

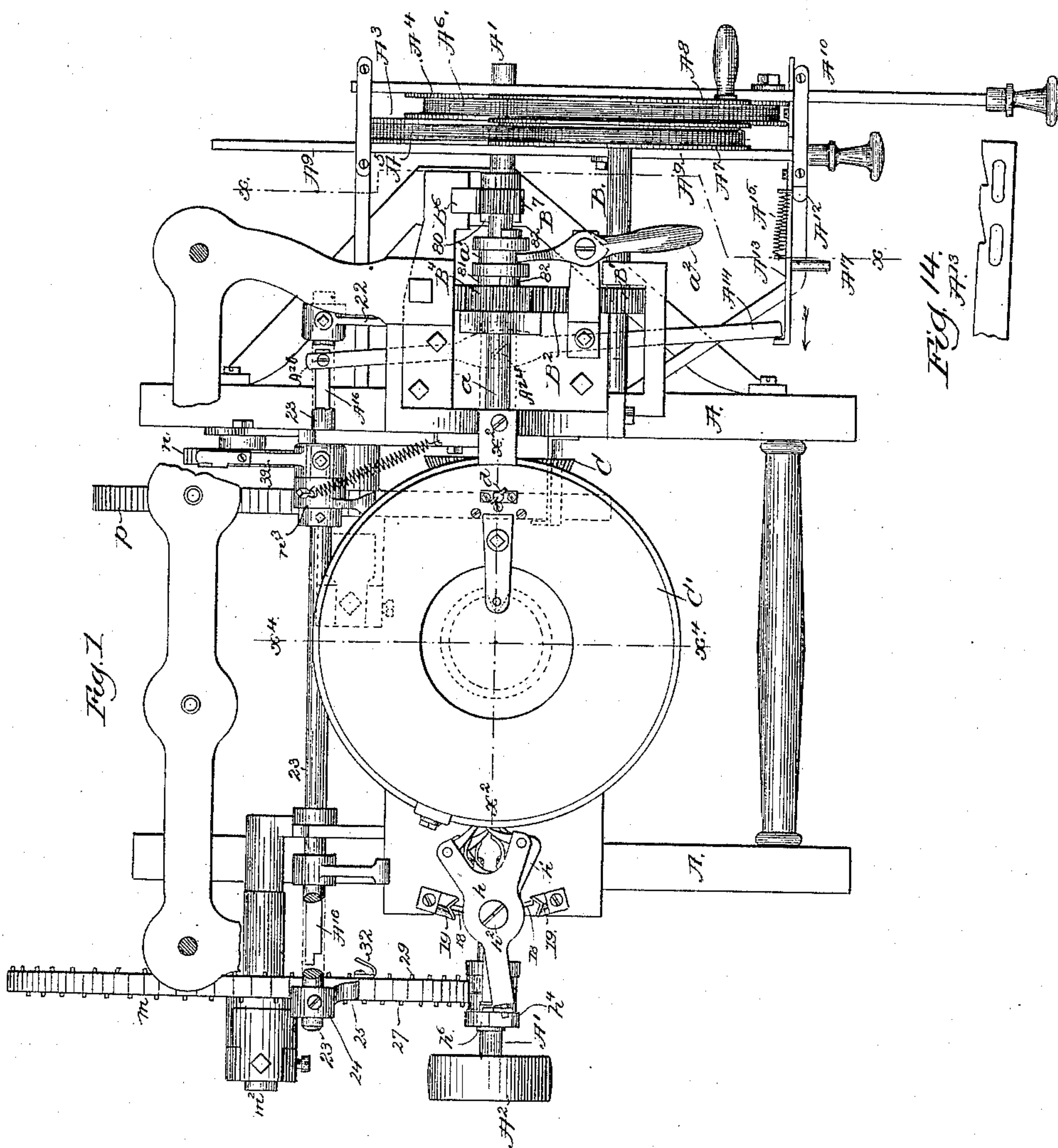
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7 Sheets—Sheet 1.

W. AIKEN.
KNITTING MACHINE.

No. 324,795.

Patented Aug. 25, 1885.



Witnesses.
John F. C. Prinkert
O. J. Moyer

Inventor.
Walter Aiken.
by Crosby Gregory

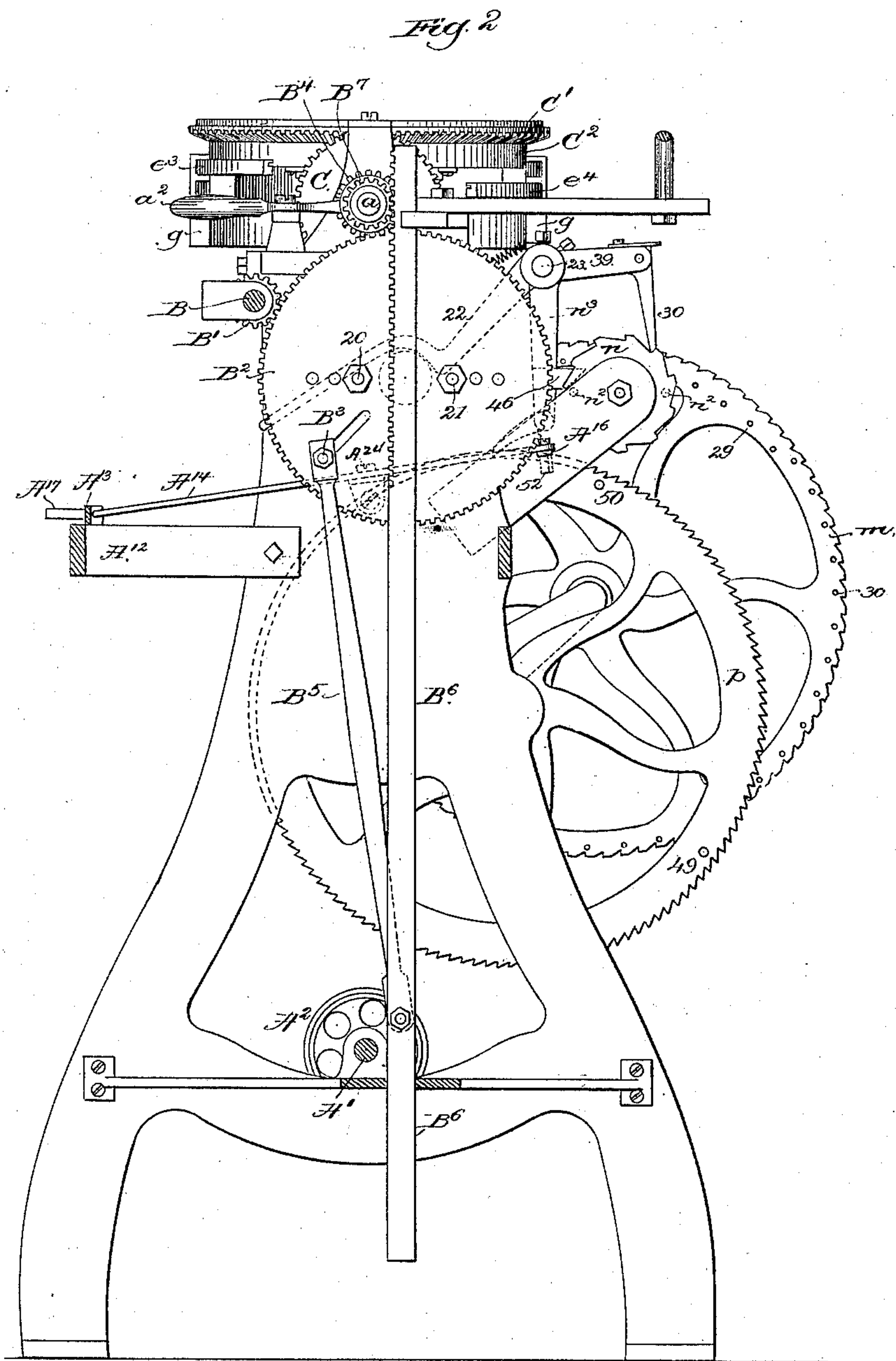
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7 Sheets—Sheet 2.

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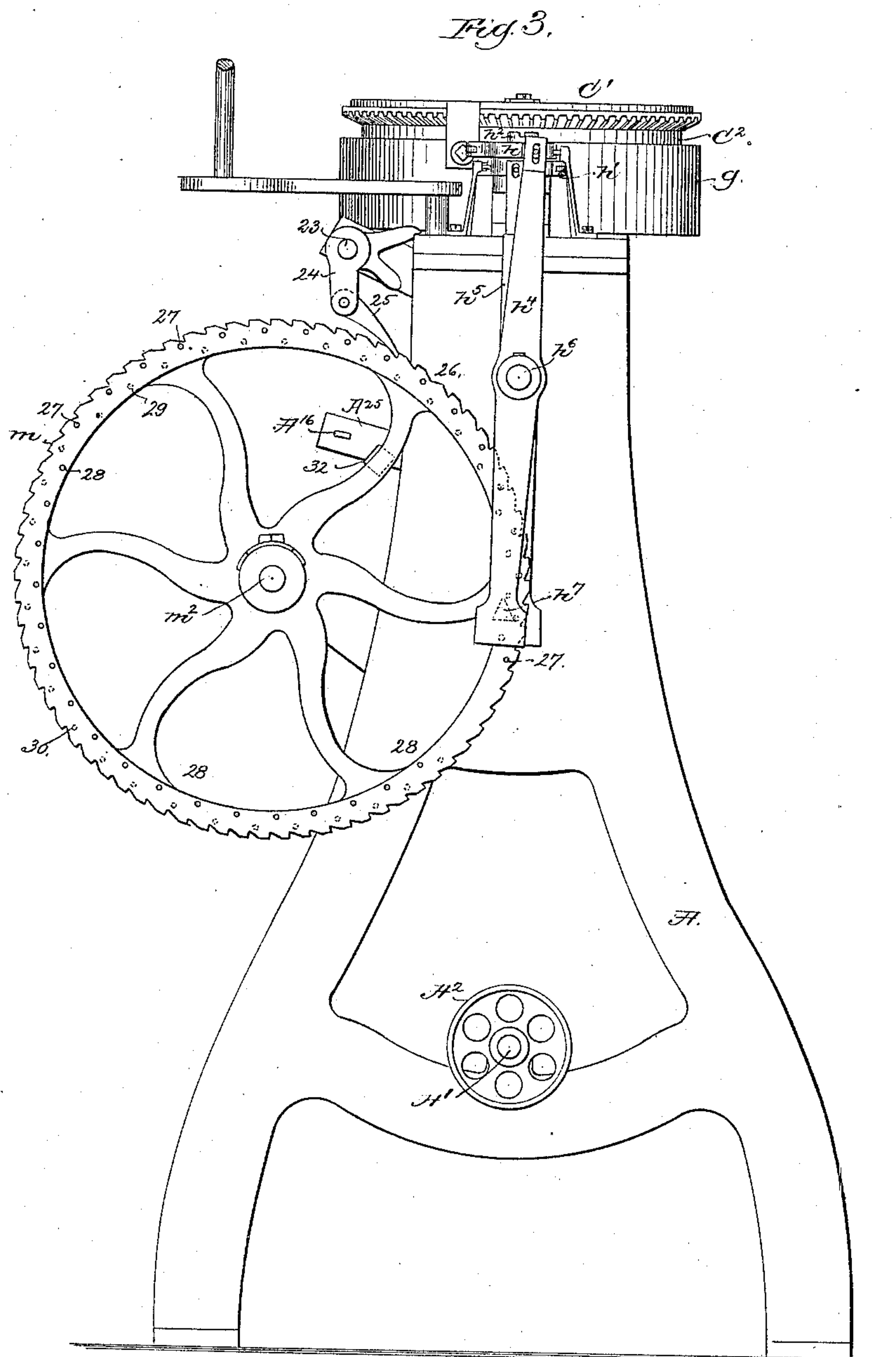
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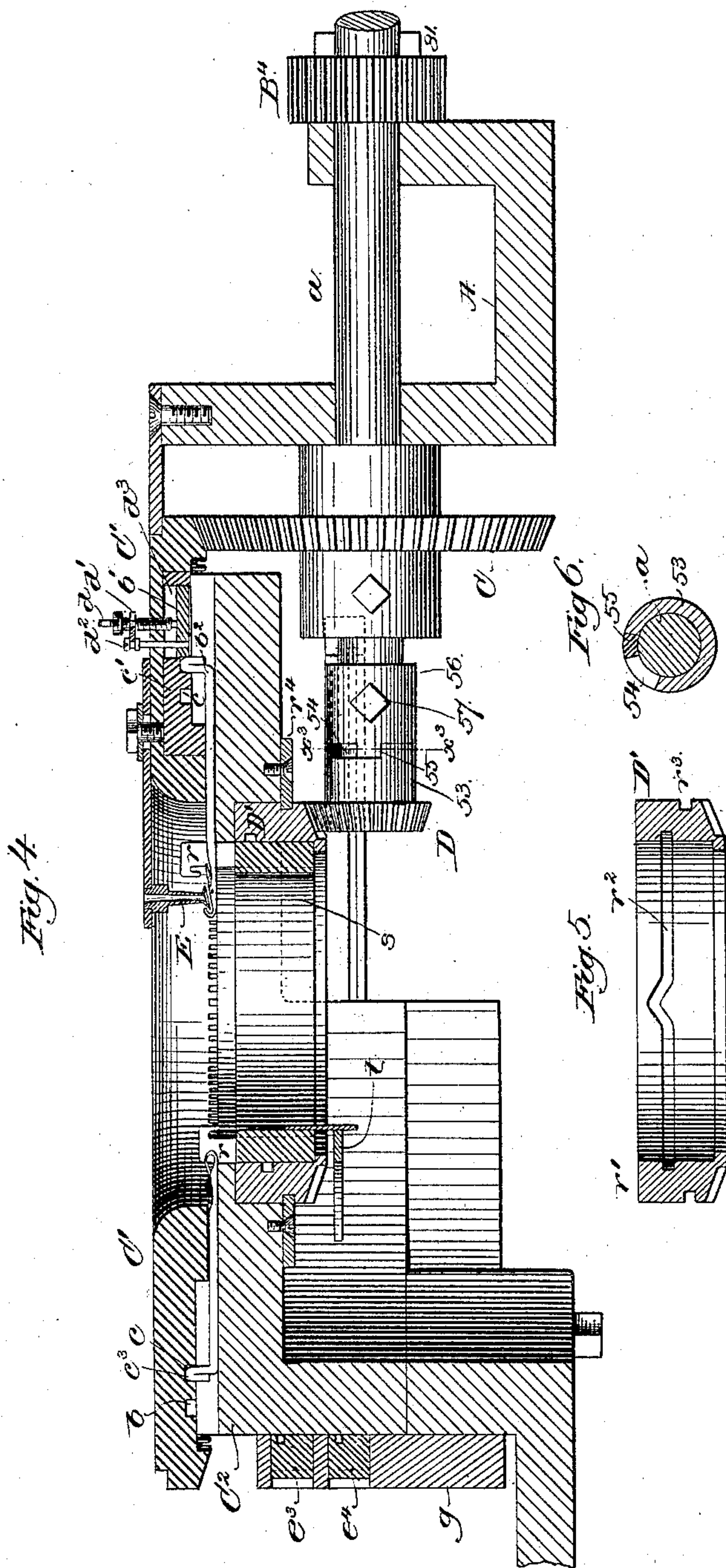
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Patented Aug. 25, 1885.



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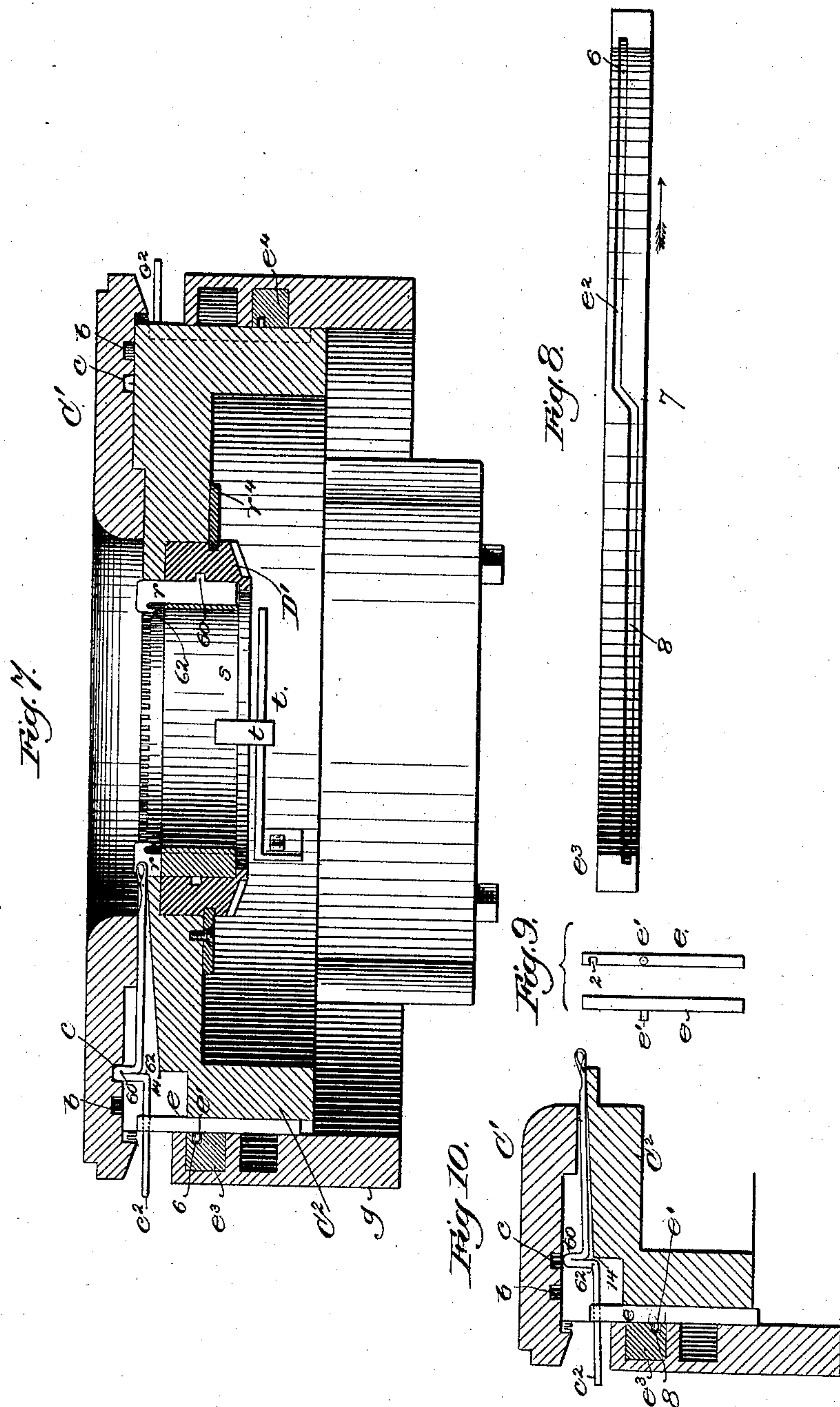
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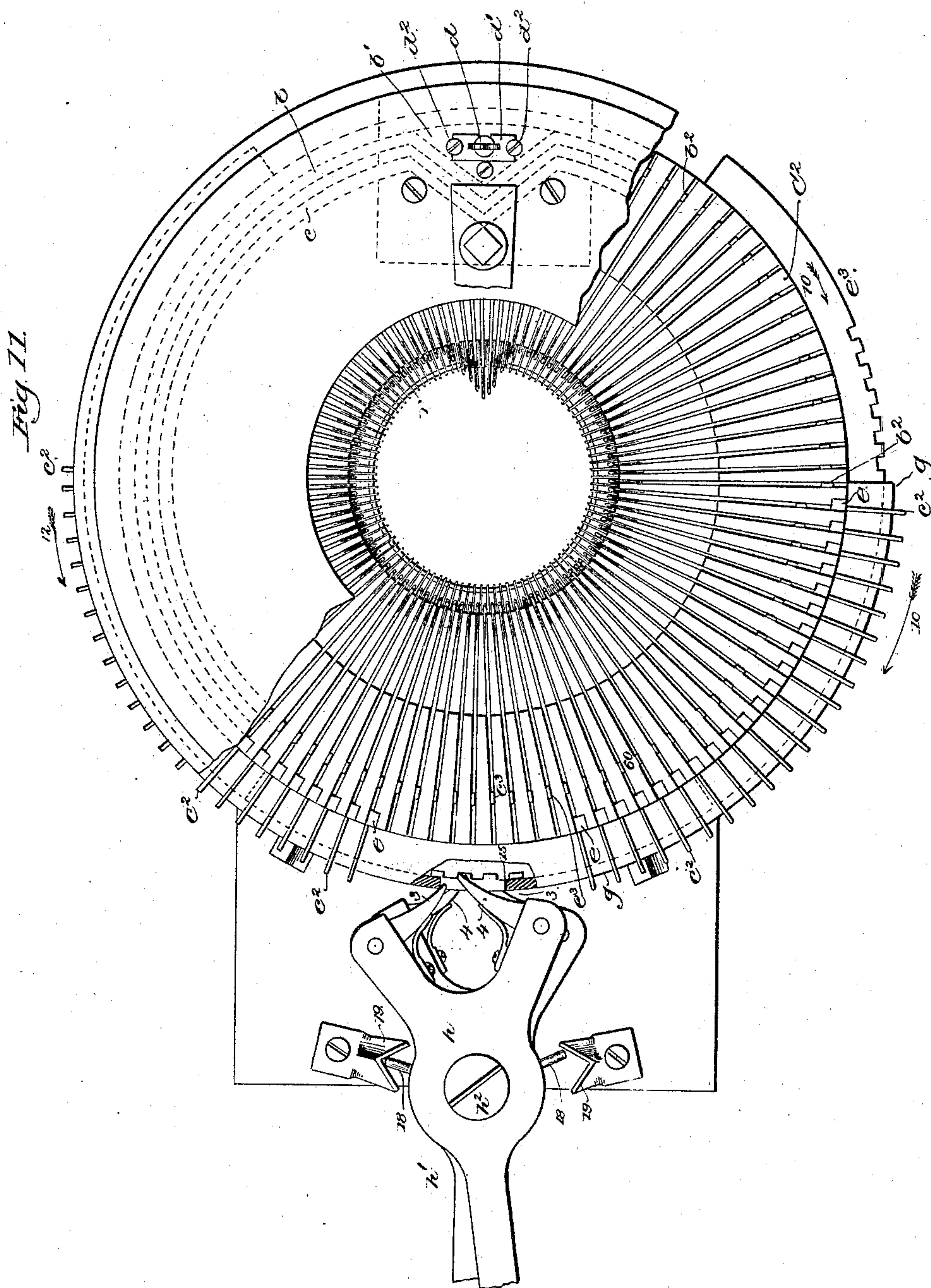
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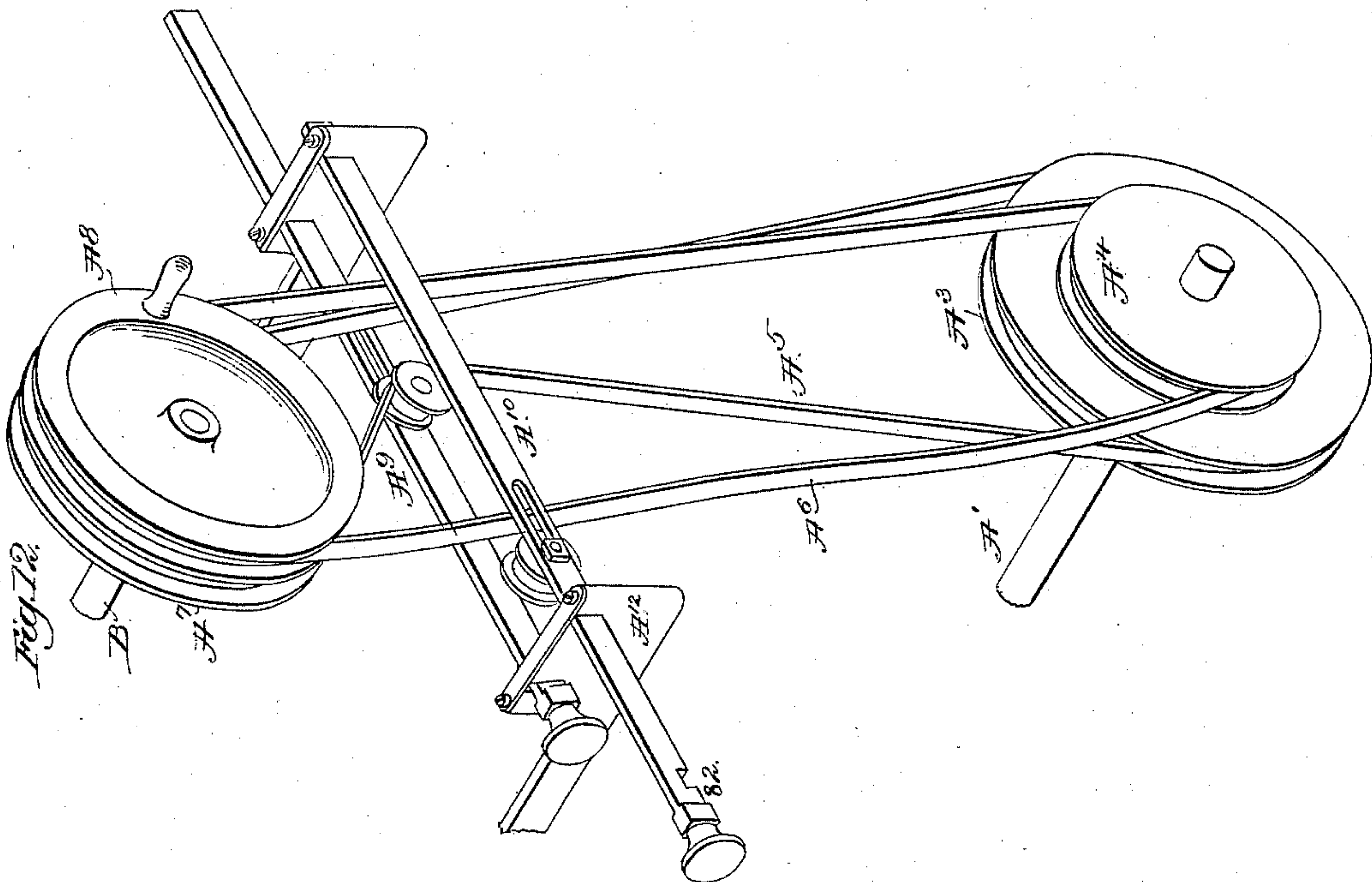
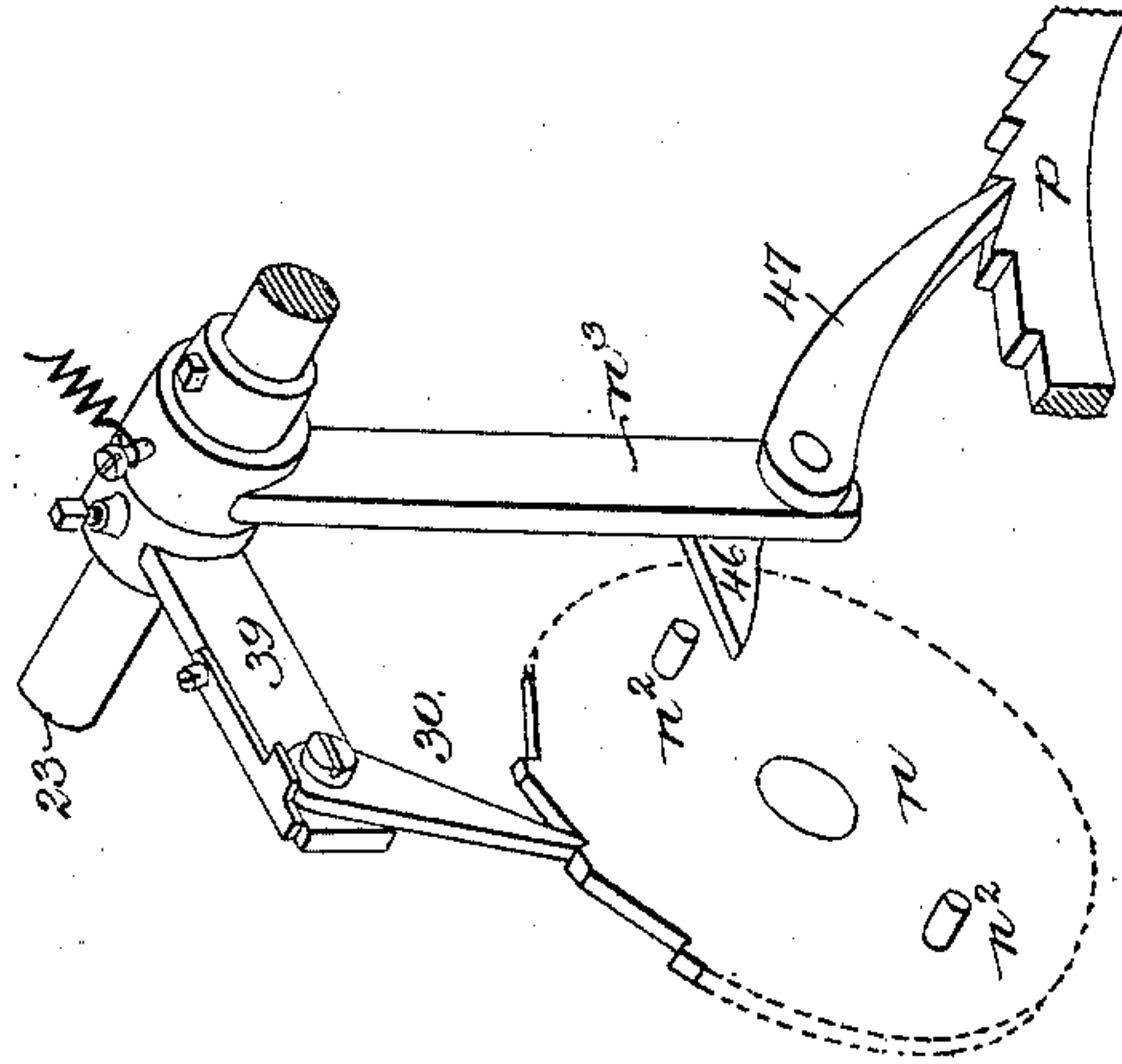
7 Sheets—Sheet 7.

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Fig. 13.



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UNITED STATES PATENT OFFICE.

WALTER AIKEN, OF FRANKLIN, NEW HAMPSHIRE.

KNITTING-MACHINE.

SPECIFICATION forming part of Letters Patent No. 324,795, dated August 25, 1885.

Application filed September 8, 1883. (No model.)

To all whom it may concern

Be it known that I, WALTER AIKEN, of Franklin, county of Merrimac, 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 letters on the drawings representing like parts.

10 Prior to my invention knitting-machines of the class known as "straight" machines have been provided with mechanism to automatically remove a projection on the needle or on a bar connected therewith from the needle-actuating cam-groove when narrowing was to be done, to place the said projection in the said groove when the fabric was to be widened, the projections of all the needles being in the said grooves when the widest part of the fabric was being knitted.

20 The chief object of my invention is to improve and simplify the means employed to remove the butts or projections of the needles from and to thereafter replace them in the needle-actuating cam-groove, according to the character of the work being done.

30 My invention is shown as embodied in that class of machine known as "circular," the cam-plate being at times rotated continuously for the production of a tubular fabric, and at other times being reciprocated to narrow and then widen the fabric, as when forming the heels and toes of stockings.

35 In this my invention each needle which is to be thrown out of and then into action for heel and toe work has a backwardly-extended tail piece or connection, which is placed and is made to slide backward and forward in a groove in a needle-shifter, one for each needle. 40 These needle-shifters, made as short bars, are placed each in its own groove in the needle-bed, at right angles to the needle-grooves therein, the grooves which receive the needle-shifters being of such depth as to protect the shifters from injury or lateral strain, thus insuring their easy and correct movement when moving the needle-butts from or into their actuating cam-grooves. The needle-shifters have been provided with pins or projections, 45 which are engaged by segmental slides, the movement of the latter actuating one needle-shifter after another.

When the heel and toe portions are to be knitted, those needles in excess of the maximum number needed for the production of the widest course used in the heel or toe are drawn in and made to retain their loops, while the needles not so drawn in are actuated as usual, the cam-plate being, however, at such time reciprocated. To narrow the web, one needle at each side of the series of needles used for heel and toe work is thrown out of action at or just before each stroke or movement of the cam-plate, thus employing fewer and fewer needles in each succeeding course until there are left in operation only that number of needles which are needed for the production of the shortest course for the heel or toe, after which the needles so thrown out of operation one at a time, as described, are again replaced one at a time into position to receive yarn from the yarn-guide, each knitted course being widened to produce a portion of flat web the counterpart of that knitted when the fabric was narrowed, thus forming a pouch. While the needles which are used to knit the pouch are being reciprocated in their grooves by the reciprocating cam-plate, that one of the cams, to be described, of the said cam-plate which when the cam-plate is rotated actuates the needles which are held back as described, is retracted or lifted from the path of the butts of the needles which it is to actuate, thus compelling the said needles to rest in their grooves in the needle-bed.

85 As the last course of a heel or toe portion is knitted all the needles are again brought into operative position with relation to their actuating cam-grooves in the cam-plate, and the cam which was retracted is returned and circular knitting is resumed for the tubular parts of the stocking. 90

Those needles which are to be thrown out of and into operation singly in the formation of heels and toes are longer than the remaining needles of the series, and the said longer needles and the shorter needles between them, all together equal in number to the number of stitches in the shortest course to be knitted when producing the heel or toe portions, have their butts entered in one cam-groove of the cam-plate, (as herein shown, the inner groove,) while all the remaining short needles or those which are not slid backward and forward in 100

the grooves of the needle-bed when the cam-plate is being reciprocated are made to enter a second groove, herein shown as located outside the groove before mentioned. The tails of these longer needles are embraced by and supported at their outer ends upon needle-shifters, which, when it is desired to narrow the stocking-web, may be drawn down or depressed one at a time prior to each stroke of the cam-plate from each side of the series of needles being used for the formation of the heel or toe portions by means of two oppositely-moving cam-segments or segmental slides, and the said needles may subsequently be raised one at a time when it is desired to widen the stocking-web to complete the heel or toe.

The cam-segments are moved toward each other intermittently the distance of substantially the width of one needle groove for each stroke of the cam-plate when narrowing is being done, and in the opposite direction or away from each other when widening is being done.

The particular features in which my invention consists will be pointed out in the claims at the end of this specification.

Figure 1 is a top or plan view of a knitting-machine containing my invention, the needles being, however, omitted, and part of the bobbin or spool-holding frame being broken out, and the bobbin or spool-holding spindles being broken off. Fig. 2 is a vertical section of Fig. 1 on the dotted line xx , looking toward the left. Fig. 3 is a left-hand end elevation of Fig. 1. Fig. 4, on a larger scale, represents in vertical section the needle-bed part of the frame work, sinker-carrying bed, sinker-actuating cam-ring, devices for holding the latter, cam-plate, its cams, the yarn-guide, and the cam-grooved slides or segments and their guide, the line of section being along the dotted line x^2 , Fig. 1, the needles, the gears for driving, the cam-plate and sinker-actuating cam-ring, and their moving shaft and one of its toothed gears being in elevation. Fig. 5 is a section of the sinker-actuating cam-ring; Fig. 6, a section on the line x^3 , Fig. 4; Fig. 7, a partial vertical section on a larger scale of a machine containing my improvements, the line of section being at x^4 , Fig. 1, the said figure, however, showing one long needle, needle-shifter, and sinker in elevation. Fig. 8 is an inner side view of one of the cam-grooved segments for actuating the needle shifters; Fig. 9, two views of a needle-shifter detached; Fig. 10, a detail to show one of the long needles with its butt lowered from its cam-groove and locked back; Fig. 11, a detail of part of the top of the machine with the cam-plate broken partially away to show the needle-bed and needles, the frame which holds the cam-grooved segments being broken out to show the teeth upon one of the said segments and the operation of the pawls which actuate them. Fig. 12 represents the belt-controlling devices and pulleys about which the

belts are extended, the said parts being omitted from Fig. 2. Fig. 13 is a detail of the devices for moving auxiliary pattern-surface and the pattern-surface which controls the length of the circular part of the leg and foot of the stocking.

The frame-work A, of suitable shape to contain the working parts, has a main or power shaft, A' , which at one end is provided with a pulley, A^2 , which receives a driven belt, and at the other end the said shaft has fast on it two pulleys, $A^3 A^4$, of different diameters, the larger pulley, A^3 , being used to control the speed of the machine when circular knitting is being done, and the smaller pulley, A^4 , the speed of the machine when the cam plate is being reciprocated for heel and toe work. The pulleys $A^3 A^4$ receive belts $A^5 A^6$, extended, respectively, over the pulleys $A^7 A^8$, fast on the shaft B, and by means of usual belt-tighteners, $A^9 A^{10}$, shown as slides provided with rolls which bear directly against the said belts. Either of them may be made taut at will, and thus become the driver for the shaft B at the desired speed. In Figs. 1 and 12 the belt A^5 is made taut and the shaft B is ready to be driven at its highest relative speed for the production of circular or tubular work.

Each belt-tightener $A^9 A^{10}$ has a notch, such as shown at 82, Fig. 12, in the tightener A^{10} , so that when the tightener is pushed in, as shown by tightener A^9 , the said notch will embrace a part of the extension A^{12} of the frame-work. The extension referred to, at its inner side, (see Fig. 1,) has a sliding bar, A^{13} , (shown in detail, Fig. 14,) provided with cams or inclines to act upon and lift one or the other of the said belt-tighteners and disengage their notched parts from the said extension when it is desired to stop the machine or change its speed. This bar A^{13} , herein shown as having a bent end, is acted upon and moved in one direction by the outer end of the lever A^{14} , pivoted near its center, (see Fig. 1,) and in the other direction by the spring A^{15} , suitably connected with a pin carried by it and with a pin carried by the said extension.

The lever A^{14} , pivoted at A^{24} , as shown in dotted lines, Figs. 1 and 2, is acted upon to effect the release of the belt-tightener and stop the machine when a change of speed is to take place, or otherwise, by means of a slide-bar, A^{16} , secured to its inner end, which is acted upon by a projection, 32, on the pattern-surface m , and the operator prior to starting the machine will move the hub a' by hand to engage the proper pinion, B^4 or B^7 . The slide A^{16} is supported in bearings attached to the frame A^{25} , one of which is shown in Fig. 3, and the said slide is joined with the lever A^{14} by the screw A^{26} .

The slide A^{16} has a projection, A^{17} , to enable it to be moved by hand when desired.

The shaft B has a pinion, B' , that engages and rotates the toothed wheel B^2 , which in turn engages pinion B^4 , loose on shaft a , the said toothed wheel also having an adjustable

crank-pin, B^3 , which is connected by link B^5 with the rack-bar B^6 , held in suitable guides, and having its rack-teeth in engagement with the teeth of the pinion B^7 , also loose on the shaft a . The shaft a has splined upon it a toothed or notched hub or clutch part a' , under the control of a hand-lever, a^2 , the movement of the said clutch part to the right or left, in Fig. 1, enabling its teeth to engage cooperating clutch-teeth at the sides of either the loose pinion B^7 or the loose pinion B^4 , thus fixing one or the other of them with relation to and so as to enable it and its actuating devices to control the movement of the shaft a —as, for instance, if the hub a' engages the pinion B^7 , which is reciprocated by the rack B^6 , the shaft a will have imparted to it a rotary reciprocating movement, and its attached bevel-gears C D will engage the bevel-teeth of and move respectively the cam plate or disk C' and the sinker-actuating cam-ring D' backward and forward for part of a rotation, or reciprocate them for flat web or heel and toe work; whereas, if the hub a' engages the pinion B^4 , the shaft a will be rotated continuously, and its gears C D , referred to, will rotate the said cam-plate C' and ring D' continuously for the production of a tubular fabric.

The cam-plate C' , at its under side, as herein shown, has two grooves, b c , having cooperating knitting-cams b' c' . The outer groove, b , receives the butts of the short needles b^2 , which are held back out of action with their loops in their hooks when heel and toe knitting is commenced, the cam plate C' at that time being reciprocated so that its cams b' c' travel over the opposite half of the needle-bed, C^2 , from that over which the said cams rest in Fig. 11, the length of the stroke of the cam-plate at each reciprocation being only sufficient to carry the yarn-guide E sufficiently far beyond the long needles c^2 to enable the yarn to be delivered into the hooks of such long needles and those short needles c^3 (see left of Figs. 11 and 3) which are in number equal to or less than the number of stitches in the narrowest course of knitting in the flat web to be made for the production of a heel or toe, as is well understood. The knitting-cam c' is fixed with relation to the cam-plate, but the knitting-cam b' is made vertically movable with relation to the said plate by a screw, d , screwed into the cam-plate, and provided near its head with an annular groove to receive a yoke, d' , which embraces annular grooves at the upper ends of two screw-studs, d^2 , connected at their lower ends with the said cam b' .

The rotation of the screw d in one direction enables the cam b' to be drawn up into the space d^3 above it in the plate C' , (see Fig. 4,) thus withdrawing or removing the said cam-plate b' out of the path of the butts of the needles b^2 resting in the groove b at such times as the said cam-plate is being reciprocated for heel and toe work or flat web knitting.

Instead of the devices shown for withdraw-

ing the said cam b' , I may use any other well-known equivalent. In Fig. 4 the cam b' is in position to slide the needle b^2 .

The long needles c^2 and the intermediate short needles, c^3 , for narrowing and widening, have their butts entered into the groove c , and the longer needles c^2 have their tails outside their butts extended each into a pocket, 2, of a needle-shifter, e , shown as a small square rod, (see Figs. 7, 9, 10, and 11,) located at the outer ends of the usual needle-receiving grooves in the needle-bed, the periphery of the said bed being grooved or cut away longitudinally at the outer end of each of said grooves for the reception of the said needle-shifters, one side wall of each groove acting against one side of the said needles.

Each needle-shifter is shown as provided with a pin or projection, e' , to enter a cam-groove, e^2 , in the cam-grooved segments or slides e^3 e^4 , there being two such segments independently movable in grooves or ways in guide g , which latter is a nearly cylindrical wall. The convexed faces of the segments e^3 e^4 have teeth, which are engaged, the teeth of each segment, as herein shown, by either of two pawls, 3 4, carried by pawl-carriers h h' , pivoted at h^2 , the said pawls constituting means under the control of a pattern-surface, m , by which to shift or shog the said segments one tooth at a time in either direction, according to whether or not narrowing or widening is to be done.

When the rotation of the cam-plate is stopped preparatory to reciprocating it for the production of a flat portion for a heel or toe, the segments e^3 e^4 are extended about the machine for their greatest distance, and the pins or projections e' of the shifters e are in the highest parts 6 of the grooves of the segments.

When the reciprocation of the cam-plate is to be commenced, the hub a' is thrown into engagement with pinion B^7 , and the cam b' is withdrawn, and the pawl-carriers h h' are turned into the position, Fig. 11, so that their pawls 4 become effective to engage and move the segments e^3 e^4 in the direction, respectively, of the arrows 10 and 12, thus enabling the end-most of the longer or narrowing and widening needles c^2 to descend one at a time, the pins e' of the shifters e gradually passing down the incline 7 into the groove 8. (See Fig. 8.) As the shifters are moved from their highest to their lowest positions, Fig. 10, as described, they act to draw the butts of the said long needles c^2 out from the groove c , and when lowered the front end of the tail-piece next the butt falls below the shoulder 14 of the needle-bed C^2 , thus locking the said needles while drawn back in the grooves of the needle-bed and holding loops of yarn in their hooks. When the stocking-web has been sufficiently narrowed, the pawl-carriers h h' are automatically shifted on their fulcrum h^2 so that the pawls 3 3 become effective, the pawls 4 being held out of effective

action by a corner or shoulder, 15, of the guide g , and thereafter the segments $e^3 e^4$ are moved in the opposite direction to gradually drive upward the needle-shifters and cause them to

5 elevate the long needles c^2 one at a time into operative position, with their butts in the groove c , where they will be acted upon by the cam c' and be reciprocated for knitting, the stocking-web at such time being widened.

10 The pawl-carrier h is vibrated by a lever, h^4 , and pawl-carrier h' by a lever, h^5 , having a common fulcrum, h^6 , and each lever has at one side of it, at its lower end, a wedge-block, h^7 , one of which is shown in dotted lines, Fig. 3.

15 Each pawl-carrier has a pin, 18, which, at the end of the effective stroke of the pawl carried by it, will strike against one or the other side of a two-faced spring, 19, which will spring back and cause the wedge-block carried by

20 the lever h^4 or h^5 to remain pressed against the pattern-pins, to be described, which act upon and vibrate the said levers.

The toothed gear B^2 , at its rear side, has two projections, 20 21, which act upon the arm 22 of the rock-shaft 23 and move the same twice during each rotation of wheel B^2 , so that its arm 24 causes the pawl 25, connected therewith, to move the pattern-wheel m the distance of two teeth during each rotation of

30 wheel B^2 , provided the long space 26 of the said wheel is not opposite the pawl 25, in which event the pattern-surface remains at rest or does not rotate.

When it is desired that the pattern-surface be moved by the pawl 25, the said wheel is started by hand until the pawl engages the tooth next back of the said long space 26, after which the said wheel will be rotated until the long space is again under the said pawl, at

40 which time a heel or toe portion has been completed. The pattern-surface m has at its outer side two rows of pattern-pins, 27 28, at different distances from the axis m^2 , about which the said pattern-surface is rotated, and at its

45 rear side the said surface has two series of pattern-pins, 29 30, the latter being shown by dotted lines in Fig. 3 and full lines, Fig. 2. The number of pins of each series 27, 28, 29,

50 and 30 equal one-half the number of courses knitted in the stocking-web during formation of a heel or toe, and the said pins are so set that each lever $h^4 h^5$ will be positively and simultaneously moved in opposite directions—

as, for instance, if the pins 27 act positively against the right-hand side of the wedge-block h^7 , as in Fig. 3, to cause pawl 4 of the pawl-carrier h to be operative, the row of pins 29 at the opposite side of the said wheel will act against the left-hand side of the wedge-

60 block carried by lever h^5 , (not shown,) a wedge-block just like wedge-block h^7 on lever h^4 causing the lever h^5 to be moved positively in a direction opposite that of lever h^4 to move the pawl-carrier h' in the direction to make its

65 pawl 4 the effective pawl. When the pins 27 and 29 move the levers $h^4 h^5$, and cause the pawl 4 to be effective, the cam-grooved seg-

ments $e^3 e^4$ are moved toward each other to narrow the stocking-web; but as soon as the same has been narrowed the pins 28 and 30, 70 at opposite sides of the wheel m , turn the levers $h^4 h^5$ positively in the opposite direction, which makes the pawl 3 effective for moving the segments $e^3 e^4$ to replace the needles c^2 to widen the stocking-web.

75 At its rear side the pattern-surface m has a projection, 32, which, as the heel or toe is completed, and the reciprocation of the cam-plates is to cease, acts against the bar A^{16} and slides it toward the right hand end of the machine, Fig. 1, causing the lever A^{14} to be moved to completely stop the machine, as described.

The rock-shaft 23 has an arm, 39, provided with a spring-held pawl, 30, the end of which engages the teeth of an auxiliary pattern- 85 wheel, n , provided at one side with two pins, n^2 , (shown in full lines, Fig. 13, and dotted lines, Fig. 2,) which at the proper times act upon the toe 46, attached to the pawl-carrying arm n^3 , loose on the shaft 23, and provided

90 with a pawl, 47, which engages the ratchet-teeth of the pattern-wheel p , provided with adjustable pins 49 50, to effect the stopping of the machine after the completion of any desired number of rotations of the cam-plate, 95 the said pins consequently determining by their position the length of the circular or tubular part of the web for both the leg and the foot of the stocking, stopping the machine in

time for the operator to attend to and properly 100 start the heel and toe web.

The pattern-wheel p may be provided with other pins to stop it at any desired course of circular work. The pins 49 50 act against a downward projection, 52, (shown in dotted 105 lines, Fig. 2,) of the sliding bar A^{16} , and move it and the shipper-lever A^{14} .

Whenever the machine is to be started, after having been stopped, the attendant will grasp the hand-lever a^2 , and cause the clutch part a' 110 to be moved to the right or left, according to the movement which the cam-plate is to have.

The sinkers r , located one in each space between adjacent needles and placed in grooves in the sinker-bed s , supported by bracket t , 115 have each a projection, 60, which enters the cam-groove r^2 in the sinker-actuating cam-ring D' , supported by the lugs r^4 . At their inner edges and top the sinkers have hooks or holders 62, which, when the same are depressed by the cam r^2 , pass below the needles and act to prevent the web from being drawn from the needles, obviating the use of weights to keep the work down on the needles.

The hub 53 of the gear D , loose on the shaft 125 a , (see Figs. 4 and 6,) has a slot, 54, which is entered by a projection, 55, on a collar, 56, fastened to a shaft, a , by the set-screw 57.

The bevel-gear D is moved in one or the other direction by the projection 55, the lost 130 motion between the same and the walls of the slot 54 permitting the cam-ring D' to fall behind the cam-plate C' to enable the holders or hooks 62 of the sinkers to be properly raised

above the needles when the latter are being drawn into their grooves in the needle-bed.

The sinkers descend just behind each needle and in front of the knitting-thread as the loop is being formed, and the sinkers remain down and hold the work back on the needles until the needles next to them are again moved out to take yarn, the sinkers during such outward movement acting to hold back the work as the needles are moved forward.

The clutch-tooth of the pinion B⁷ (see Fig. 1) is marked 80, that of pinion B⁴ is marked 81, and the teeth of the hub a' are marked 82.

The tails of the latchet-needles c² are in a plane lower than the shanks in front of their butts 60, and the butts have shoulders 62 extended below the said shanks, as shown in Fig. 10, to enable the said needles to be locked back by the shoulder 14. As seen in Figs. 7 and 10, the bottoms of the grooves in the needle-bed which receive the needles c² are inclined downward and outward, or are made deeper toward the shoulder 14, to thereby make a space in which the shanks of the needles may rise and fall under the action of the shifters, while the front ends of the said needles near their latches rest upon the inner edge of the wall of the needle-bed.

I am aware that needle-bits having projections placed in a cam-groove and acted upon by a cam have been used to place the butts of needles in such position in their cam-grooves as to be struck and moved by a knitting-cam, and also that the cam to actuate the said needle-bits has been made movable laterally out from its co-operating cam-groove.

I claim—

1. The horizontal needle-bed, two series of needles placed therein, the cam-plate provided with two independent grooves, one to receive the butts of the needles which are to remain motionless when the cam-plate is being reciprocated, while the other groove receives the butts of the series of needles which are to be moved to knit when the cam-plate is being reciprocated, and two knitting-cams, one for each groove, and means to rotate and to reciprocate the said cam-plate at intervals, according to the work to be done, combined with means to withdraw one of the said cams when the cam-plate is to be reciprocated to operate substantially as described.

2. The cam-plate and the radially-grooved shouldered needle-bed and shouldered needles placed in the grooves in the bed, combined with the independent needle-shifters, one for each needle, fitted into grooves in the needle-bed at right angles to the needle-groove, and grooved to receive and to support the rear ends only of the said needles, and with means to raise and lower the said shifters and needles singly, substantially as described.

3. The radially-grooved needle-bed, a series of needles placed in the said grooves, the needle-shifters fitted to slide vertically and independently in vertical grooves at the outer ends of the needle-grooves and at right angles

thereto, and needles embraced by the said shifters only at or near their outer ends, combined with a cam-plate provided with grooves for the reception of the butts of the needles, and means to both rotate and reciprocate the said cam-plate, and with means to reciprocate the said needle-shifters to withdraw the butts of the needles which are embraced by the said shifters from their actuating cam-groove, and to replace them therein at the proper times, substantially as described.

4. The needle-bed grooved radially for the reception of the needles and provided with a shoulder, 14, and the cam-plate having a groove for the reception of the butts of the needles, combined with a series of needles provided with shoulders 62, and with a series of independent vertically-movable needle-shifters, one for each needle, the butt of which is to be withdrawn from and raised into the said groove, and with means for automatically operating the said shifters to automatically withdraw the butts of the needles from the cam-groove in the cam-plate and place the needles in position with relation to the shoulder 14 to lock the same in place, substantially as described.

5. The grooved needle-bed, the needles placed directly in the said grooves, and the independent needle-shifters, one for each needle to be shifted, the said shifters being located in grooves in the needle-bed at the rear ends of the needle-receiving grooves, combined with the segmental slides to engage and operate the shifters, substantially as described.

6. The grooved cam-plate, the needle-shifters grooved for the reception of the needles and provided each with a heel or projection, the needle-bed and needles, and the toothed segmental slides provided each with a cam-groove to receive the heels or projections of the needle-shifters, combined with means to engage and operate the said segmental slides in opposite directions to lower and raise the needles for narrowing or widening the fabric, substantially as described.

7. The grooved cam-plate, the needle-shifters grooved for the reception of the needles and provided each with a heel or projection, the needle-bed and needles, the toothed segmental slides provided each with a cam-groove to receive the heels or projections of the needle-shifters, combined with means to engage and operate the said segmental slides in opposite directions to lower and raise the needles for narrowing or widening the fabric, and with a pattern-surface and means actuated thereby to move the said segmental slides, substantially as described.

8. The needle-bed, the series of needles c², the cam-plate C', the sinker-actuating cam-ring D', and suitable means to reciprocate the said plate and cam-ring, combined with a sinker-carrying bed, and a series of sinkers provided with hooks or projections 62, and with the needle-shifters, and means to actuate them at the proper times, substantially as described.

9. The grooved cam plate C' , its knitting-cams, means to both rotate and reciprocate the said cam-plate, the needle-bed provided with grooves in which the needles rest and slide, and with other grooves intersecting the needle-grooves for the reception of the needle-shifters, and series of needles and needle-shifters provided with grooves to receive and guide the rear ends of the said needles to raise and lower their butts into and from their actuating-groove in the cam-plate, and provided with heels or projections to be engaged by the segmental cam-slides, combined with the segmental cam-slides, and with a pattern-surface and means actuated thereby to move the said segmental slides in the proper direction to automatically operate the needle shifters and needles for narrowing and widening the fabric, substantially as described.

10. The pattern-surface m , provided with two rows of pins at one side and two rows of pins at its other side, and the two levers $h^4 h^5$, provided with wedge-blocks h^7 , combined with the pawl-carriers $h h'$, their attached pawls, the toothed cam segments or slides, and the guide g for the said slides, the cam being and operating substantially as described.

11. The auxiliary pattern-plate n , means to rotate it, the pattern-surface p , provided with pins to indicate the times at which the machine should stop the production of circular web, and means intermediate between the said auxiliary pattern and pattern-surface p to actuate the latter, combined with the needle-bed, needles, cam-plate, and shaft a , and gearing to actuate the cam-plate, and with the shipper-slide and means, intermediate between it and the belt, which moves the shaft a , substantially as described.

12. In combination, the cam-ring D' , the sinker-carrying bed, the sinkers, the needle-bed, the needles, the cam-plate, the shaft a , means to reciprocate it, the gear C , fast on the said shaft to move the cam-plate, the gear D , loose on the said shaft to drive the cam-ring, and a projection carried by the shaft a and adapted to enter a notch or slot in the hub of the gear D to permit lost motion between the

said gear and shaft as the direction of reciprocation of the cam-plate is changed, substantially as described.

13. The needle-bed, its needles, the cam-plate, the shaft a , the attached bevel gear C , toothed hub a' splined thereon, and the pinions $B^4 B^7$, provided with clutching-teeth and loose on the said shaft, combined with the toothed wheel B^2 , its crank, the link, and rack-bar, and with means to rotate the gear B^2 , the shaft a having a rotary or reciprocating motion, according to which of the pinions B^4 or B^7 is engaged by the clutch a' , substantially as described.

14. The latched needles provided with shoulders and tail-pieces extended backward from their butts, and the needle-bed provided with the shoulder 14, and cam-plate to reciprocate the said needles, combined with the independent needle-shifters to receive and guide the tails of the needles and permit them to slide therein when the butts of the needles are in the groove of the cam-plate, and which hold the tails of the said needles when the shoulders of the butts engage the shoulder of the needle-bed, and with means for actuating the needle-shifters, substantially as described.

15. The needle-bed having independent needle and needle-shifter grooves, the former made deeper from their inner edges outward to form a shoulder, 14, the cam-plate provided with a groove, c , a series of hooked needles, c^2 , each having a shank, butt, and tail, and provided with a shoulder, 62, at the junction of the butt and tail, and a series of shifters adapted to hold the tails of the needles and provided with projections, combined with means to move the said shifters to raise and lower the outer ends of the said needles in their grooves in the needle-bed, substantially as described.

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

WALTER AIKEN.

Witnesses:

FRANK PROCTOR,
J. A. TAYLOR.