

E. J. FRANCK.  
CIRCULAR FASHIONING KNITTING MACHINE.  
APPLICATION FILED AUG. 27, 1906. RENEWED OCT. 5, 1910.

991,711.

Patented May 9, 1911.

8 SHEETS—SHEET 1.

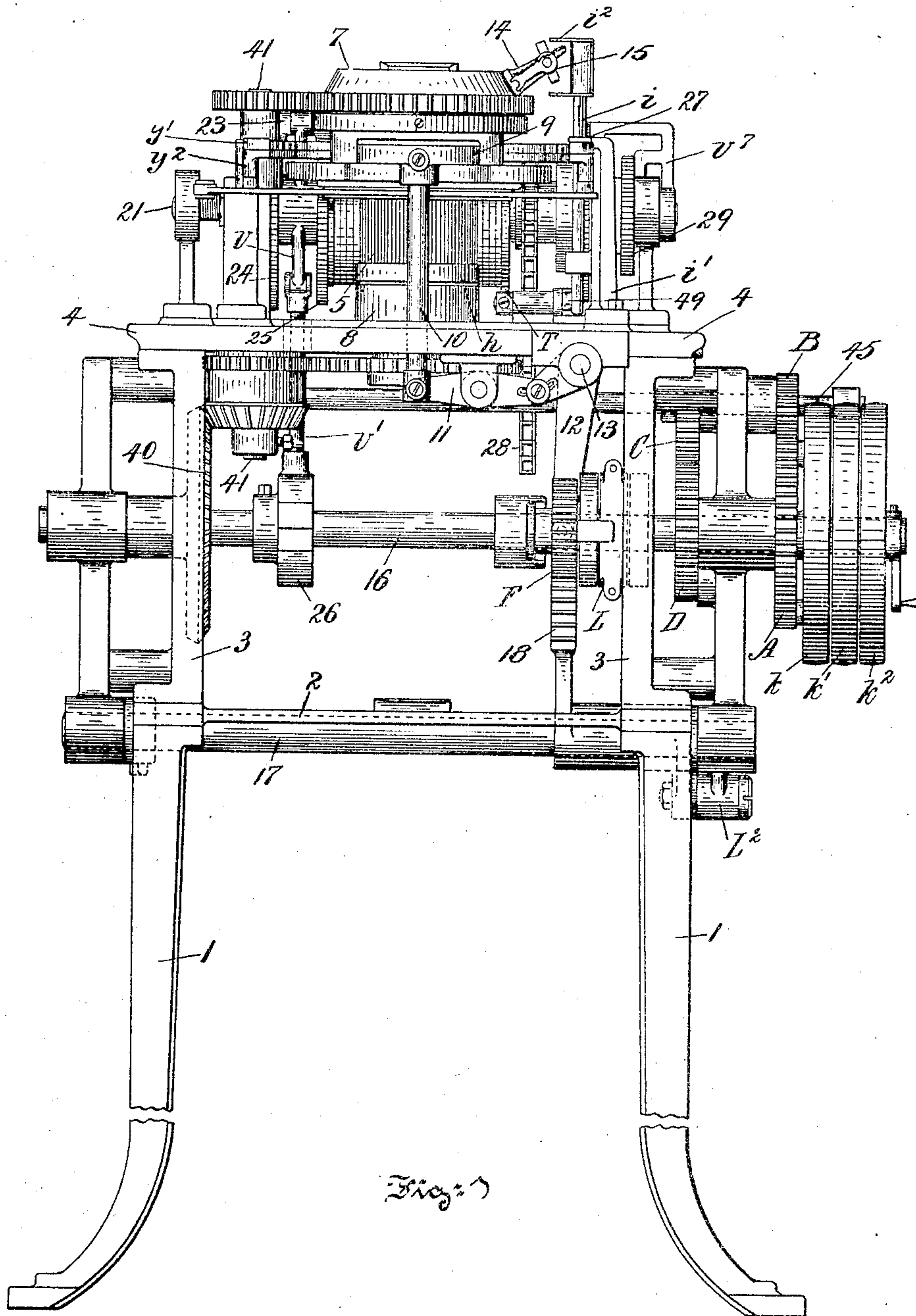


Fig. 1

Witnesses:  
*Maxson*  
Frank C. Finch.

Inventor:  
Emil J. Franck.  
By  
Augustus S. Slaughter  
Att'y.

E. J. FRANCK.  
CIRCULAR FASHIONING KNITTING MACHINE.  
APPLICATION FILED AUG. 27, 1906. RENEWED OCT. 5, 1910.

991,711.

Patented May 9, 1911.

8 SHEETS—SHEET 2.

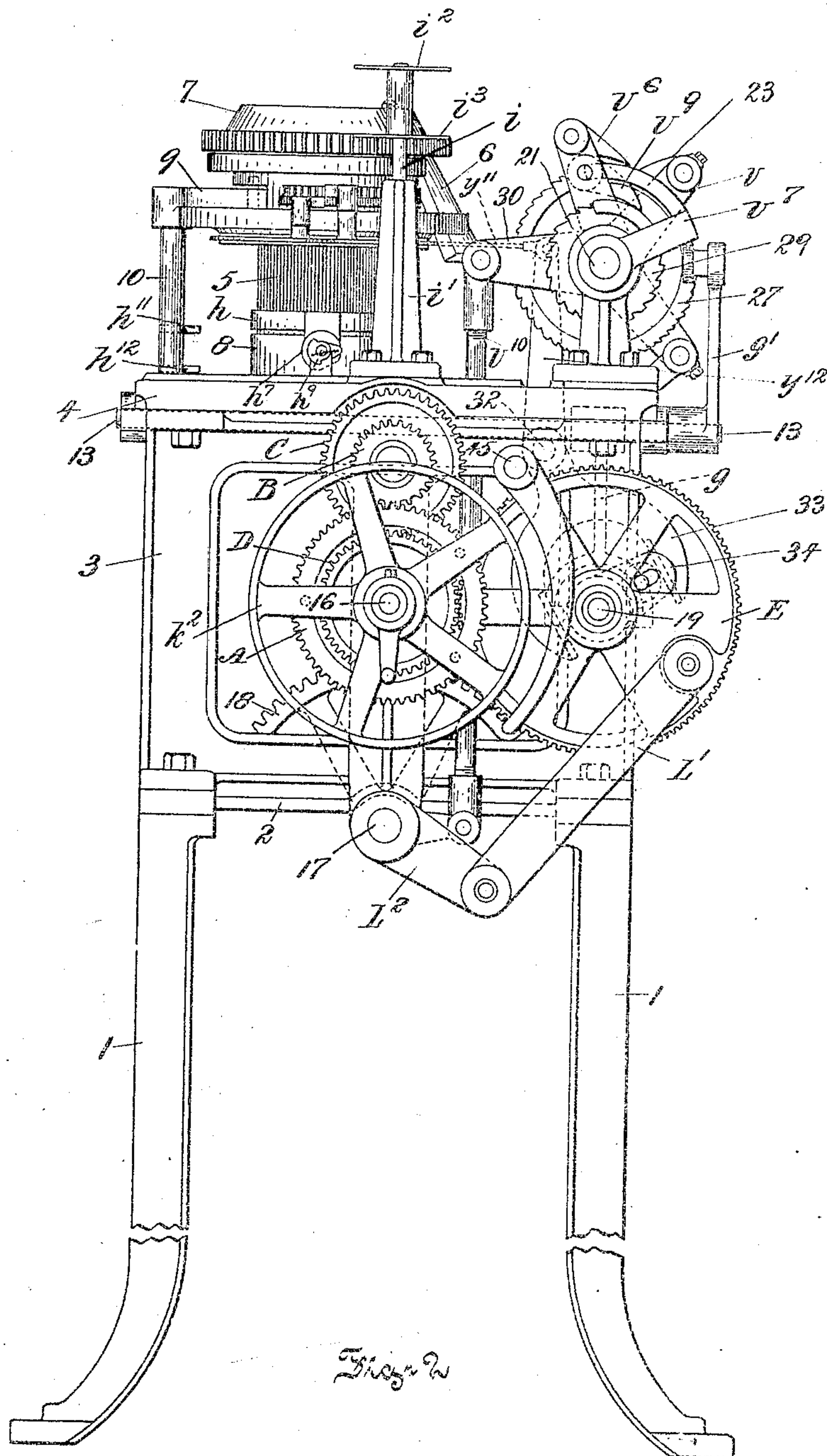


Fig. 2

Witnesses:  
*Frank E. Franck.*

Inventor:  
Emil J. Franck.  
By  
Carrollus S. Kromogilow  
Att'y.

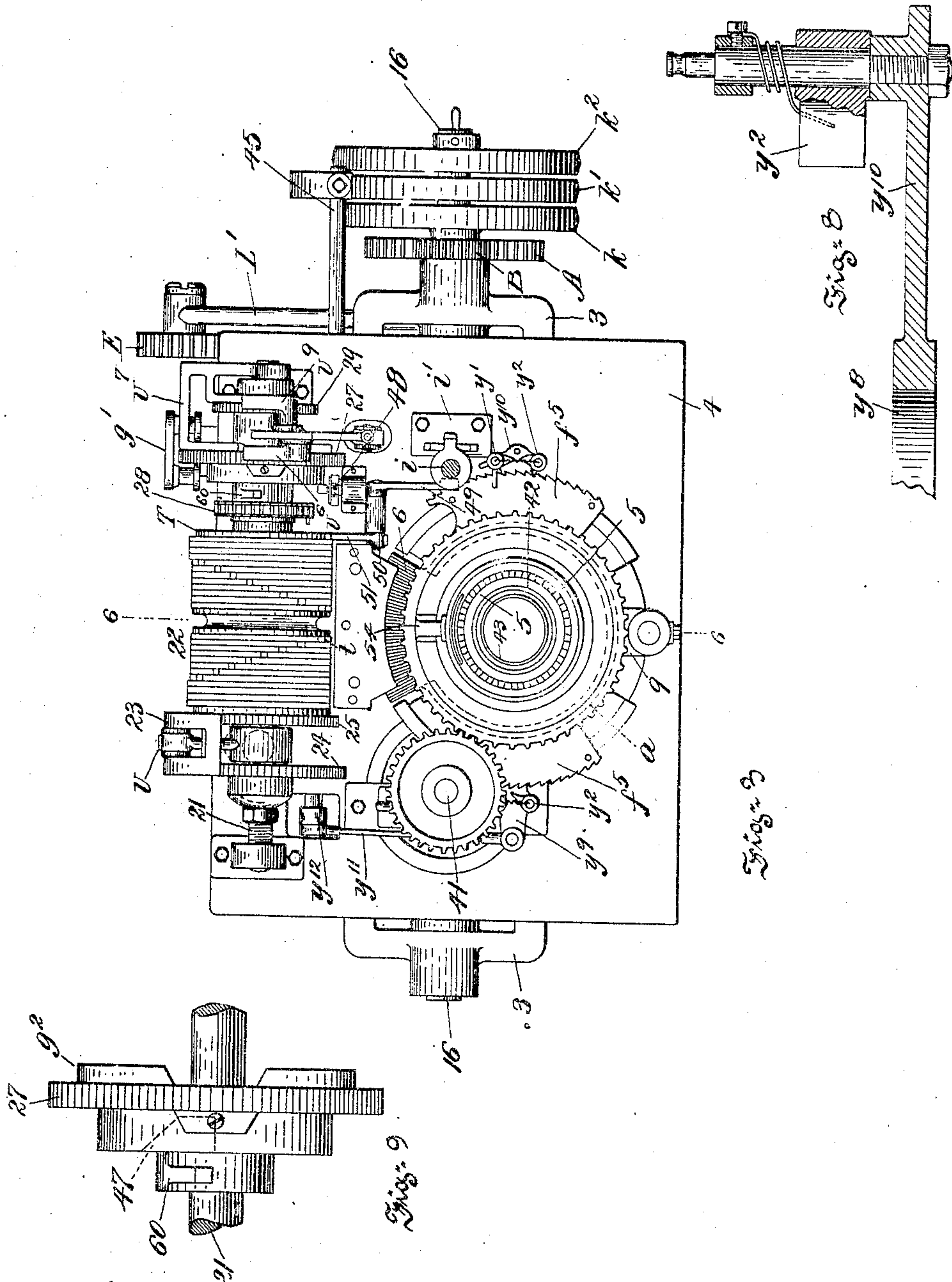


E. J. FRANCK.  
CIRCULAR FASHIONING KNITTING MACHINE.  
APPLICATION FILED AUG. 27, 1906. RENEWED OCT. 5, 1910.

991,711.

Patented May 9, 1911.

8 SHEETS—SHEET 3.



*449Xmgses*  
*Frank C. Hine*

Inventor.  
Emil J. Franck.  
By  
Augustus S. Skougston,  
Att'y.

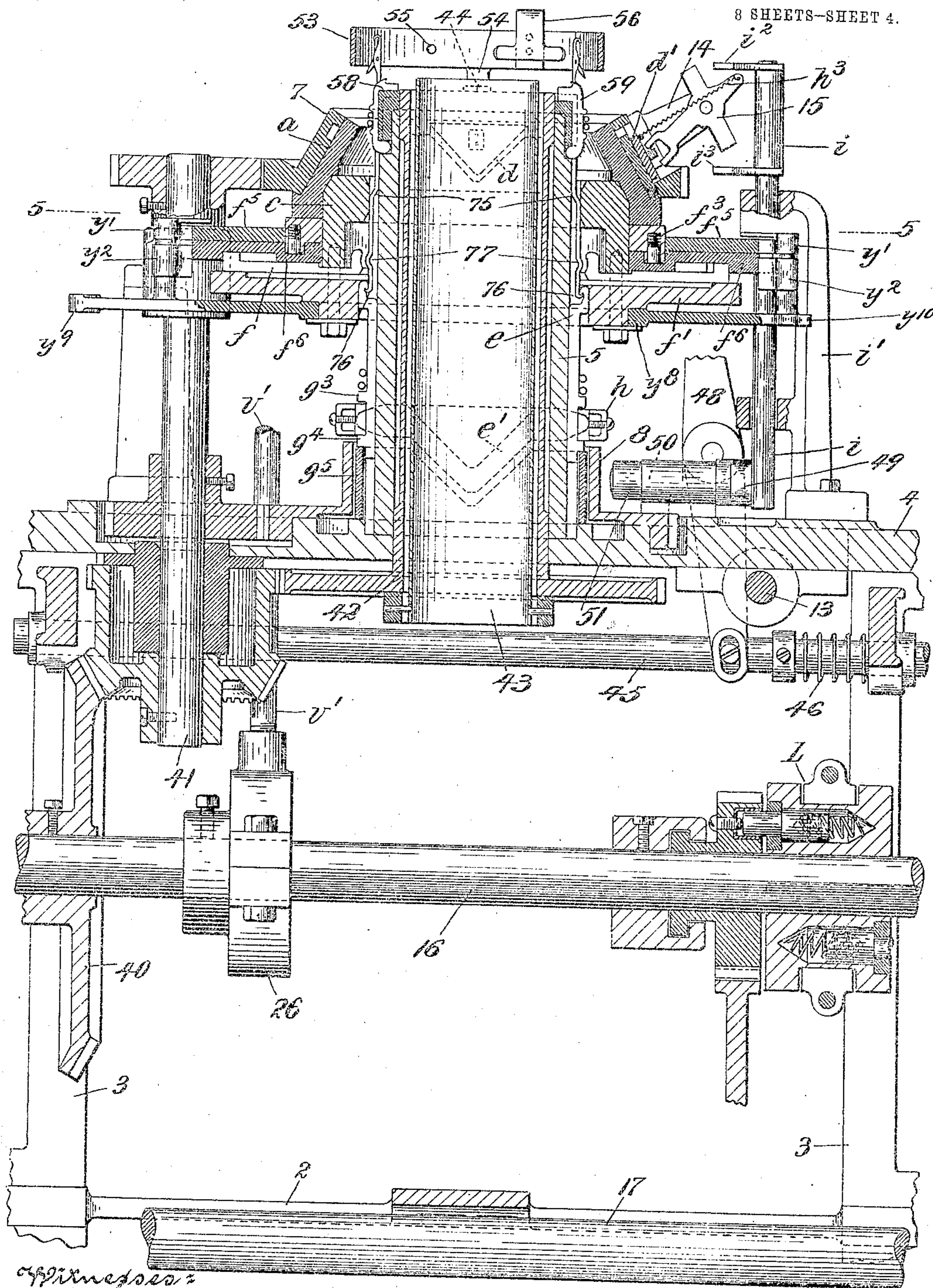


E. J. FRANCK.  
CIRCULAR FASHIONING KNITTING MACHINE.  
APPLICATION FILED AUG. 27, 1906. RENEWED OCT. 5, 1910.

991,711.

Patented May 9, 1911.

8 SHEETS—SHEET 4.



*Witnesses:*  
*Frank E. French*

*Fig. 4*

*Inventor.*  
*Emil E. Franck.*  
*By* *Augustus S. Skene*  
*Att'y.*

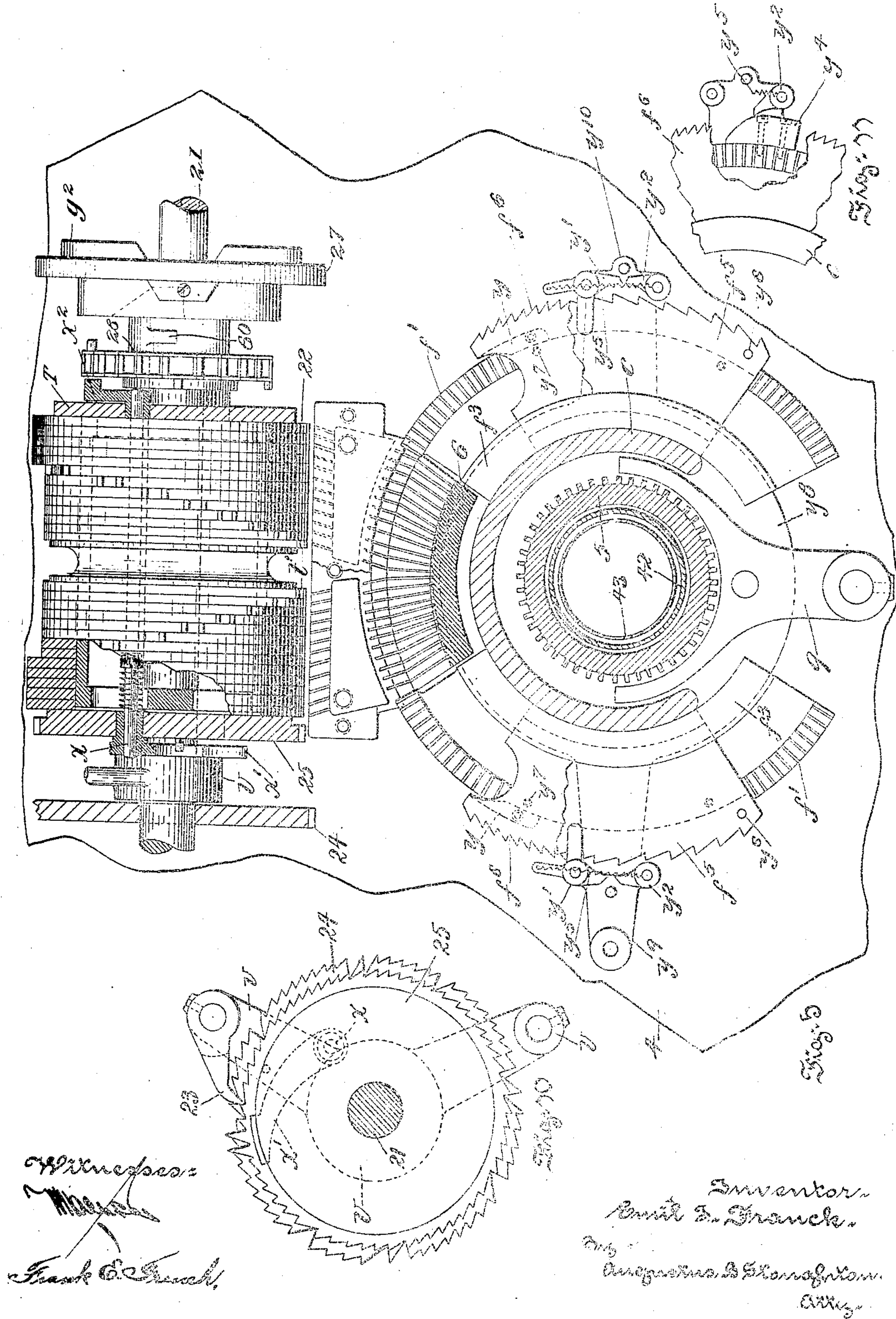


E. J. FRANCK.  
 CIRCULAR FASHIONING KNITTING MACHINE.  
 APPLICATION FILED AUG. 27, 1906. RENEWED OCT. 5, 1910.

991,711.

Patented May 9, 1911.

8 SHEETS—SHEET 5.



Witnesses:  
 Frank C. Franck.

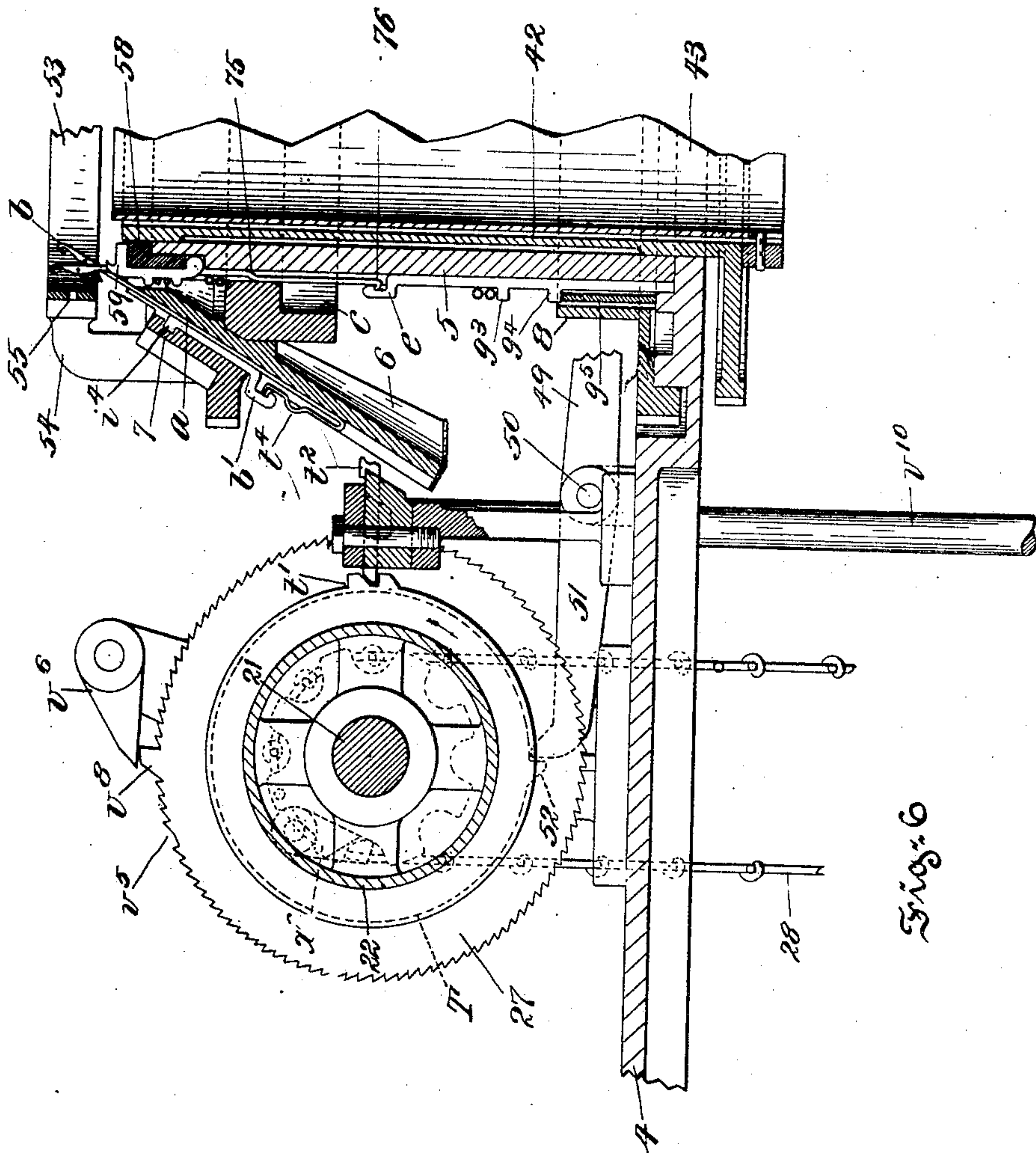
Inventor:  
 Emil S. Franck.  
 Attorney:  
 Augustus B. Franck.

E. J. FRANCK.  
CIRCULAR FASHIONING KNITTING MACHINE.  
APPLICATION FILED AUG. 27, 1906. RENEWED OCT. 5, 1910.

991,711.

Patented May 9, 1911

8 SHEETS—SHEET 6.



Witnesses:  
[Signature]  
Frank E. Franck.

Inventor.  
Emil J. Franck.  
By  
Augustus S. Skanogdon.  
Att'y.



E. J. FRANCK.  
CIRCULAR FASHIONING KNITTING MACHINE.  
APPLICATION FILED AUG. 27, 1906, RENEWED OCT. 5, 1910.

991,711.

Patented May 9, 1911.

8 SHEETS—SHEET 7.

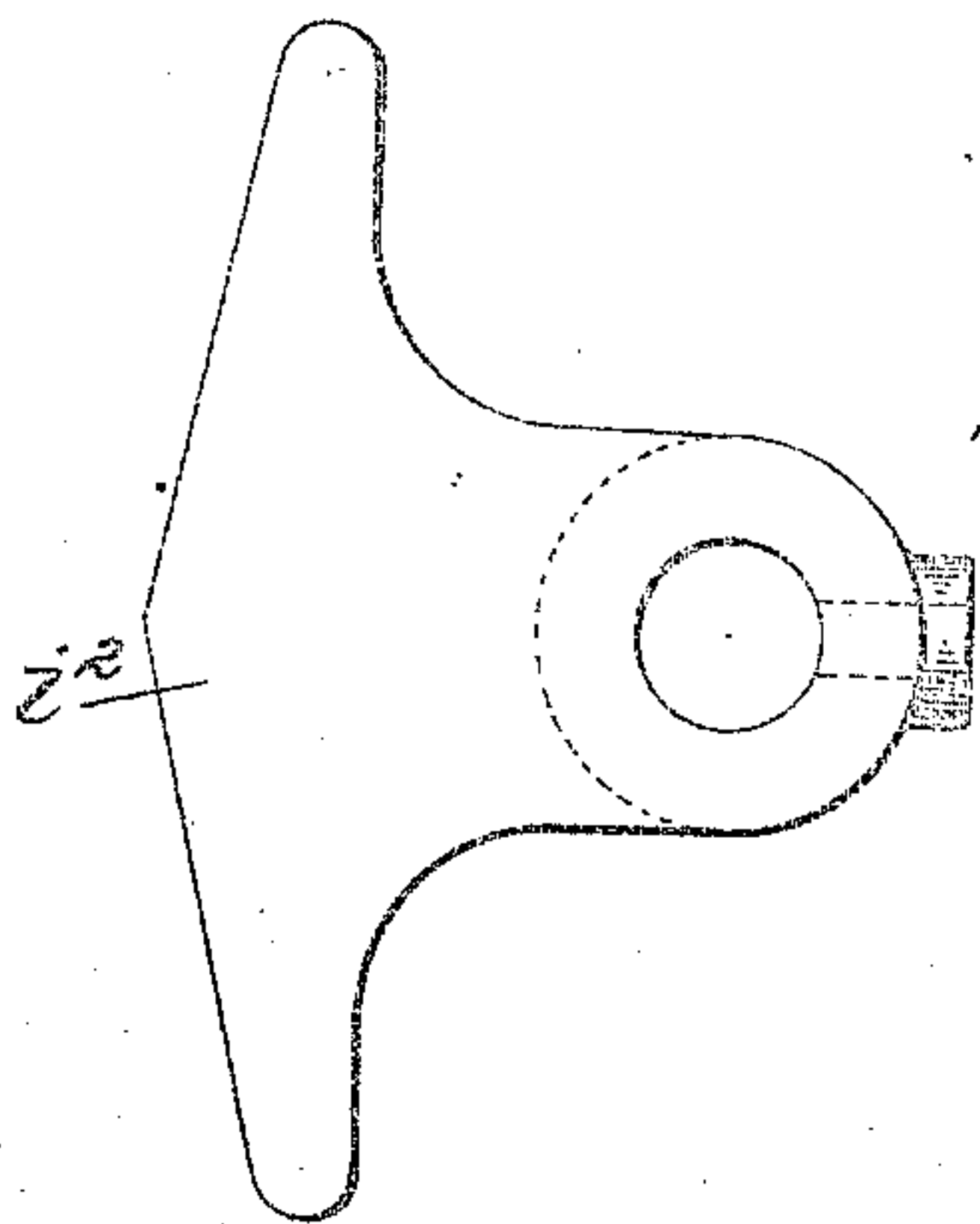


Fig. 12

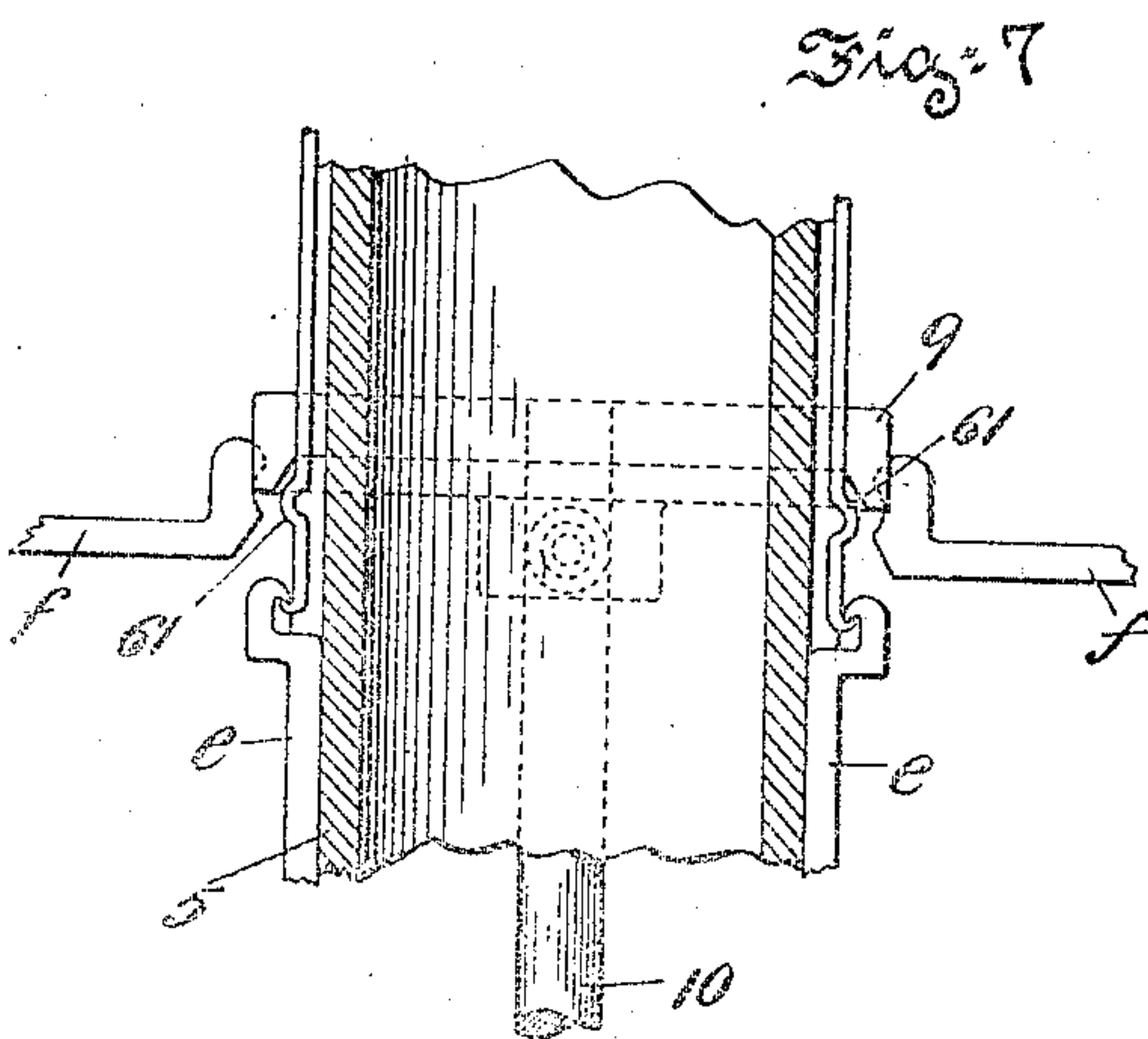


Fig. 7

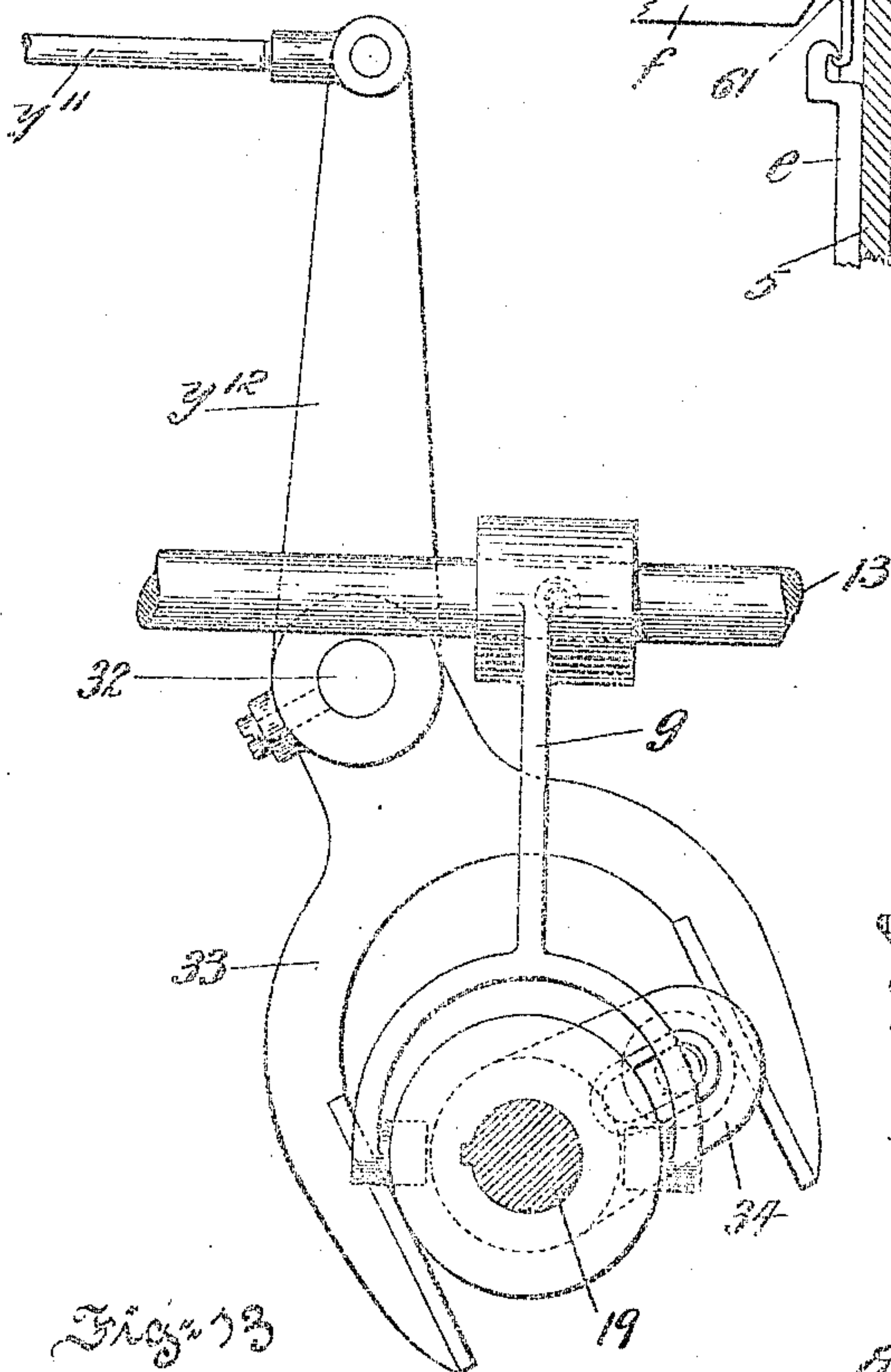


Fig. 13

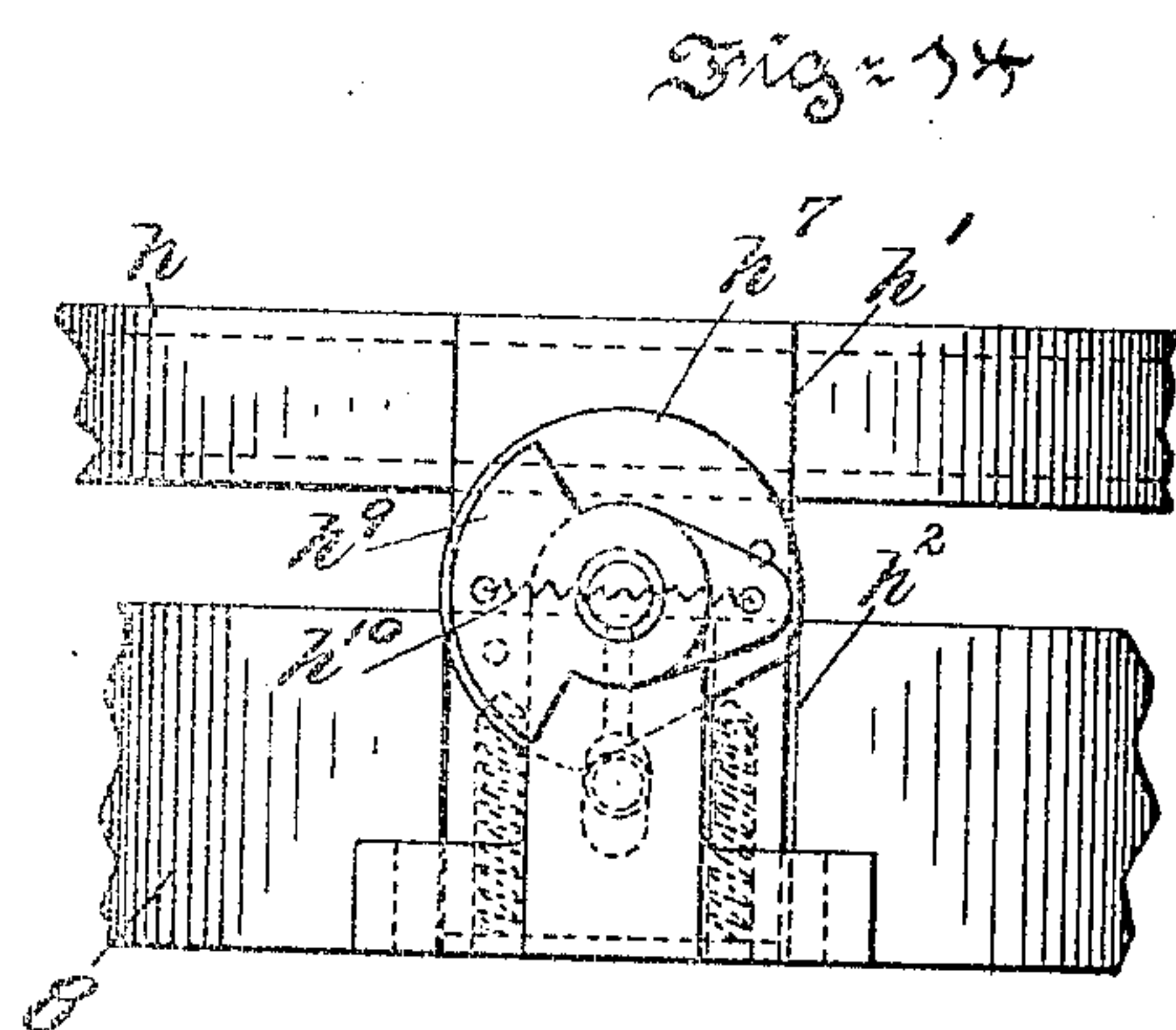


Fig. 14

*Witnesses:*  
*Frank E. Franck.*

*Inventor:*  
*Emil S. Franck.*  
*Augustus B. Franckson.*  
*Att.*

E. J. FRANCK.  
CIRCULAR FASHIONING KNITTING MACHINE.  
APPLICATION FILED AUG. 27, 1906. RENEWED OCT. 5, 1910.

991,711.

Patented May 9, 1911.

8 SHEETS—SHEET 8.

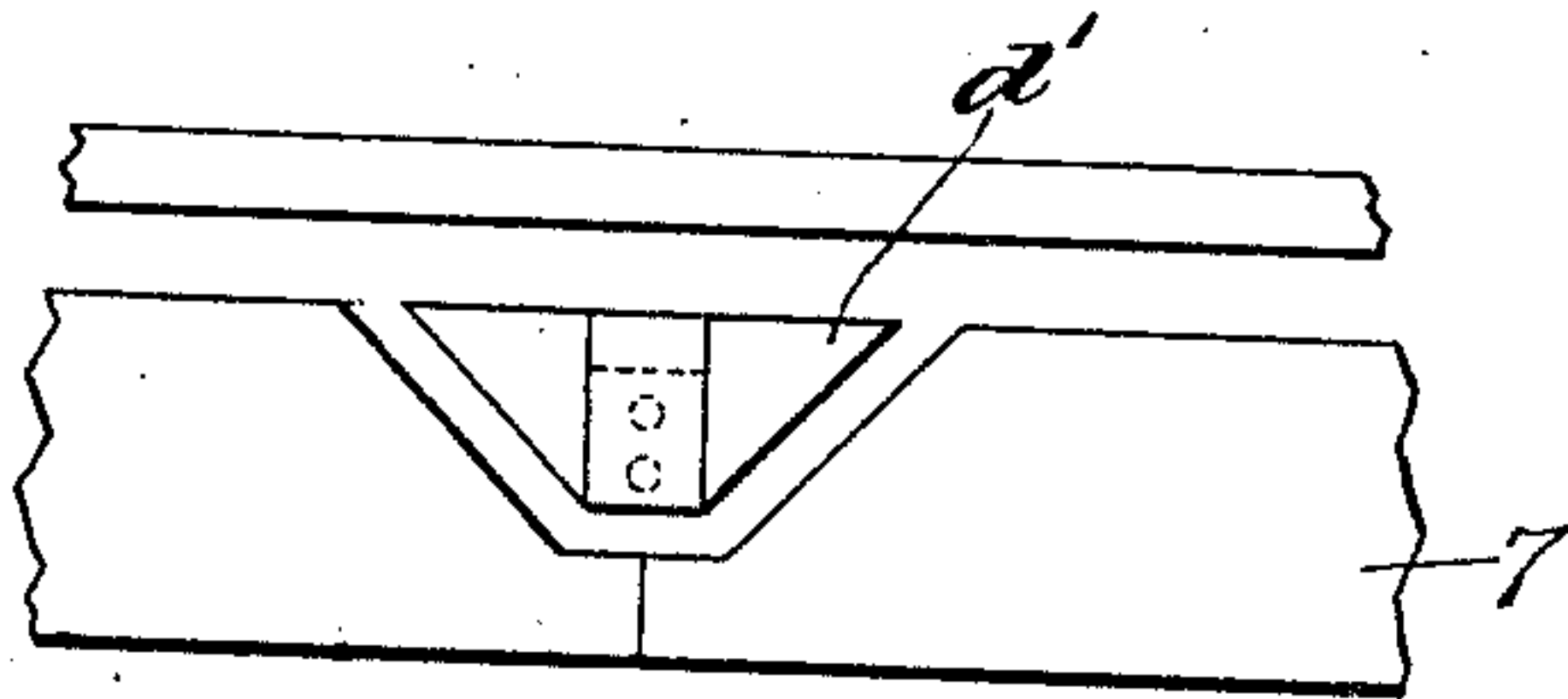


Fig. 15

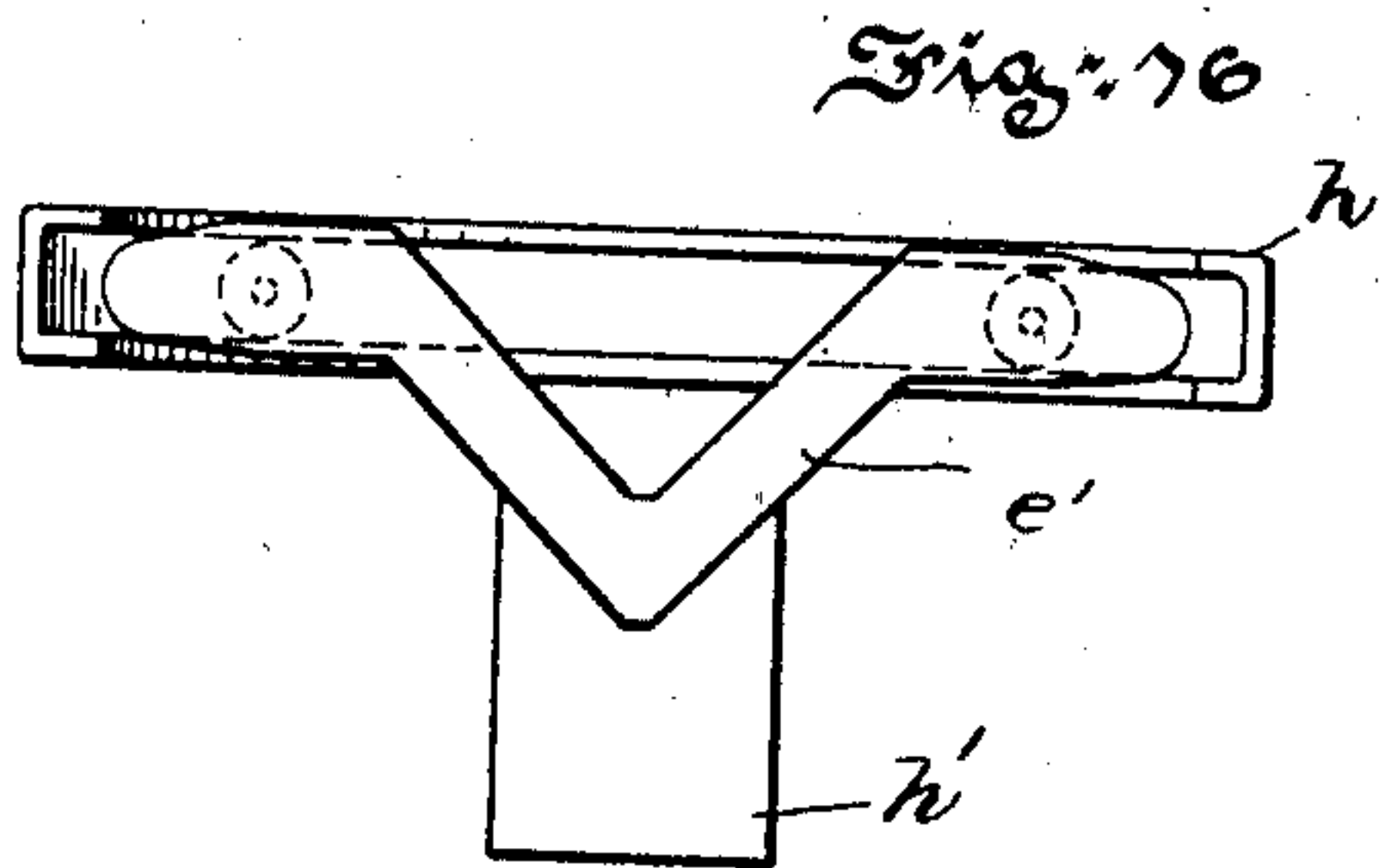


Fig. 16

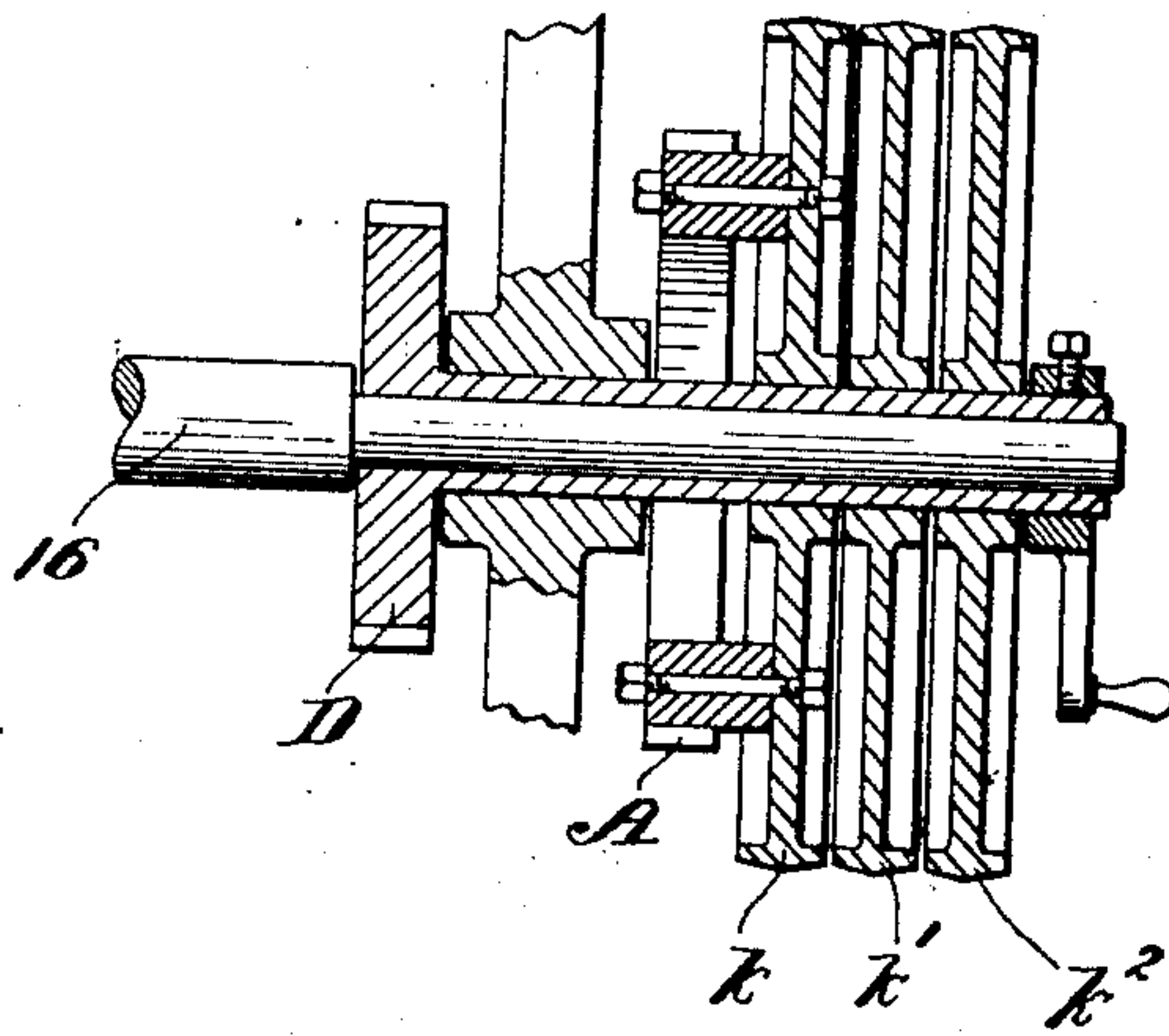


Fig. 17

Fig. 18

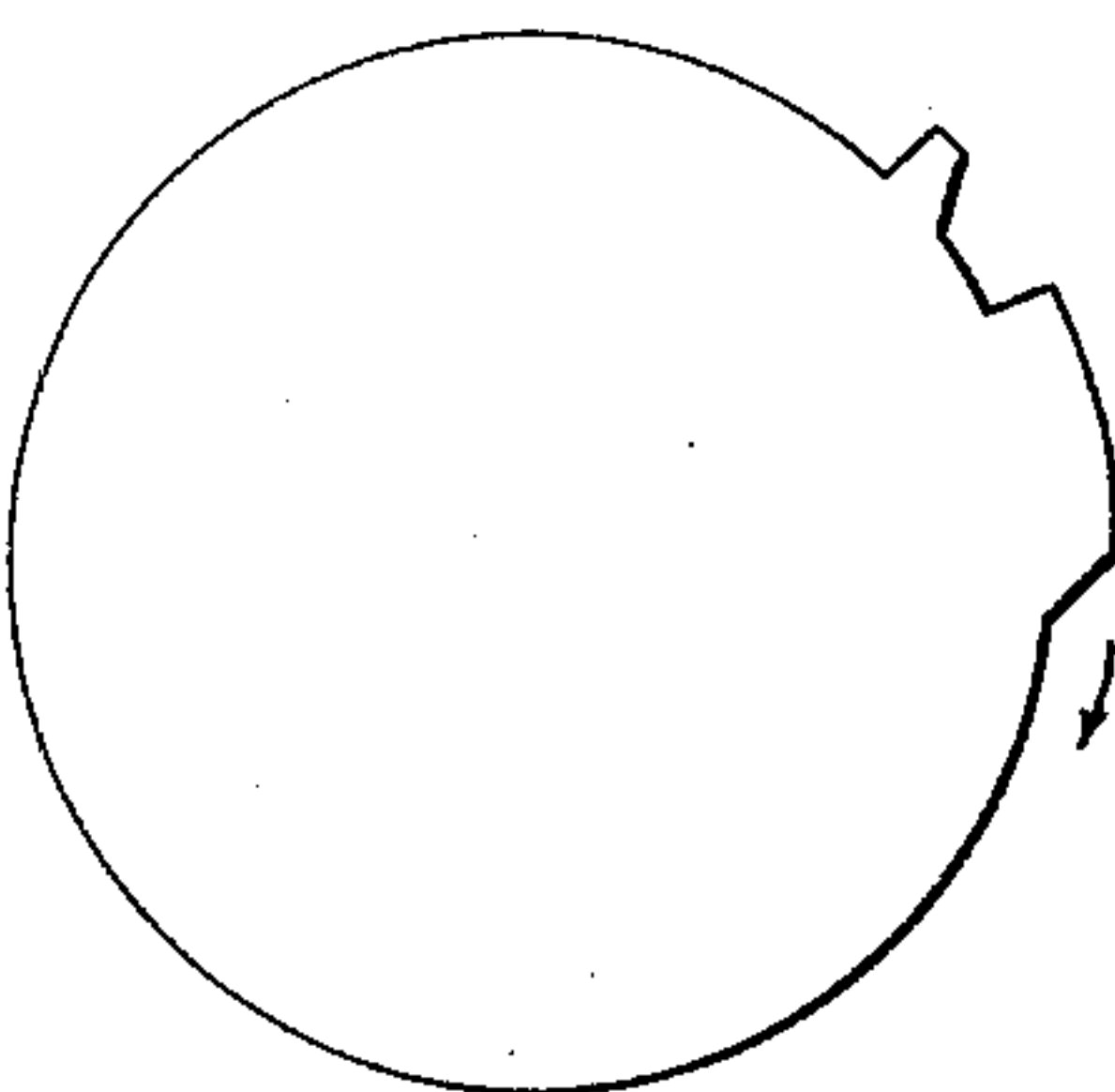
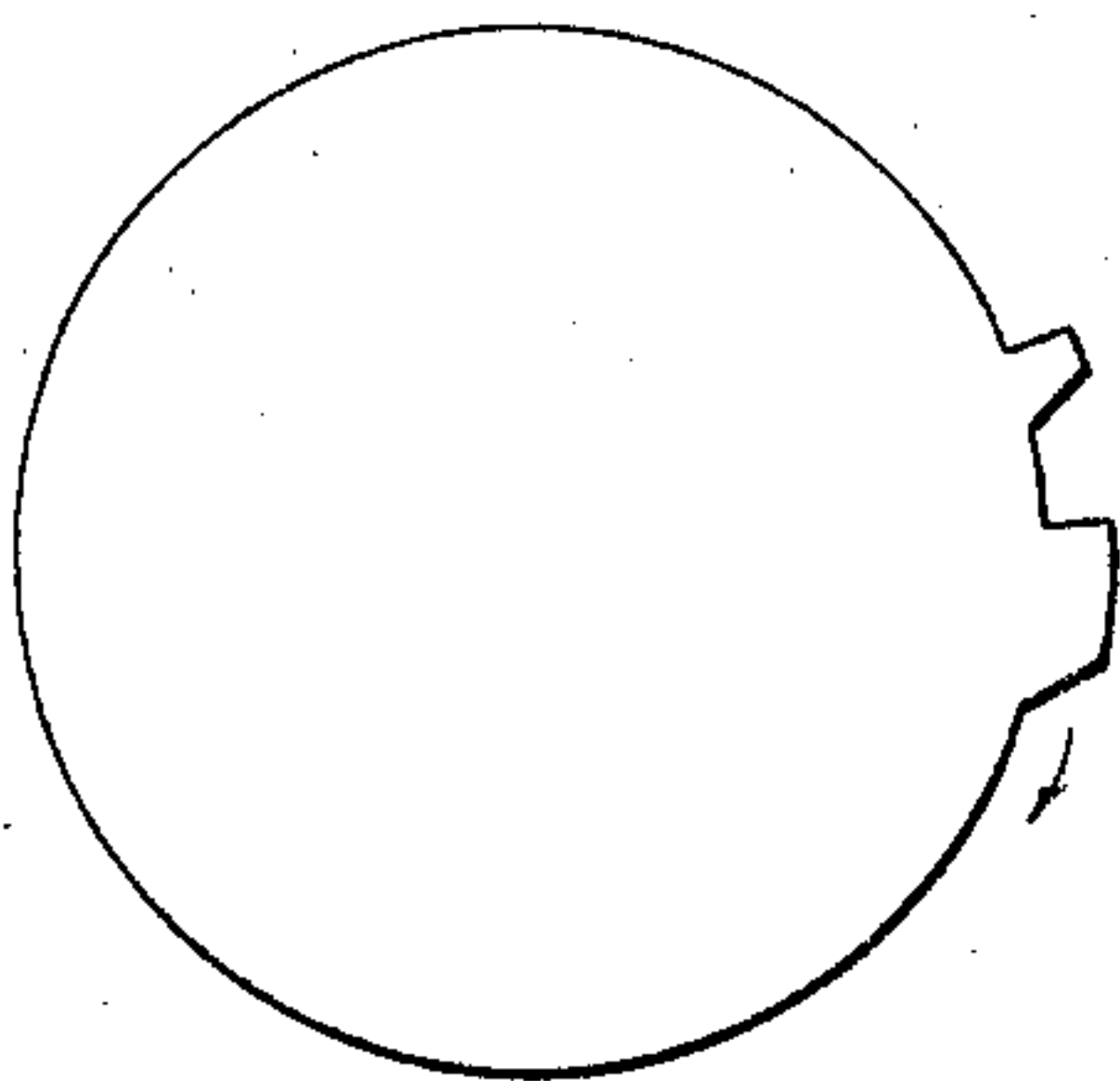


Fig. 19

Fig. 20

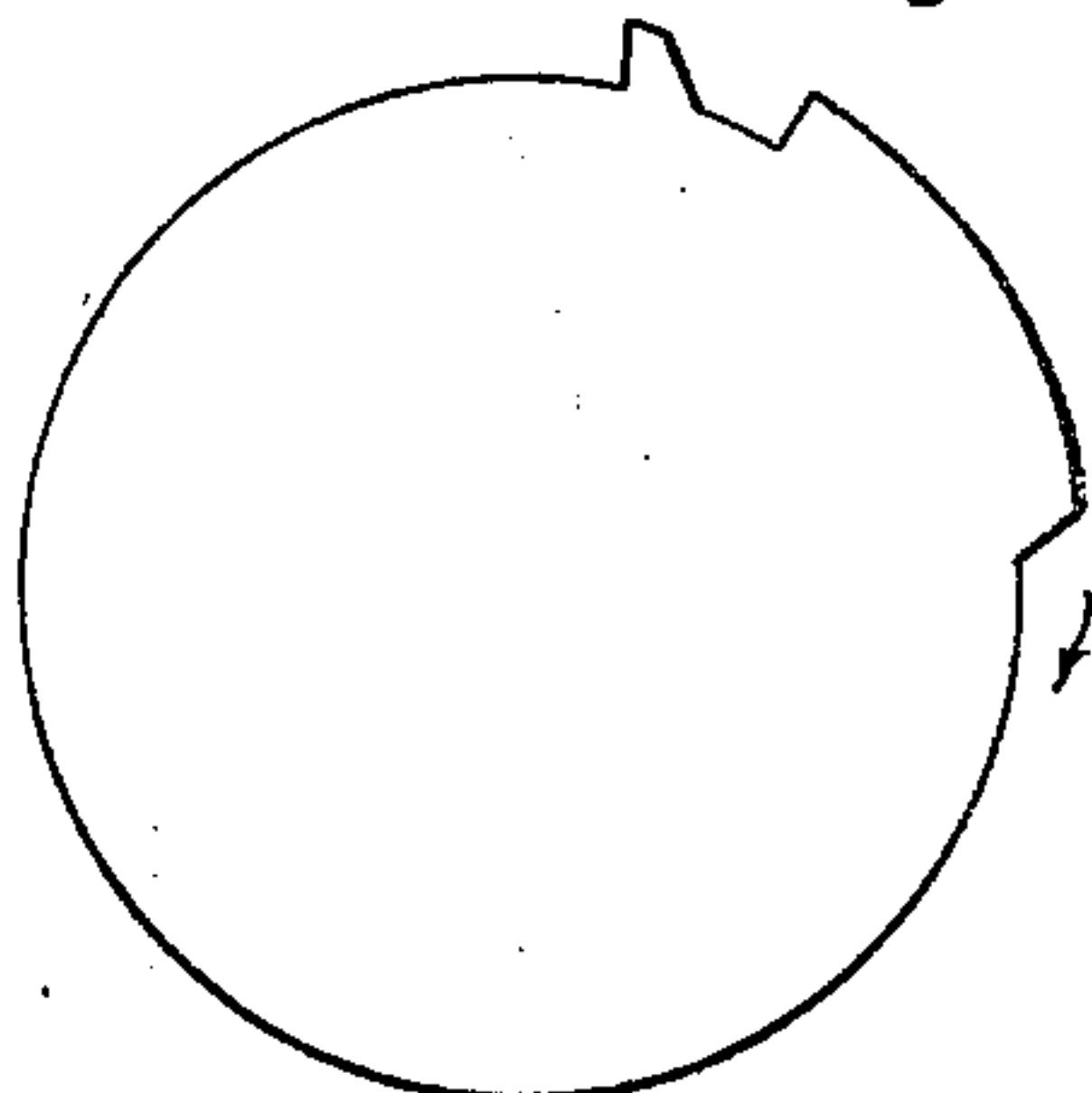
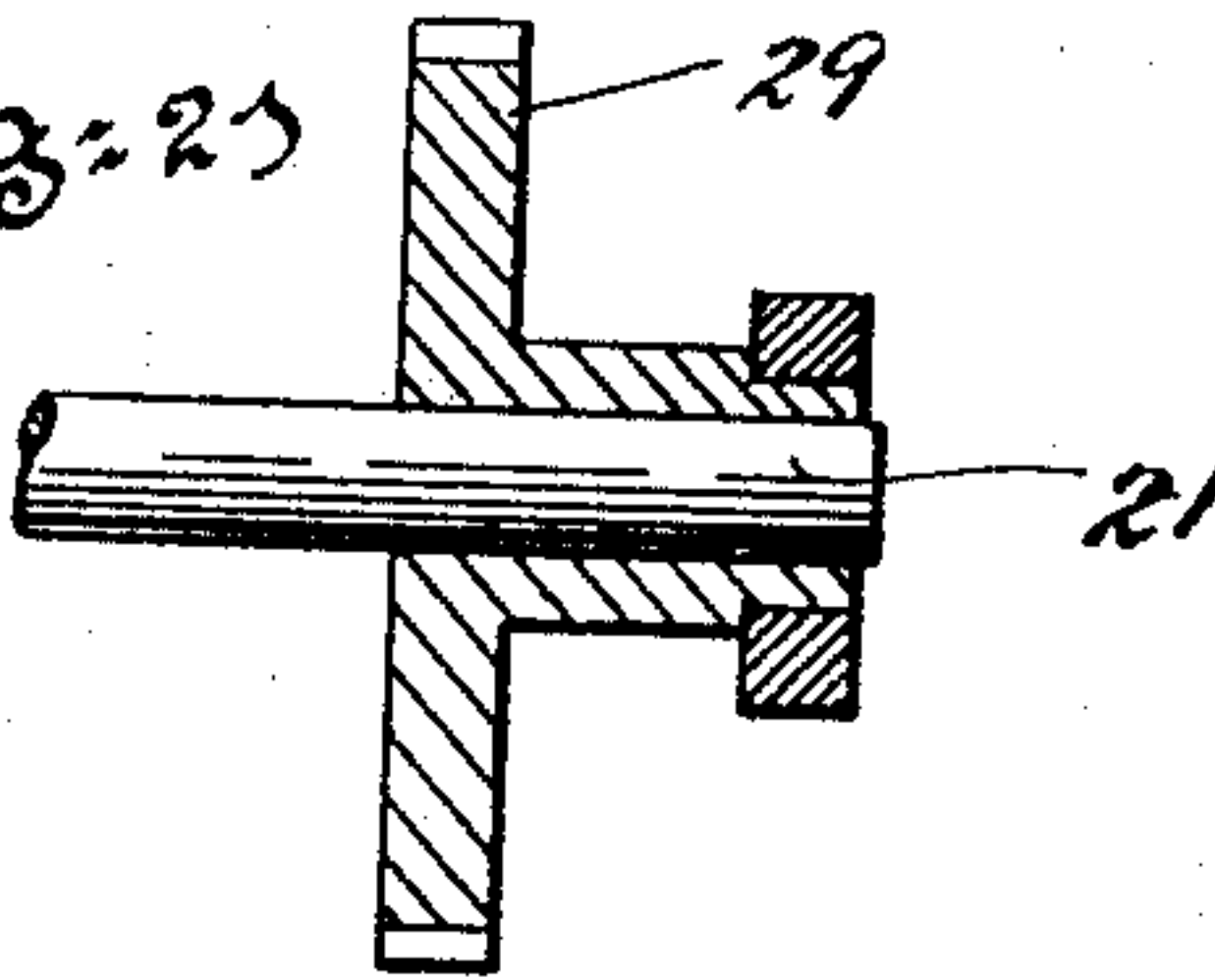


Fig. 21



Witnesses  
[Signature]  
Frank E. Hunch.

Inventor  
Emil J. Franck.  
By  
Augustus D. Houghton  
Attorney



# UNITED STATES PATENT OFFICE.

EMIL J. FRANCK, OF PHILADELPHIA, PENNSYLVANIA.

CIRCULAR-FASHIONING KNITTING-MACHINE.

991,711.

Specification of Letters Patent.

Patented May 9, 1911.

Application filed August 27, 1906, Serial No. 332,150. Renewed October 5, 1910. Serial No. 585,519.

*To all whom it may concern:*

Be it known that I, EMIL J. FRANCK, a citizen of the United States, residing at Philadelphia, in the county of Philadelphia and State of Pennsylvania, have invented a certain new and useful Circular-Fashioning Knitting-Machine, of which the following is a specification.

The principal object of the present invention is to provide a circular knitting machine which will not only automatically shape the legs of seamless stockings in the course of their manufacture, but also automatically make seamless heels and toes.

Another object of the invention is to provide for such a machine a comparatively simple and very reliable construction and arrangement of parts.

To these and other ends the invention comprises the improvements to be presently described in connection with the embodiment of the invention illustrated in the accompanying drawings and finally claimed.

In the drawings, Figure 1, is a front elevational view of a machine embodying features of the invention. Fig. 2, is a similar view of the right-hand end of the machine, having reference to Fig. 1. Fig. 3, is a top or plan view of the machine shown in Fig. 1. Fig. 4, is a transverse sectional view taken through the needle cylinder and drawn to an enlarged scale. Fig. 5, is a plan view partly in section taken on the line 5-5 of Fig. 4. Fig. 6, is a transverse sectional view taken on the line 6-6 of Fig. 3, looking toward the right. Fig. 7, is a detached sectional view through the needle cylinder taken from the back of the machine and looking toward the front of it. Fig. 8, is a sectional view illustrating one of the pawls shown in Fig. 5. Fig. 9, is an enlarged edge view of one of the cams shown in Fig. 3. Fig. 10, is a face view of ratchet wheels shown in Fig. 5. Fig. 11, is a top or plan view with parts broken away and showing the same pawl as shown in Fig. 8, together with some of its accessories. Fig. 12, is a top or plan view of a cam shown at the upper right-hand part of Fig. 4. Fig. 13, is an elevational view partly in section showing mechanism for actuating the parts to make heels and toes. Fig. 14, is a front elevational view of mechanism for changing the stitch height while

making the heels and toes and Figs 15-21, are detail views hereinafter referred to.

There are four legs 1, on top of which is a brace 2, of generally I-shape, and the legs are arranged at the ends of its cross-arms.

3, are side frames of generally hollow rectangular shape and which are arranged upon the brace 2, and carry the bed plate 4. On top of the bed plate 4, and centrally thereof and toward the front is arranged a fixed needle cylinder 5.

58, is a ring secured to the top of the needle cylinder 5, and arranged inside of the circle of needles. It is provided with notches for the web holders 59. Arranged around the needle cylinder near the top thereof and in fixed position, is a conical or inclined circular bed *a*, having a depending apron 6, which is provided with needle grooves inclined to the needle grooves of the cylinder 5.

*b*, are additional or calf needles arranged in the inclined grooves and which are put into action with and taken out of action in respect to the main needles, so as to shape the leg of the stocking.

The bed *a*, is carried by a ring *c*, fixed to the cylinder 5. This conical bed *a*, constitutes a way upon which the cam carrier 7, rotates.

53, is a ring carried by an arm 54, rising from the ring 7. This ring 53, has a thread guide 55, and it also holds the latches against accidental closing. This ring 53, also carries a guard 56, for the latches of the calf needles. This cam carrier 7 is provided with two cams *d*, and *d'*; one, *d*, is a cam for making the calf needles *b*, knit; and the other *d'*, Fig. 15 is a cam called auxiliary or cast-off cam for throwing the calf needles down so that they may be put out of action and throw off the stitches. There is no thread carrier opposite the cam *d'*, so that when it permits the needles to be put out of action they do not secure a thread. This cam *d'*, comes into use when the wide part of a stocking is completed. These two cams *d*, and *d'*, do not work directly on the needles *b*, but on jacks *b'*, which are arranged on top of the needles *b*, and in the same grooves.

The main needles are not operated upon directly by their cam, but are operated upon through the intervention of jacks *e*, which



in their turn are operated by the cam  $e^1$  of the ring 8, which revolves around the cylinder 5, upon a suitable way formed on the bed plate 4. The jacks  $e$ , are arranged in the same grooves as the needles. The cam ring 8, is either revolved to make tubes, or reciprocated during fashioning.

To fashion the heel and toe there are fashioning pressers  $f$ , arranged to work in radial grooves formed in a bed  $f^1$ , mounted around the needle cylinder and attached to the ring  $c$ . On this last mentioned bed  $f^1$ , and beneath the parts  $f^3$ , there are ways upon which travel two-part strippers  $f^1$  and  $f^2$ , which may have an edge cam which pushes the pressers  $f$  in, to disengage the needles from their jacks the spring of the offsets of the needles serving to push them out. 57, are spring pressed plungers which prevent over running of the strippers  $f^1$  and  $f^2$ . There is a semi-circular ring 9, which when elevated clears all the needles and which when depressed engages the off-sets in the needles which are out of action during the fashioning of the heels and toes, and thus the ring pushes the butts of these needles out of engagement with their jacks  $e$ . This ring 9, is worked up and down by a rod 10. This rod 10, is connected to one end of a centrally pivoted lever 11, the other end of which is connected with one arm of a bell crank lever 12, the other arm of which is connected with a clutch to be described. The shaft 13, on which the bell-crank 12, is fixed runs cross-wise of the machine and has upon it a clutch shifting arm  $g$  (Fig. 13), and it also has an arm  $g^1$  (Fig. 2), which is worked by a cam  $g^2$  of ratchet wheel 27 (Fig. 9) so that the cam ratchet wheel  $g^2$  works the ring 9, and the clutch and the cam in respect to arms 33. The skirt of the ring  $c$ , shown in Fig. 4, is cut away as shown at the front of Fig. 5, so as to accommodate the arm of the ring 9. The cam  $e^1$ , that works the jacks for the main needles is somewhat peculiar, in that each jack  $e$ , has two wings  $g^3$  and  $g^4$ , and the cam works between the two wings and there is a ring  $g^5$ , under the bottom wing  $g^4$ , that keeps the jacks from coming down after the passage of the cam.

The cam  $e^1$ , for the needle jacks consists of a V-shaped piece of steel mounted slidably in a half ring  $h$ , Fig. 16 arranged above the ring 8 and supported by a rod  $h^1$ , that works vertically in a socket  $h^2$ , carried by the ring 8. It also consists of a ring  $g^5$ , Fig. 5 cut to correspond with the V-shaped part and having sliding connection with the ring 8, so that both parts of the cam lag a little when the direction of revolution of the ring 8, is changed. The ring 7, carries the cams for the fashioning needles. The part 7, carries a fixed arm 14, to which is centrally pivoted an arm 15, having its inner

end connected with a block slidable up and down in the ring 7, and attached to the cam  $d^1$ . The other end of this arm has attached to it a spring  $h^3$ , which draws to one side or the other of the pivot point and thus holds the arm 15 and cam  $d^1$  in either position in which it may be placed. The rod  $i$ , is slidable vertically in the strand  $i^1$ , and is fitted with two cams  $i^2$  and  $i^3$ , Fig. 12, spaced apart. When the rod  $i$ , is elevated the cam  $i^2$  is struck by the lower cross-arm on the part 15, turning it so as to lift the cam  $d^1$  up, for example, after the widest part of the stocking is completed; when the rod  $i$ , is depressed the cam  $i^3$  is struck by the upper cross-arm on the part 15, and thus the cam  $d^1$  is lowered so that the wings  $i^4$  of the jacks  $b^1$  pass over the cam  $d^1$ , and are not operated by it. The rod  $i$ , is lifted and lowered by an arm 49, on a rock shaft 50, Fig. 6. On the other end of shaft 50, is another arm 51, projecting in a direction opposite to that of the arm 49. The arm 51, is operated by a high part 52, on the disk 7. Beneath the rod  $h^1$ , are springs tending to elevate it, Fig. 14. The ring 8, carries a bracket in which is mounted a rotatable shaft having a cam  $h^7$  of circular form with a flattened portion. This cam operates upon a projection on the arm  $h^1$ , so that the circular part holds the ring  $h$ , down and the flattened part permits it to rise. The purpose is to lower the cam  $d^1$  and make a looser stitch during heel and toe fashioning. The shaft which carries the cam  $h^7$  also carries a tappet cam  $h^9$ , having a positioning spring  $h^{10}$ , which operates like the spring of the arm 15. The tappet cam  $h^9$ , is struck by lugs  $h^{11}$  and  $h^{12}$ , on the rod 10.

16, is a main driving shaft carrying a sleeve and the sleeve has three pulleys  $k$ ,  $k^1$  and  $k^2$  on it, of which one  $k^1$  is fast and one  $k^2$  is loose. One  $k$  is loose and provided with a gear wheel. The pulley  $k$ , is for high speed when making tubes, and the pulley  $k^1$ , is for low speed when fashioning heels and toes. The inner high speed pulley  $k$ , drives by way of the spur wheels A, B, C and D, and when clutch L, Figs. 1 and 4, is in engagement with wheel D, turns shaft 16.

17, is an oscillating shaft. This shaft 17, carries a quadrant 18, having two arms. There is another shaft 19, Fig. 2, behind the shaft 16 and it is revolved and has a link  $L^1$  which is connected to the arm  $L^2$  of the quadrant and to a wheel E, fast on shaft 19. The wheel D, meshes with the wheel E, on the shaft 19, so as to rotate it and oscillate the quadrant. The low speed pulley  $k^1$ , Fig. 17 is connected to gear D, by a sleeve, and the high speed pulley  $k$ , is connected directly to gear A, and the high speed pulley and gear run loose on the sleeve. The clutch L, attached to the shaft 16, may be made to



engage a pinion F, which meshes with the quadrant 18, so as to oscillate the shaft 16, or the clutch may be made to engage the wheel D, so as to rotate the shaft.

21, is a controlling shaft and it is fixed and does not rotate, but a number of parts rotate on it. On this shaft 21, is a drum 22, consisting of a collar at the middle, and on each side of the collar are strung a number of washers each of which has two teeth, but the length of the face of the leading tooth  $t^1$ , is not the same on each pair of washers; for instance, this length is the same on the two middle washers and is greater on the successive washers toward the respective ends. Each of these teeth  $t^1$ , pushes one of the calf needle pressers  $t^2$ , which are arranged in grooves in a bed  $t^3$ , carried by a bracket from the bed 4, inward to release a calf needle from its jack, and all of the calf needles are thus held by the pressers  $t^2$ , engaging offsets  $t^4$ , in such position that the butts are clear of the jacks  $b^1$ , while the toe, heel and ankle parts are being made, then these teeth  $t^1$ , on the two middle washers pass by their pressers  $t^2$  and the latter get in between the teeth and remain thus for one revolution of the ring 7. The greater length of faces of the leading teeth of the other washers holds the corresponding pressers in so as to keep the corresponding needles out of action. See Figs. 18, 19 and 20. The drum then moves until the teeth  $t^1$ , on the middle washers or disks pinch the needles out and then rests for three or four courses, then the teeth clear the pressers entirely and the drum stands still until several courses have been made. The drum then turns again and the pressers  $t^2$ , corresponding to the two disks or washers next on opposite sides are, after an interval released from the comparatively long leading teeth  $t^1$ , and the described operation is repeated, and this takes place with the successive disks.

The washers and disks are clamped to form the drum 22 between the ratchet wheel 25, and the part T which has a single tooth. The pawl 23 works the drum 22 by engaging the wheel 25. 24, is a ratchet wheel also engaged by the pawl 23 and it is loose on the shaft 21. 24, has deep cuts, is large and is loose and the pawl simply turns it around until it comes to a low tooth and then the pawl engages 25 and turns it so as to give the drum a rest motion and this is repeated at intervals. The deep cuts occur in pairs so that 25 is driven two teeth and then let rest. The wheel 25, has a pair of high teeth. The wheel 25, has teeth so that it may be driven by the pawl and it is driven to turn the drum. This pawl 23, is carried by an arm  $v$ , worked by the rod  $v^1$  of an eccentric 26, on the shaft 16. There is on the shaft 21, a ratchet wheel 27, Fig. 9, which is part of the cam wheel  $g^2$ , which

works the clutch L, that makes the machine run continuously or reciprocatingly as has been described. This wheel 27, is started by a lug on the right (Fig. 5) of the pattern chain 28, so that the pattern chain starts the wheel and gets its pawl  $v^6$ , out of the space  $v^5$ , into work on the teeth Fig. 6. The pawl  $v^6$ , works with a long stroke, but shield  $v^7$ , Fig. 2 holds it clear of the teeth except at the end of its stroke. However, there is a high tooth  $v^8$ , Fig. 6 which extends above the shield so that it receives a long push, and this long push shifts the clutches properly.

The sprocket wheel for the pattern chain 80 is attached to the sleeve which has on it a ratchet wheel 29 Fig. 21. There is a pawl arm 30, which carries the pawls  $v^6$  and  $v^9$  that work the wheels 29 and 27.  $v^9$ , is also provided with a shield made in one piece with the shield  $v^7$ . This arm 30, has a link  $v^{10}$ , that goes down to a crank arm on the quadrant 18. There is a rock shaft  $x$ , that goes through and is carried by the drum and it is provided at one end with an arm  $x^1$ , arranged under the pawl 23, that works wheels 24, and 25, and at the other end with an arm  $x^2$ , that has on its face a cam lug. A spring on shaft  $x$ , tends to turn it for causing the arm  $x^1$ , to lift the pawl 23. A lug on the left of the pattern chain 28, engages the cam lug on arm  $x^2$ , and turns the shaft into position for causing the arm  $x^1$ , to permit the pawl 23, to work its ratchet wheel.

There are strippers  $f^5$ , and  $f^6$ , which work around on the bed as has been stated and are movable around the central head and their cams  $y$ , (Fig. 5), engage the pressers  $f$ , and push them in singly. These strippers are worked by pawls of which there are four, two  $y^1$  and  $y^2$ , for each stripper, one to run it one way and one to run it the other. Each stripper has oppositely arranged teeth, of which the coarse teeth are above the fine teeth. The pawl  $y^1$ , takes the upper or coarse teeth and the pawl  $y^2$ , takes the fine teeth. In narrowing half the needles are put out by the ring 9, and the pawls  $y^2$ , drive the strippers toward the top of Fig. 5, engaging for this purpose the fine teeth one at a time. The operation of ring 9, is automatic and is accomplished through parts 10, 11, 12, 13,  $g^1$  and cam  $g^2$ , on ratchet wheel 27, as has been described. The shield  $y^4$ , permits these pawls to operate only at the ends of their strokes. During this, the springs  $y^5$ , lie to one side of the pivots of the pawls  $y^1$ , and hold them out of action. At the end of the narrowing, pins  $y^6$ , strike the tails of the pawls  $y^1$  and throw them into action. The pawls  $y^1$ , then engage the coarse teeth, one at a time, and return the strippers. However, the pawls  $y^2$  remain in action so that the strippers are not returned



too rapidly. At the end of the return travel of the strippers, pins  $y^7$ , throw or turn the pawls  $y^1$ , out of action.

There is a circular frame  $y^8$ , with two arms  $y^9$  and  $y^{10}$ , that have upon them the pawls  $y^1$  and  $y^2$ , and it is arranged generally speaking under bed  $f^1$ . The frame  $y^8$ , oscillates and its arm  $y^9$ , is connected by a rod  $y^{11}$ , to a rocker arm  $y^{12}$ , on a shaft 32, that has a fork 33, on it and the fork 33, engages a cam or crank 34, provided with a roller and splined on the shaft 19. The shaft 13, that carries the part  $y^{12}$ , also carries the part  $g$ , for shifting the crank 34, with the roller on it into the fork or out of it. From the shaft 16, beveled gearing 40, turns a vertical shaft 41, which turns both the knitting cams and also a sleeve 42, arranged between the cylinder and a stationary tube 43, and provided with a cam 44, on the top which works the web holders. The belt shifter rod 45, is pushed toward the left in Fig. 4, by a spring 46, and it is shifted toward the right by a cam 47, on the part 27, Fig. 9, through the intervention of a lever 48 one end of which is acted upon by the cam 47, and the other end of which is connected to the rod 45. The cam 47, is carried by the wheel 27. The object of shifting the belt is to obtain high speed for all the tubular work and low speed for fashioning the heels and toes. The shaft 17, has two bearings, one in each side frame 3, and these bearings are comparatively far apart so that the shaft is well supported for carrying and actuating the crank gear  $L^1$  and  $L^2$ .

The stocking is made from toe to heel. In the beginning a few courses of a tubular fabric are knit upon all of the needles of the needle cylinder 5, or in other words upon all of the needles which have vertical motion. For this purpose the belt is on the pulley  $k$ . The clutch is in engagement with the spur wheel  $d$ , and the shaft 16, is therefore rotated in the same direction at a comparatively high speed through the gear wheels A, B, C, and D. The rotation of the shaft 16, acting through the beveled wheels 40, rotates the cam ring 8, and also the sleeve 42. In consequence of this the jacks  $e$ , work the needles up and down, the cam on the sleeve 42, operates the web holders 59, and the rotating ring 7, revolves the ring 53, and with it the thread carrier 55. The various movements of the other parts of the machine are so timed that the knitting elements which they control are out of operation. In the drawings, however, and for the sake of clearness the various parts have been shown principally in their intermediate positions, but those skilled in the art will understand how the timing should be accomplished. Upon the completion of these few courses the pattern chain 28 has ad-

vanced into such position that a lug on its right-hand side in Fig. 5, comes in contact with a lug 60, Fig. 9, and thus turns the wheel 27, in such a way that its pawl begins to rotate it and with it, the cams  $g^2$  and 47. The cam 47 operating upon the rod 48 shifts the belt shipper rod 45, toward the right so that the belt runs upon the pulley  $k^1$ , and this slows the machine down because the pulley  $k^1$ , drives the wheel D, by means of a sleeve and the speed gears A, B, and C, are cut out. The cam  $g^2$  thereupon turns the shaft 13. The result of this is that the half ring 9, is dropped and its lower edge catches the off sets 61, Fig. 7, of approximately half the needles, sometimes called instep needles  $s$ , and thus pushes them out of engagement with their jacks so that they are out of action. The movement of the rod 10, brings the pin  $h^{11}$ , Fig. 2, into such position that it operates upon the tappet  $h^9$ , and thus lowers the cam  $e^1$ , thereby making a looser stitch. The movement of the shaft 13, also shifts the clutch L, so that it engages the pinion F, which is turned first in one direction and then in the other by means of the quadrant 18. The turning of the shaft 13, also shifts the crank 34, into engagement with the fork 33, Fig. 13. Thus the rod  $y^{11}$ , operates to reciprocate the ring  $y^8$ , and thus the pawls shift the strippers  $f^5$ , and  $f^6$ , in the manner described. The result of this is that the toe is fashioned. The further travel of the part 27, shown in Fig. 9, operates to restore the parts to the position first described, it being understood that the order is reversed in that the high speed is again availed of after all of the parts have been returned to their original positions. The foot part of the stocking is then manufactured in the manner which has been described in connection with the few initial courses. During this time the pawl  $e^6$ , works in the space  $v^5$ . When it is proper that the heel should be made the pattern chain again turns the part 27 and the operation is the same as when the toe is made. Thereafter the tubular ankle portion is made and upon its completion a lug on the left-hand side of the pattern chain (Fig. 5) collides with the arm  $w^2$  and turns down the arm  $w^1$ , which has been holding the pawl 23 out of action (Fig. 10), the pawl 23, thereupon begins to drive the drum 22. The initial motion of this drum permits the two middle needles that work on the inclined bed to come into action and the subsequent movements bring the needles outside of these two successively into operation in the manner that has been described. The result of this is that the tube is fabricated not only by means of the needles of the cylinder 5, but also by means of the inclined needles as they are brought into play so that the calf portion is shaped appropriately. As the in-



clined needles are brought into action by the rotation of the drum 22, the arm  $\alpha^1$ , is carried by the drum clear of the pawl 23, so that the pawl 23 continues to turn the drum 5 until it has made substantially a revolution whereupon the arm  $\alpha$  again lifts the pawl out and the drum remains at rest while the widest portion above the calf, which may be called the knee portion, is being made. 10 When the stocking is sufficiently long, a lug on the left-hand side of the pattern chain again operates to turn the part  $\alpha^1$ , and permit the pawl to bring the drum to its initial position in which the pressers  $t^2$  15 (Fig. 6) are in range of the humps  $t^4$ , thus detaching the inclined needles  $b$  from the jacks  $b^1$ . Prior to the pressing in of the pressers  $t^2$ , the cam  $d$ , has passed by all the butts  $i^4$  of the inclined needles  $b$ . Before 20 the cam  $d^1$ , reaches the butts  $i^4$ , it has been elevated through the action of the rod  $i$ , and its accessories, which rod  $i$ , is lifted by the lug 52 (Fig. 6). When the cam  $d^1$ , in elevated position comes to the butts  $i^4$ , it pushes 25 the needles  $b$ , down, throwing off their stitches so that their humps  $t^4$ , are in range of and are pressed by the pressers  $t^2$ , thus the needles  $b$ , are disengaged from their jacks and remain out of action while the 30 few courses are made which intervene from one stocking to the next.

Immediately after the cam  $d^1$  in elevated position has passed the butts  $i^4$ , it is returned to its lower position because the high part 35 52 has passed the lever 51 and thus lowers the rod  $i$ . The inner sleeve 43 serves to permit the work to pass down through the cylinder without contact with the intermediate rotating sleeve 42. At 75, the needles 40 are off-set so as to allow the hooks 76, at their lower ends to be pushed clear of the hooks in the jacks and the humps or off-sets 77, in the needles afford the pressers  $f$ , an opportunity to detach the needles from the 45 jacks even though the pressers may operate a little out of time, thus jamming is obviated. The ends of the pressers are slightly rounded and thus by engaging the humps they serve to hold the needles against 50 dropping.

Certain features of the machine described herein constitute the subject-matter of my application for patent, serially numbered 276,371.

55 It may be desirable to attempt to summarize the foregoing specification and description to the pattern mechanism and this accordingly will be done.

Of course the only pattern that the machine is concerned with is the shaping of 60 the tube and it may be said that in operation there is first knit a short tube of relatively small diameter, then the toe is knit, then the foot part which is a tube of small 65 diameter, then the heel part, then the leg or

calf portion, which is of relatively large diameter and then the small tube of small diameter, which is a repetition of the beginning of the operation.

When the initial tube of small diameter 70 is being made the drum which is shown at the top of Fig. 5, is at rest and it is holding the additional or calf needles  $b$ , out of engagement with their jacks and therefore out of action, by the means and instrumentalities 75 which have been heretofore described. Under these circumstances the main needles are knitting the small tube, being operated by the revolution of the cam  $e^1$ , while the drum is standing still as has been stated, the 80 pattern chain is being driven and is advancing as has been described. The toe is then made and during this operation the drum still stands still, but a lug on the right-hand edge of the advancing pattern 85 chain, Fig. 5, sets in motion a ratchet wheel 27, which is therefore driven by its pawl and this ratchet wheel 27 sets in motion the ring 9, which throws half the main needles out of action and also the strippers, which 90 by first throwing the needles out of and then into action, narrows and widens for the toe, all of which has been in detail described above. After the completion of the toe the 95 foot part is made and when this is to be done the ratchet wheel 27, has come to rest, the drum remains at rest and the main needles form a tube under the action of the cam  $e^1$ . Upon the completion of this foot portion 100 the heel is to be made and to do this another lug on the right-hand side of the pattern chain shown in Fig. 5, again starts up the ratchet wheel 27, which continues in motion and causes the parts to narrow and widen to 105 make the heel. The parts have been described above and also their manner of operation in effecting this work. To make the ankle part, the drum stands still, the pattern chain continues to move and a tube of relatively small diameter is made in the manner 110 as has been described. The next thing is to make the calf or widened portion. For this purpose a lug on the left-hand side of the pattern chain collides with the arm  $X^2$  and turns the rock shaft  $X$ , thereby permit- 115 ting a pawl, which has already been described, to come into play and rotate the drum. In consequence of this rotation the additional or calf needles  $b$ , are brought into action in the manner that has been described 120 and by the means which have been referred to, so that they take part along with the cylinder needles and fabricate the tube of larger diameter. It may be remarked that while this wide tube is being knit the drum 125 is again standing still and when this wide tube is long enough, another lug in the left-hand side of the pattern chain, shown in Fig. 5, again operates the rocker arm which operates the driving pawl of the drum in 130



such a way that the drum is moved sufficiently to throw out the calf needles, the particular mechanism by which this has been accomplished has already been described.

I claim:

1. A knitting machine comprising the combination of a knitting cylinder having needles arranged for vertical motion, a bed inclined in respect to the axis of the cylinder and having a set of needles adapted for movement at an inclination to the vertical and between some of the first mentioned needles, mechanism for automatically throwing some of the vertical needles into and out of action for widening and narrowing heels and toes, means for automatically operating all of the vertical needles to make tubular work and automatic devices for successively throwing the inclined needles into action to widen the tubular fabric, and automatic mechanism for throwing the inclined needles out of action, substantially as described.

2. A circular knitting machine provided with vertical needles arranged in a circle and with inclined needles arranged adjacent to a group less than all the upright needles, all said needles arranged to make plain knitting and with means for automatically operating the upright needles to fabricate the toe, foot, heel and ankle portions of a stocking and for automatically causing the inclined needles to cooperate with the upright needles to shape the calf and fabricate the knee portion of the stocking, substantially as described.

3. A knitting machine provided with a single cylinder having vertical needle grooves and a cam ring, jacks arranged in the needle grooves of the single cylinder and operatively and always in engagement with the cam ring, needles arranged in the needle grooves having their lower portions off-set in respect to their upper portions and provided at their lower ends with hooks adapted to the jacks, and devices for unhooking and detaching the needles from the jacks, substantially as described.

4. In combination a grooved needle cylinder and its knitting cam, jacks operated by the cam and provided with hooks and arranged in the needle grooves, needles arranged in the needle grooves and off-set at their lower ends and provided with hooks for engaging the jacks, and pressers for shifting the off-set ends of the needles to clear the jacks, substantially as described.

5. The combination of a needle cylinder having needle grooves, a cam ring, jacks arranged in the needle grooves and operated by the cam ring and provided with hooks, needles provided with offsets and humps and hooks for engaging the jacks, and pressers having concave working ends corresponding to the form of the humps and adapted to

unhook the needles from the jacks and to hold the needles, substantially as described.

6. In a knitting machine the combination of a needle cylinder and an inclined needle bed, needles for the needle cylinder and for the bed, cams and jacks having hook connection with the needles, means for connecting and disconnecting the jacks and the needles, mechanisms for actuating said means to produce heels, toes and shaped legs, and a single pattern chain for automatically controlling all said mechanisms, substantially as described.

7. The combination of an inclined needle bed and its cam ring and jacks, needles hooked to said jacks, pressers for unhooking the needles, a drum provided with a ratchet wheel and with high parts for actuating the pressers, a pawl for the ratchet wheel, means carried by the drum for throwing the pawl out of action, and a pattern chain for controlling said means, substantially as described.

8. In combination a drum provided with a ratchet wheel, a driven pawl for driving the ratchet wheel and turning the drum, means carried by the drum and including provisions for throwing the pawl out of action and provisions engageable by a pattern chain, and a pattern chain for actuating said means, substantially as described.

9. In a knitting machine the combination of a needle cylinder and its needles, actuating means for reciprocating said needles and from which means the needles may be disengaged by springing them, a half ring surrounding one-half of the cylinder and normally clear of the needles and adapted to be shifted to press upon and spring some of them thereby disconnecting them from their actuating means, and devices for shifting said ring in the direction of the length of the needles, substantially as described.

10. The combination of a needle cylinder and its needles, actuating means connected with the needles for actuating them and from which means the needles may be detached by springing them, a generally semi-circular ring surrounding the needle cylinder and in one position clear of the needles and in the other position adapted to spring some of them and disconnect them from their actuating means, and devices for automatically shifting said ring in the direction of the length of said needles, substantially as described.

11. A circular knitting machine having, in combination, a cylinder and dial, each equipped with a set of needles, those of one set being disposed at an acute angle in respect to those of the other set, but both drawing stitches to the same face of the web, means for knitting first upon the needles of one set to produce narrow, tubular, seamless web, and then upon said needles



and a progressively increasing number of needles of the other set to gradually widen said tubular, seamless web, and means for simultaneously rendering inoperative the needles thus progressively introduced.

12. The combination of a needle cylinder and its needles, jacks detachably connected with the needles, a knitting cam for operating the jacks, strippers for disconnecting the jacks and certain of the needles, a part ring for disconnecting certain of the needles and jacks, an inclined needle bed provided with needles and a knitting cam and jacks detachably connected with the needles, means for revolving the knitting cam and for oscillating it, devices for actuating the strippers, pressers for disconnecting the jacks and needles of the inclined bed, a controller shaft provided with controlling mechanism including a cam wheel and a pattern chain, and a drum having high and low parts for operating the last mentioned pressers substantially as described.

13. The combination of an inclined needle bed provided with jacks and needles detachably hooked together, a drum consisting of disks each having a pair of teeth whereof the leading tooth in each pair is in alignment and whereof the leading teeth increase in length of face from the center of the drum toward the ends, and pressers operatively arranged in respect to the disks for unhooking the needles, substantially as described.

14. The combination of an inclined needle bed provided with jacks and needles detachably hooked together, a drum provided with teeth arranged circumferentially in sets and whereof the leading tooth in each set is in alignment and whereof the leading teeth increase in length of face from the center of the drum toward the ends, and pressers operatively arranged in respect to the disks for unlocking the needles substantially as described.

15. The combination of a needle cylinder having grooves, jacks arranged in said grooves and having their hooked ends opening inward, needles having their lower portions offset and provided with outwardly arranged hooks, substantially as described.

16. In a knitting machine the combination of needles having humps and pressers ar-

ranged at right angles with the needles and having their working ends concave in similitude with the humps to hold the needles in two directions, substantially as described.

17. The combination of a thread guide structure a needle cylinder provided with a way for a cam ring and with an inclined needle bed and needles, jacks for the needles, and a cam ring provided with a knitting cam and with a second movable cam for positioning the needles clear of the thread of the guide, substantially as described.

18. The combination of needles, jacks detachably connected with the needles, means for actuating the jacks, pressers for detaching the needles, and a cam drum adapted to actuate the pressers and consisting of a shaft having a central collar and cam disks arranged on opposite sides of the collar, substantially as described.

19. The combination of a table, a knitting cylinder arranged at the front of the table and provided with a rearwardly extending inclined needle bed having needles, and extending partway of the cylinder a horizontal controller shaft arranged at the rear of the table, and mechanism on the controller shaft for throwing said needles out of action, substantially as described.

20. In a knitting machine the combination of the needles which increase the diameter of the tube and extend part way around the machine, a cam ring adapted to operate said needles to make them knit and provided with an auxiliary movable cam, and means for shifting the last mentioned cam when clear of the needles, substantially as described.

21. In a knitting machine the combination of the needles which increase the diameter of the tube and extend part way around the machine, a cam ring provided with a knitting cam adapted to make said needles knit and with an auxiliary cam adapted to make said needles cast off stitches, said cams being spaced apart, and a thread carrier adjacent said knitting cam, substantially as described.

In testimony whereof I have hereunto signed my name.

EMIL J. FRANCK.

In presence of—

WM. J. JACKSON,  
FRANK E. FRENCH.