broken away, shows the skeleton cylinder and the manner of building up the same. Fig. 5 is a horizontal sectional detail of Fig. 4, taken on the dotted line 5 5 thereon. Fig. 6 is a vertical sectional detail of Figs. 4 and 5, the section being taken on the irregular dotted line 6 6, Fig. 5. Fig. 7 is a perspective detail showing the formation of the inner holding-ring of the skeleton cylinder in which the bars are placed and clamped. Fig. 8 is a perspective detail of the lower end of one of the removable skeleton-cylinder bars. Figs. 9 and 10 are developed views of the cam-carrier and stitch-forming cam-surfaces and pickers. In Fig. 9 the picker 62 is in position at the right of the stitch-forming cam, while Fig. 10 shows the other picker 61 in position at the left of

the said stitch-forming cam. Fig. 11 is a horizontal section on the dotted line 11 11, Fig. 3, looking downward. Fig. 12 is a side elevation of Fig. 3 looking from about the left of Fig. 3. Fig. 13 is a top plan view of Figs. 3 and 12. Fig. 14 is a detail showing the segment 50 and switch-cam shaft 48. Fig. 15 is a section on the dotted line 15 15, Fig. 3, looking upward. Fig. 16 is a detail of a part of Fig. 12, showing the T-shaped lever 74^a in abnormal position. Fig. 17 is a view looking at the face of the picker-guide, showing the pickers in position, the view illustrating the action of the guide upon the pickers. Fig. 18 is a sectional detail on the dotted line 18 18, Fig. 15, showing the short shaft 80 mounted in the bed-plate. Fig. 19 is a sectional detail showing the pattern-shaft and parts mounted thereon. Fig. 20 is a detail in perspective, showing one of the sinkers detached. Fig. 21 is a top plan view of the sinker-cylinder. Fig. 22 is a cross-section of Fig. 21, the section being on the dotted line 22. Fig. 23 is an enlarged sectional detail showing the main shaft 40 and parts mounted thereon. Fig. 24 is a detail in side elevation, partially broken away, showing the frame portion of the machine with the various parts mounted therein. Fig. 25 is a sectional detail showing a part of the frame and with the means for actuating the pattern-shaft and multiplier mechanism; Fig. 26, a detail illustrating the friction means for controlling the movements of the pattern and multiplier wheels. Figs. 27, 28, and 29 are details showing the belt-shipping lever in different positions; Fig. 30, a sectional detail showing some of the parts shown in Fig. 25, the view being broken away to show the manner of mounting the multiplier-ratchet wheel and with the pawl 178 in different position. Fig. 31 shows the clutch-lever-operating wheel developed; Figs. 32 and 33, cross sectional details through the stitch-forming cam, showing the latter in its different positions; Fig. 34, a detail showing the pattern-sprocket and a part of its chain and the multiplier-ratchet. Fig. 35 is a sectional detail looking at the pattern-cylinder 101, Fig. 19, from the right. Fig. 36 shows the peripheral surface of the pattern-cylinder 35 developed;

Fig. 37, a sectional detail on the dotted line 37 37, Fig. 23; and Fig. 38, a detail to be referred to.

Referring first to Fig. 3, the needle-cylinder 1 is of usual construction, but is shorter than has been customary heretofore, it being slotted vertically at its outer face to receive the needles n of the usual latch type and provided, respectively, with heels n' , which are acted upon by the various cams to cause elevation and depression of the needles at the proper times in well-known manner. Preferably the butts of the needles throughout one half of the needle-cylinder are longer than the butts of the remaining needles to facilitate elevating one-half of the needles for the widening and narrowing processes. The needle-cylinder here shown surrounds a suitable carrier-cylinder 2, which is shaped to furnish a continuous ring-like support for the bottom of the needle-cylinder, thereby insuring stability of the latter while the machine is in operation. This carrier 2 is provided at one side with a depending lug 3, rigidly attached to the top of a vertically-movable supporting-rod 4, (see Figs. 1 and 2,) which rests at its lower end upon a suitable adjustable support, shown as an adjusting-screw 5, tapped into the base-plate A of the machine-frame.

The needle-cylinder carrier 2 is guided in its vertical movements by the tubular bearing 6, depending from the bed-plate B of the machine-head, and by the supporting-rod bearing 7, Fig. 2, adjustably mounted upon the frame base-plate A. The wide separation of the depending guide 6 and the supporting-post guide 7 permits the cylinder-support and its bearings to be made sufficiently free for easy vertical movement of the needle-cylinder without danger of any detrimental looseness or wobbling.

Surrounding the needle-cylinder is a skeleton cylinder S, between the bars 8 of which project the heels n' of the needles to be guided thereby. Skeleton cylinders in machines heretofore constructed have usually been formed by setting up the bars in a mold and casting the base about them, thus forming a rigid cylinder none of the bars of which are removable apart from the others. My invention comprehends a skeleton cylinder the bars of which are removable, so that in case of damage to any one or more of the bars the damaged bar or bars may be removed without destroying or taking down the cylinder as a whole and without removing the cylinder from the machine.

Referring to Figs. 4 to 8, inclusive, the skeleton-cylinder bars 8 are supported at their lower ends in vertical slots 9 in the exterior face of a ring 10, (see Fig. 3,) supported upon the bed-plate B. Surrounding the ring 10 and also the lower ends of the bars 8 is an outer ring 11, also resting upon the bed-plate.

Both the bars 8 and the separating ring portions 12 are shown as transversely grooved or

recessed at their outer faces, as at 13, Figs. 6, 7, and 8, to receive the lips 14 upon the clamping and locking segments 15, seated in the said outer ring 11. These clamping and locking segments 15 may be made to embrace any desired number of bars, and they are severally clamped in position by screws 16, tapped into the said ring 11. The outer faces of the locking-segments 15, which are acted upon by screws 16, are inclined upward and inward, and the axes of the clamping-screws 16 may also be inclined inward and downward, if desired, so that when the said screws are set up against the said segments the latter will be clamped downward as well as inward against and upon the cylinder-bars 8. This tends to seat and hold the said bars more firmly than would be the case were there simply an inward clamping action. Obviously should any bar become damaged it may be readily removed by releasing the clamping and locking segment 15, which holds it in position, and the release of any one bar involves the release only of such other bars as are clamped and locked by the same segment and which would vary according to the lengths of the segments. The separating portions 12 of the said inner ring 10, Fig. 7, are shown as provided at their lower ends with radially-extended foot portions 17, which underlie an inwardly-extending lip 18 upon the said outer ring 11, and the latter in turn is permanently secured, as by screws 19, to the bed-plate B. Thus the said inner and outer rings 10 11, together with the bars 8, held thereby, are permanently secured to the bed-plate, so that all the bars of the skeleton cylinder, excepting such as are temporarily released for the removal of one or more damaged bars, remain permanently locked in position in the machine. There is therefore no liability of inadvertently lifting or displacing all the perfect bars while removing and renewing damaged ones.

At their upper ends the skeleton-cylinder bars 8 are spaced and positioned by a device 20, resembling a crown-toothed gear, the teeth of which enter the spaces between the bars and hold the latter permanently and positively spaced. This crown-toothed spacing-ring 20 is in turn inclosed in and held by the crown-ring 21, the depending flanges 22 of which overlie not only the outer and inner faces of the spacing-ring 20, but also the upper end portions of the bars 8. Thus the said bars are locked at their upper ends not only against radial but also against lateral movement, the whole structure going to make up a skeleton cylinder at once as firm and rigid as though cast in a single base or otherwise made integral, as heretofore, yet which when necessary permits of the removal of any number of bars less than the whole number by simply removing the crown-ring 21 and spacing-ring 20 and releasing one or more of the locking and clamping segments 15.

Surrounding the skeleton cylinder S is the

rotatable cam-carrier C, which is seated upon the top of the outer skeleton-cylinder ring 11, heretofore referred to. This cam-carrier carries the needle-operating cams or cam-surfaces and is shown developed in Fig. 9.

As many needle-operating cams or groups of cams are provided as there are feeds to the machine, and in the machine shown I have provided for a single feed to take a single thread or group of threads, although a plurality of feeds may be used, if desired.

Referring now to Figs. 9 and 10, at the right thereof the cam-carrier C is cut away sufficiently to receive the cam-plate 24, the ends of which overlap the adjacent walls of the carrier at the sides of said cut-away portion, in which they are seated and to which they are secured in suitable manner, as by the screws 25, accessible at the exterior of the said carrier. This cam-plate 24 has a V-shaped central recess, the side walls 26 of which constitute needle-elevating cam-surfaces. Centrally arranged within this V-shaped recess is the V-shaped needle-depressing cam 27, presenting the needle-depressing cam-surfaces 28, which are opposed, respectively, to the needle-elevating cam-surfaces 26, leaving between them a track in which the heels of the needles may travel. The needle-depressing cam 27 is provided at its upper portion with laterally-extended guiding-ears 29, which overlie the top of the cam-carrier and serve to control the needles as they approach and leave the cam-surfaces 26 and 28.

The ends of the guiding-ears 29 are pointed to provide surfaces 30 and 31, which aid in depressing and lifting the needles during narrowing and widening, as will hereinafter more fully appear.

In the regular continuous rotation of the cam-carrier for straight circular knitting the needle-heels rest upon the top of the cam-carrier C, are engaged at each rotation of the said carrier by the leading needle-depressing cam-surface 28, and are depressed thereby to cause their needles to engage the knitting thread or threads and pull the same in loop form downward through the loops previously formed and held by the needles. As the heels of the depressed needles pass under the depressing-cam 27 they engage and ride up the needle-elevating cam-surface 26, which is beyond, and thereby elevate their needles to cause the shanks thereof to rise through the newly-formed loops preparatory to the formation of new loops.

The path between the needle elevating and depressing cam-surfaces, as will appear from Fig. 9, is always open for the passage there-through of the heels of the needles in either direction, and whatever be the direction of travel the needle-heels are acted upon and depressed by the said cam, thus insuring absolute uniformity of stitch in both directions of travel of the cam-carrier. This is not obtainable in practice with machines where sepa-

rate depressing-cams are employed for opposite movements of the cam-carrier. Furthermore, excepting to facilitate the transfer of work to the machine, the said depressing-cam 27 remains fixedly and permanently in position. Thus my machine is not open to any of the objections or difficulties which inevitably accompany the use of pivoted, swinging, or otherwise movable depressing-cams which require to be shifted at each reciprocation of the cam-carrier during narrowing and widening. My invention therefore not only greatly simplifies the first construction, but renders the machine much more durable and certain in operation.

To facilitate transfer of work, the needle-depressing cam 27 (see Figs. 9, 10, and 11) is mounted to slide radially in a suitable guideway upon the outwardly-projecting base-flange of the cam-carrier and is provided with suitable means, as the lever 32, Fig. 11, fulcrumed at 33 upon the said carrier, whereby the said depressing-cam may be withdrawn or removed from the path of the needle-heels when desired and without necessarily changing the direction of relative movement between the needle and cam to avoid depressing the needles and permit the said needles to be raised into one and the same elevated plane for transfer of work. I have herein provided a spring 34 to move the lever 32, so as to maintain the said depressing-cam normally in its innermost needle-engaging position, and when it is desired to elevate all the needles for transfer of work the said lever is pressed inwardly by the operator to withdraw the depressing-cam to permit the cam-carrier to be rotated sufficiently to elevate the depressed needles, after which the said depressing-cam may be released to permit its said spring to move it inwardly against the heels of the raised needles, against which it rests until the transfer has been completed. When the machine is again set in operation, the said depressing-cam travels around, pressing upon the heels of the needles, until it reaches the leading needle of the long-heel series, when the leading needle-depressing cam-surface 28 will engage said long-heel needles and will depress the same successively until the depressing-cam has traveled beyond and has cleared the series of short-heel needles, when it springs inwardly to its normal position close to the shanks of the needles, where it will thereafter engage and depress in regular order the heels of all the needles of both series. Thus whereas in machines as heretofore constructed, so far as known to me, it has been necessary when transferring to positively and manually operate the cams or needle-operating devices not only at the beginning, but also at the end of the transfer operation, with my construction as here shown after the depressing-cam has been withdrawn to permit of the raising of the needles to a uniform level the said cam thereafter and automatically at the proper time resumes its

proper operative position, requiring no further attention from the operator.

To rotate the cam-carrier, I have provided the same, Fig. 11, at its periphery with a pair
5 of preferably cushioned lugs 35 36, between which stands an operating-arm 37, fast on the gear-ring 38, which surrounds the cam-carrier and is seated in the bed-plate B, in which it is freely rotatable. This gear-ring is driven
10 by a bevel-gear 39, Fig. 3, fast on the main shaft 40 of the machine, (see Figs. 1 and 2,) which shaft is journaled in suitable bearings in the uprights *a a* of the frame. As the gear-ring is rotated it operates through the arm 37
15 and one of the lugs 36, referred to, to push before and with it the cam-carrier C, causing the latter to act upon the needles, as described. Upon the gear-ring 38 at a point in the vicinity of the depressing-cam 27 stands
20 a post 41, (see Figs. 3, 11, 12, and 13,) and to the top of this post is hinged at 42 the usual latch-ring 43, which surrounds the upper hooked ends of the needles, said ring being provided at its side opposite the hinge 42 with a
25 projecting arm 44, which when the said latch-ring is down enters a recess therefor provided in the upper end of a post 45, also mounted upon the cam-carrier 38, but at a point thereon diametrically opposite the post 41.

30 The posts 41 and 45 carry, respectively, the horizontally-arranged yielding or spring-controlled hold-down-pins 41^a, which at their inner ends overlie the crown-ring of the skeleton cylinder and hold the latter down in its
35 proper position upon the crown-toothed ring which surmounts the removable skeleton-cylinder bars.

The latch-ring at a point adjacent the post 41, Figs. 3 and 13, is provided with a thread-
40 guide 46, through which the thread is conducted to the needles within the said ring. In the operation of the machine this thread-guide should be always slightly in advance of the leading needle-depressing surface 28
45 of the depressing-cam 27, so that it may deliver its thread to the successive needles slightly in advance of the depression thereof.

Referring to Fig. 11, with the arm 37 in position against the lug 35 to rotate the cam-
50 carrier in the direction of the arrow thereon, said thread-guide 46, while not shown in said figure, but which is opposite the vertical center of the post 41, occupies a position slightly in advance of the leading edge of the needle-
55 depressing surface 28 of the stitch-cam 27 (see Fig. 10) to deliver the thread to each needle immediately before it is depressed. In narrowing and widening, however, when the
60 cam-carrier reciprocates first in one and then in an opposite direction it is necessary to shift this thread-guide 46 from one to the opposite side of the needle-depressing cam 27, so that the thread will always be delivered to the needles slightly in advance of the de-
65 pression thereof irrespective of the direction of movement of the cam-carrier. To accomplish this, I have separated the lugs 35 36 on

the cam-carrier to provide a lost motion between the gear-ring 38 and the said cam carrier C, which causes the said gear-ring upon
70 reversal of its movement to travel a given distance sufficient to shift the thread-guide 46 automatically from one to the other side of the depressing-cam 27 before the said cam-
75 carrier is engaged and rotated with the gear-ring, thus insuring correct position of the thread-guide at all times, whether the cam-carrier be rotated continuously in one direction or reciprocated in opposite directions.

In narrowing and widening, as for the for-
80 mation of the heel and toe of a stocking, it is necessary first to raise approximately one half the needles above the path of movement of the depressing cam-surfaces and to operate by reciprocatory movement of the cam-carrier
85 upon the remaining half of the needles only. It is further necessary during such reciprocations of the cam-carrier first to raise one needle at each reciprocation or change of direction of movement of the said carrier during the nar-
90 rowing process, thereby gradually to shorten the successive courses knit, and for subsequent widening to depress or bring again into operation one or more needles at each reciprocation of the cam-carrier for the gradual lengthen-
95 ing of the successive courses knit until the heel or toe has been completed. The raised needles are then brought again to an operative level for the resumption of circular knitting. To accomplish this, I have mounted upon the
100 gear-ring (see Fig. 11) a bearing 47, in which is mounted a short horizontal shaft 48, provided at its inner end (see Fig. 9) with a laterally-extended switch-cam 49, which normally stands in elevated position, as shown
105 in dotted lines, in which position during circular knitting it travels above and clears the heels of all the needles. At its outer end the said short shaft 48, Figs. 11, 13, and 14, has formed therein a segmental series of teeth,
110 which are engaged by a toothed segment 50, pivoted at 51 to the side of said bearing 47 and provided with a laterally-extended arm 52, which carries an outwardly-projecting pin 53, adapted to be engaged at the proper times
115 by suitable operating means upon the bed-plate of the machine. In the present instance for such operating means I have provided a vertical shaft 54, (see Figs. 11 and
120 15,) journaled in said bed-plate and provided with oppositely-extended lifting and pull-down cam-surfaces 55 56. When the said shaft 54 is turned into its dotted position, Fig. 11, to swing its pull-down cam-surface 56 into the path of travel of the pin 53,
125 said pin will engage said cam-surface and travel downward thereon and will thereby turn its segment 50 to throw the switch-cam into its depressed or full-line position, Fig. 9, with its point slightly below the top of the
130 cam-carrier and of course below the needle-butts resting thereon. In this position said switch-cam will upon rotation of the cam-carrier engage all the long-heel needles in the

machine and raise the latter to a level above the path of movement of the depressing-cam 27, so that as the latter rotates it will fail to act upon the raised needles. The needles thus raised are held in their elevated positions by the usual offsets n^2 , Fig. 3, of the needles rising above the usual spring friction-band n^3 , which encircles the needle-cylinder and needles. To again lower the raised needles, the short shaft 54 is turned into position to swing the other or lifting cam-surface 55 into the path of movement of the pin 53 of the toothed segment 50, so that the said pin will engage and ride upward on said cam-surface 55 and will thereby lift its arm 52 and turn the switch-cam 49 into its dotted-line position, Fig. 9, where it will engage the heels of the raised needles and will depress the same upon the cam-carrier.

The switch-cam shaft 48 (see Fig. 11) is provided with a radially-extended pin or screw 57, which works in a spiral slot 58 in the bearing 47, so that as said switch-cam is turned from its depressed into its elevated position preparatory to drawing down the raised needles at the close of the narrowing and widening processes said switch-cam will also be moved inward into position to engage any short-heel needle which may have been left in raised position at the close of the widening and will draw the same, together with the others, down into the operating level, where they will be engaged by the depressing-cam 27.

The switch-cam segment 50 may be provided with suitable friction means, as the plate 59, to hold the said cam frictionally in either of its extreme positions.

For the formation of the heel and toe of a stocking it is necessary gradually to reduce the number of needles operated upon while narrowing and similarly to increase the number of needles operated upon while widening. This I accomplish by the following-described means. (See Figs. 2, 11, 16, and 17.) Upon the oppositely-extended foot portion of the post 41, which carries the thread-guide, hence movable with the gear-ring, I have arranged two freely-rotatable vertical shafts 60, the upper ends of which are slotted vertically to receive the needle-pickers 61 62, pivotally mounted at 63 in said shafts to swing vertically. These pickers at their free ends, adjacent the needle-cylinder, are provided with heads (see Figs. 9 and 17) which have upper and lower needle-engaging portions 64 65. As here shown, these needle-engaging portions are notch-shaped, and the notches may be made of the same depth to engage, respectively, the heels of the same number of needles, or, as herein shown, the lower notch may be deeper than the upper notch, whereby it may engage two or more needles, as desired, while the upper notch ordinarily will engage a single needle. These pickers 61 62 project, respectively, through the wings of a vertically-positioned guide-plate 66, secured to the inner face of the post 41, the open-

ings in said guide-plate next the post 41 being bounded, respectively, by the converging guide walls or surfaces 67 68, terminating, respectively, at the adjacent ends in the horizontal pockets or slots 69, as best shown in Fig. 17. At their outer portions the said openings are respectively bounded by the downwardly and outwardly inclined guide walls or surfaces 70. The lengths of these pickers are such that when projecting radially inward the free ends thereof will just clear the skeleton cylinder, and the heels of the needles, which project outward through and beyond the said skeleton cylinder, will overlie or underlie the heads of the pickers, so that during circular knitting said pickers rotate idly with the gear-ring. The separation of the vertical picker-carrying shafts 60 is less than the amount of lost motion between the gear-ring and the cam-carrier, so that during narrowing and widening at each change of direction of movement of the gear-ring the lost motion between it and the cam-carrier operates to carry first one and then the other of the pickers into position in front of the said needle-depressing cam 27 and in each case trailing the other picker upon the outside of the said depressing-cam; but neither picker can be trailed behind the needle-depressing cam without causing it to be swung about its vertical axis 60 by and to clear the said cam, and this swinging movement of such picker brings it against the outer downwardly-inclined guide-surface 70 of the guide-plate 66, which causes the swinging picker to be depressed into its lowermost position, as shown at the right in Fig. 17. When, therefore, the direction of reciprocation is again changed and the depressed picker is by the lost motion between the gear-ring and cam-carrier moved into position in front of the needle-depressing cam, it will be in its said lowermost position, where its upper notch 64 will engage the heel of the first needle of the lower or knitting series. Since the needles do not rotate, this engagement of the free end of the depressed picker with the said first needle acts to stop said free end, so that continued rotation by the gear-ring of the pivotal end of said picker causes the latter to swing about its vertical axis 60, but in an opposite direction from before, and as it swings it engages the upwardly-inclined guide-face 68 of the opening in the guide-plate through which it extends, which causes the said picker to rise as it swings, and as it rises it takes with it, of course, the needle which it has engaged, thus lifting said needle above the apex of the pointed end of the depressing-cam 27 and delivering it to the upper inclined face 31 thereof, which continues to raise the needle to the top of the said cam, where it remains held frictionally by the bands n^3 referred to. As the active end of the rising picker delivers the needle-heel to the cam-surface 31 the swinging movement of the picker continues sufficiently to carry it into the clearing-notch 69 of the

guide-plate, in which it moves until it has freed itself from the needle-heel, when it is automatically swung back to a central radial position by a C-shaped spring 72^a, encircling the picker-shaft bearing, said spring at its ends bearing upon two studs 72 and 73, the former upon the bearing and the latter upon the shaft 60 and projecting outward through said bearing. As the picker-shaft is rotated in either direction one end of the spring is carried by the stud 73 away from the other end, which remains seated against the stud 72 of the bearing, and as soon as the picker is released the spring returns the stud 73, which was moved to its normal position, where it remains centered between the ends of the spring. The picker after having been raised by the needle which it engaged to the level of the clearing-notch 69, which is substantially central vertically between the limits of movements of the picker, remains held frictionally in such central position by a vertically-movable spring-actuated pin 74, Fig. 3, arranged in the picker-shaft and engaging a notch in the under side of the picker. Other notches to be engaged by the same spring-actuated pin serve to retain the picker frictionally in its extreme elevated and depressed positions. Thus into whatever vertical position it is moved by its several guide-surfaces the picker is there held until acted upon by another guide-surface and moved freely—i.e., without opposing force or spring—into a different position. Following the narrowing it becomes necessary for subsequent widening to depress one or more of the elevated needles at each ensuing reciprocation of the cam-carrier, thereby gradually to lengthen the courses knit until circular knitting is resumed. The leading picker, therefore, at each reciprocation of the machine during widening must be elevated to engage the endmost needle of the elevated series and depress the same. To accomplish this, I have provided a T-shaped shifting-lever 74^a, Fig. 16, pivoted centrally at 75 to the outer face of the post 41. The oppositely-extended horizontal arms of the said T-shaped lever overlie the extended tail ends of the pickers 61-62, while the central depending arm 76 of the said lever is arranged to be acted upon at times by a radially-shiftable cam 77, (see Figs. 11, 13, and 16,) mounted to slide in the bed-plate B. This cam has a pin 78, which enters the slotted end of an arm 79, fast on the upper end of a short shaft 80, Figs. 15 and 18, which extends downwardly through the bed-plate. When this cam-plate 77 is moved radially inward close to the gear-ring 38 and into the path of rotation of the depending arm 76 of the picker-shifting lever, it engages and swings the said depending arm to rock the said lever and cause the leading horizontal arm thereof to depress the tail end of the leading picker and elevate the free end thereof, so that just before the reciprocating movement is completed the lower notch 65 in said

picker will engage the projecting heels one or more, herein two, of the needles of the stationary elevated series. This causes the said picker to be swung inwardly about its vertical axis 60, and in swinging it is acted upon by the downwardly-inclined guide-surface 67, Fig. 17, which causes the said picker to be depressed to its middle position, where it enters the clearance-recess 69, as before, thereby depressing the needles engaged by it to a level where they will be engaged by the lowermost leading cam-surface 30 of the depressing-cam 27, which takes them from the picker and completes the downward movement thereof into the plane of the active needles, where they are acted upon by the depressing-cam 27 prior to the end of the reciprocatory movement. Before coming to a stop the cam-carrier is moved beyond the end of the lowermost or active series of needles sufficiently to permit the direction of movement to be reversed and the lost motion between the gear-ring and cam-carrier to be taken up to shift the thread-guide and pickers before the return movement commences. Upon reversal for the next reciprocation the other depressed picker, now brought into leading position, engages the first of the depressed series of needles and lifts the latter into elevated inactive position, the needle so elevated being one of the needles just previously depressed by the companion picker near the close of the preceding reciprocating movement. In the further return of the reciprocating cam-carrier the depending arm 76 of the T-shaped picker-actuator meets the stationary cam 77, but at the opposite end thereof from the previous movement, and is tipped thereby into an opposite dotted position, Fig. 16, thereby to depress the tail end of the now leading picker, causing the free end thereof, being the same picker which at the beginning of said return movement had raised a needle into inactive position, now to be elevated, so that as it approaches the end of the return movement its lower notch 65 will engage one or more, herein two, endmost needles at the other or opposite end of the elevated series and depress the latter into position to be acted upon by the needle-depressing cam 27 before such return movement ceases. Thus during the reciprocatory movements of the machine when narrowing the depressed leading picker engages the leading needle of the lowermost or active series and elevates the said needle to shorten the courses knit, while during widening the said depressed leading picker at each reciprocation first elevates the leading needle of the active series just as in narrowing, and before the end of the same reciprocation it is elevated by the T-shaped actuator described to engage a plurality of needles at the rear end of the elevated series and depresses them to join the active series, thus widening the successive courses knit at each reciprocation by as many needles as the number depressed exceeds the

number raised. To rock the vertical shaft 54, Fig. 11, carrying the raising and pull-down cam-surfaces 55 and 56, which control the switch-cam 49, and also to operate the shaft 80, which controls the radially-movable cam 77, for positioning the pickers, as described, I have extended the said two shafts through to the under side of the bed-plate, as best shown in Fig. 15, which is a view looking at the under side of the bed-plate.

Secured to the under side of the bed-plate (see Figs. 3 and 15) is a series of lugs 81, which furnish bearings for the suspended ring 82, having a short rotary reciprocatory movement. This ring is provided at its periphery with a pair of depressions 83 84, separated by a projection 85, which coöperates with the two arms of a yoke 86, fast on the lower end of the shaft 80. When it is desired to shift the said radially-movable cam 77, this suspended ring 82 is rotated slightly, causing the projection 85 to engage the yoke 86 and swing the latter to rotate the shaft 80 and slide the cam outwardly, it being restored to its original position by a reverse movement of the said suspended ring. The said ring is also provided with a second projection 87, which engages a finger 88, fast on the lower end of the said shaft 54, a spring 89 acting to hold said finger always in contact with the periphery of said ring.

In the operation of the machine the ring 82 is first shifted in the direction of the arrow thereon, Fig. 15, to cause the projection 87, engaging the finger 88 on the shaft 54, to turn said shaft and swing the cam-surface 55 into position to shift the switch-cam and cause elevation of substantially one-half the needles preparatory to narrowing. This movement of the ring, however, is insufficient to bring the projection 85 against the yoke 86 of the radially-movable cam 77, said ring remaining in this intermediate position until the narrowing has been completed, when preparatory to widening the said ring is given a further movement in the same direction as before to cause said projection 85 to engage the yoke 86 and rotate the shaft 80 to slide the cam 77 into position to act upon the T-shaped lever 74^a and operate the latter to cause gradual depression of the elevated needles for the widening. The widening having been completed, the suspended ring 82 is returned by a single movement to its original position, acting thereby and substantially simultaneously first to withdraw the radially-movable cam 77 and then to swing the finger 88 and cause the cam-surface 56, Fig. 11, to be brought into position to depress the remaining elevated needles. This suspended ring 82 may be rotated, as described, by any suitable means. I have herein connected the same (see Figs. 15 and 2) by a link 90 with an arm 91 on a vertical shaft 92, journaled in suitable bearings 93. The lowermost bearing 93 is located on the base A of the

machine-frame, while the topmost bearing 93 is secured to the thread-guide post 94, which latter is fixedly positioned upon the crown-plate of the frame or a bracket secured thereto. This vertical ring-actuating shaft 92 is provided at its lower end with a toothed segment 95, which is engaged by an intermeshing segment 96 on a hub 97, loosely surrounding the bearing for the needle-cylinder-supporting post 4 and provided with an oppositely-extended arm 98, having a roller-stud 99, which enters a path-cam 100 (see Fig. 19) in a pattern-cylinder 101. This cylinder is fast on a pattern-shaft 102, journaled in bearings 103 on or secured to the base A of the frame.

Reverting to Fig. 3, the sinkers 104, one of which is shown separately in Fig. 20, consist of a single member struck out from sheet metal and shaped to present the inwardly-extended parallel guiding parts or legs 105, the outer upturned lip 106, and work-engaging portion 107.

The sinker-cylinder K (see Figs. 3, 21, and 22) will best be understood by describing its mode of formation. Said cylinder is first cast with an outwardly-extended flange or lip 108 at its upper end. The cylinder is then placed in a lathe, and a groove 109 is turned in its inner face, said groove being located just below the horizontal middle of the said flange 108, the same being turned to a depth somewhat in excess of the thickness of the cylinder proper, as best shown in Fig. 22. The flange 108 is then by suitable means slotted vertically, as at 110, said slots extending inward to the outer periphery of the cylinder proper, which causes them to cut through into the groove 109, and thereafter (or it may be previously) the top end of the said cylinder is slotted radially, the radial slots being shown at 110^a and registering with the vertical slots at the circumference of the cylinder. There is thus provided a single integral or one-part sinker-cylinder, presenting at its outer face the vertical and radial slots 110 110^a to receive and properly space the sinkers. The sinkers are inserted from the outside of the cylinder, the lower legs 105 of the sinkers entering the groove 109 first turned in the interior of the cylinder and the upper legs 105 entering the radial slots milled in the top end of the cylinder. The said upper legs of the sinkers have long side bearings furnished by the long walls of the radial cuts in the top end of the cylinder, while the lower legs of the sinkers have the best possible top and bottom bearing-surfaces provided for them by the turned walls of the annular groove 109 in the inner wall of said cylinder, it being recognized that a turned surface is smoother and better for a sliding action such as required by the sinker than any milled or sawed surface such as ordinarily produced. Furthermore, the formation by turning of the top and bottom guiding-surfaces for the sinkers insures absolute accuracy and uniformity of alinement and

action for all the sinkers, which is rarely, if ever, possible where the guiding-surfaces are separately produced by sawing or milling.

The sinker-cylinder described is extremely simple in construction, furnishes uniform guiding-surfaces, and also presents the greatest possible strength and accuracy in the vicinity of the sinker-guiding slots or grooves.

The sinker-cylinder is wholly separate and distinct from the needle-cylinder and is dropped within the latter and supported by its projecting vertically-slotted portion 108, resting upon the top of the needle-cylinder, as shown in Fig. 3.

Outside the needle-cylinder, Fig. 3, and resting upon a ledge 111, near the top of said cylinder, is an outer ring-like sinker-guide 112, the same being radially grooved at its upper side and in alinement with the radial grooves of the top of the sinker-cylinder, so that the sinkers may rest and be guided therein. This outer supporting and guiding ring 112 may be secured in position by screws 113, acting against the face of the needle-cylinder.

Resting upon the top of the guiding and supporting ring 112 is a rotatable sinker cam-ring 114, provided at its under side with a cam-groove which receives the upturned operating-fingers 106 of the sinkers, said cam-ring having also a depending peripheral lip or flange 115, which surrounds the ring 112 and furnishes proper bearings to enable said cam-ring to be rotated by and with the needle-cam carrier. The cam-groove in this ring 114 is shaped in usual manner to cause the sinkers to be withdrawn at the knitting-point and thereafter to be projected inward to carry the loops over the hooks of the needles, they being then withdrawn slightly in a manner common to knitting-machines of this type. This cam-ring (see Fig. 13) is rotated by two adjustable stops 116, mounted in brackets 117 on its periphery and adapted to be acted upon by the post 45, rising from the gear-ring 38. As the gear-ring rotates it carries with it the sinker cam-ring, and during narrowing and widening each reversal of movement of the gear-ring causes a corresponding reversal of movement of the sinker cam-ring with sufficient lost motion to provide for the adjustment of the cam-ring properly with reference to the knitting-point, it being in this respect similar to other machines of the class.

Having now described the knitting devices and their operation, I will take up the means for governing the operation thereof.

Turning to Figs. 1, 2, 23, and 24 the main shaft 40, hereinbefore referred to and upon which the driving-gear 39 is mounted, has splined upon it the slidable clutch member 119, grooved at its periphery to receive the forked end of the clutch-lever 120, (see Fig. 1,) pivoted at 121 upon a bracket of the frame and having its oppositely-extended arm 122 provided with a roller-stud 123, adapted to be acted upon and moved by the clutch-operating wheel 188 on the said pattern-shaft 102, referred

to. This slidable clutch member is provided at its opposite faces with engaging lugs 124 125, the lug 124 when the said member is slid to the right, Figs. 1 and 23, entering a cooperating recess in the opposing head of a sleeve 126, surrounding the outer end of the said shaft 40 and carrying upon its outer end the fast pulley 127. This fast pulley, which may be provided with a handle 128, is cupped at its inner face and is provided thereat with an inwardly-extended stud 129, (shown also in Fig. 24,) upon which are loosely mounted two pinions 130 and 131, made integral or otherwise attached one to the other so that they will rotate in unison. The pinion 130, which is preferably smaller than the pinion 131, meshes with a gear 132, formed upon the end of a sleeve 133, which surrounds loosely the sleeve 126, upon which the driving-pulley 127 is mounted, said sleeve 133 being firmly clamped in the supporting-bearing for the shaft (see Fig. 37) and itself furnishing the bearing-surface within which the said sleeve 126 revolves. The gear 132 therefore is a fixed or stationary gear, and in the rotation of the drive-pulley 127 the pinion 130, carried thereby, is rolled about and upon the stationary gear 132. The pinion 131, referred to as integrally united with the pinion 130, meshes with an intermediate pinion 131^a, mounted on drive-pulley 127, said intermediate pinion 131^a meshing with a gear 134, loosely mounted upon the fixed sleeve 133 and in turn secured to and for rotation with the intermediate pulley 135, also loosely mounted upon the said fixed sleeve 133. Thus when the driving-belt is upon the high-speed pulley 127 the sleeve 126 and the slidable clutch member 119, if engaged therewith, will rotate in unison. If, however, the belt be thrown upon the intermediate pulley 135, the said pulley in its rotation will operate through its gear 134 to turn the pinions 131 and 131^a and by them the smaller pinion 130, causing the latter by meshing with the stationary gear 132 to rotate the high-speed pulley 127 in the same direction as before, but at a reduced speed, the difference in speed depending upon the proportions of the several gears and pinions involved. I have also provided a third loose or idle pulley 136, loosely mounted upon the hub of the intermediate pulley 135 and upon which the belt may be run when the machine is to be stopped. The driving-sleeve 126 at its clutch end has formed upon it a gear 137, (see Figs. 1 and 24,) which meshes with a back gear 138, mounted loosely upon a stud 139 on the frame. This back gear has a crank-pin 141, joined by a connecting-rod 142 (see also Fig. 2) to a segmental gear 143, fast on a shaft 144, journaled in the frame. This segmental gear in turn meshes with a clutch-gear 145, (see Figs. 1 and 23,) loosely mounted upon a bushing 146, which is clamped in the frame and furnishes a long journal-bearing for the main shaft. The said bushing is flanged outwardly at its end to retain the

clutch-gear 145 in position. The clutch-gear 145 is provided at its face adjacent the slidable clutch member 119 with a suitable recess for the reception of the lug 125 on the said clutch member. Thus whenever the machine is in operation and whether the belt be upon the high-speed pulley 127 or upon the intermediate pulley 135 rotation of the back gear 138, through its connecting-rod 142, causes reciprocation or back-and-forth movement of the gear-segment 143 and through it a corresponding back-and-forth or reciprocatory movement of the clutch-gear 145. Thus there is provided at one side of the slidable clutch member a member 126, which rotates continuously in one direction, but at varying speeds, determined by the particular pulley which for the time being is employed to drive it, and at the opposite side of said slidable clutch member a clutch-gear 145, which reciprocates constantly and also at a rate of speed determined by the particular driving-pulley employed.

During circular knitting the slidable clutch member 119 is retained in engagement with the continuously-rotating clutch member 126, and when the reciprocating movements of the cam-cylinder are required for narrowing and widening, as heretofore described, the said clutch member 119 is slid to the left, Fig. 23, into engagement with the clutch-gear 145, causing the latter to impart its reciprocatory movements to the said slidable clutch member and main shaft, thence through the driving-gear 39 to the gear-ring and cam-carrier described. I have thus provided a speed-reducing mechanism which is exceedingly compact and is arranged wholly within the diameter of and concealed by the driving-pulleys, where the said mechanism is kept free from dust and also by its concealed gears guards against accident such as may result where gears are exposed.

In the operation of the machine it is desirable that the belt be shifted from the high-speed pulley 127 to the intermediate or reduced-speed pulley 135, so that the speed of the machine shall be reduced just previous to and during the continuance of the reciprocatory or narrowing and widening movements. This is accomplished, also the shifting of the clutch member, together with the rotation of the depending cam-ring 82, by a suitable pattern mechanism properly adapted for the purpose and which may be of suitable or desired type or construction. In the embodiment of my invention here shown and described this pattern mechanism includes a pattern-chain (shown at 147, Figs. 1 and 2) passed over a suitably-toothed sprocket-wheel 148, Fig. 19, loosely mounted upon the pattern-shaft 102, hereinbefore referred to. Fast to the side of the said toothed sprocket-wheel 148 is secured a ratchet-wheel 149, arranged to be operated by a pawl 151, (see Fig. 25,) connected at 152 with a cam 153, fast on the pivotal shaft 144 of the reciprocatory seg-

mental gear 143. The said pawl 151 therefore receives a forward-and-back movement coincident with the reciprocatory movements of the segmental gear which produces the reciprocating movements of the machine. To control the movements of said ratchet and sprocket wheels, I provide a pair of friction-springs 154, Fig. 26, which embrace and engage, respectively, the ratchet and sprocket wheels, which constitute, in effect, a single structure always rotating together. The belt-shifting mechanism, which is operated by or from the pattern-chain, (see Figs. 1 and 24,) comprises a usual belt-shifting lever 157, fulcrumed at its lower end upon a stud 158. This belt-shifting lever (see Figs. 24 and 25 to 29) is provided with a spring 159, which tends constantly to throw the said lever to the left or in a direction to shift the belt from the high-speed pulley to the intermediate pulleys, such spring-actuated movement being normally resisted by a forwardly-projecting stud 160 on the said lever and resting against a trip-dog 161, pivoted at 162 on the frame and held normally in elevated or holding position by a spring 163. The said trip-dog also has an arm 164, which underlies the tail of an intermediate lever 165, (shown best in Fig. 24,) pivoted at 166 on the frame and having its active end standing in position over and close to the periphery of a pattern-wheel 167, which is fast on the pattern-shaft 102. (See Fig. 19.) Upon the periphery of this pattern-wheel, Fig. 24, are diametrically opposite lugs 168, either of which may be brought into position under and to lift the active end of the said intermediate lever 165 and by its tail end depress the arm 164 of the trip-dog 161 and move the latter to free the belt-shifter, and when freed said belt-shifter, under the action of its spring 159, will be moved into position to carry the belt from the high-speed pulley onto the intermediate-pulley movement, it being there arrested by contact of the post 160 with a step 169 on the said dog 161. (See Fig. 28.) The belt-shifter may be released from this intermediate position and be moved by its spring to carry the belt upon the idle pulley by any lug upon the pattern-wheel 167—such, for instance, as is indicated in dotted lines at 170, Fig. 24—properly positioned thereon to stop the machine when desired. I have also provided hand-operated means for moving the belt-shifter, the same (see Figs. 1 and 24) comprising a rock-shaft 171, journaled in a suitable bearing 172 on the frame and provided at its outer end with a laterally-extended handle 173. At its inner end (see Fig. 24, also Figs. 27 and 29) said rock-shaft is provided with a depending arm 174, which stands behind the stud 160 on the belt-shifting lever. Obviously if the said handle 173 be raised the depending arm 174 will be swung to the right, Fig. 29, and will throw the belt-shifting lever toward or upon the high-speed pulley, Fig. 27, where it will be automatically caught and held by the trip-dog referred

to. Depression of the operating-handle 173 causes the depending inner arm 174 to engage a pin 175, Figs. 27 and 29, on the latch-dog and depress said dog to release the post 160 and belt-shifting lever to permit the latter under the action of its spring to move to the left upon the intermediate pulley, as in Fig. 28, or the idle pulley, as in Fig. 29. The belt-shifting lever after having moved upon the intermediate pulley may be returned at the proper times again to its outermost position to place the belt upon the high-speed pulley by other beveled-faced lugs 176, Figs. 1 and 24, which in the rotation of the said pattern-wheel engage the shifter-post 160 from behind and force the shifter into its outermost position just as it is thrown outward by the hand-lever described.

The pattern-shaft 102, upon which, as heretofore stated, the chain sprocket-wheel is loosely mounted, may itself be moved by a ratchet-wheel 177, fast thereon, (see Fig. 19,) and arranged to be moved by a pawl 178, (see Fig. 25,) connected with the upper end of a swinging lever 179, pivoted at 180 upon the frame. This pawl-carrying lever 179 also has a roller-stud 181, which is held by a spring 182 against the face of the cam 153, heretofore referred to as mounted upon the pivot-shaft of the segmental gear 143 and reciprocable therewith. Thus at each reciprocation of the said segmental gear the said pawl 178 is also reciprocated to ratchet around the wheel 177 and the pattern-shaft 102 if said pawl be in engagement with said ratchet-wheel. The said pawl, however, is normally disengaged from its ratchet-wheel by a controlling-lever 183, (see Fig. 25,) pivoted at 184 in the frame and having its forward end at the right provided with a laterally-extended lug 185, which (see Fig. 1) overlies the pattern-chain. At its inner end, Fig. 25, said controlling-lever underlies a pin 186 on the side of the pawl 178, and a spring 187, encircling the hub of the said controlling-lever and connected therewith and with the arm, maintains said lever normally in position with its said inner end elevated and holding the said pawl out of engagement with its ratchet-wheel.

At the proper times in the operation of the machine a lug 200 upon one of the links of the pattern-chain (see Fig. 30) reaches the lug 185 upon the said controlling-lever, lifts the latter, and thereby drops the said pawl 178 into engagement with its ratchet-wheel 177, whereupon the said pawl imparts a step-by-step rotation to said ratchet-wheel and the pattern-shaft 102, with the various parts mounted thereon. This step-by-step rotation of the pattern-shaft continues for a period and is determined by the number of links of the pattern-chain provided with the required lugs which come into position or by the length of time during which any single chain-link having a proper lug is maintained in position

under and to hold the said controlling-lever in its elevated or abnormal position.

The pattern-shaft 102 at the left of the sprocket-wheel, Figs. 1 and 19, has fast upon it a clutch-shifting wheel 188, which is provided at its periphery with a plurality of pairs (herein two) of slanting peripheral notches 189 (see Fig. 31) with laterally-extended inclined cam-faces 190 to direct the stud 123 on the clutch-shaft lever 122 into the said openings. The said clutch-shifting-lever stud 123 stands always at one or the other side of this wheel 188, and as the latter is rotated by the ratchet-wheel 177, referred to, the said pin is engaged first by the cam-lug at one side of the wheel and thrown through to the opposite side thereof and then at the proper time is engaged by the cam-lug at the opposite face of said wheel and thrown back again to the first side thereof or into its original position, thereby to shift the slidable clutch member 119 first into engagement with the continuously-rotating clutch gear or member and then into engagement with the opposite or reciprocatory clutch gear or member to impart to the machine continuous rotary or reciprocatory movements. The timing of these movements is determined by the rotation of the said wheel 188, and this in turn is determined by the periods of operative engagement of the pawl 178.

Referring to Fig. 26, a spiral spring 200, seated in a part of the frame, carries at its end two friction-disks 201, which are pressed by the said spring respectively against the adjacent faces of the chain-feed ratchet 177 and the pattern-wheel 167 to keep the latter always under sufficient friction to control them during the step-by-step movements thereof. The multiplier feed-ratchet 151^a is also controlled by suitable friction means—as, for instance, (see Fig. 30,) the friction-faced spring 202, which bears against the periphery thereof. The pattern-cylinder 101, Fig. 19, heretofore referred to as mounted upon the said pattern-shaft 102, and which controls the rotative movements of the vertical shaft 92 and the depending ring 82, heretofore referred to, has also upon its periphery a plurality of raised cam-surfaces 194 195. (See Fig. 36.) These cam-surfaces in the rotation of the pattern-cylinder 101 pass under a lever 196, which (see Figs. 1 and 2) is pivoted at 197 upon a bracket on the machine-frame. This lever 196 underlies a lug 198, Fig. 1, adjustably secured to the rod 4, which supports the needle-cylinder. Consequently raising and lowering of the said lever by the said cams will act to raise and lower the said supporting-rod and needle-cylinder to vary the lengths of stitches taken by the needles in the said cylinder. To permit of these vertical movements being readily adjusted, I have provided the under side of the elevating-lever 196 (see Fig. 38) with a pair of adjustable contact members 199, shown as

5 springs and acted upon by set-screws 199^a, by means of which the free ends of said springs or members may be adjusted to a greater or less distance from the under side of said lever. The cams 194 195 act upon these adjustable spring members, and by adjustment of the latter the extent of lift of the needle-cylinder by either cam may be adjusted at will, the lowermost position of said needle-cylinder in either case being determined by adjustment of the adjustable screw 5, upon which the post 4 normally rests.

Any usual means may be employed for delivering the thread to the thread-carrier of the machine and for controlling the thread at all times—as, for instance, during the reciprocations of the machine. Also any usual means may be employed for delivering a thickening or supplemental thread when needed and for removing the same at the proper time.

In the operation of the machine, assuming it is desired to knit a half-hose, the ribbed top, which is commonly knit on a separate machine, is first transferred to the present machine. To do this, the machine being of course at rest, the lever 32, Fig. 11, is pressed inward toward the cam-ring, thereby to withdraw the stitch-cam 27 from its operative position, Fig. 32, to its inoperative position, Fig. 33, outside the circle of heels of the short-heel needles. The machine is then turned partially by hand, causing one of the elevating cam-surfaces 26, Fig. 9, to raise the depressed needles, so as to bring all the needles to a common level. The entire needle-cylinder is now raised bodily (and relative to the needles, which latter remain stationary) by means of a hand-lever 250, Fig. 2, arranged under the lifting-lug 198 on the cylinder-supporting rod 4, the raising of the needle-cylinder carrying with it the sinker-cylinder and raising the latter until its sinkers stand at substantially the level of the hooked ends of the needles, whereby the sinkers may serve as guides for the positioning of the transfer device. The transfer device carrying the ribbed top is now placed in position with its points between the sinkers and directly behind the respective needles of the machine, which brings the loops in the ribbed top directly over the needles. By means of the said lever 250 the needle and sinker cylinders are now dropped, together with the transfer device resting upon the latter, which causes the needles to penetrate the said loops, after which the transfer device is withdrawn, leaving the ribbed top upon the needles as if knit thereon. The thread is now led through the thread-guide 46 to the needles and the cam-carrier is turned until the stitch-cam 27, which is held by its spring against the ends of the heels of the needles, (see Fig. 33,) reaches the series of long-heel needles, when the said cam engages the said long-heel needles and depresses the same and after having cleared the short-heel needles springs forward into position, Fig. 32, where it may thereafter engage the heels of

all the needles whether long or short. The hand-shipper 173 is now lifted thereby through its inner depending arm 174 to throw the belt-shipper 157 to the right, Figs. 1 and 29, upon the high-speed pulley 127, Fig. 27, which starts the machine upon circular knitting. The pattern-chain feeds forward until at the proper time a lug 200 upon one of the links of said chain engages and lifts the lug 185 on the outer end of the pawl-supporting lever 183 and drops the inner end of said lever, Fig. 30, to permit the pawl 178, resting thereon, to engage its ratchet-wheel 177 and move the same, thereby to cause one of the lugs 168, Fig. 24, on the wheel 167 to lift the trip-lever 165 and depress the trip-dog 164, Fig. 28, to drop the end 161 of the latter below the stud 160 of the belt-shipper and permit the latter, acted upon by its spring 159, to be thrown to the left until the said post brings up against the step 169, thereby carrying the belt upon the intermediate pulley 135 and reducing the speed of the machine. The said pawl 178, remaining in engagement with its said ratchet-wheel, continues to rotate the pattern-shaft 102, and thereafter and immediately following the change in speed of the machine the clutch-controlling stud 123 on the lever 122, Fig. 1, meets one of the inclined lugs 190, Fig. 31, and is thrown thereby through one of the peripheral notches in its wheel to the opposite side of the latter, thereby turning the clutch-lever 120 to carry the slidable clutch member 119 from engagement with the continuously-rotating clutch member 126 into engagement with the reciprocating clutch member 145, thus establishing reciprocatory movement of the cam-carrier. Subsequent to the reduction in speed and substantially simultaneously with the shifting of the clutch from the continuous rotary member to the reciprocatory members, as described, the cam-groove 100 in the pattern-cylinder 101 acts upon the lever 98, Fig. 2, and turns the latter to rock the vertical shaft 92 and cause the latter, through the connecting-rod 90, Fig. 15, to shift the depending ring 82 sufficiently to cause the pull-down cam-surface 56 to be turned into position to engage the pin 53 on the toothed segment 50, turning the switch-cam 49, Fig. 9, down into position to catch all the long-heel needles to throw the same out of action. These movements are so timed that the elevation of the long-heel needles, which comprise substantially one-half the needles of the machine, take place on the final half-rotation of the continuous rotation of the cam-carrier and before the reciprocatory movements thereof commence. At the same time and it may be by the same rocking movement of the vertical rock-shaft 92 the usual "take-up," typified at T', Fig. 2, is released to care for the thread during the reciprocatory movements of the machine and also the means to automatically introduce a thickening-thread, if one is to be used. During reciprocatory

movements the lost motion between the gear-
ring and the cam-carrier operates, as de-
scribed, to carry the thread-guide first to one
and then to the opposite side of the stitch-
cam 27, so that the said thread shall always
be in advance of the said cam, and the same
lost motion operates also to carry the pickers
alternately into position in front of the said
stitch-cam to enable the same at each recipro-
cation to throw up a needle, thereby gradually
to shorten the successive courses knit until the
narrowing is completed. Immediately fol-
lowing the commencement of the narrowing
the movement of the pattern-chain dropped
the pawl-holding lever 183, Figs. 25 and 30,
and caused the latter to lift the pawl 178 out
of engagement with its ratchet-wheel 177 and
caused the movements of the pattern-shaft
102 to cease. At the completion of the nar-
rowing the further movement of the pattern-
chain brings another lug 200 into position,
Fig. 30, to again drop the said pawl 178 into
engagement with its ratchet-wheel 177 to
cause further rotation of the latter and the
pattern-shaft 102. This further movement of
the pattern-shaft operates through the cam-
groove 100 in the pattern-cylinder 101, Figs.
1 and 19, to impart further rotation to the
vertical rock-shaft 92 and cause further rota-
tion of the depending ring 82, Fig. 15, there-
by to throw inward the sliding radially-mov-
able cam 77 to cause the latter to swing the
T-shaped lever 74^a, Fig. 16, at each succeed-
ing reciprocation of the cam-carrier first in
one and then in the opposite direction to
cause the pickers alternately to be raised into
elevated position to engage one or more of
the elevated series of needles, thereby to bring
the latter, as heretofore described, gradually
down into working level to increase the
lengths of the successive courses knit. The
pattern-shaft 102 after having moved suffi-
ciently to produce the final movement of the
depending ring 82 for widening is stopped by
disengagement of its pawl 178 upon move-
ment of the pattern-chain. When the widen-
ing has been completed, continued movement
of the pattern-chain brings another lug 200
into position, again to drop the pawl 178 into
engagement with its wheel to cause further
rotation of the pattern-shaft 102. Such fur-
ther movement operates to cause the clutch-
controlling wheel 188 to shift the slidable
clutch member from the reciprocating gear
member to the continuously-rotating driving
member, thereby to restore continuous circu-
lar movement of the cam-carrier. The groove
100 in the pattern-cylinder 101 also operates
to restore the depending ring 82 to its origi-
nal position, thereby moving the radially-slid-
ing cam 77 from further engagement by the
depending arm of the T-shaped picker-con-
trolling lever and swinging the raising cam-
surfaces 55, Fig. 11, into position to raise the
pin 53 on the toothed segment 50 to raise the
switch-cam 49, Fig. 9, to catch the long-heel
needles in elevated position and bring the

latter down into working position. Return
movement of the vertical rock-shaft 92 also
removes the take-up and thickening thread, 70
if one was used. These changes having been
accomplished substantially simultaneously,
further rotation of the pattern-shaft by con-
tinued engagement of the pawl 178 with its
ratchet-wheel 177 brings one of the inclined 75
side lugs 176 into engagement with the stud
160 and positively throws the shipper into ex-
treme right-hand position, Fig. 27, to carry
the belt upon the high-speed pulley, said ship-
per being caught and locked in its new posi- 80
tion by spring-actuated movement of the end
of the trip-dog 161 behind it. Circular knit-
ting is now resumed for the formation of the
foot portion of the stocking and is continued
for the required length of time, determined 85
by the movements of the pattern-chain, until
when the toe is reached the said chain operates
to reduce the speed, shift the clutch to produce
reciprocatory movement of the cam-carrier,
and thereafter to cause further movements for 90
narrowing and widening at the toe precisely as
at the heel. The toe having been completed,
any desired number of rounds are knit circu-
larly to facilitate subsequent usual looping,
and the machine is then automatically stopped 95
by a lug 170, Fig. 24, coming in position un-
der the trip-lever 165 and depressing the latter
and the holding-lever 164 sufficiently to per-
mit the belt-shifter, under the action of its
spring, to throw to the left to carry the belt 100
past the intermediate pulley and upon the
loose pulley. At the proper times in the ro-
tation of the pattern-cylinder 101 the sur-
face-cams 194 195 thereon act to elevate the
needle-cylinder, as hereinbefore described, 105
to lengthen the stitches—as, for instance,
when knitting the heel and toe of the stock-
ing when an extra thread is introduced there-
at. The parts are so adjusted, being con-
trolled by the chain, that the pattern-shaft 110
102, with its belt-controlling and clutch-con-
trolling wheels and pattern-cylinder, makes a
complete rotation for each complete cycle of
movements necessary for the knitting of a
single stocking. 115

From the foregoing description it appears
that the various movements of the machine
which take place automatically are governed
or timed by the pattern-chain, and as the
circular knitting is usually continued for a 120
considerable period of time, as while knit-
ting the leg and foot, during which time the
pattern-chain is called upon to perform no
work, it is obvious that said chain would
necessarily be of considerable and inconven- 125
ient length if during these periods its move-
ments were continued. To obviate this and
to enable the length of the chain to be short-
ened, so that it shall move approximately
only at such times as it is called upon to per- 130
form work, I have provided a multiplier,
which comprises in the present instance the
ratchet-wheel 151^a, Fig. 19, loosely mounted
upon the pattern-chain sprocket 148 and be-

tween the latter and the pattern-feed wheel 149, and the chain-ratchet-feed pawl 151 overlies this multiplier-ratchet. This multiplier-ratchet wheel 151^a is larger in diameter than the chain-ratchet 149 and has a mutilated portion 156. (Best shown in Figs. 30 and 34.) At the times when the chain is to perform work the chain-feed pawl 151 while operating to ratchet around the pattern sprocket-wheel works in the mutilated or recessed portion of the multiplier-ratchet 151^a, hence produces no movement of the latter. When the pattern-chain in its movement has performed its last function of operation, immediately preceding a long period of knitting—as, for instance, the leg or foot of the stocking—during which time if continued in motion it would merely rotate or move, idly a small lug 201, Fig. 34, upon one of the links of the chain in the final movement of the chain engages a pin 202, Fig. 19, on the side of the multiplier-ratchet 151^a and moves the latter forward sufficiently to bring the first of its series of teeth behind the mutilated portion into position in front of and to be engaged by the pawl 151, and since the multiplier-ratchet is larger in diameter than the chain-feed ratchet 149 the said pawl upon engagement with the multiplier-ratchet is raised out of engagement with the chain-ratchet, so that the further movements of the said pawl engage only the multiplier-ratchet without moving the chain. The diameter of this multiplier-ratchet is such that it is permitted to make a complete turn before further movement of the chain becomes necessary, and when such complete turn of the said multiplier-ratchet has been made and the mutilated portion is again reached the pawl 151 drops into engagement with the chain-ratchet, while feed of the multiplier-ratchet ceases. The chain is thus fed sufficiently to produce the required movements or operations, when a lug 201 thereon again moves the multiplier-ratchet forward, where it takes the feed of the pawl 151, thereby again stopping the chain. In this way the chain is caused to move only at such times as it is called upon to perform work in timing various operations of the machine, and at all other times—that is, when if in motion it would merely move idly—the chain remains at rest and the multiplier-wheel 151^a is rotated. Should the period of time during which the multiplier is desired to operate exceed that required for a complete rotation of the said multiplier-ratchet, the first link of the chain brought into position at the end of a complete rotation of the multiplier-wheel may cause the latter to be moved forward for a second rotation without further movement of the chain. In this manner the multiplier-ratchet may be given as many complete rotations as necessary to permit the chain to remain stationary for the required length of time. If it is desired to reduce the time during which the multiplier operates below that required for a complete rotation of the mul-

tiplier-ratchet, the latter may be provided with one or more additional mutilated portions, which will permit operation of the chain to be commenced more frequently than where a single mutilation only is provided. In this way the movements of the chain may be reduced to a minimum, and the multiplier may be thrown into action at any time upon movement of the chain through a distance equivalent to a single link.

Referring to Figs. 19, 35, and 36, the latter figure showing the surface of the pattern-cylinder 101 developed, it will be noticed that the two raised-surface cams 194 and 195 are circumferentially in line, they being adapted to act upon the left-hand spring 199, Fig. 1, so that in the rotation of the said pattern-cylinder in the knitting of a short hose or stocking, hereinbefore described, the surface-cam 194 will first through the said spring 199 and lever 196 lift the needle-cylinder to increase the length of the stitches while knitting the heel, then drop the said lever and needle-cylinder until in the further rotation of the said pattern-cylinder the surface-cam 195 reaches and lifts the said spring 199, thereby again to lift the needle-cylinder to lengthen the stitches for the knitting of the toe. In the knitting of long or ladies' hose, however, additional movements must be imparted by the pattern-cylinder to the needle-cylinder.

Referring to Figs. 35 and 36, there is circumferentially between the rear end of the surface-cam 195 and the leading end of the cam 194 a third cam 196^a, which is offset from the said cams 194 195, so as to clear the left-hand spring 199 on the lifting-lever, but to act upon the right-hand spring 199 on the said lever, and this third cam 196^a is made tapering from its leading to its rear ends, as best shown in Fig. 35. These surface-cams are so positioned upon the pattern-cylinder that when circular knitting is commenced at the top of the leg the pattern-cylinder 101 occupies a position with the active ends of the two springs 199 at the point marked 197^a on Fig. 36 with the active end of the right-hand spring resting upon the leading end of the cam 196^a. The pattern-cylinder is maintained at rest during the knitting of the leg by means of the multiplier described, and when the knitting has progressed down to the vicinity of the ankle, where it is desired to gradually shorten or tighten the stitches to draw in or shape the stocking to fit the ankle, a lug 200 on the pattern-chain, Fig. 30, drops the feed-pawl 178 into engagement with the pattern-ratchet 177, causing the pattern-shaft 102 to be fed forward until the first of a series of teeth 198^a on the said pattern-cylinder comes into position under the active end of a feed-pawl 220, (shown in dotted lines, Fig. 2,) the same being mounted upon the free end of a pawl-carrying lever 221, fulcrumed upon the bed-plate A and held by a spring 222 with its upper end in the path of movement of the segmental gear 143. A pin 223 (see Fig. 1)

on the side of said pawl by contacting with one of the bars *a* of the machine-frame limits the rearward spring-actuated movement of the pawl and prevents it following the segmental gear throughout the entire movement of the latter. Therefore said segmental gear toward the close of its forward movement meets the upper end of the pawl-carrying lever 221 and moves the latter forward slightly, the said pawl following the segmental gear on the return movement until the pin 223 brings up against the frame. When, therefore, the first of the series of teeth 198 on the pattern-cylinder has been brought into engagement with the feed-pawl 220, the latter during the ensuing reciprocations of the segmental gear ratchets the pattern-cylinder and pattern-shaft slowly forward throughout the length of the series of teeth 198^a, thereby causing the right-hand needle-cylinder-supporting spring 199 to follow down upon the inclined cam-surface 196^a and gradually shorten the stitches knit in the vicinity of the ankle. The needle-cylinder follows down this inclined cam for the entire length of the cam or until the needle-cylinder in its lowering movement is arrested by the adjustable stop-screw 5, which has been previously adjusted to give the minimum length of stitch. After the pawl 220 has rotated the pattern-cylinder for a distance represented by the length of the series of teeth 198^a the pattern-cylinder and pattern-shaft remain at rest until another lug 200 on the pattern-chain again throws into action the pattern-chain feed 177, when the said pattern-cylinder will be further rotated to cause the left-hand spring 199 to ride upon the cam-surface 194 to lengthen the stitches for the heel. At the close of the heel the said spring 199 leaves the cam-surface 194 and drops the needle-cylinder upon the stop-screw 5, which supports the cylinder until the toe is reached, when further rotation of the pattern-cylinder causes the said left-hand spring 199 to ride upon the cam 195 and again lift the needle-cylinder to increase the length of the stitches at the toe. The cam 195 at its rear end has a raised portion or toe 225, which after the toe is finished and a sufficient number of courses have been knit for the purpose of looping the toe further lifts the needle-cylinder to cause a few, usually one or two, courses of extra long stitches to be knit, along which the stocking may be severed from the preceding or succeeding stocking.

I have herein described the operation of my improved machine as when the latter is used with a single feed—that is, with the thread or yarn delivered to the needles at one point on a cam-ring only, a single stitch-cam being required for this purpose.

I have herein described one embodiment of my invention; but it is understood that my invention in no respect is limited to the specific embodiment here shown and described, for the same obviously may be varied

without departing from the spirit and scope of the invention.

Having described my invention and without limiting myself to details, what I claim, and desire to secure by Letters Patent, is—

1. In a knitting-machine, a skeleton cylinder provided with removable bars and means to release less than the whole number of bars.
2. In a knitting-machine, a skeleton cylinder provided with removable bars and means to release said bars without removing the same from working position in said machine.
3. In a knitting-machine, a skeleton cylinder provided with removable bars and means to release one or more of said bars without removing the same from working position in said machine.
4. In a knitting-machine a skeleton cylinder comprising a supporting-base permanently secured in the machine, bars removably mounted upon said base, and means to release less than the whole number of bars, for removal of the same.
5. In a knitting-machine a skeleton cylinder comprising a supporting-base permanently secured in the machine, bars removably mounted upon said base, means to support said bars at opposite faces thereof and means to retain said bars in working position.
6. In a knitting-machine a skeleton cylinder comprising removable bars, and means engaging the lower ends of said bars and holding them positively against lifting movement from working position.
7. In a knitting-machine a skeleton cylinder comprising removable bars, means engaging the lower ends of said bars to hold them against lifting movement from working position, and cooperating supporting means removably engaging the tops of said bars.
8. In a knitting-machine, a skeleton cylinder comprising removable bars, means engaging the lower ends of said bars to hold them against lifting movement from working position, and cooperating spacing means removably engaging the tops of said bars.
9. In a knitting-machine, a skeleton cylinder comprising removable bars, and means to hold said bars positively against vertical movement from their working positions.
10. In a knitting-machine, a skeleton cylinder comprising removable bars, means engaging the lower ends of said bars to hold them against lifting movement from their working positions, and a crown-ring engaging the tops of said bars.
11. In a knitting-machine, a skeleton cylinder comprising removable bars, means engaging the lower ends of said bars to hold them against lifting movement from their working positions, a crown-ring engaging the tops, of said bars and means to hold said crown-ring in position.
12. In a knitting-machine, a skeleton cylinder comprising removable bars, means engaging the lower ends of said bars to hold them against lifting movement from their working

positions, a crown-ring engaging the tops of said bars and traveling means to hold said crown-ring in position.

13. In a knitting-machine a skeleton cylinder comprising bars, and a crown-ring covering the tops thereof.

14. In a knitting-machine a skeleton cylinder comprising bars, and a crown-ring covering and embracing the tops of said bars.

15. In a knitting-machine, a skeleton cylinder comprising bars, a crown-ring surmounting the same, and spacing means independent of said crown-ring for and at the tops of said bars.

16. In a knitting-machine a skeleton cylinder comprising bars, a crown-ring surmounting and embracing the tops of said bars and spacing means inclosed within said crown-ring.

17. In a knitting-machine a skeleton cylinder comprising bars, a crown-toothed spacing-ring surmounting the same, and a crown-ring surmounting in turn the said crown-toothed ring.

18. In a knitting-machine a skeleton cylinder provided with removable bars and retaining devices for the lower ends of said bars, each retaining device retaining a plurality of bars.

19. In a knitting-machine a skeleton cylinder comprising removable bars, clamping devices for the lower ends of said bars, each clamping device engaging a plurality of bars.

20. In a knitting-machine, a skeleton cylinder comprising removable bars, and contracting clamping means for engaging and clamping the lower ends of said bars.

21. In a knitting-machine, a sinker-cylinder presenting integrally-formed top and bottom guiding-surfaces arranged facing each other.

22. In a knitting-machine, a sinker-cylinder presenting integrally-formed top and bottom guiding-surfaces arranged facing each other, also lateral guiding-surfaces.

23. In a knitting-machine, a sinker-cylinder having radially-arranged sinker-guideways and a holddown portion above the same combined with sinkers arranged in said guideways and having portions overlying said holddown portion.

24. In a knitting-machine the combination with sinkers each having a plurality of arms, of a sinker-cylinder therefor provided with guideways open at both ends for both the arms of said sinkers.

25. In a knitting-machine a sinker-cylinder presenting turned top and bottom sinker-guiding surfaces, also lateral guiding-surfaces.

26. In a knitting-machine a sinker-cylinder presenting near its top at its inner surface an annular groove, and at its outer surface, opposite said groove, a ring-like projection slotted vertically to a depth that will intersect said groove.

27. In a knitting-machine, a sinker-cylinder having a holddown-ring, and spacing-

walls constituting the sole connection between said ring and the sinker-cylinder proper.

28. In a knitting-machine an internally annularly grooved sinker-cylinder having, opposite said groove, an outwardly-projecting portion provided with a plurality of radial cuts extended from the periphery thereof through into said groove to form integral connecting-spacers between the portions of said cylinder respectively above and below said groove.

29. In a knitting-machine, an internally annularly grooved sinker-cylinder having its top radially slotted and having opposite said groove an outwardly-projecting portion provided with a plurality of radial cuts extended from the periphery thereof through into said groove to form integral connecting-spacers between the portions of said cylinder respectively above and below said groove.

30. In a knitting-machine, an internally annularly grooved sinker-cylinder having its top radially slotted and having opposite said groove an outwardly-projecting portion provided with a plurality of radial cuts extended from the periphery thereof through into said groove to form integral connecting-spacers between the portions of said cylinder respectively above and below said groove, said radial cuts intersecting and registering with said top radial slots.

31. A knitting-machine provided with a plurality of driving-pulleys, one of which is connected with and to operate said machine, and speed-varying devices between said pulleys for varying the speed of said connected pulley from and by another of said pulleys.

32. In a knitting-machine, a plurality of driving-pulleys connected with and to operate the machine respectively at varying speeds, one of said pulleys operating through the medium of another.

33. A knitting-machine provided with a plurality of driving-pulleys having the capacity to drive said machine respectively at different speeds and means to connect said machine at will with and to be operated by either pulley.

34. A knitting-machine provided with a loose pulley, and a plurality of driving-pulleys, all axially aligned, and speed-varying devices intermediate the said driving-pulleys for driving one by the other.

35. In a knitting-machine, a plurality of driving-pulleys connected with and to operate said machine, one of said pulleys operating through the medium of another, and reciprocatory driving mechanism arranged to operate said machine through either of said pulleys.

36. A knitting-machine provided with a plurality of driving-pulleys connected with and to operate said machine, one of said pulleys operating through the medium of another, reciprocatory driving mechanism and

means to throw the same into action with the change of drive from one to another of said pulleys.

37. A knitting-machine provided with a plurality of driving-pulleys, one of which may be driven direct, and speed-varying devices between it and another of said pulleys for driving it at a different speed from and by said other pulley.

38. A knitting-machine provided with a double-acting stitch-forming cam and means to withdraw it bodily from operative engagement with the needles.

39. A knitting-machine provided with a double-acting stitch-forming cam and means to withdraw it bodily and radially from operative position.

40. A knitting-machine provided with a double-acting stitch-forming cam, means to withdraw it from operative position, and means automatically to restore it to operative position.

41. In a knitting-machine, the combination with a double-acting stitch-forming cam, adapted for circular and reciprocatory knitting, means for removing the depressing-surfaces thereof without removing the needle-elevating surfaces, of needle-picking means operating in connection therewith.

42. In a knitting-machine the combination with a double-acting stitch-forming cam adapted for circular and reciprocatory knitting, of a needle-picking device operating at each side of said cam both to elevate and depress needles.

43. In a knitting-machine the combination with a double-acting stitch-forming cam adapted for circular and reciprocatory knitting, means for removing the depressing-surfaces thereof without removing the needle-elevating surfaces, of needle-picking means operating alternately at opposite sides of said cam.

44. In a knitting-machine the combination with a double-acting stitch-forming cam adapted for circular and reciprocatory knitting, of a needle-picking device cooperating with said cam and at each side thereof to elevate or depress the needles during narrowing or widening.

45. In a knitting-machine the combination with a double-acting stitch-forming cam adapted for circular and reciprocatory knitting, means for removing the depressing-surfaces thereof without removing the needle-elevating surfaces, of needle-picking means cooperating with said cam to elevate or depress the needles.

46. In a knitting-machine the combination with a double-acting stitch-forming cam adapted for circular and reciprocatory knitting, means for removing the depressing-surfaces thereof without removing the needle-elevating surfaces, of needle-picking means operable alternately at opposite sides of said cam, the latter having portions cooperating with said needle-picking means to continue

the elevating or depressing movements of the needles after movement thereof by said picking means.

47. The combination with a double-acting stitch-forming cam and means to withdraw only the depressing-surfaces thereof from operative position, of needle-picking means operable at opposite sides of said cam.

48. A knitting-machine containing needles and cooperating stitch-forming cam-surfaces combined with means for withdrawing said cam-surfaces from operative engagement with the needles and without changing the direction of relative movement between the same and said needles.

49. In a knitting-machine the combination with needles and means to maintain the same in elevated position of a double-acting stitch-forming cam and means to withdraw the same from operative engagement with its needles.

50. A knitting-machine provided with a stitch-forming cam adapted for circular and reciprocatory knitting and presenting the same path of movement for the needles irrespective of the direction of relative movement between the same and said cam and needle-picking means supported independently of said cam and adapted to operate automatically in connection with the respective ends of said cam.

51. A knitting-machine containing needles and stitch-forming cam-surfaces for operating the same, combined with a plurality of automatically-operable needle-picking devices, each adapted for movement for elevating and depressing the needles about a fulcrum, fixed with respect to the needle-levels.

52. In a knitting-machine, the combination with needles and stitch-forming cam-surfaces for operating the same, of a plurality of vertically and horizontally movable needle-picking devices, each having movement about a fulcrum, fixed with respect to the needle-levels, to elevate and depress the needles.

53. In a knitting-machine, the combination with needles and stitch-forming cam-surfaces for operating the same of a plurality of vertically and horizontally movable needle-picking devices, each having movement about a fulcrum, fixed with respect to the needle-levels, to elevate and depress the needles and means for controlling the time of operation of each.

54. In a knitting-machine, the combination with needles and stitch-forming cam-surfaces for operating the same, of a plurality of alternately operable, vertically and horizontally movable needle-picking devices, each having movement about a fulcrum, fixed with respect to the needle-levels, to elevate and depress the needles.

55. In a knitting-machine the combination with needles and stitch-forming cam-surfaces for operating the same of a needle-picking device having movement about a

fulcrum fixed with respect to the needle-levels and means to elevate or depress the active end of said picking device according to the desired movement of the needles.

5 56. In a knitting-machine the combination with needles and with stitch-forming cam-surfaces for operating the same, of a plurality of vertically and horizontally swinging picking devices arranged respectively to swing
10 about axes fixed with respect to the needle-levels, and guide-surfaces for directing the movements thereof.

57. In a knitting-machine, the combination with a stitch-forming cam of needle-picking means and means for shifting the same alternately into position at opposite sides said cam on opposite reciprocations of the machine.

58. In a knitting-machine, the combination
20 with the needle-operating cam-surfaces of needle-picking means supported independently of said cam-surfaces, and means providing a lost motion between the picking-means support and the said cam-surfaces,
25 whereby at each reciprocation of the machine the said picking means is positioned first at one and then at the opposite side of the said cam-surfaces.

59. In a knitting-machine the combination
30 with stitch-forming cam-surfaces of needle-actuated needle-picking means supported and operated independently of said cam-surfaces.

60. In a circular-knitting machine, the combination with a cam-carrier having stitch-forming cam-surfaces of needle-actuated needle-picking means supported and operated independently of said cam-carrier.

61. In a circular-knitting machine, the combination with a cam-carrier provided with
40 stitch-forming cam-surfaces of an operating member for said cam-carrier the same having movement in unison therewith and also independently thereof, and needle-picking means mounted on said operating member.

45 62. In a knitting-machine, a needle-picking device having needle-engaging surfaces at one side only for elevating and depressing needles when moving in one direction only.

63. In a knitting-machine, the combination
50 with a stitch-forming cam-surface of a needle-picking device supported independently of said cam-surface for elevating and depressing needles when moving in one direction only.

64. In a knitting-machine, a needle-operated, needle elevating and depressing picker and cooperating means whereby it may remain in the plane into which it is moved by a needle.

65. In a knitting-machine, a freely vertically movable, needle elevating and depressing needle-actuated picker.

66. In a knitting-machine, a freely vertically movable, needle elevating and depressing picker, means to operate the same and
65 other locking means, to hold it in one or more of its different positions.

67. In a knitting-machine, a freely verti-

cally movable, needle elevating and depressing picker, means to operate the same and friction-locking means to hold it in one or
70 more of its different positions.

68. In a knitting-machine, a needle-picker having a horizontal movement and yielding means to restore the same automatically to its starting position, said picker having also
75 a free vertical movement.

69. In a knitting-machine, a needle-picker having a horizontal movement, and yielding means to restore the same automatically to its starting position, said picker having also
80 a free vertical movement and means to hold the same in one or another of its vertical positions.

70. In a knitting-machine, the combination with the needles and stitch-forming cam-surfaces therefor, of a needle-picker and a support therefor having a movement independent of said stitch-forming cam-surfaces for positioning said picker either in or out of operative relation to said needles and means operated upon withdrawal of said picker from
85 said operative relation for positioning the same in readiness for engagement when again moved into operative relation.

71. In a circular-knitting machine, the combination with the needles and the cam-carrier having stitch-forming cam-surfaces of an independent ring having a movement both with and independently of said cam-carrier and a needle-picker mounted on said independently-movable ring, and adapted upon independent movement thereof to be moved into and out of operative relation to said needles and means whereby upon withdrawal of said picker from said operative relation, the same
95 is automatically positioned for reengagement when subsequently moved into operative relation.

72. In a knitting-machine the combination with needles and a cam-carrier having stitch-forming cam-surfaces of an independent member having a movement both with and independently of said cam-carrier, a plurality of pickers mounted on said independent member and having a free lateral needle-actuated movement, and means on said independent member and rendered operative by said needle-actuated swinging movement for raising and lowering said pickers for elevating and depressing the needles.
110

73. In a knitting-machine the combination with needles and a cam-carrier having stitch-forming cam-surfaces of an independent member having a movement both with and independently of said cam-carrier, a plurality of pickers mounted on said independent member and having a free lateral needle-actuated movement, and means on said independent member, for raising and lowering said pickers for elevating and depressing
115 the needles.

74. In a knitting-machine a needle-cylinder and its needles, and a cam-carrier provided with stitch-forming cam-surfaces com-

bined with an independent member having a movement both with and independently of the said cam-carrier, thread-guiding means and needle-picker means, both arranged on
 5 said independent member and adapted upon independent movement thereof relative to said cam-carrier to be shifted automatically into operative positions relative to said needle-stitch-forming cam-surfaces according to
 10 the direction of independent movement.

75. In a knitting-machine, the needle-cylinder and its needles and the cam-carrier with its stitch-forming cam for operating said needles combined with a member having a movement both with and independently of said
 15 cam-carrier and a plurality of needle-pickers mounted on said member and separated by a distance less than the length of said movement, whereby such independent movement
 20 causes one of said pickers to be shifted into operative position in front of said stitch-forming cam and the other of said pickers to be shifted at the same time into position behind said cam.

76. In a knitting-machine, the needle-cylinder and its needles and the cam-carrier with its stitch-forming cam for operating said
 25 needles combined with a member having a movement both with and independently of said cam-carrier and a plurality of needle-pickers mounted on said member and separated by a distance less than the length of
 30 said movement, whereby such independent movement causes one of said pickers to be shifted into operative position in front of said stitch-forming cam and the other of said pickers to be shifted at the same time into position behind said cam, and means whereby
 35 the shifting of said last-mentioned picker behind said cam positions said picker for action when subsequently shifted into position in front of said cam.

77. In a knitting-machine, the combination with a cam-carrier, and a member arranged
 45 adjacent thereto and having movements both in unison with and independently of said cam-carrier, and a switch-cam mounted on said independently-movable member and means for operating the same.

78. In a knitting-machine, a cam-carrier, an independently-mounted switch-cam, and means automatically to impart vertical and also in-and-out movements thereto.

79. In a knitting-machine employing long
 55 and short heel needles, a cam-carrier, an independently-mounted switch-cam, and means automatically to impart vertical and also in-and-out movements thereto.

80. In a knitting-machine the combination with a switch-cam of operating means therefor comprising swinging cam-surfaces and means simultaneously to swing the same respectively into and out of operative position.

81. In a knitting-machine the combination
 65 with a switch-cam of operating means therefor including a rocking member and cam-surfaces thereon for operating said cam and

means to rock said member to carry one of said cam-surfaces into and the other out of operative position. 70

82. In a knitting-machine, a cam-carrier, an independent operating member therefor and permitting a lost motion between it and said cam-carrier at each reciprocation of the latter, a switch-cam mounted on said operating
 75 member, and means to operate the said switch-cam.

83. In a knitting-machine, a cam-carrier, an independent operating member therefor and permitting a lost motion between it and said
 80 cam-carrier at each reciprocation of the latter, a switch-cam mounted on said operating member, a stationary support and means thereon to operate said switch-cam.

84. In a knitting-machine, a needle-cylinder and its needles, a stitch-forming cam, a carrier therefor, and a switch-cam supported independently of said cam-carrier and operating means therefor. 85

85. In a knitting-machine, a needle-cylinder and its needles, stitch-forming cam-surfaces and a carrier therefor combined with needle-actuated needle-picker means supported independently of said cam-carrier. 90

86. In a knitting-machine a needle-cylinder
 95 and its needles, stitch-forming cam-surfaces and a carrier therefor combined with needle-picker means and a switch-cam, both supported independently of said cam-carrier.

87. In a knitting-machine, a needle-actuated, needle elevating and depressing picker having a fixed fulcrum and means to move said picker into preparatory elevated and depressed position. 100

88. In a knitting-machine, a plurality of
 105 needle-actuated needle elevating and depressing pickers normally occupying intermediate positions, and means to move them respectively into preparatory elevated and depressed positions. 110

89. In a knitting-machine, a plurality of needle-actuated needle elevating and depressing pickers normally occupying intermediate positions and means common to both pickers for moving them respectively into preparatory elevated and depressed positions. 115

90. In a knitting-machine, a needle-cylinder and its needles, stitch-forming cam-surfaces, and a carrier therefor combined with a supporting member independent of said cam-carrier, a needle-actuated picker carried by said member and means to position the said picker independently of the said needle. 120

91. In a knitting-machine a needle-cylinder and its needles, stitch-forming cam-surfaces
 125 and a carrier therefor combined with a plurality of needle-actuated needle-pickers and a support therefor independent of the said cam-carrier and means to control the operation of said pickers. 130

92. In a knitting-machine a needle-cylinder and its needles, stitch-forming cam-surfaces and a carrier therefor combined with a supporting member independent of said cam-carrier

rier, a needle-actuated picker carried by said member and means on a stationary part of the machine to position the said picker independently of the said needle.

93. In a knitting-machine a needle-cylinder and its needles, stitch-forming cam-surfaces and a carrier therefor combined with a plurality of needle-pickers, a support therefor independent of the said cam-carrier and means on a stationary part of the machine to control the operation of said pickers.

94. In a knitting-machine, a needle-cylinder, a stationary bed-plate surrounding the same, and a needle-cylinder support independent of said bed-plate and offset to one side of said needle-cylinder.

95. In a knitting-machine, a needle-cylinder, a bed-plate surrounding the same and a needle-cylinder support independent of said bed-plate.

96. In a knitting-machine, a needle-cylinder, a bed-plate surrounding the same and a needle-cylinder support independent of said bed-plate and having a vertical movement relative to said bed-plate.

97. In a knitting-machine, a bed-plate, a needle-cylinder, a continuous ring-like support therefor, and vertically-sliding supporting means therefor wholly at one side the needle-cylinder and carried independently of said bed-plate.

98. In a knitting-machine, a bed-plate, a needle-cylinder, a cylindrical support therefor, and a supporting-post for and at one side of the support and carried independently of said bed-plate.

99. In a knitting-machine, a bed-plate, a needle-cylinder, a continuous ring-like support therefor, a carrying-post for said support and bearings for the said support and for and at the lower end of said supporting-post said post-bearing being independent of said bed-plate.

100. In a knitting-machine a shipper, means to move it in one direction, a step-by-step releasing device to permit such movement, and a pattern mechanism governing the operation of such step-by-step device.

101. In a knitting-machine a shipper, means to move it in one direction, a step-by-step releasing device to permit such movement, and a pattern mechanism governing the operation of said step-by-step device, said pattern mechanism operating also to move said shipper in a direction opposed to said means.

102. In a knitting-machine, a shipper, means to move the same in one direction, a step-by-step pattern-controlled releasing device, said pattern mechanism being also constructed to move said shipper from an intermediate position back to normal position and manually-operable means to move said shipper from its extreme position back to said normal position.

103. In a knitting-machine, the combination with opposed fixed clutch members, with

means to rotate one and to reciprocate the other therefrom, of a movable clutch member between said fixed clutch members and to cooperate singly therewith, and a rotary pattern-controlled clutch-actuator, and means operated thereby for positively moving said clutch member in both directions.

104. In a knitting-machine, a needle-cylinder, stitch-forming cam-surfaces, a carrier therefor, a bed-plate and a switch-cam combined with a controlling device depending from said bed-plate and pattern-controlled means for rotating it to control the operation of said switch-cam.

105. In a knitting-machine, a needle-cylinder and its needles, stitch-forming cam-surfaces therefor, a bed-plate, and needle-picker mechanism combined with a rotatable controller depending from said bed-plate and connected with and to control the operation of said picker mechanism and pattern means governing the operation of said depending controller.

106. In a knitting-machine, a needle-cylinder, its needles, stitch-forming cam-surfaces, a carrier therefor, a bed-plate, and switch-cam and needle-picker devices combined with a pattern-timed controller depending from said bed-plate and connected with and to control the operations of said switch-cam and picker mechanisms.

107. In a knitting-machine, a needle-cylinder and its needles, stitch-forming cam-surfaces and a carrier therefor, needle-actuated picker mechanism supported independently of said cam-carrier and pattern-controlled devices for governing the operation of said picker mechanism.

108. In a knitting-machine, a needle-cylinder and its needles, stitch-forming cam-surfaces and the carrier therefor, a switch-cam supported independently of said cam-carrier and pattern-controlled means for governing the operation of said switch-cam.

109. In a knitting-machine, a needle-cylinder and its needles, stitch-forming cam-surfaces and a carrier therefor, a switch-cam and needle-picker devices, both carried independently of said cam-carrier, and pattern-controlled means for governing the operation thereof.

110. In a knitting-machine pattern mechanism including a pattern-chain, a ratchet-wheel for positively rotating the same, its pawl, a multiplier-ratchet arranged to be operated by the chain-ratchet pawl and means on the said chain to impart movement to said multiplier-ratchet, to bring the latter into driving engagement with said pawl.

111. In a knitting-machine, a pattern mechanism comprising alternately-operable pattern and multiplier ratchets and a pawl for rotating the same, said multiplier-ratchet being such that when in operation it will hold said pawl from engagement with said pattern-ratchet, and a pattern-chain moved by said

pattern-ratchet and constructed to impart forward movement to said multiplier-ratchet to bring the latter into operation.

112. In a knitting-machine a pattern mechanism comprising pattern and multiplier ratchets, a single operating-pawl therefor and means to cause said pawl to engage said ratchets alternately.

113. In a knitting-machine, speed-changing mechanism, a pattern mechanism to control the same and comprising a pattern-chain and its ratchet, a multiplier-ratchet operable alternately with said chain-ratchet and means on said chain to determine the periods of operation of said multiplier-ratchet.

114. In a knitting-machine a needle-cylinder, needle-operating cam-surfaces and a carrier therefor, picker and switch devices supported independently of said cam-carrier, a needle-support and pattern-controlled mechanism for raising and lowering it.

115. In a knitting-machine a pattern mechanism including a pattern-chain, a ratchet device for feeding the same, a multiplier controlling the movements of said pattern-chain and means to operate said ratchet device and multiplier, alternately.

116. In a knitting-machine a pattern mechanism comprising a pattern-shaft carrying pattern devices, a pattern-chain having movements independent of the said pattern-shaft, and controlling the periods of operation of the latter and a multiplier having movements independent of the pattern-chain and controlling the movements of the said chain.

117. In a knitting-machine a needle-cylinder and its needles, a stitch-forming cam, a carrier therefor, a switch-cam supported independently of said cam-carrier and operating means therefor, and pattern-controlled means for raising and lowering said needle-cylinder to vary the length of stitch.

118. In a knitting-machine a needle-cylinder and its needles, a stitch-forming cam, a carrier therefor, a switch-cam supported independently of said cam-carrier, and means to operate the same, pattern-controlled means for raising the needle-cylinder temporarily to increase the length of stitch, and pattern-controlled means for gradually lowering said cylinder to shorten the stitch.

119. In a knitting-machine, the combination with a needle-cylinder, its needles and means to operate the same, of a skeleton needle-cylinder provided with removable bars, and means to release less than the whole number of said bars.

120. In a knitting-machine, the combination with a needle-cylinder, its needles and means for operating the same, of a skeleton cylinder provided with removable bars, and means to release one or more of said bars without removing the same from working position in said machine.

121. In a knitting-machine, the combination with a needle-cylinder, its needles, and means for operating the same, of a skeleton needle-

cylinder comprising a supporting-base, bars removably mounted upon said base between which the needles project, and clamping means to secure said bars in working position.

122. In a knitting-machine, the combination with a needle-cylinder, its needles, and means to operate the same, of a skeleton needle-cylinder comprising removable bars, means to secure the same in position at or near their lower ends, and means to support the upper ends of said bars.

123. In a knitting-machine, the combination with a needle-cylinder, its needles and means to operate the same, of a skeleton needle-cylinder comprising removable bars, means to secure the same at or near their lower ends and a crown-ring engaging the tops of said bars.

124. In a knitting-machine the combination of a needle-cylinder, its needles, means to operate the same, a skeleton cylinder and a one-part sinker-cylinder presenting top and bottom guiding-surfaces arranged facing each other, and sinkers carried thereby.

125. In a knitting-machine the combination of a needle-cylinder, its needles, means to operate the same, a skeleton needle-cylinder, and a sinker-cylinder presenting near its top and at its inner surface an annular groove and at its outer surface opposite said groove a ring-like projection slotted vertically to a depth that will intersect said groove with radial slots in the end of said sinker-cylinder and registering with said vertical slots and sinkers in said vertical and radial slots.

126. In a knitting-machine the combination of a cylinder, its needles, means to operate said needles, a skeleton needle-cylinder, and a sinker-cylinder having a hold-down-ring with spacing-walls constituting the sole connection between said ring and the sinker-cylinder proper, and sinkers mounted in said sinker-cylinder and between said spacing-walls.

127. In a knitting-machine, the combination of a needle-cylinder, its needles, means to operate said needles, a skeleton needle-cylinder having removable bars and means to secure the same in position, and a sinker-cylinder having a hold-down portion connected with the cylinder proper by integral spacing-walls and sinkers mounted in said cylinder.

128. In a knitting-machine the combination of a needle-cylinder, its needles, a double-acting stitch-forming cam adapted for circular and reciprocatory knitting, needle-picking means operating at both sides said cam, and a skeleton needle-cylinder having removable bars and means to secure the same in position.

129. In a knitting-machine the combination of a needle-cylinder, its needles, a double-acting stitch-forming cam adapted for circular and reciprocatory knitting, means to withdraw said cam from operative position, needle-picking means cooperating with said cam, and a skeleton cylinder having removable bars.

130. A knitting-machine provided with a

double-acting stitch-forming cam adapted to act upon and depress the needles, and means to withdraw it from operative position relative to needles standing below it.

5 131. A knitting-machine containing needles, and stitch-forming cam-surfaces for operating the same combined with a needle-actuated needle-picker having the capacity for truly vertical and truly horizontal move-
10 ments.

132. In a knitting-machine, the combination with needles and means to operate the same of a needle-actuated needle-picker adapted to both elevate and depress needles on move-
15 ment in one direction and standing normally in inoperative relation to the needles and means to move said picker into needle-engaging position.

133. In a knitting-machine the combination
20 with needles and a double-acting stitch-forming cam for operating the same, of a needle-actuated needle-picker adapted to both elevate and depress needles on movement in one direction and normally standing in inop-
25 erative position with respect to the needles, and means to move it into needle-engaging position.

134. In a knitting-machine the combination with needles and means to operate the same,
30 of a needle-actuated needle-picker adapted to operate upon needles in different planes, needle-actuated movement of said picker carrying it always into a plane intermediate said needle planes.

35 135. In a knitting-machine a needle-cylinder and its needles, a skeleton needle-cylinder, having removable bars, a stitch-forming cam, a carrier therefor and a switch-cam supported independently of said cam-carrier and
40 operating means therefor.

136. In a knitting-machine the combination of a driving-shaft, means to rotate it, rotary and reciprocatory clutch members alined with said shaft and driven thereby, a movable clutch member between and to cooperate sin- 45
gly with said rotary and reciprocatory clutch members, a rotary pattern-controlled clutch-actuator and means operated thereby for posi-
tively moving said clutch member in both di-
50 rections.

137. In a knitting-machine the combination of a driving-shaft, a plurality of variable-speed driving-pulleys thereon to rotate said shaft at varying speeds, rotary and recipro- 55
catory clutch members alined with said shaft and driven thereby, a movable clutch member between and cooperating singly with said rotary and reciprocatory clutch members, a rotary pattern-controlled clutch-actuator, and means operated thereby for positively mov- 60
ing said clutch member in both directions.

138. In a knitting-machine a needle-cylinder, its needles, a stitch-forming cam, a carrier therefor, a switch-cam supported inde- 65
pendently of said cam-carrier, operating means therefor, pattern-controlled means for raising and lowering said needle-cylinder, and independent means for raising said cylinder.

139. In a knitting-machine, the combination with the needles, of a needle-actuated, needle-picking device, having needle elevating and depressing movements in one direction only. 70

In testimony whereof I have signed my name to this specification in the presence of 75
two subscribing witnesses.

GEORGE D. MAYO.

Witnesses:

FREDERICK L. EMERY,
ANNIE E. CHESLEY.