

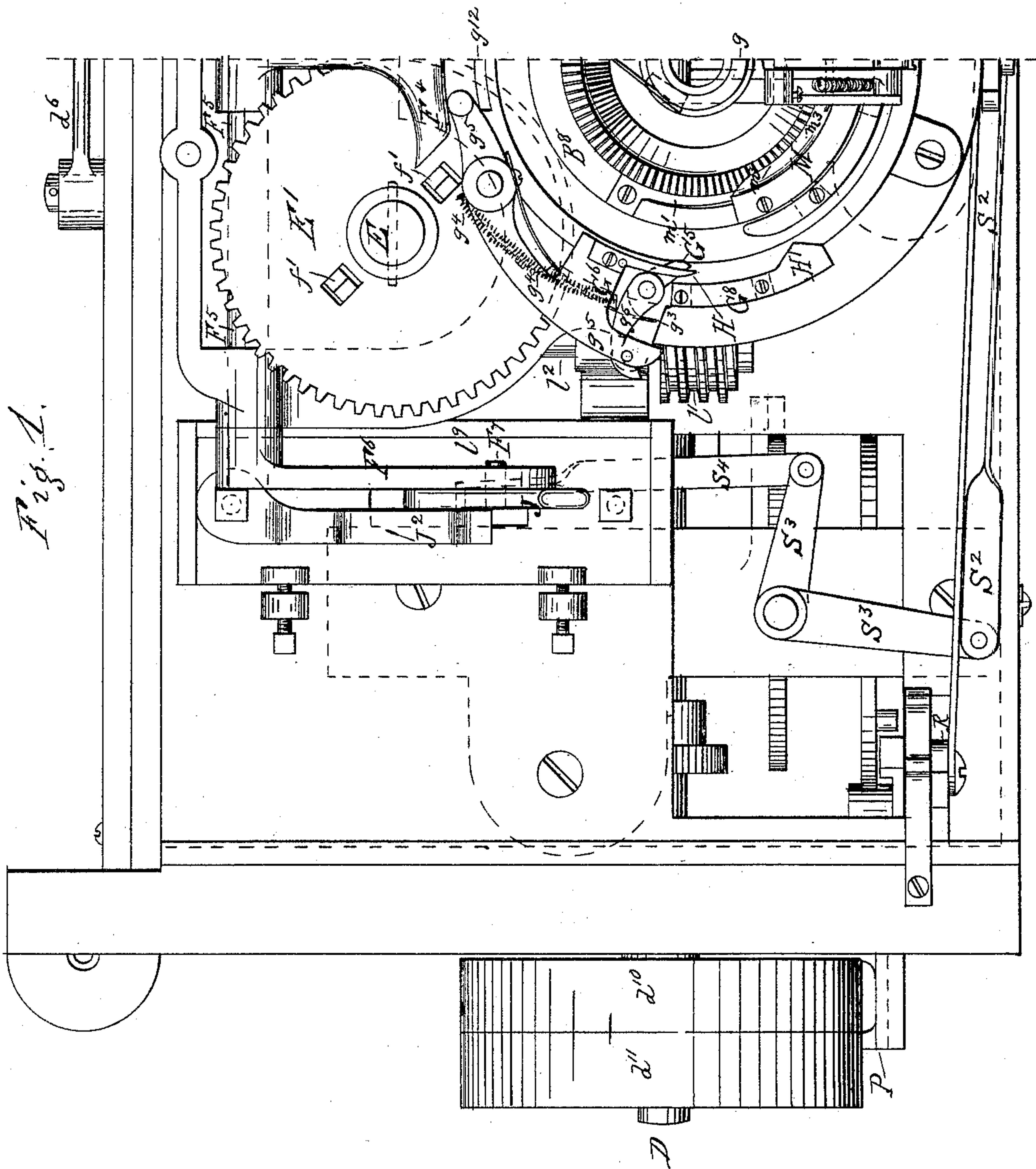
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19 Sheets—Sheet 1.

E. E. KILBOURN.
CIRCULAR KNITTING MACHINE.

No. 432,946.

Patented July 22, 1890.



Witnesses

L. B. Whitaker
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Whitaker & Nevins

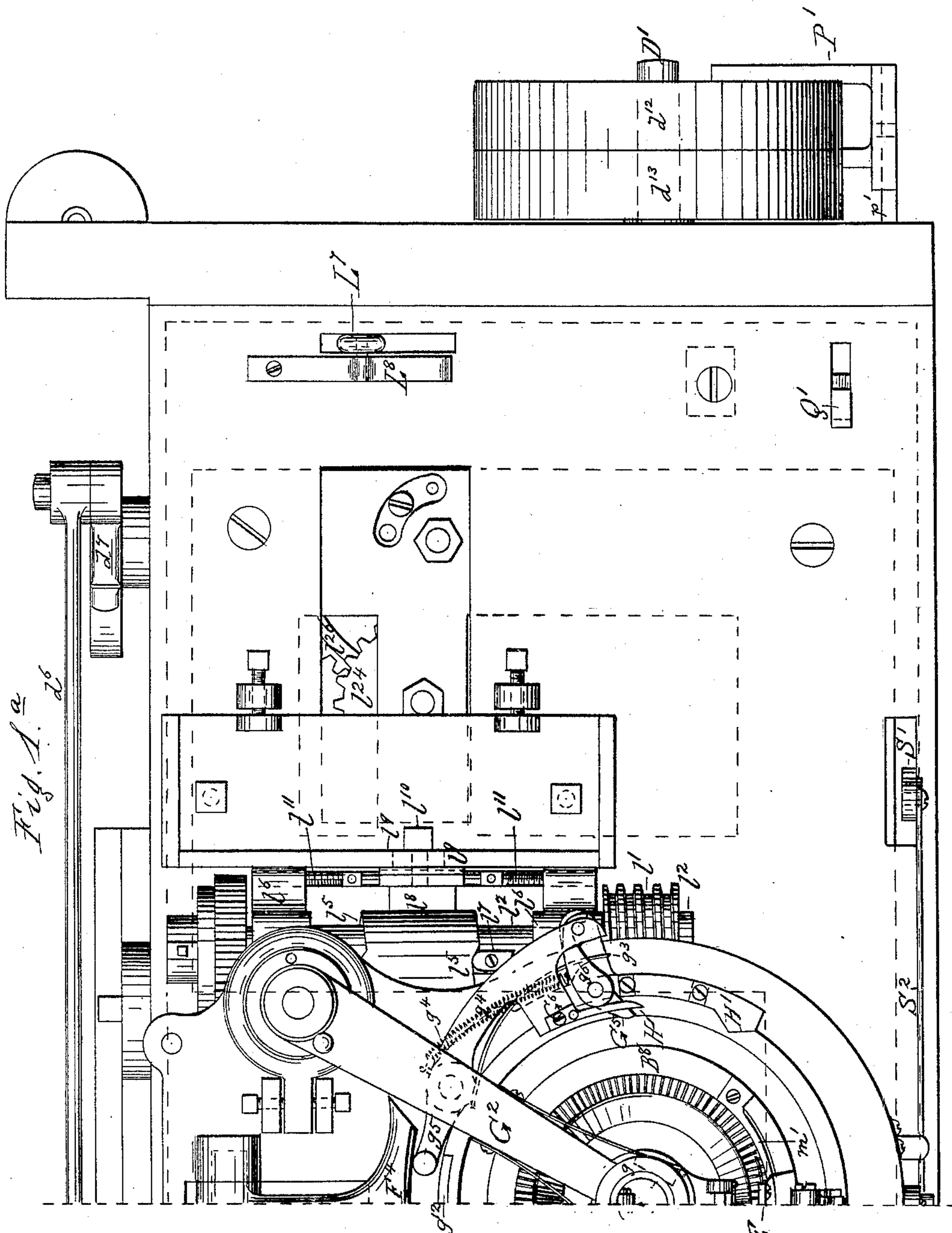
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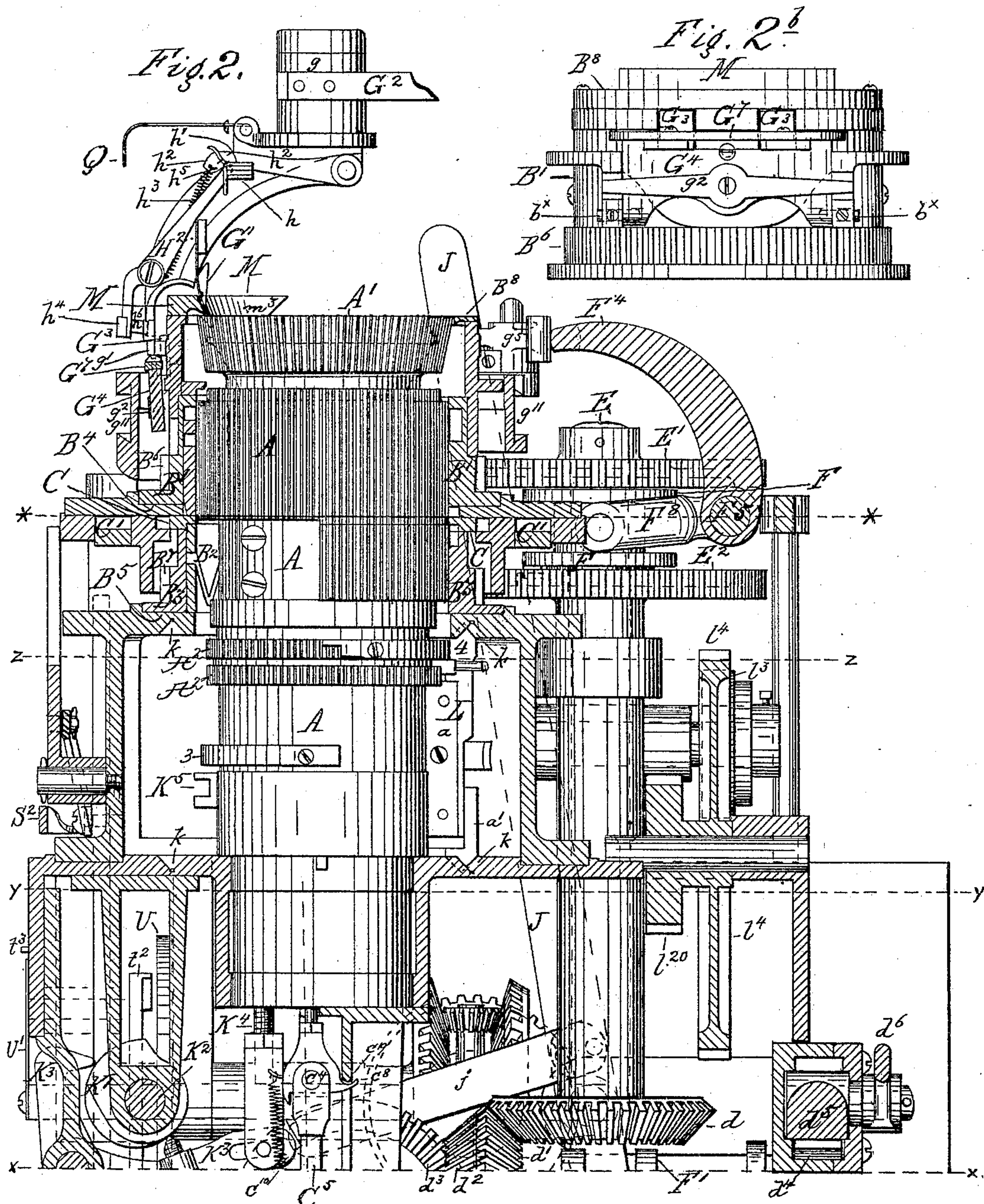
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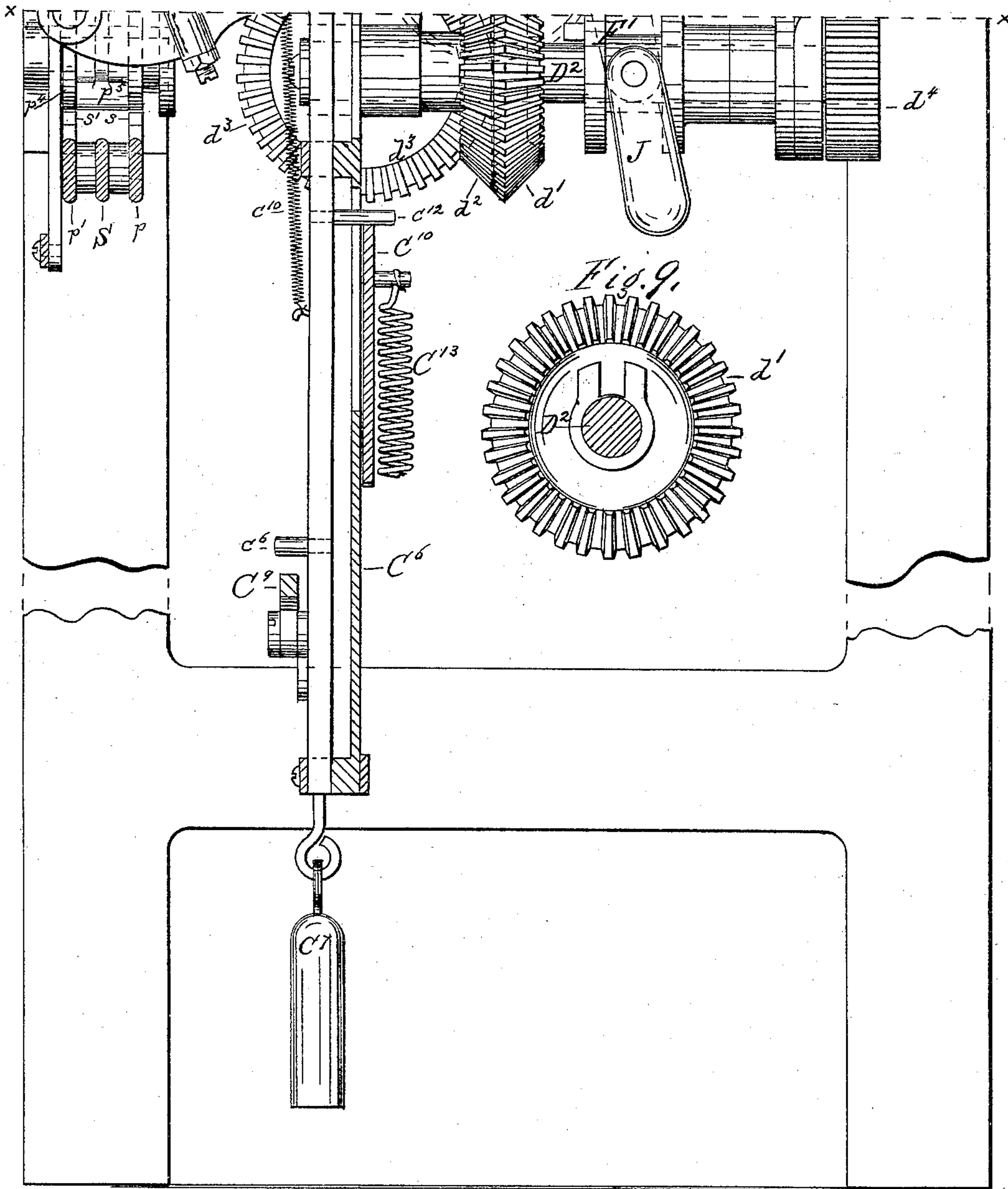
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Fig. 2.^a



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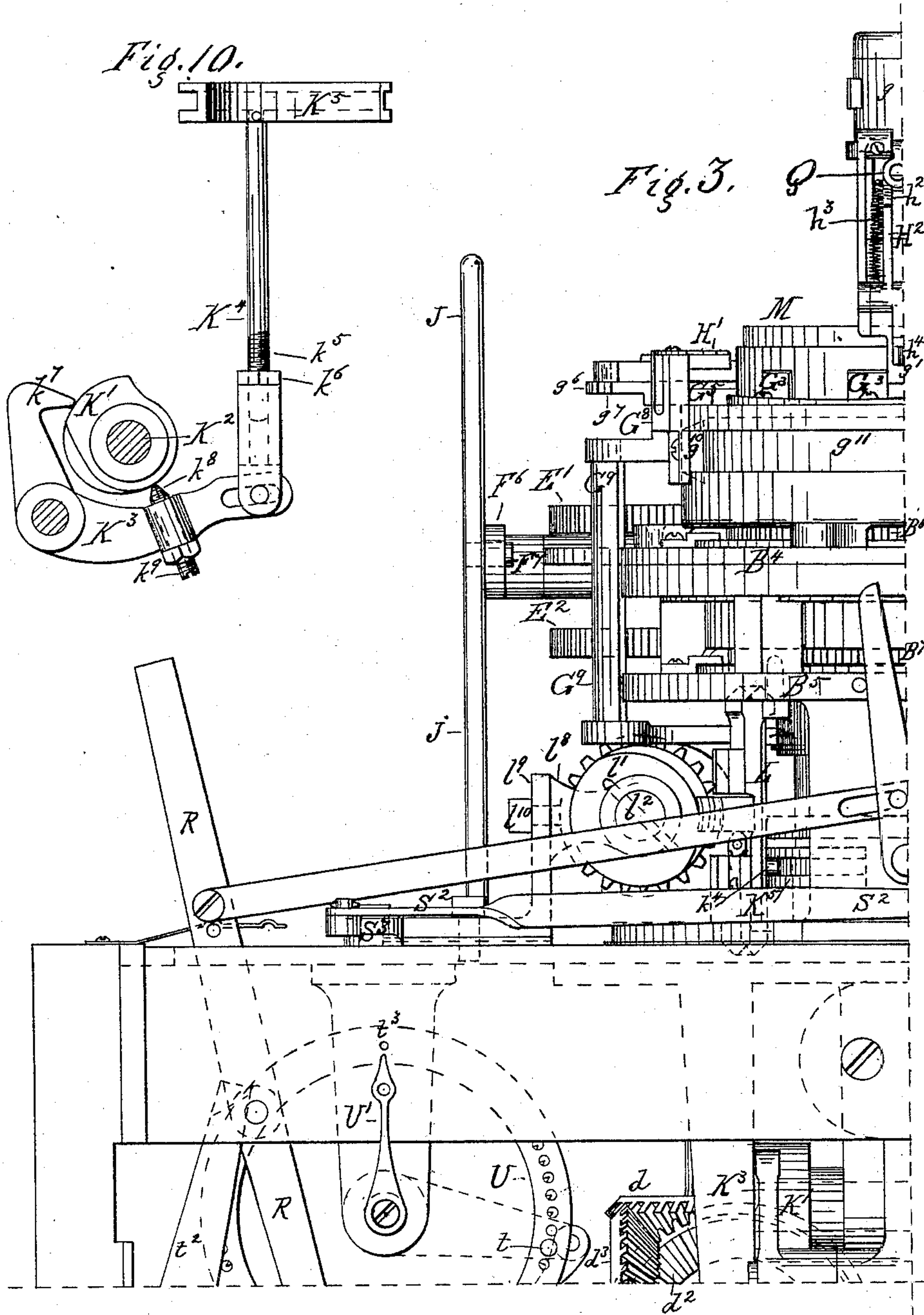
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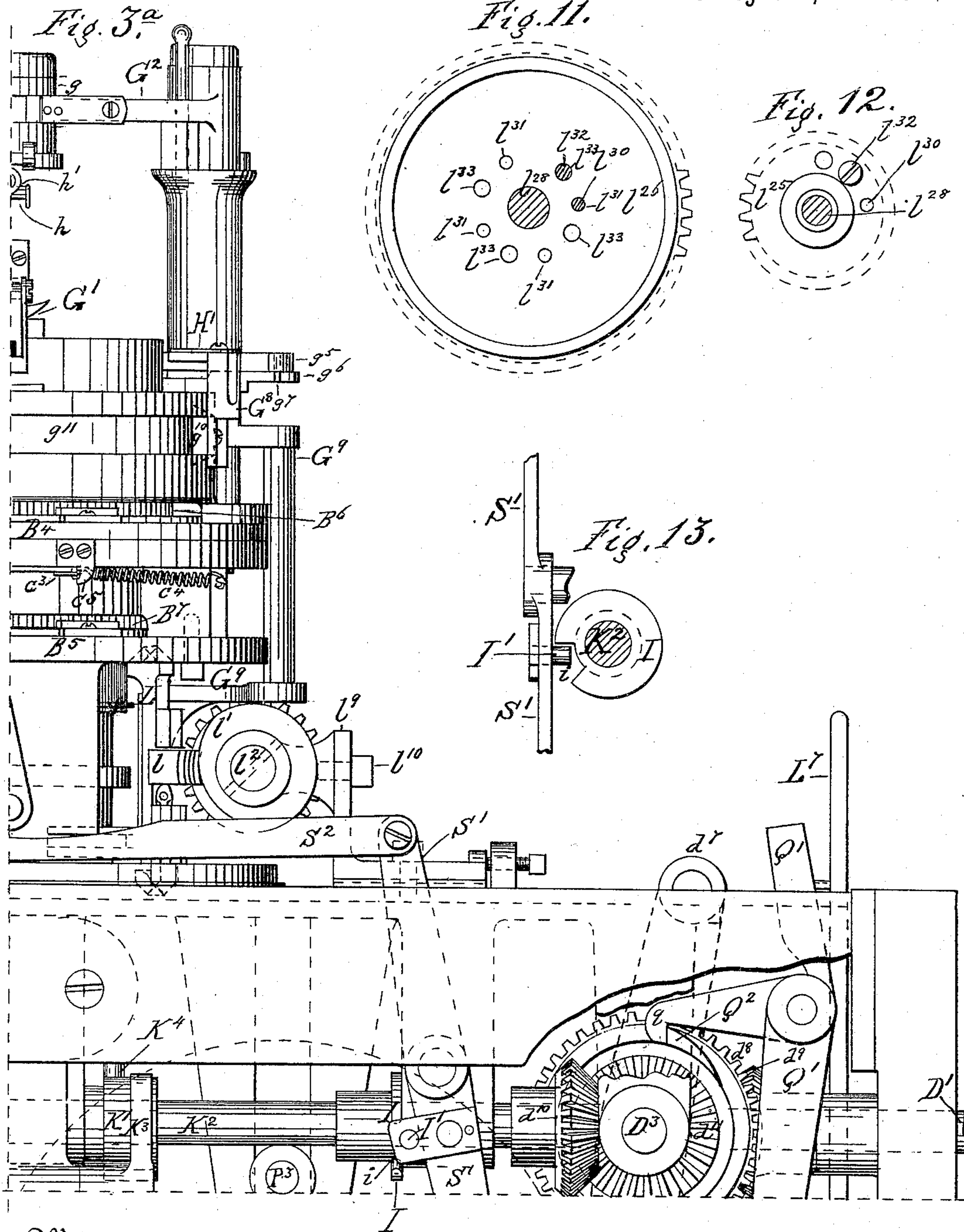
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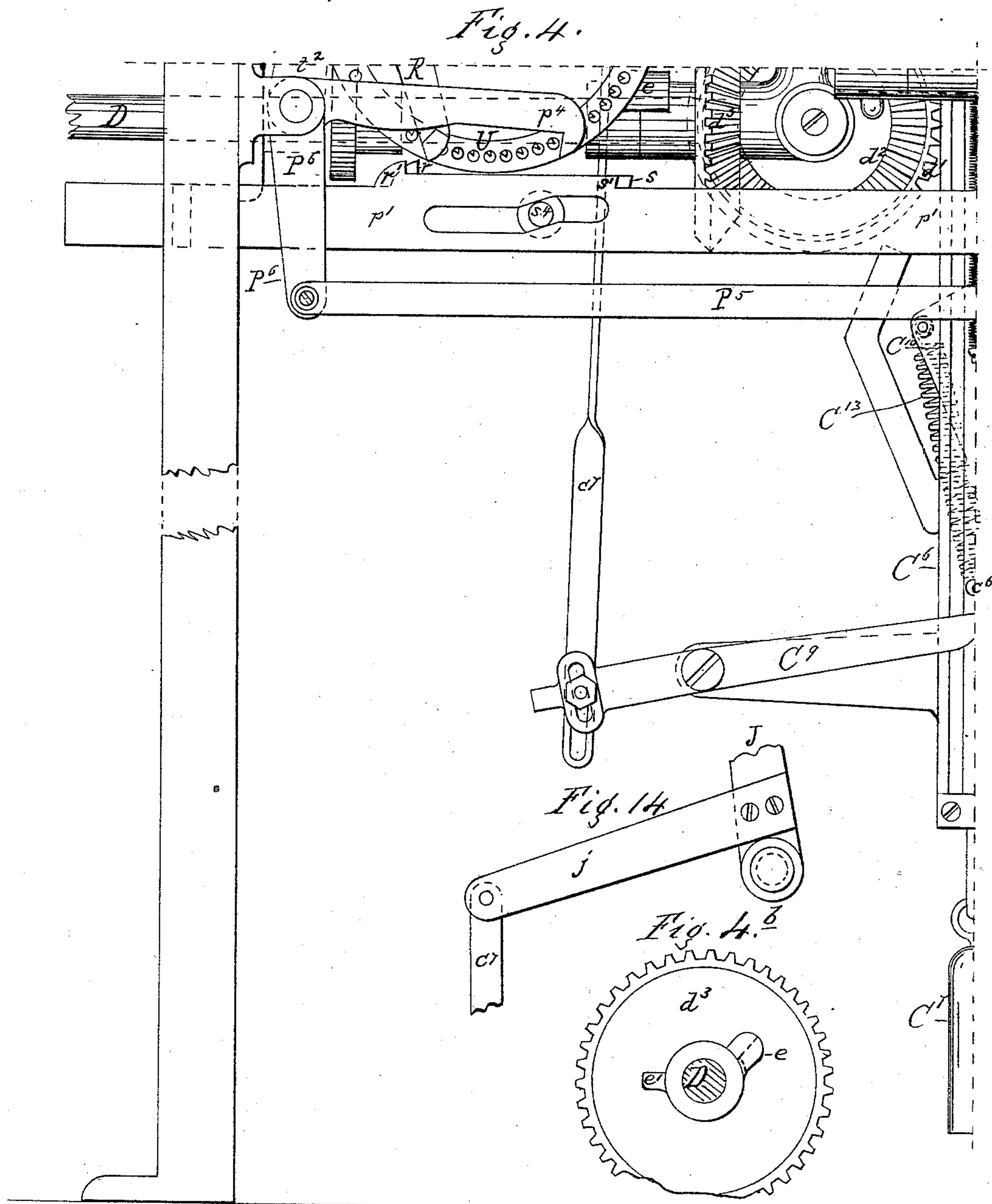
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Fig. 4.

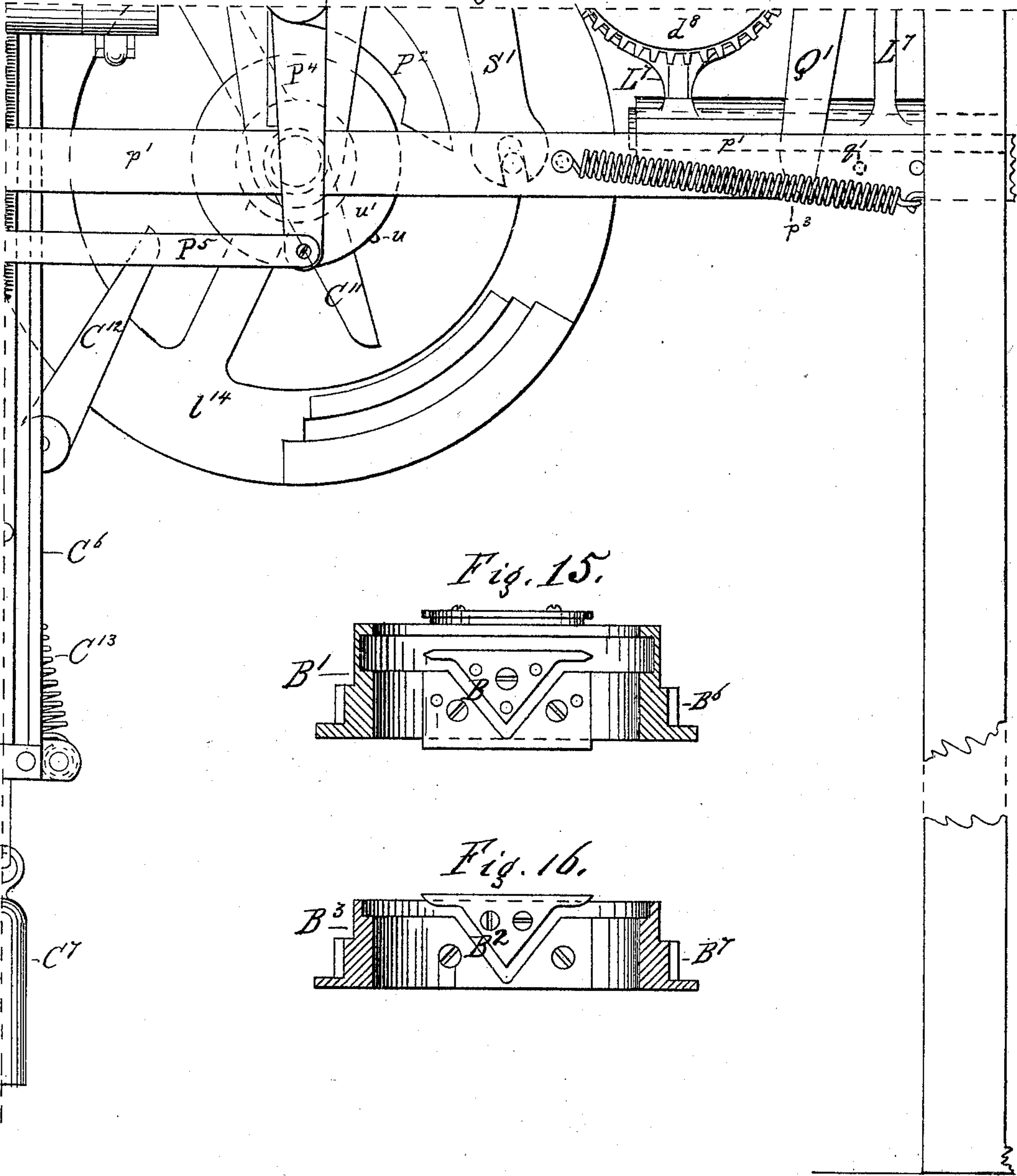


Fig. 15.

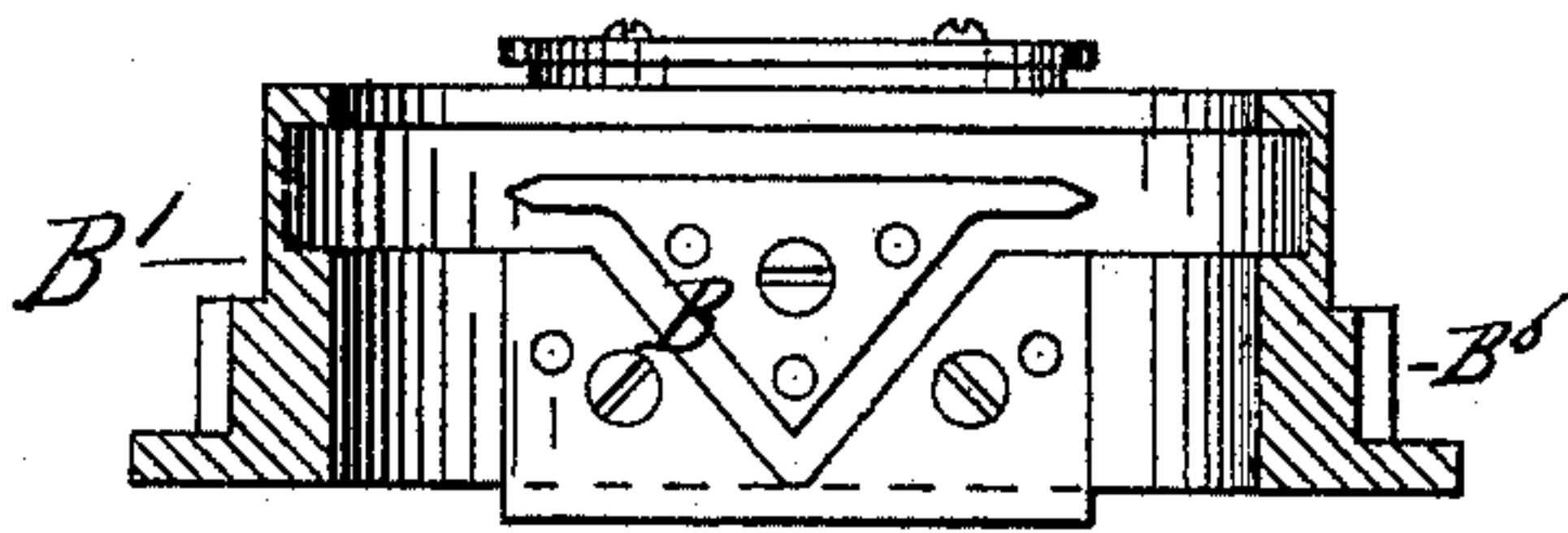
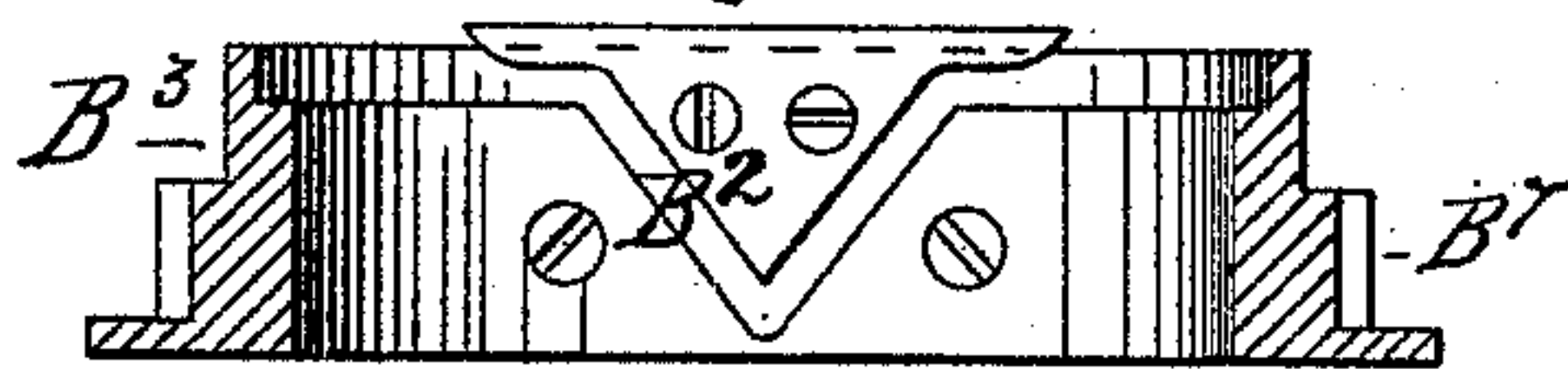


Fig. 16.



Witnesses

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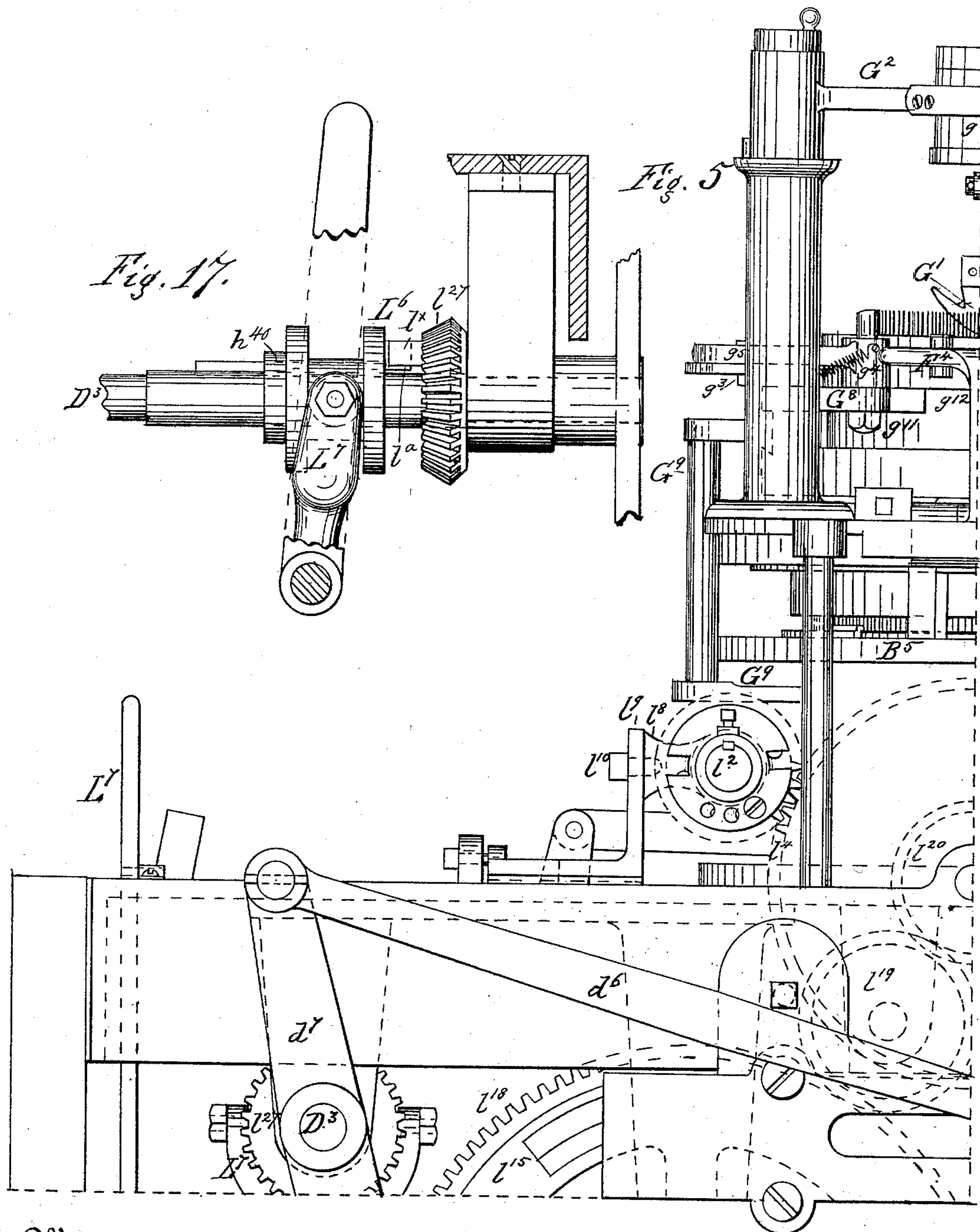
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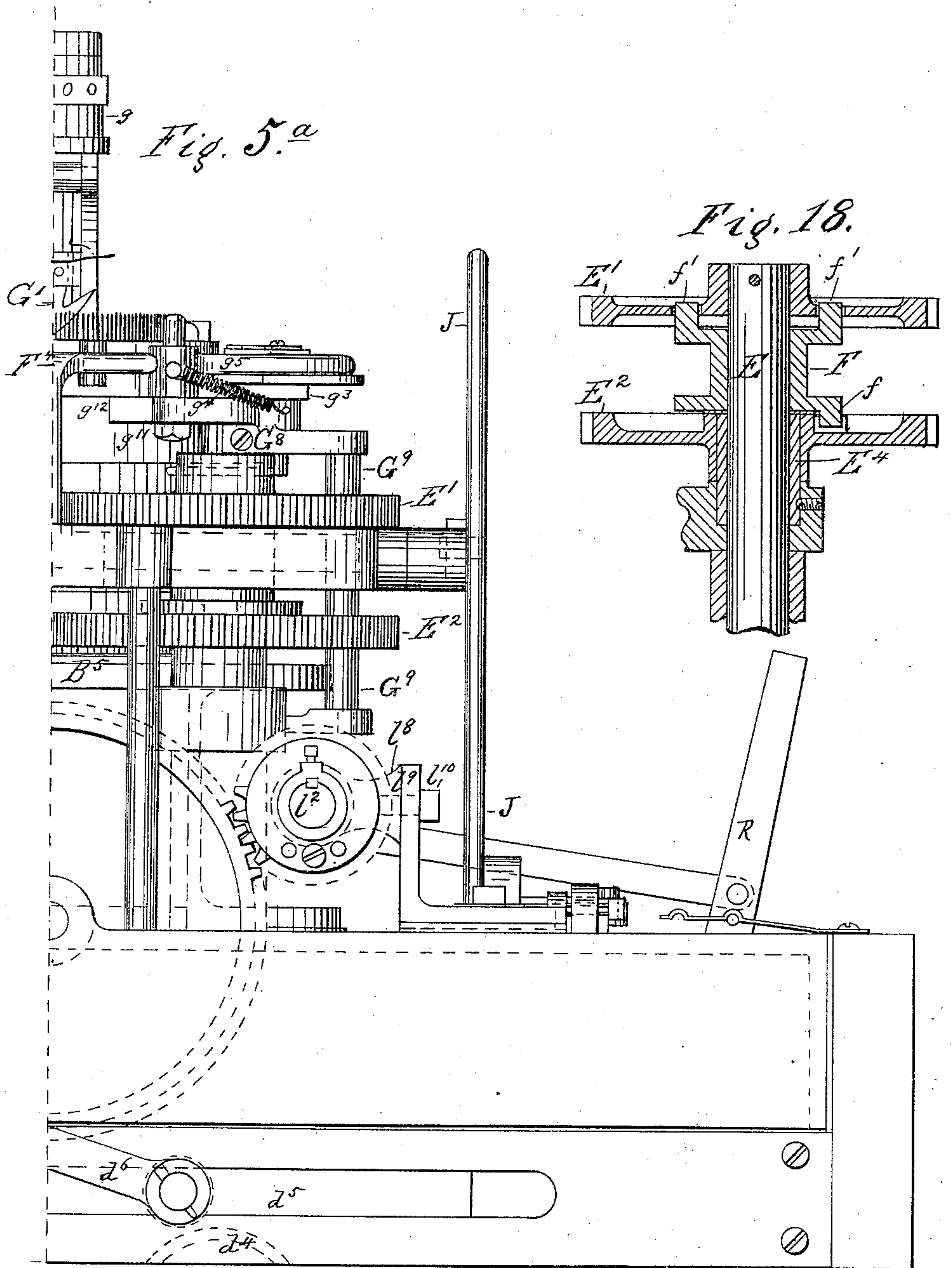
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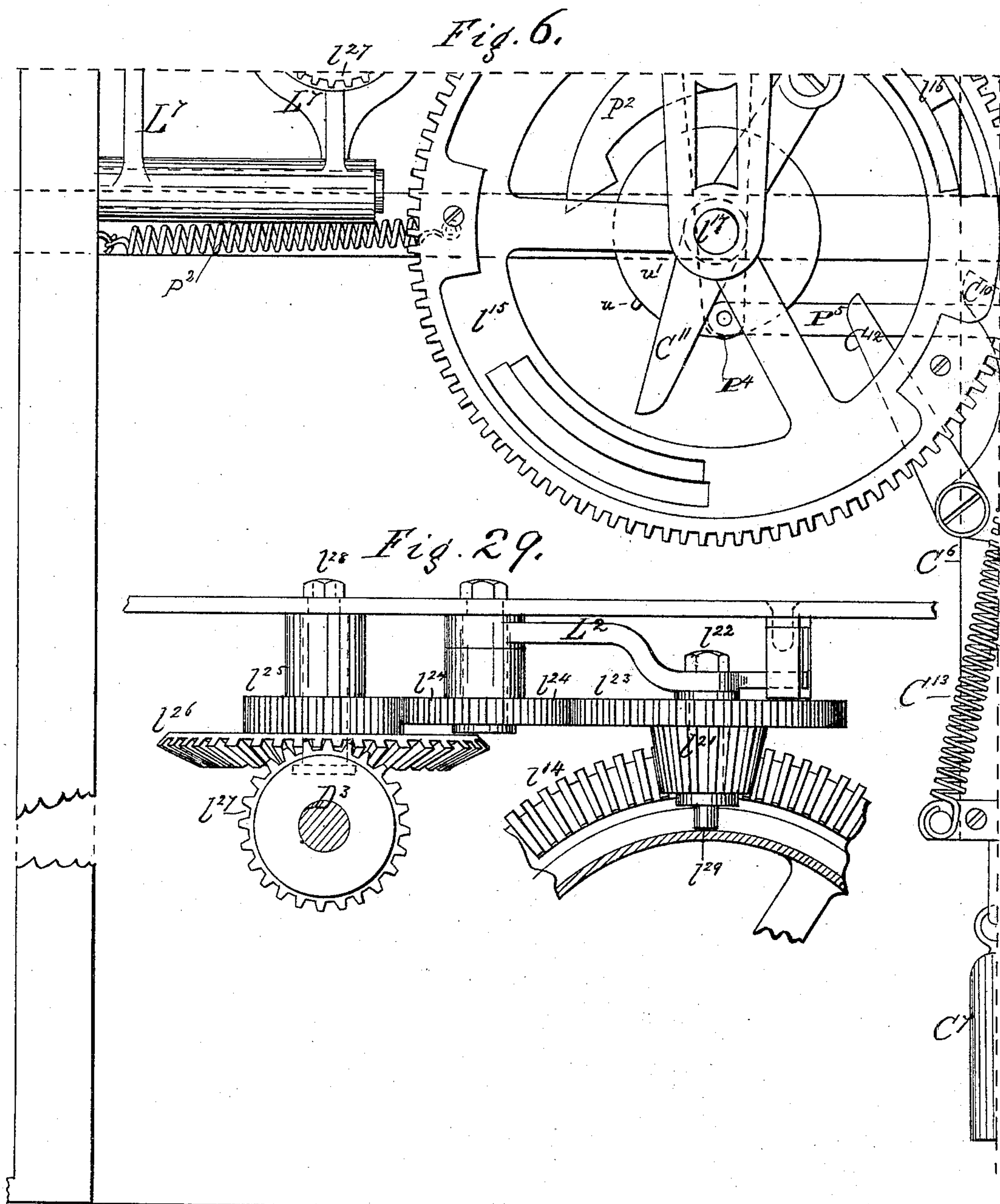
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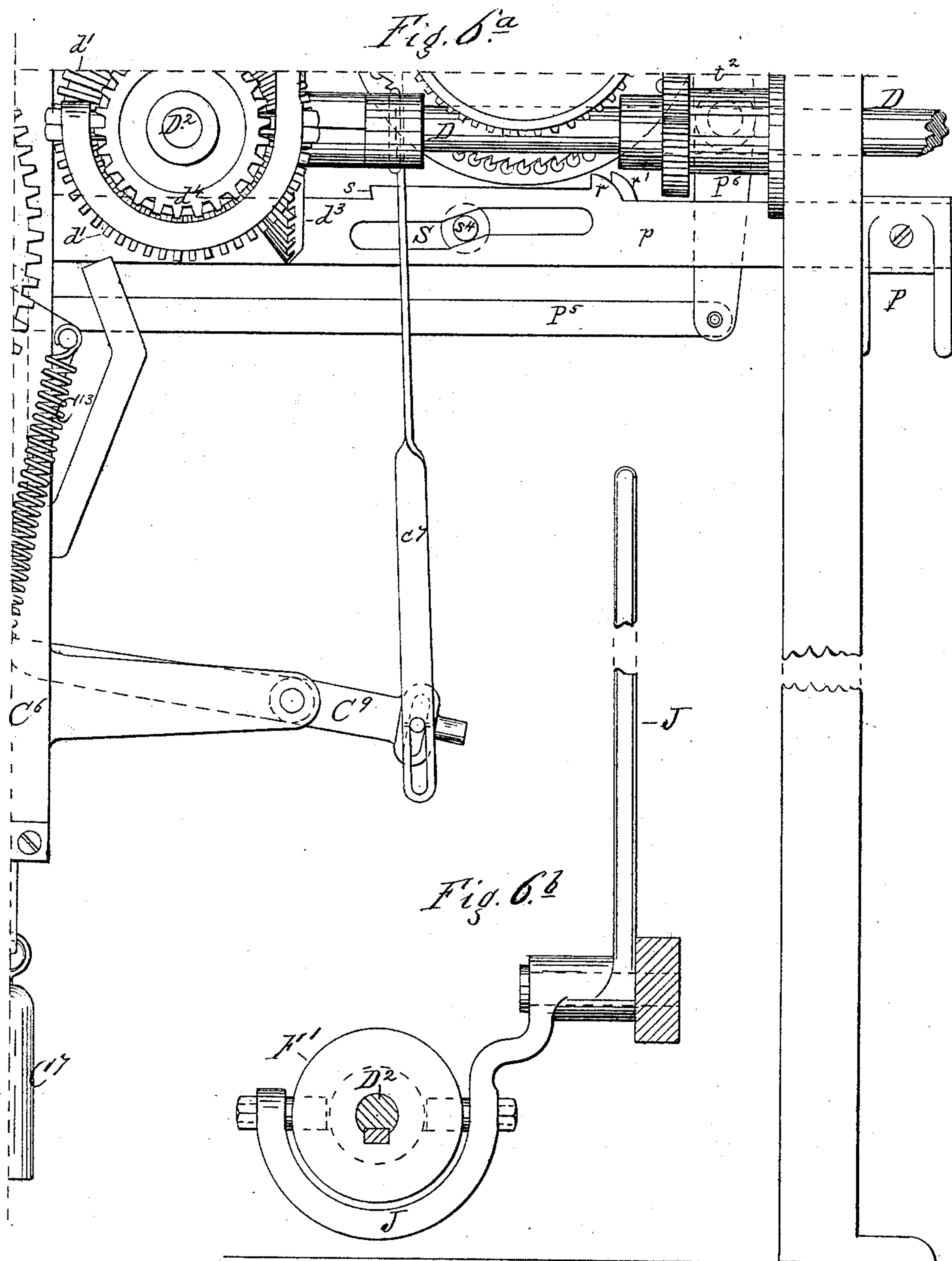
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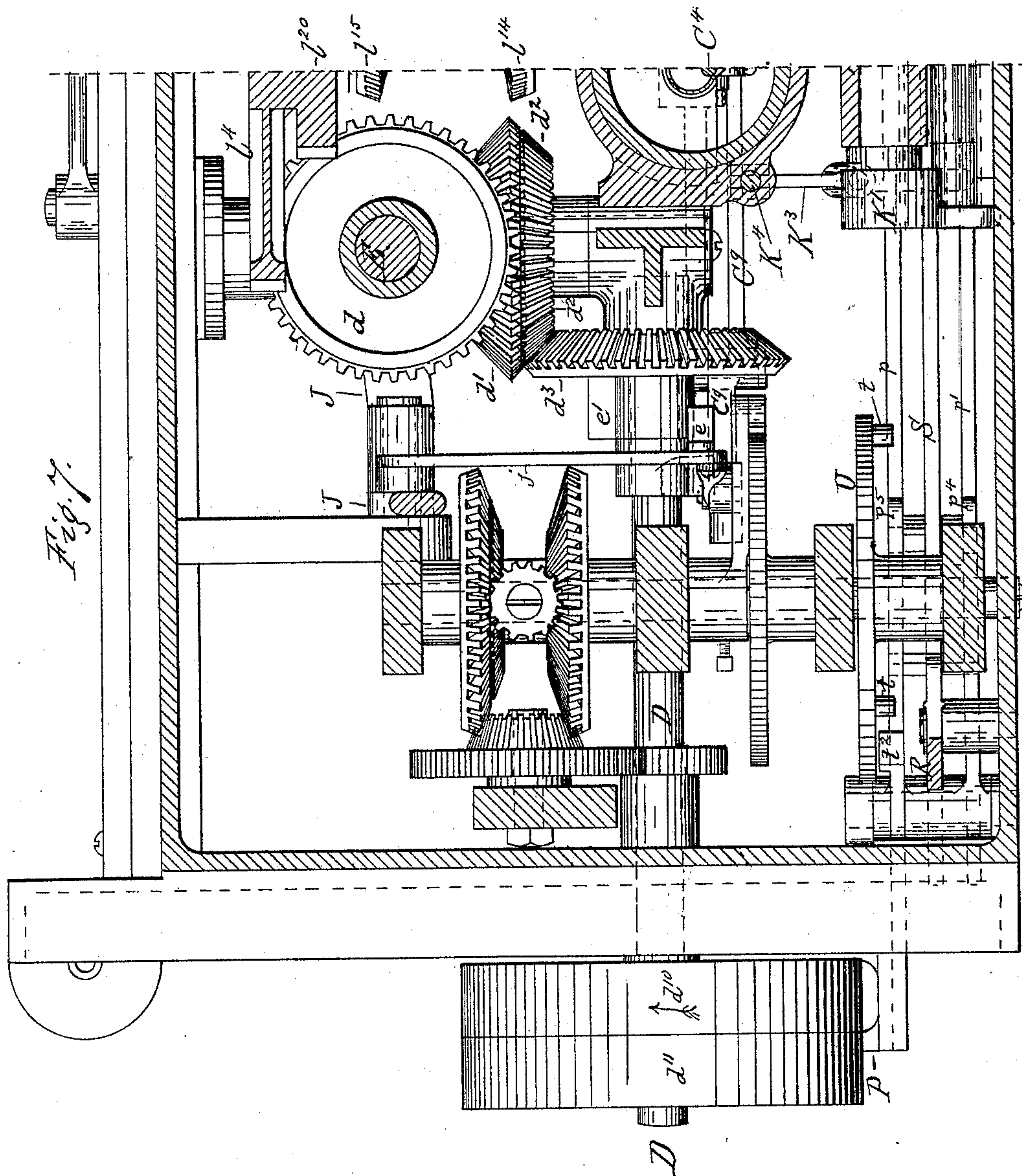
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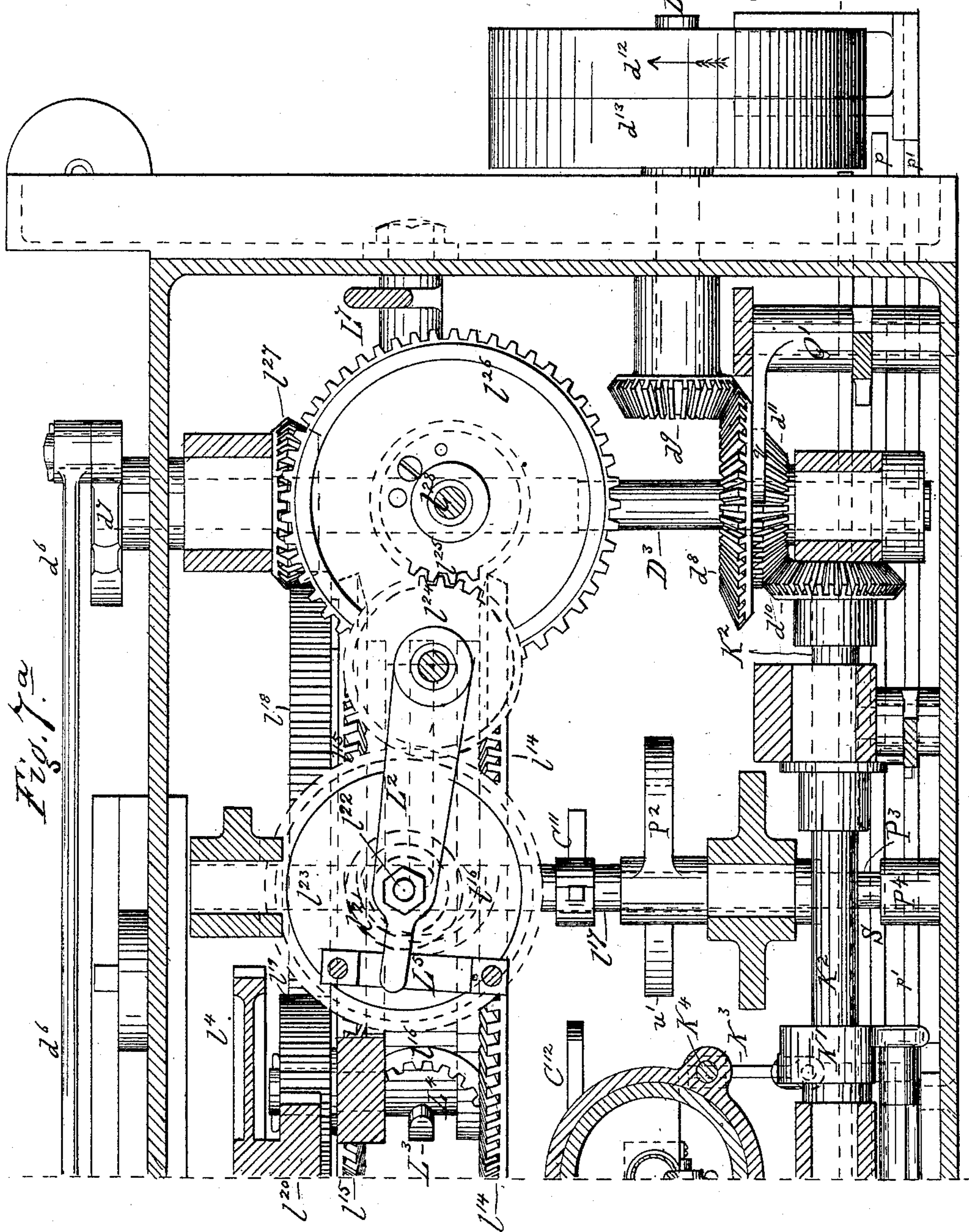
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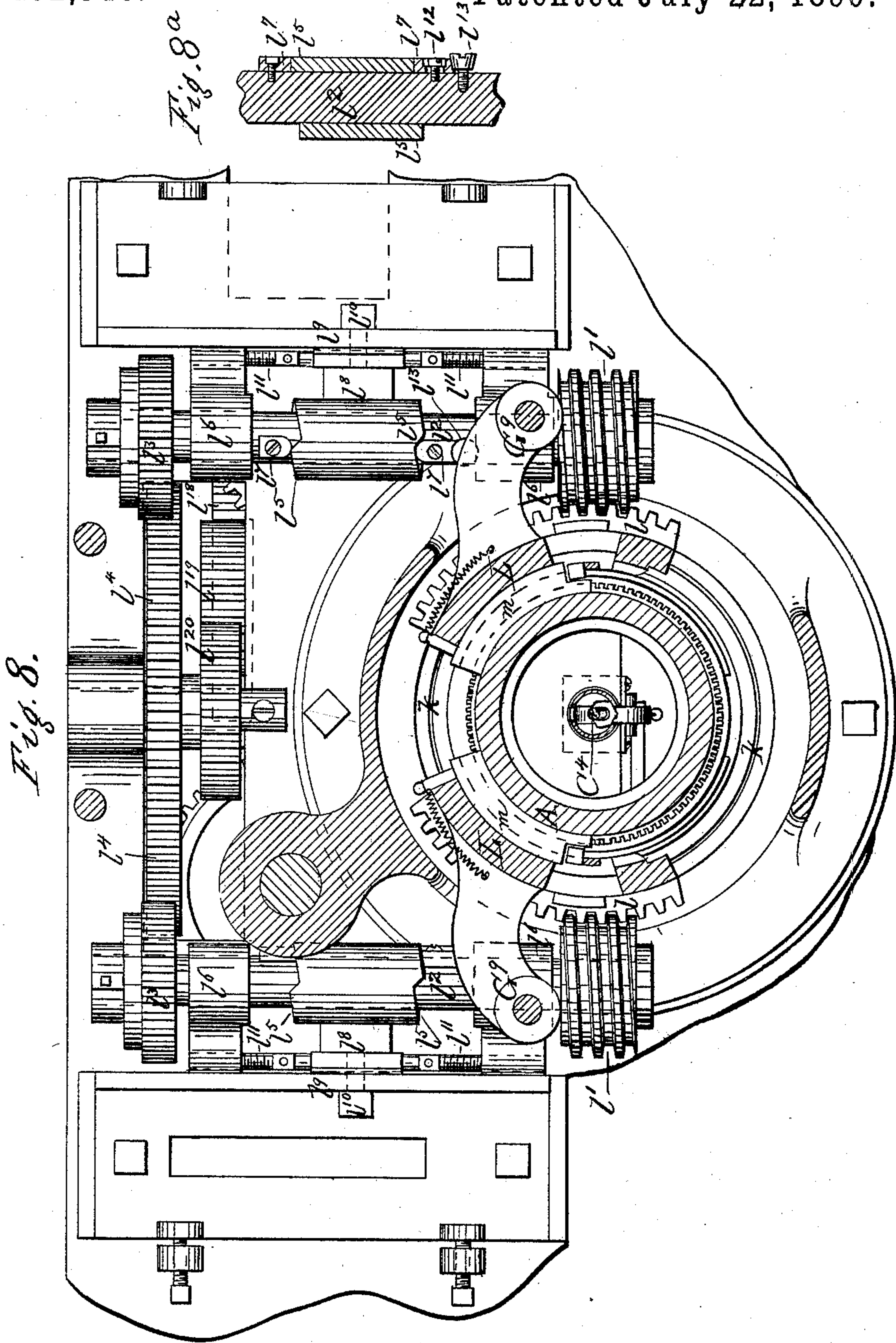
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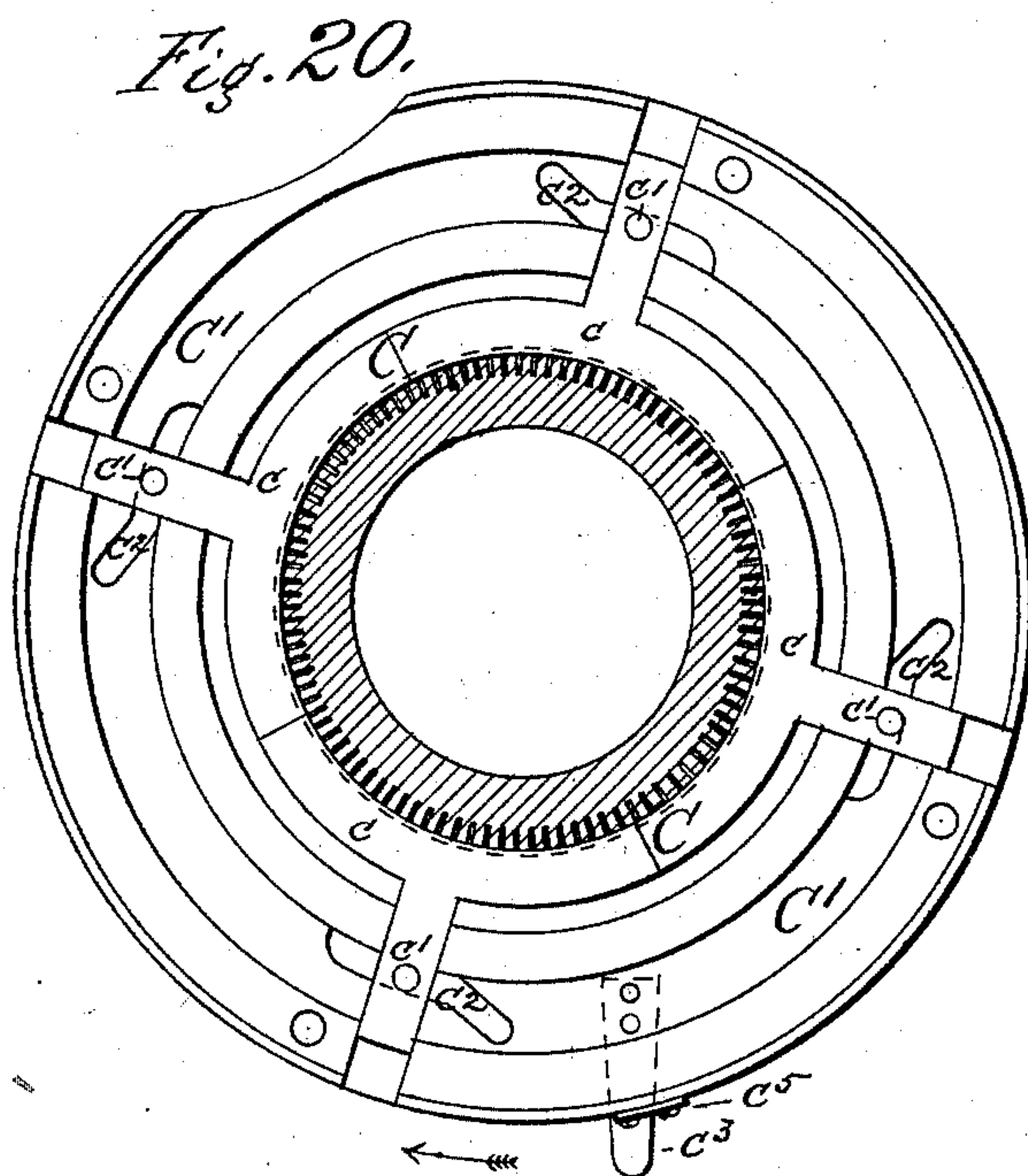
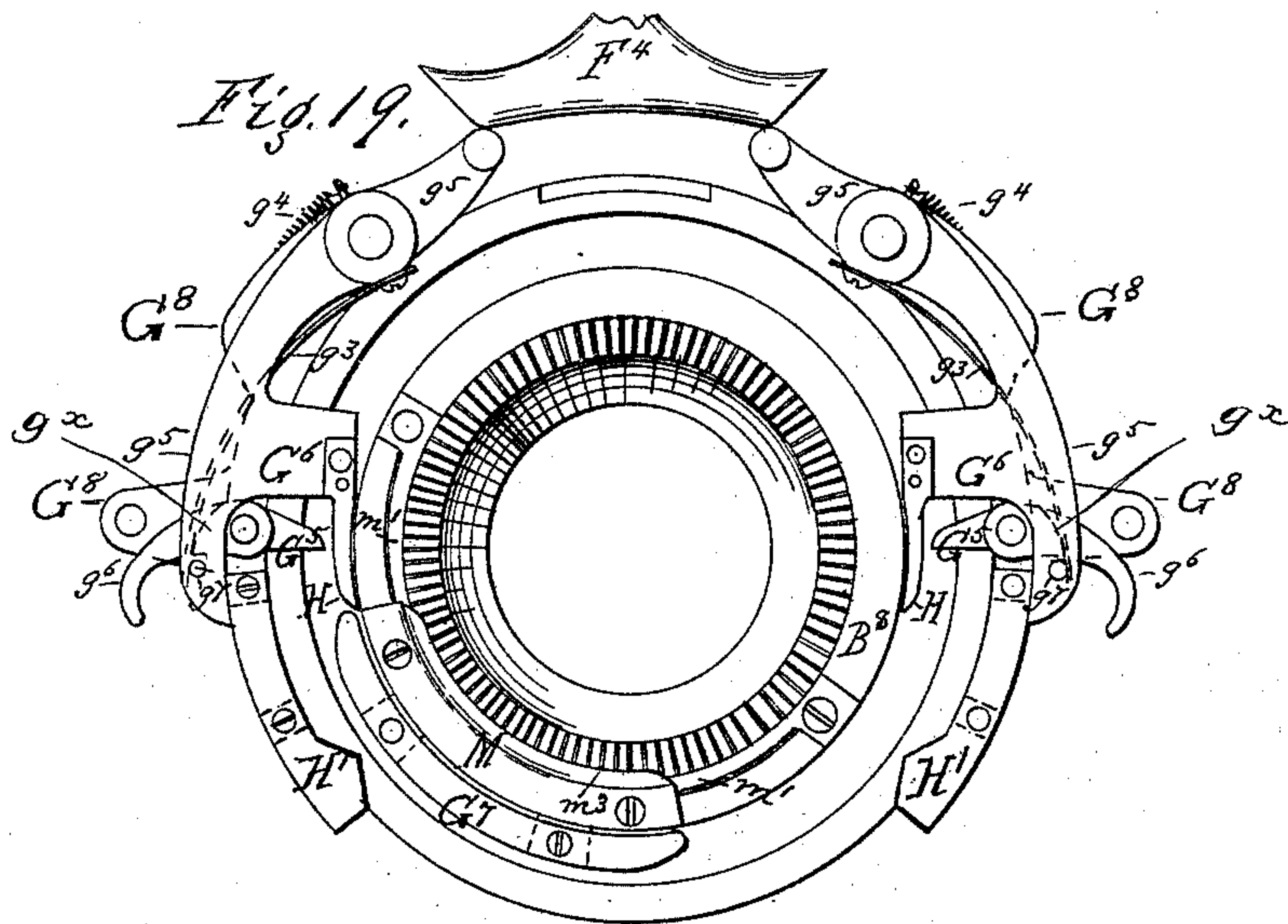
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Fig. 21.

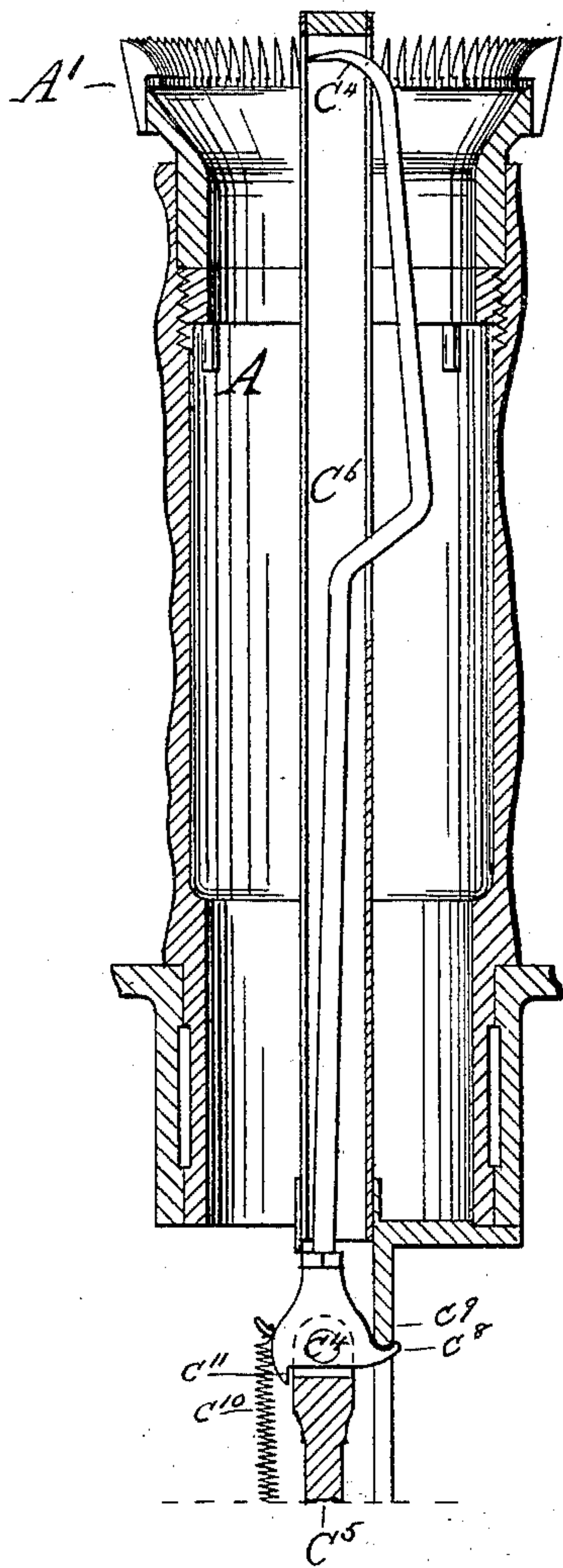
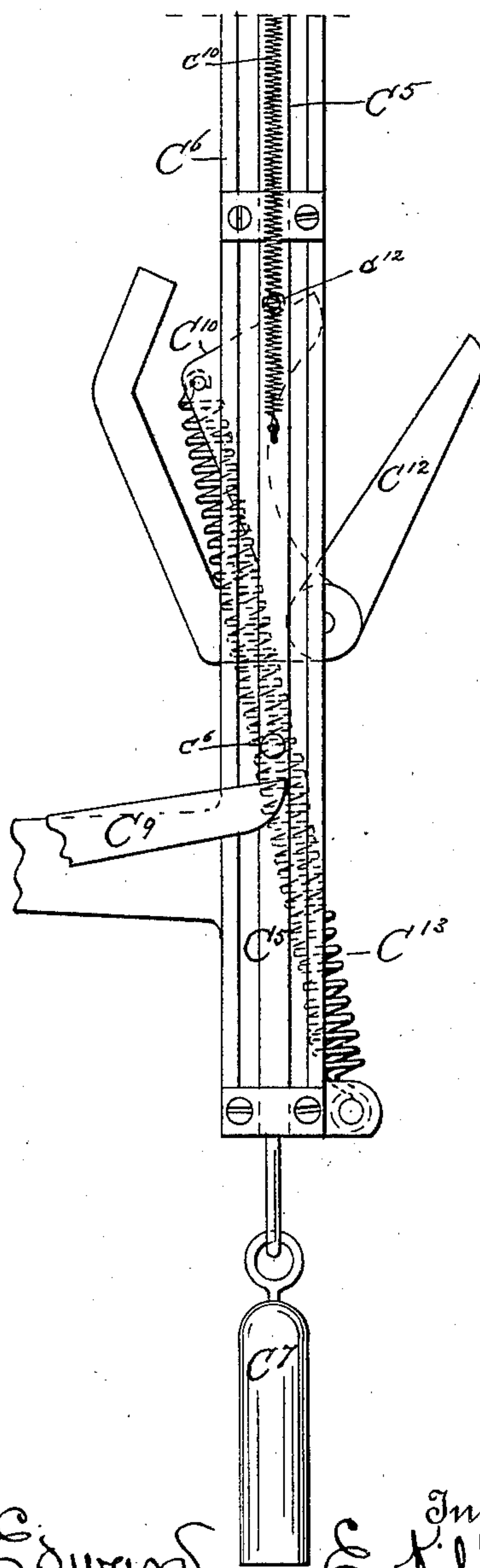


Fig. 22.



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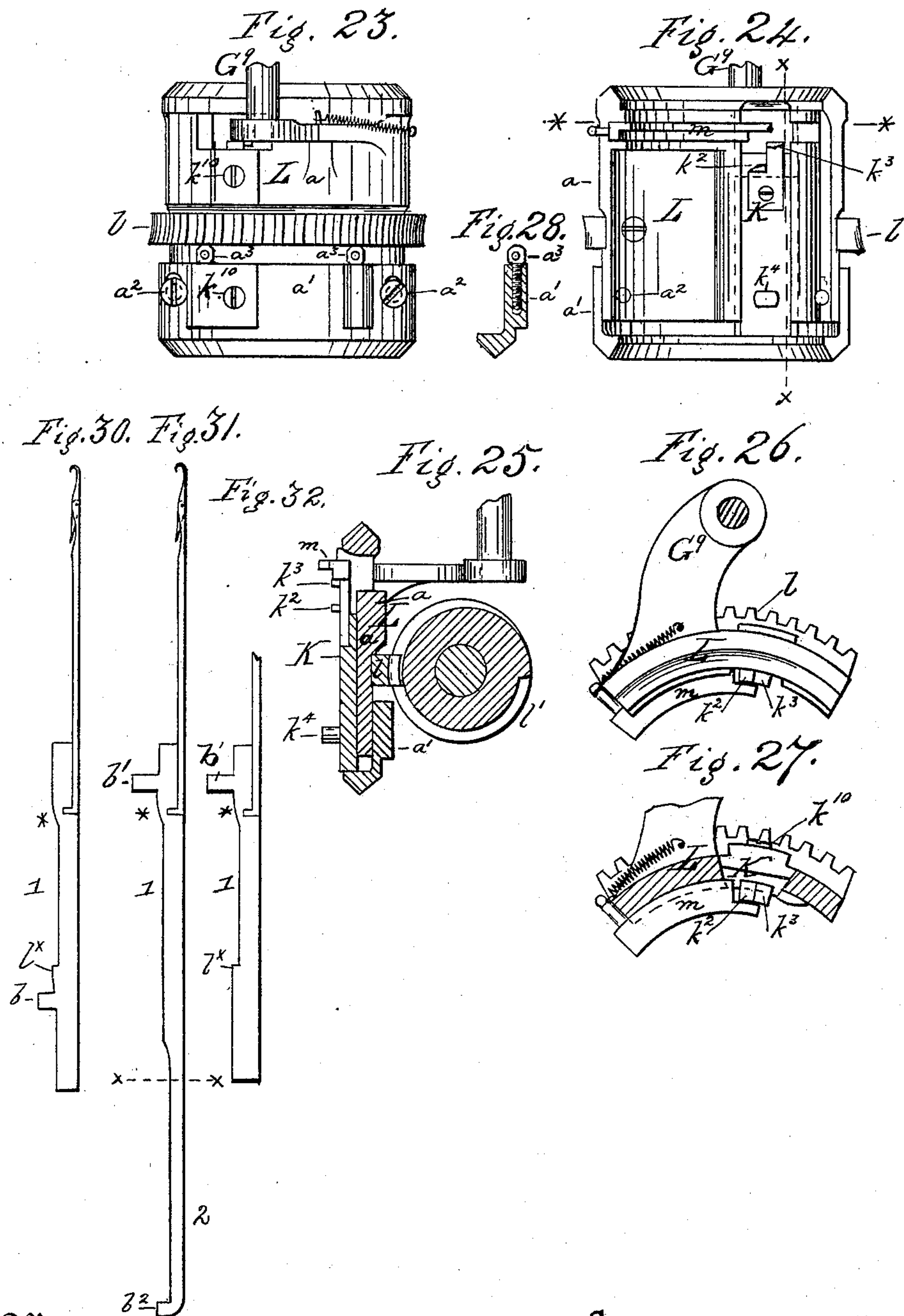
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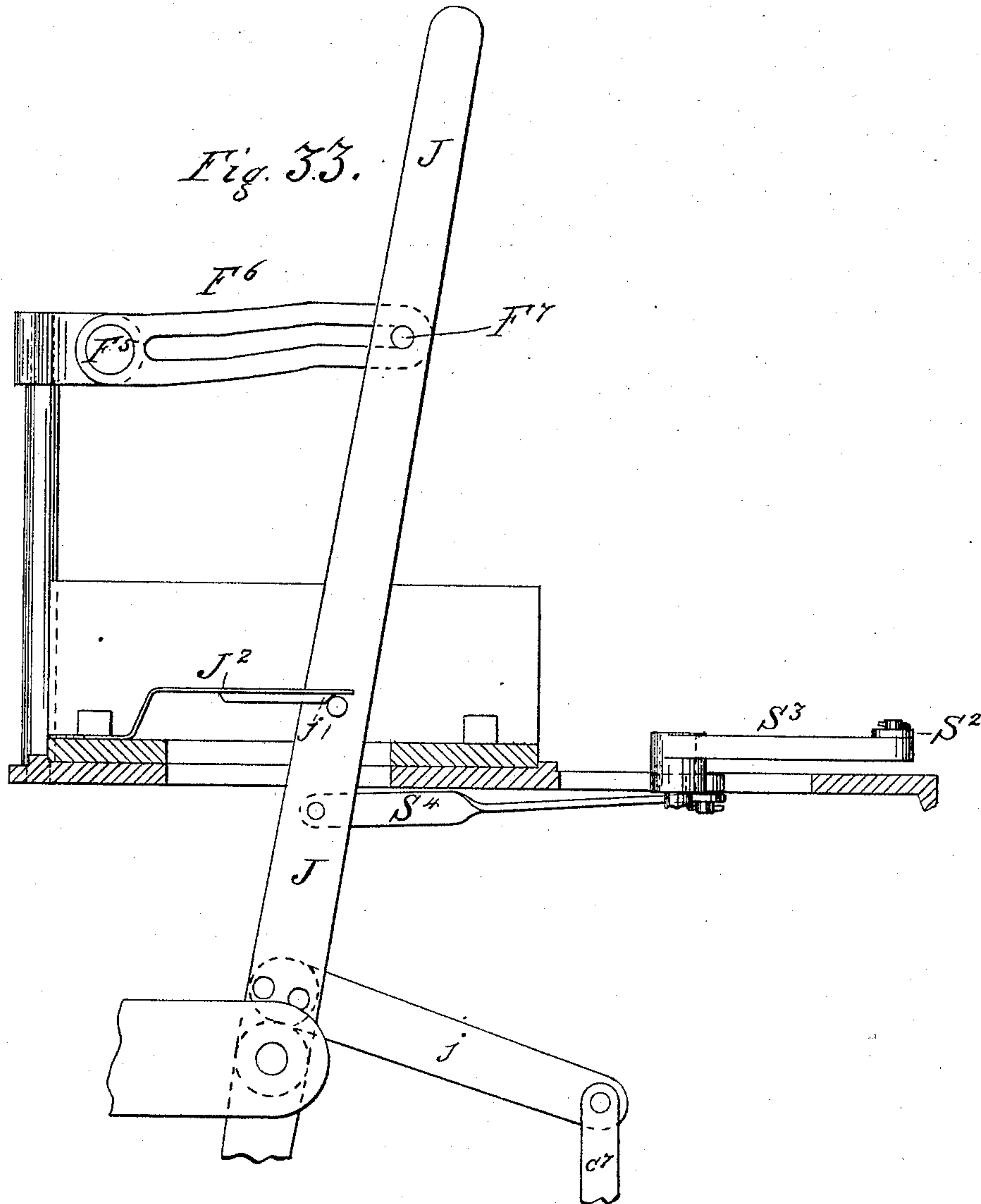
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UNITED STATES PATENT OFFICE.

EDWARD ELISHA KILBOURN, OF NEW BRUNSWICK, NEW JERSEY.

CIRCULAR-KNITTING MACHINE.

SPECIFICATION forming part of Letters Patent No. 432,946, dated July 22, 1890.

Application filed May 13, 1889. Serial No. 310,661. (No model.)

To all whom it may concern:

Be it known that I, EDWARD ELISHA KILBOURN, of New Brunswick, in the county of Middlesex and State of New Jersey, have made an invention of certain new and useful Improvements in Circular-Knitting Machines; and I do hereby declare that the following, in connection with the accompanying drawings, is a full, clear, and exact description and specification of the same.

This invention has reference to cylinder knitting-machines in which the needles are combined in a ring series so that the yarn may be fed to the needles by a continuous circular movement for the formation of continuous rows of stitches or loops, and in which also the thread-guide may be moved to and fro for reciprocating work.

The object of the invention is to facilitate the labor of attending to such machines, to enable them to be worked with greater speed, and to improve their operation.

The invention consists of certain new and useful combinations of mechanical devices, which are set forth in the claims at the close of this specification, and which are mainly modifications of or improvements upon the invention set forth in my patents, Nos. 408,180, 408,110, 408,111, 408,181, of July 30, 1889.

In order that these combinations may be more fully understood, I have represented in the accompanying drawings and will proceed to describe a cylinder knitting-machine embodying them in the form in which I prefer to embody them for the purpose of knitting stockings, it being understood that the mechanism may be varied to suit the views of different makers and users.

Figures 1 and 1^a represent jointly a view of the upper side or top of the said machine, the two figures being respectively at the left hand and right hand sides of the axis of the knitting-cylinder. Figs. 2 and 2^a represent jointly a vertical transverse section of the machine (with some parts in elevation) at the axis of the knitting-cylinder, as viewed from the right-hand end of the machine, the two figures meeting at the transverse lines *xx*. Fig. 2^b represents a front view of one of the knitting cam-cylinders. Figs. 3 and 3^a represent jointly a front view of the part of

the machine above the line *xx* of Figs. 2 and 2^a, the two figures meeting at the axis of the knitting-cylinder. Figs. 4 and 4^a represent jointly a front view of the part of the machine below the line *xx* of Figs. 2 and 2^a, the two figures meeting at the line of the axis of the knitting-cylinder. Fig. 4^b is a view transversely of the machine, showing the disconnectible drivers, hereinafter described. Figs. 5 and 5^a represent jointly a view of the part of the back of the machine above the line *xx* of Figs. 2 and 2^a, the two figures meeting at the axis of the knitting-cylinder. Figs. 6 and 6^a represent jointly a view of the part of the back of the machine below the line *xx* of Figs. 2 and 2^a, the two figures meeting at the line of the axis of the knitting-cylinder. Fig. 6^b represents a back view of the clutch-lever and its appurtenances detached from other parts of the machine. Figs. 7 and 7^a represent jointly a horizontal section of the machine with the portions above the line *yy* of Fig. 2 removed, the two figures meeting at the transverse vertical plane of the axis of the knitting-cylinder. Fig. 8 represents a horizontal section of parts of the machine at the line *zz* of Fig. 2, and Fig. 8^a represents a partial longitudinal section through one of the worm-shafts. Fig. 9, Sheet 4, represents a front view of one of the gear-wheels, and of the clutch-notch, hereinafter referred to. Fig. 10, Sheet 5, represents a view crosswise of the machine of the connecting devices of one of the pickers with the respective picker-cam. Figs. 11 and 12, Sheet 6, represent, respectively, horizontal views of two gear-wheels, hereinafter described. Fig. 13, Sheet 6, represents a view crosswise of the machine of the guard and lever, hereinafter referred to. Fig. 14, Sheet 7, represents a view crosswise of the machine of parts of connecting devices, hereinafter referred to. Figs. 15 and 16, Sheet 8, represent, respectively, vertical sections of the two cam-cylinders and knitting-cams. Fig. 17, Sheet 9, represents a view of the clutch, clutch-lever, and adjacent parts. Fig. 18, Sheet 10, represents a vertical axial section of the cam-gear shaft, one of its bearings, and gear-wheels. Fig. 19, Sheet 16, represents a plan of parts of the machine, showing certain devices, hereinafter de-

scribed, for operating the thread-guide, and in different positions from those represented in Figs. 1 and 1^a. Fig. 20 represents a plan at the line * * of Fig. 2, showing the ring-holder and devices for moving the sections, as hereinafter described. Fig. 21 represents a transverse axial section of part of the knitting-cylinder and pull-hook. Fig. 22 represents a face view of other parts of the said pull-hook. Fig. 23 represents a view transversely of the machine, showing the exterior of one of the picker-carriers, and Fig. 24 represents a view of the interior of the same. Fig. 25 represents a vertical section of one of the picker-carriers at the line *x x* of Fig. 24, and Fig. 26 represents a top view of one of said picker-carriers. Fig. 27 represents a partial horizontal section of one of the picker-carriers at the line * * of Fig. 24, and Fig. 28 represents a partial transverse vertical section of the same at one of the adjusting-screws. Fig. 29, Sheet 11, represents a rear view of the shifting-pinion and parts adjacent to it, hereinafter described. Figs. 30, 31, and 32 represent views of the needles used in the machine. Fig. 33 represents a view of the clutch or change lever and adjacent parts.

The machine represented in the said drawings is constructed to operate upon the same principle as that described in each of my said previous patents, and is substantially like the same in its general construction and mode of operation, so that it will be most convenient to describe the present machine by reference to the machine described in the said previous patents, and to describe in detail the particular parts in which the present machine is an improvement upon the machine of the said previous patents. Some of the improvements, however, are applicable to cylinder knitting-machines of different construction from that of my previous patents and may be applied with advantage to them.

The needles of the present machine are arranged in a circular series and are fitted to slide up and down in the grooves of the knitting-cylinder A and its nosing A'. These needles may be divided into two gangs, the one of which is used for circular work only, while the second gang is used in connection with the first gang for circular work and is used without the first gang for reciprocating work, the needles of the first gang being then at rest.

The needles are operated by means of two knitting-cams B B², which are arranged one above the other and are secured to and moved by two cam-cylinders B' B³, which are concentric with the series of needles and are fitted to turn around the knitting-cylinder A. The two concentric cam-cylinders are preferably of the same diameter. The lower cam-cylinder B³ is in this example of my invention used only for circular work, while the upper cam-cylinder B' is used both for circular work and reciprocating work.

Instead of supporting one cam-cylinder

upon the other, as has been previously done in knitting-machines having two cam-cylinders, each cam-cylinder with its knitting-cam is supported independently of the other cam-cylinder and knitting-cam by the frame of the machine, the lower cam-cylinder B³ being supported by a fixed ring-bearing B⁵, and the upper cam-cylinder being supported by a second fixed ring-bearing B⁴. As these two ring-bearings are independent of each other, the two cam-cylinders also are independent of each other, and the tendency of one cam-cylinder to impart motion by frictional contact to a second cam-cylinder which rests upon it is avoided, and consequently the necessity of employing a locking device to hold one of the two cam-cylinders at rest while the other is moving is dispensed with. The knitting-cams carried respectively by the two cam-cylinders are also supported independently of each other through the intervention of the cam-cylinders.

Those needles, Fig. 30, Sheet 18, which are to be operated by the lower knitting-cam B², Fig. 16, Sheet 8, of cam-cylinder B³ have their nibs *b* arranged at the required distance from their heads to be operated upon by that cam for circular work, and those needles, Figs. 31 and 32, which are to be operated by the upper knitting-cam B, Fig. 15, of cam-cylinder B' during reciprocating work, and which may be called the "gang of fashioning-needles," have their nibs *b'* arranged at the required distance from their heads to be operated by that cam for both circular work and reciprocating work.

In order that all the needles may be held snugly in the grooves of the knitting-cylinder, a needle-holder C, Fig. 2, Sheet 3, and Fig. 20, Sheet 16, of circular form, is provided to embrace the slides or shanks of the needles and hold them in their places; and in order that this needle-holder may be readily withdrawn from the shanks of the needles, so that they may be applied to and taken from the knitting cylinder, this needle-holder is a sectional needle-holder, it being constructed of movable sections *c*, each of which is preferably fitted to slide crosswise of the axis of the knitting-cylinder. Each of the sections of this sectional needle-holder might be withdrawn separately from the needle-cylinder by means of a screw or a cam; but as it is most convenient for attendance upon the machine that all the sections of the sectional needle-holder should be withdrawn from and applied to the shanks of the needles simultaneously, I prefer to combine all the ring-sections with one cam-ring C', Figs. 2 and 20, by the circular movement of which in one direction all the sections of the ring-holder may be withdrawn from the knitting-cylinder, and by the movement of which in the opposite direction the said sections may be applied to the knitting-cylinder for the purpose of holding the needles thereto. For this purpose each section of the ring-holder is fitted with a pin *c'*, Fig.

20, which projects into one of the cam-slots c^2 of the cam-ring C' . The edges of each of these cam-slots constitute cams, one of which operates to move a section of the needle-holder from the knitting-cylinder and the other operates to move said sections toward it. So when this cam-ring is turned in a forward direction (indicated by the arrow in Fig. 20) all the ring-sections are simultaneously opened by being withdrawn from the needle-slides and knitting-cylinder, and when the cam-ring is turned in the opposite or backward direction all the ring-sections are simultaneously closed by being returned to their inner positions for holding the needle-slides. The cam-ring may be conveniently operated by a handle or arm c^3 .

In order that sections may not remain in their open positions in case the attendant should omit to close them, a holding-spring c^4 , Fig. 3^a, Sheet 6, is provided, and is connected preferably with the handle c^3 of the cam-ring C' so that this spring will move the cam-ring backward and effect the closing of the sections of the ring-needle holder in case the attendant should omit to do so. The spring also insures the holding of the ring-needle holder in its closed condition against any tendency to work open by the tremor of the machine. I prefer also to employ a stop c^5 , Figs. 3^a and 20, to limit the distance to which the cam-ring C' may be moved in a backward direction.

While the needle-holder holds all of the needles in place in the grooves of the knitting-cylinder, it serves also an important function in holding all of the needles, except the narrowing and widening needles, from being improperly or accidentally raised out of operative position. The holder is so located that it is opposite some part of the straight portion 1 of the needles during all the movements of the needles. All of the needles, except the narrowing and widening needles, have a shoulder 1^x , which is so located that when these needles are in the highest position to which they can be raised by the operating-cam, while in contact therewith these shoulders will lack but very little of being in contact with the needle-holder, and if any of such needles should be raised in contact with it the nibs of those needles would still be in position properly to be engaged and depressed by the depressing-grade of the cam. It will thus be seen that if any of the needles, except the narrowing-needles, are accidentally caught and raised the needle-holder will prevent their nibs being raised out of position in respect to the cam, thereby preventing errors or faults in knitting and avoiding one of the frequent causes of breakage.

In Fig. 2 of the drawings a portion of the cylinder at the left is shown with the needle-grooves extending downward only to the lower edge of the upper cam-ring. This portion of the knitting-cylinder is occupied by the narrowing and widening needles at one

side of the cylinder. The knitting-cylinder is provided with one or more rings A^2 , having grooves of less depth, which receive the narrower portion 2 of the jacks of the narrowing and widening needles. This construction is employed for the whole gang of needles used in reciprocating work. Below these rings is placed the needle-stop 3, which extends beneath all of the reciprocating gang of needles, and is so located that when the said reciprocating needles are in the lowest position to which they can be depressed, while their nibs are in contact with the depressing portion of the cam, the lower end of the needles will lack but very little of being in contact with the needle-stop. The other portions of the knitting-cylinder are constructed as shown on the right of Fig. 2, and below the other needles is placed a needle stop or stops 4, having a like relation to the other needles.

In machines of usual construction in running at a high rate of speed the needles as their nibs leave the depressing grade of the cam are under considerable momentum, and while moving under this momentum the nibs are caught by the elevating grade of the cam, resulting in a very sharp impact, which often results in injury to and destruction of the nibs of the needles. I avoid this by the construction described, as the momentum imparted to the needles causes them to strike against the stops and rebound therefrom, the elevating grade of the cam catching them on the rebound when the needle is moving in the direction in which it is impelled by the cam, and this greatly lessens the force of the impact and permits the machine to run at a higher rate of speed.

The said machine is provided with a nosing A' for the knitting-cylinder, and this nosing is fitted preferably with hook-formed partitions, as in my Patent No. 408,110, to prevent the stitches being accidentally raised when the needle-heads are moved upward.

The said machine is provided with two driving-shafts $D D'$, one of which D is employed when the two knitting-cams $B B^2$ and their cylinders $B' B^3$ are to be operated for circular work, while the other driving-shaft D' is used to impart motion to the upper cam-cylinder only for reciprocating work.

In order that both cam-cylinders and the knitting-cams carried by them may have motion imparted to them from the driving-shaft D for circular work, each cam-cylinder is fitted with an annular cog-wheel B^6 and B^7 , whose teeth engage respectively with those of two driving gear-wheels E' and E^2 , which are applied to an upright shaft E , which may be designated the "cam-gear shaft," and which is connected with the driving-shaft D for circular work through the intervention of the beveled wheel d , Fig. 7, secured to the lower end of the said cam-gear shaft E , the beveled wheel d' , which is mounted loose upon an intermediate shaft D^2 , the beveled wheel d^2 , which is secured to the back of the bev-

eled wheel d' , and the beveled wheel d^3 , secured to a hub, which is fitted loose upon the said driving-shaft D and is driven from it through the intervention of the disconnectible drivers $e e'$, Figs. 4 and 4^b, Sheet 7, and Fig. 7, Sheet 13, one e being secured to said shaft and one e' being secured to the hub of said beveled wheel.

The combination of the cams B B² and cam-cylinder B' B³ with the driving-shaft D for circular work through the intervention of the disconnectible drivers $e e'$ is to enable a portion of the same gearing which is used for circular work to be employed to transmit motion from the second driving-shaft D' to one (B') of the two cam-cylinders B' B³ for reciprocating work without also moving the driving-shaft D, which is used for circular work.

In order that the necessary extent of reciprocating movement for the cam-gear shaft E might be attained in the machine of my previous Patent No. 408,180, a notched collar and certain appurtenances were interposed between the disconnectible drivers of that machine and the beveled wheel driven thereby; but in the present machine the beveled gear-wheel d^3 , which is mounted upon the driving-shaft D, is constructed of larger diameter than the beveled gear-wheel d^2 with which it engages, so that the beveled wheel d^2 and the cam-gear shaft E and driving-wheel E' may be reciprocated to the required extent to drive the knitting-cam B and its cam-cylinder B' for reciprocating work without requiring the beveled wheel d^3 to make a complete revolution, and consequently the notched collar of the preceding machine is dispensed with.

In order that the knitting-cam B² and its cam-cylinder B³ for circular work may be disconnected from the cam-gear shaft E and may be permitted to remain at rest while the other knitting-cam B and its cam-cylinder B' are operated for reciprocating work, the driving-wheel E², through which motion is imparted to the circular-knitting cam B² and its cam-cylinder B³, is not secured to the cam-gear shaft E, but is connected with it through the intervention of a clutch F, Figs. 1, 2 and 18, Sheet 10, whose upper teeth f' are always engaged with the driving gear-wheel E', that drives the cam-cylinder B', while its lower tooth f is engaged with the said driving gear-wheel E², that drives the circular-knitting cam cylinder B³ when circular work is to be knitted, but is disengaged from the said driving-wheel E² when reciprocating work is to be knitted. In order also that the said cam-gear shaft E when operating for reciprocating work may not tend to turn the said driving-wheel E² for circular work by frictional contact, the hub of the said driving gear-wheel E² is supported independently of the said cam-gear shaft by means of a tubular bearing E⁴, Fig. 18, so that when the clutch is shifted from the said driving-wheel there is no tend-

ency in the other portions of the gearing to move the latter.

The same cam-gear shaft E and a portion of the other gearing, which are employed to transmit motion to both cams and both cam-cylinders for circular work, are preferably employed to transmit motion to the upper cam-cylinder alone for reciprocating work. For this purpose the cam-gear shaft E is connected with the second driving-shaft D' for reciprocating work through the intervention of reciprocating gearing, and the reciprocating gearing which I prefer to use for this purpose is the following: A counter-shaft D², Figs. 2^a and 6^a, is employed, and a clutch F', Figs. 2^a, 6^a, and 6^b, is fitted to this counter-shaft D² so that the said counter-shaft may be connected with the beveled wheel d' when it and the cam-gear shaft E are to be reciprocated. The counter-shaft D² also is connected with the second driving-shaft D' through the intervention of the pinion d^4 , secured to the rear end of the counter-shaft, the rack d^5 , Figs. 2 and 5^a, the connecting-rod d^6 , Figs. 5 and 5^a, the crank d^7 , Fig. 5, the crank-shaft D³, and the beveled wheels d^8 d^9 , Fig. 3^a. Hence when the clutch F is so shifted as to disconnect the lower cam-cylinder B³ from the cam-gear shaft E, and the clutch F' is so shifted as to connect the counter-shaft D² with the beveled wheel d' , the upper cam-cylinder B' and its cam are caused to reciprocate by the revolution of the second driving-shaft D', the motion then being transmitted to the upper cam-cylinder B' through the intervention of the cog-wheel B⁶ and driving-wheel E', the cam-gear shaft E, the beveled wheels $d d'$, the counter-shaft D², and the reciprocating gearing before described. The clutch F' may be shifted by means of the clutch-lever J.

During reciprocating work with the gang of fashioning-needles they, or some of them, are raised successively from their operating positions (with their nibs within the range of movement of the cam B) for the purpose of narrowing the work and are restored successively to their operating positions when the work is to be widened. The raising of the fashioning-needles is effected as described in my previous Patent No. 408,181, by means of a picker K, Figs. 24, 25, 26, and 27, Sheet 18, one of which is employed for each side of the gang of fashioning-needles. Each picker is provided with two lugs $k^2 k^3$, Figs. 24, 25, 26, and 27, the one k^2 for pushing the needles one at a time out of their operating positions and the other lug k^3 for moving the needles back to those positions. These lugs operate upon the feet b^2 , Fig. 31, of the fashioning-needles. Each picker also is carried by a picker-carrier L, Figs. 2, 3, 3^a, 8, 23, 24, 25, 26, and 27, in which it is fitted to slide up and down, and which is moved partially around the knitting-cylinder progressively from each side of the gang of fashioning-needles toward the middle

thereof during the narrowing work and is moved in the opposite direction during the widening of the work, so that in each case the picker may act upon the shank or slide of the proper needle which is to be put out of operation and brought into operation. When the needles are moved out of their operating positions, they are supported (as in the machine of my said previous Patent No. 408,181) by a needle-holder *m*, Figs. 2, 8, 24, 25, 26, and 27, which is connected with the picker-carrier *L* of each picker, and is a ring-segment fitted with a spring *m*³, as described in said previous patent.

The said picker, picker-carrier, and needle-holder for each side of the gang of fashioning-needles is operated in substantially the same manner as the same devices are operated in the machine described in my said previous Patent No. 408,181; but I have devised various improvements in the mechanism, which are embodied in the machine represented in the accompanying drawings. Thus, in the machine of my said previous Patent No. 408,181 the picker-carriers were constructed of one piece of material and were fitted to move around the knitting-cylinder in flat-bottomed concentric grooves. With this construction of grooves and picker-carriers the latter become loose in their grooves by wear. In order to obviate this loosening of the picker-carrier it is constructed sectional, as represented in Figs. 23, 24, 25, and 2, it being constructed of two sections *a a'*, which overlap each other and are connected by screws *a*² *a*², the bodies of which are passed through upright slots in the lower section and are screwed into the overlapping upper section so that the two sections shall move concentrically together. Adjusting-screws *a*³ *a*³ also are provided, which, as represented at Fig. 28, are screwed into sockets in one section *a'* and have their heads bearing against a collar of the other section *a*; hence the two sections operate as one piece of material to move the picker, but may be adjusted to take up the wear of their edges in the concentric grooves by turning the adjusting-screws *a*³ *a*³.

The concentric bearings *k* in which each picker-carrier moves and the upper and lower edges of each picker-carrier are of V-section, so that when the play produced by wear is taken up by the adjustment of the sectional picker-carrier radial movement of the latter relatively to the needle-cylinder is prevented. If preferred, the bearings may have concentric V-formed ribs, and the upper and lower edges of the picker-carrier may be V-grooves to slide upon these ribs.

In the form of machine described in my previous Patent No. 408,181 the pickers are operated by means of a picker-cam, which is fitted to turn on the knitting or needle cylinder. This is a costly construction and requires the arrangement of the picker-cam at a part of the machine which is difficult of access for oiling and repairs. My improve-

ment upon that construction consists in operating the picker by means of a cam which is independent of the knitting-cylinder so that it may be arranged at a part of the machine where it is readily accessible for oiling, adjustment, and repairs. The mode in which I prefer to arrange this independent picker-cam and its connections with the picker is represented more particularly in Figs. 2, 3, 3^a, 7, 7^a, and 10. A separate cam *K'* and *K'* is employed for each picker. These picker-cams are secured to a picker-cam shaft *K*², which is connected with the supplementary or second driving-shaft *D'* by means of the beveled wheels *d*¹⁰ *d*¹¹ *d*⁸ *d*⁹, so that when the said second driving-shaft *D'* is operated the picker-cam shaft and its picker-cams will be continuously revolved. Each of the picker-cams operates upon its respective picker through the intervention of a cam-lever *K*³, (more particularly represented at Fig. 10, Sheet 5,) a rod *K*⁴, and a picker-driver *K*⁵, which last has the form of a grooved segment, that is constructed to slide up and down upon the exterior of the knitting-cylinder and is connected with the picker through the intervention of a lug or pin *k*⁴, Figs. 3, 24, and 25, projecting inward from the picker *K* into the groove of the picker-driver *K*⁵, the extent of the groove of the picker-driver circumferentially of the knitting-cylinder being sufficient to receive the lug *k*⁴ of the picker in whatever position the picker may be moved by the movement of the picker-carrier.

The picker-driver *K*⁵ is preferably connected with the cam-lever *K*³ through the intervention of a rod *K*⁴, Fig. 10, which is made of sections united by a screw-threaded connection *k*⁵ so that the length of the rod may be adjusted, and a jam-nut *k*⁶ is provided to make the sections of the rod rigid when the proper adjustment is effected.

The cam-lever is provided with two projections *k*⁷ *k*⁸, and the picker-cam has two grades, one of which, acting on the projection *k*⁷ of the cam-lever, operates for the purpose of raising the picker, and the other grade operates upon the projection *k*⁸ of the cam-lever when the picker is to be moved downward. One *k*⁸ of these projections also is preferably made adjustable upon the cam-lever, so that the play produced by wear can be taken up. The means of adjustment which I prefer for this purpose is to construct the adjustable projection with a screw-threaded shank *k*⁹, Fig. 10, which is screwed into a corresponding socket in the cam-lever.

As the picker-slide is liable to become loose by wear in the groove of the picker-carrier in which it moves, the body of the picker *K* and the groove in the picker-carrier are constructed of dovetailed cross-section, as shown in Fig. 27, and set-screws *k*¹⁰, Figs. 23 and 27, are provided to bear against the back of the picker and hold it snug in the groove in which it slides.

The movement of the picker-carrier cir-

cumferentially of the knitting-cylinder is effected in the machine represented in the drawings, as it is in the machine described in my said previous Patent No. 408,181, by combining each picker-carrier with the supplementary driving-shaft D' for reciprocating work through the intervention of continuous or inseparable combining mechanism, which imparts a positive and intermittent motion to the picker-carrier at proper intervals without ever letting go of the picker-carrier and permitting it to overmove by momentum or to be accidentally misplaced, and this inseparable combining mechanism embodies, preferably, a worm-segment l , Figs. 23 to 27, and Fig. 8, upon the picker-carrier L, a screw l' , and two cams for each screw. These cams are constructed in the form of cam-collars l^5 l^5 , Figs. 8, 8^a, and 1^a, which operate upon lugs l^7 l^7 , that are secured to the screw-shaft l^2 and bear against the cam-collars so that these lugs move along the inclined faces of the cam-collars during the turning of the screw, and as the cam-collars are stationary the screw-shaft and screw are caused to move endwise, and during each period in which the carrier should be moved it is moved by the conjoint turning of the screw and its endwise movement by the appropriate cam-collar, while during the interval in which the carrier should remain at rest the endwise movement of the screw by the operation of the appropriate cam upon the lug of the screw-shaft counteracts the screwing movement.

In the machine described in my said previous Patent No. 408,181, the cam-collars, as constructed in practice, were formed upon a sleeve which passed through one of the bearings of the screw-shaft, which arrangement subjected the sleeve to wear and made it difficult of adjustment. In the machine represented in the drawings I have embodied an improvement, which consists in arranging the sleeve of the cam-collars independently of the bearings l^6 of the screw-shaft and preferably between them. The said cam-sleeve is constructed with a shank l^8 , Figs. 1^a and 8, which is secured to a bracket l^9 of the frame by means of a screw l^{10} , which passes through a slot in the said bracket so that the said cam-sleeve may be adjusted longitudinally of the screw-shaft for the purpose of adjusting the position of the screw, and consequently that of the picker-carrier. The adjustment of the cam-sleeve of the cam-collars is conveniently effected by means of two adjusting-screws l^{11} , each of which is screwed through the stock of one of the bearings of the screw-shaft with the head of the screw bearing against the shank of the sleeve of the cam-collars so that any desirable adjustment of the sleeve may be effected by slackening one screw and tightening the other.

In order that the play occasioned by wear of the surfaces of the cam-collars l^5 and the lugs l^7 may be taken up, one of the said lugs is an adjustable lug. For this purpose the

lug is preferably secured to the screw-shaft by a screw l^{12} , Fig. 8^a, Sheet 15, which passes through a slot in the said lug, and the rear end of the lug is fitted to abut against the conical head of an adjusting-screw l^{13} , as represented in section at Fig. 8^a. Consequently the turning of the adjusting-screw so as to screw it more deeply into the screw-shaft brings a larger diameter of the conical screw-head in bearing against the butt of the lug and forces the lug endwise against the cam-collar. When an adjustment is to be made by turning the said adjusting-screw, the screw l^{12} , which secures the lug to the screw-shaft, should be slackened before the adjustment is made and should be tightened after the adjustment is completed.

The movement of the picker-carriers in opposite directions for the successive widening and narrowing of the work is effected substantially as in the machine described in my previous Patent No. 408,181, by combining the picker-carriers with change-wheels, through the intervention of which, motion is imparted to the picker-screws l' l' from the driving-shaft D'. In the machine described in my said previous patent these change-wheels were horizontal and were fitted to revolve upon a downward extension of the knitting-cylinder. In the machine represented in the drawings of this patent I have arranged these change-wheels l^{14} l^{15} , Figs. 7^a, 4^a, 5, 6, and 29, with their connecting-segments l^{16} l^{16} (one of which is represented in dotted lines in Fig. 7^a) upon a shaft l^{17} so that they are supported independently of the knitting-cylinder or of an extension thereof, and are more readily accessible. Motion is imparted from these change-wheels to the screw-shafts l^2 l^2 of the picker-carriers L through the intervention of the cog-wheel l^{18} , connected with one of said change-wheels, a pinion l^{19} , constructed to revolve upon a stud of the frame, a second pinion l^{20} , secured to the shaft of the screw-driving wheel l^4 , which is common to both screws, and the screw-pinions l^3 l^3 , which are secured to the screw-shafts l^2 l^2 . On the other hand, motion is imparted to the change-wheels, so as to cause them to turn in alternately opposite directions by means of the shifting-pinion l^{21} , Fig. 29, Sheet 11, and Fig. 7^a, Sheet 14, which is fitted to turn upon a stud l^{22} , that is movable, and is connected with the crank-shaft D³ through the intervention of the wheel l^{23} , secured to the hub of the shifting-pinion l^{21} , the intermediate wheel l^{24} , fitted to turn upon a stud secured to the frame, a second intermediate wheel l^{25} , and the two beveled wheels l^{26} l^{27} . The second intermediate wheel l^{25} and one l^{26} of the two beveled wheels are secured to each other and are fitted to turn upon a stud l^{28} , projecting downward from the frame of the machine.

In order that the shifting-pinion l^{21} may be permitted to shift from one change-wheel to the other, the stud l^{22} , upon which that pinion and the wheel l^{23} (secured to it) turn, is

movable, it being held by an arm L^2 , which is fitted to swing upon the axis of the intermediate wheel l^{24} as a center of motion, so that the said pinion l^{21} may be shifted from one change-wheel to the other without affecting the engagement of the teeth of the wheel l^{23} with the intermediate wheel or pinion l^{24} , through which motion is transmitted to said shifting-pinion. The said shifting-pinion also is provided with a stud or roller l^{29} , and a rail L^3 , upon which this roller bears, is secured between the two change-wheels l^{14} l^{15} to the hub L^4 , by means of which their cog-rims are connected with their shaft l^{17} . Two segments l^{16} (described in my said previous Patent No. 408,181) also are secured between the change-wheels l^{14} l^{15} with the teeth of the segments corresponding with those of the wheels. Consequently the driving or shifting pinion l^{21} , the two change wheels l^{14} l^{15} , the segments, and the rail operate as described in my previous Patent No. 408,181, to which reference may be had. In the machine described in my said patent the change-wheels l^{14} l^{15} turn in horizontal planes, one change-wheel being above the other, and the shifting or driving pinion was necessarily arranged to move up and down when shifting from one change wheel to the other. Consequently the weight of the shifting-pinion of the wheel secured to it and of the swinging arm with which the shifting-pinion was connected tended to retard the revolution of the shifting-pinion when the latter rose from one change-wheel to the other and tended to accelerate the movement of the shifting-pinion when it moved downward from one change-wheel to the other. In order to obviate this tendency I have arranged the change-wheels upon the horizontal shaft l^{17} so that they turn in vertical planes, and have arranged the swinging arm of the shifting or driving pinion to swing in a horizontal plane so that the tendency of the weight of the shifting devices to accelerate and retard movement is neutralized. The tendency of the shifting or driving pinion l^{21} and its swinging arm L^2 to sag downward and engage the shifting or driving pinion too deeply with the teeth of the change-wheels and segments may be prevented by supporting a projecting end of the swinging arm L^2 in a stirrup L^5 , Fig. 7^a, depending from the table-plate of the machine.

It is desirable that the connecting-gearing intervening between the driving or shifting pinion l^{21} and the crank-shaft D^3 should have a capacity for adjustment so that the shifting-pinion may be readily set to act properly upon the change-wheels. In a connection by toothed gearing or cog-wheels there is always a capacity for a coarse adjustment, from the fact that one of the intermediate cog-wheels may be moved sidewise out of gear with the next cog-wheel, may be turned the extent of one tooth, and may then be moved again into gear; but the capacity of adjustment so obtained is limited to the considerable angular

movement attained by shifting one of the cog or gear wheels the entire space between the centers of two consecutive teeth, which space is generally called the "pitch" of the cog-teeth. In order that an adjustment less than this angular extent may be made, I connect one of the intervening gear-wheels l^{25} with the gear-wheel l^{26} , to which it is secured by means of a pin l^{30} , Figs. 11 and 12, Sheet 6, and I provide a series of pin-holes l^{31} , Fig. 11, in any one of which the pin l^{30} may be engaged, the distances between the pin-holes of the said series being progressively smaller so that when the pin is shifted from one hole to the other a differential angular movement of one wheel relatively to the other corresponding with only a fraction of the angular movement produced by the shifting of the teeth of the wheel is attained. In practice I find that it is sufficient that this differential adjustment need not be smaller than one corresponding with one-third of the pitch of the cog-teeth, and therefore find that four pin-holes for the differential adjusting-pin l^{30} are sufficient. I find it expedient to use a screw l^{32} , for which corresponding screw-holes l^{33} are provided, to secure the wheels to each other in connection with the differential adjusting-pin, or the differential adjusting-pin itself may be screwed so as to constitute both adjusting-pin and screw.

In order that the knitting-cam B for reciprocating work may be operated without widening or narrowing the fabric the shifting-pinion l^{21} of the change-wheels is connected with the crank-shaft D^3 through the intervention of a clutch. I prefer to arrange this clutch as represented at L^6 , Fig. 17, Sheet 9, between the beveled wheel l^{27} and the crank-shaft D^3 so that when the clutch is shifted to disconnect the said wheel l^{27} from the crank-shaft D^3 the change-wheels and picker-carriers remain at rest, while the cam B for reciprocating knitting may continue to be operated by the revolution of the driving-shaft D' . The pickers will remain in the position to which they have been carried by the carriers, and, though reciprocated by their operating mechanism, will have no effect so far as the operation of the machine is concerned. This improvement permits one or more rows of straight work, consisting of stitches of uniform number, to be knitted between two rows of widened or narrowed work. It also permits one or more rows of straight work to be knitted between the circular work and the widened or narrow work, and thus materially increases the capacity of the machine. The clutch L^6 —which must be of a construction to permit the operative engagement of the parts at one point in the revolution of the shaft only (in this instance the clutch consists of the ordinary grooved hub h^{40} , splined to the shaft, provided on its end adjacent to the bevel-wheel l^{27} with a single projection or lug l^a , which, when the clutch is in position to cause the movement of said wheel and its

connected parts, engages a lug or pin l^x on the said wheel)—may be conveniently operated by the clutch-lever L^7 , whose hub is fitted to a stud projecting from the frame of the machine, and the clutch-lever is held in either position in which it may be placed by means of a spring-holder L^8 , Fig. 1^a.

In order that the opening of the latches of the latch-needles may be insured in case they are accidentally thrown up, and also to save the trouble of throwing down the latches by hand after the work has been taken from the needles, I have combined a device which I term a "scalper" M , Figs. 1, 2^b, 2, and 3, with the upper cam-cylinder. This scalper has the form in transverse section as represented at Fig. 2, with a depending edge m^3 , which is sloped upward and outward at the two ends of the scalper so that it will readily enter between the hooks of the needles and the ends of the latches, which bear against these hooks when the latches are up or closed. This scalper, being combined with the cam-cylinder B' for reciprocating work, is traversed past the thread-guide when the latter is stopped during reciprocating work at the end of each reciprocation, and on the return motion of the scalper by the cam-cylinder the former takes its position with its leading end slightly in advance of the thread-guide.

As some of the latches of the needles may be accidentally thrown outward upon the ring-guard B^8 , Figs. 1, 1^a, 2, and 2^b, which surrounds the upper end of the nosing of the cam-cylinder, and as it is important that such latches should pass beneath the edge of the scalper M , the latter is combined at each end with a spring-gate m' , Figs. 1 and 1^a, which constitutes part of the ring-guard B^8 ; but, by being elastic, yields to the pressure of a needle-latch passing between it and the leading end of the scalper M and permits the latch to pass beneath the said scalper and be thrown down by it.

In the machine described in my said previous Patent No. 408,111 two thread-guides were used alternately, one of the two being used for circular work only and the other one being used for reciprocating work only. In the machine represented in the present drawings there is an improved combination of the thread-guide with other members, which enables the same thread-guide to be used for both circular work and reciprocating work, thereby dispensing with one thread-guide and obviating the necessity of shifting the thread-guides and saving the loss of time incident to that operation. The thread-guide G' , Figs. 1^a, 2, 5, and 5^a, is connected to or constructed with a journal, which is supported in a bearing g by a bracket-arm G^2 above the needle-cylinder A , the said journal being concentric with the knitting-cylinder, and the upper knitting cam-cylinder B' for reciprocating work is provided with two movable drivers G^3 , Figs. 2^b and 3, each of which when protruded from the exterior surface of an upward extension

of the upper cam-cylinder is adapted to move the thread-guide by making contact with the lower end g' of the stock thereof. The two drivers G^3 are secured to a driver-stock G^4 , Figs. 2 and 2^b, which is constructed to oscillate upon pivots b^x b^x , that connect it with the upper cam-cylinder B' , and a spring g^2 , Figs. 2 and 2^b, is provided to operate upon the said driver-stock G^4 and protrude the drivers from the upper cam-cylinder. When the machine is being operated for circular work, both drivers are permitted to protrude, and the leading driver bearing against the stock of the thread-guide carries it around with the cam-cylinder B' in advance of the cam B so that the needles are properly supplied with yarn before the knitting-cam moves them downward.

In order that the same thread-guide may operate for reciprocating work, two thread-guide stops G^6 are provided to limit the extent of movement of the thread-guide in the two directions in which it is moved, and two bumpers G^5 are provided to force the drivers G^3 inward and disengage the driver which is operating upon the stock or arm of the thread-guide.

In order that the bumpers G^5 G^5 may operate upon the drivers, a cam G^7 with inclined ends is secured to the outer side of the driver-stock, so that the leading end of this cam, meeting with the bumper, is forced inward relatively to the knitting-cylinder, together with the driver-stock and drivers, to which the cam G^7 is secured, thereby disengaging the driver from the thread-guide and permitting the latter to be stopped by that one of the stops G^6 which is adjacent to the respective bumper G^5 or G^5 . The stops G^6 and the bumpers G^5 are made movable by connecting them with their supports G^8 by pivots, so that they may be moved respectively out of the range of movement of the thread-guide and its driver-cam G^7 when the thread-guide is to be continuously revolved for circular work. Each stop G^6 is held in its proper position for reciprocating work by means of a spring g^4 , Figs. 1, 1^a, 5, 5^a, and 19, which acts upon the pivotal stock of the stop and tends to force the stop against the surface of the upper cam-cylinder B' , and each bumper is held in its proper position for reciprocating work by a spring g^3 , appropriated to it and bearing upon its pivotal stock, which is provided at that side with a cam or inclined surface g^x , adapted to be engaged by the said spring, as shown in dotted lines in Fig. 19.

In order that the stops and the bumpers may be quickly removed from their positions for reciprocating work, a stop-mover is provided. This stop-mover has, preferably, the form of an arm F^4 , which is connected with a rock-shaft, so that it may be readily moved toward and from the needle-cylinder, and the pivotal stocks g^5 of the thread-guide stops G^6 are extended within reach of the said arm or stop-mover, so that when it is moved toward the needle-cylinder it bears against the ex-

tensions of the said pivotal stocks and removes the thread-guide stops from the range of motion of the stock or arm of the thread-guide.

5 In order that the bumpers G^5 may be simultaneously withdrawn, the pivotal stock g^6 of each bumper is extended outward and the stock of the adjacent thread-guide stop G^6 is fitted with a pin g^7 , Figs. 3, 3^a, and 19, to bear
10 against the inwardly-curved side of the bumper-stock; hence when the stop-mover F^4 is moved toward the knitting-cylinder both stops G^6 and both bumpers G^5 are simultaneously moved out of operative position, the pins g^7
15 acting upon the curved sides of the bumper-stocks to move the same in the required direction, and the thread-guide is permitted to travel with the cam-cylinder for circular work; and, on the other hand, when the stop-mover
20 F^4 is moved from the cam-cylinder the thread-guide stops G^6 and the bumpers G^5 are moved to their positions for reciprocating work by the springs before described.

When reciprocating knitting is being knit-
25 ted, it is sometimes expedient that the yarn should be drawn tighter upon the needles which stand at the end of the gang that are at work. In order that this may be readily effected with the machine represented in the
30 drawings, provision is made for putting additional tension upon the yarn before the last few loops of the row of stitches are formed, and thereby tightening the selvage of the work. For this purpose the thread-guide G'
35 is provided with an intermittent selvage-tension, consisting, preferably, of nipper-jaws h h' , Figs. 2 and 3^a, one h of which is preferably fast to the arm of the thread-guide, while the other jaw h' is connected with the thread-
40 guide by a pivotal arm h^2 . A spring h^3 is provided to press the pivotal jaw toward the fixed jaw, and thereby make a tension upon the yarn which is passing through this tension device to the eye of the thread-guide.

45 In order that the selvage-tension (consisting in this instance of nipper-jaws) may be intermittent in its operation to operate upon the yarn during the knitting of the selvages and to relieve the yarn while it is fed to the
50 needles of the gang at work which are between the selvage-needles, closing-cams H H , Figs. 1, 1^a, and 19, are provided to operate the closing of the nipper-jaws when the yarn is being fed to the selvage-needles of the gang,
55 and opening-cams H' H' are provided to open the nipper-jaws and relieve the tension of the yarn when the yarn is being fed to the intermediate needles of the gang. These cams operate upon the nipper-jaws through the in-
60 tervention of the tension-lever H^2 , Figs. 2 and 3, whose lower arm h^4 is carried within the range of said cams, and whose upper arm operates upon an extension of the pivotal nipper-arm h^2 . This nipper-arm is constructed
65 with a locking projection h^5 , Fig. 2, which holds the tension-lever H^2 in whichever position it may be placed by either a closing-cam

or an opening-cam, and thus secures the holding of the nipper-jaws closed and open the
70 required periods for knitting the selvages and the intermediate stitches of the row. The closing-cams H are so arranged that when the thread-guide approaches the end of its recip-
75 rocation in either direction the respective closing-cam, acting upon an inward projection h^6 , Fig. 2, of the lower arm of the tension-lever H^2 , carried against that cam by the
80 movement of the thread-guide, compels the movement of the upper arm of the tension-lever inward under the nipper-arm h^2 , thereby releasing the movable nipper-jaw of the in-
85 termittent selvage-tension and permitting it to bear upon the yarn with the force of its spring h^3 . The opening-cams H' also are so set that when the movement of the thread-
90 guide is reversed the respective opening-cam, acting upon the lower arm of the tension-lever, carried past it by the movement of the thread-guide, compels the upper arm of the
95 tension-lever to move outward under the nipper-arm h^2 , thereby opening the movable nipper-jaw of the intermittent selvage-tension and relieving the tension upon the yarn. The locking projection h^5 of the nipper-arm holds the tension-lever H^2 in whichever position it
100 may be moved to by one of the cams until the next succeeding cam operates upon it.

The closing-cams H H being within the range of movement of the tension-lever H^2 , carried by the thread-guide, must be removed
105 when the thread-guide is to be used for circular work. For this purpose these cams are made movable by connecting them with the stocks of the thread-guide stops G^6 , which connection is attended with the double advantage of making the cams movable and caus-
110 ing them to be moved whenever the said stops are moved. As the tension-nippers remain open during circular work, the opening-cams H' are secured to suitable projections from the supports G^8 of the stops G^5 .

As the intermittent selvage-tension above described might operate too violently upon the yarn, it is expedient to interpose between
115 it and the delivery-eye of the thread-guide G' a spring thread-arm Q , through the eye in the outer end of which the yarn is passed between the intermittent selvage-tension and the delivery-eye of the thread-guide. The
120 strength of the spring of this thread-arm determines the tension on the yarn when it is nipped. The spring-arm also operates as a take-up, giving out and taking up any slack of the yarn that may be required in the knit-
125 ting of the selvage during reciprocating work.

In order that the thread-guide G' while reciprocating may have its extent of movement varied in substantial accordance with the
130 greater or less number of fashioning-needles at work, the thread-guide stops and bumpers and the selvage-tension are combined with the pickers and picker-carriers, by which the fashioning-needles are removed from and re-
stored to the gang at work. The mode in

which I prefer to make this combination is as follows: The supports G^8 , previously mentioned, with which the stops G^6 and bumpers G^5 and selvage-tension cams H are connected, are movable carriers, which are fitted at their inner sides with slides g^{10} , Figs. 3 and 3^a, which slide in a ring dovetailed groove g^{11} , Figs. 2, 3, 3^a, 5, and 5^a, in the upper ring-division of the frame of the machine. This ring-groove g^{11} is concentric with the knitting-cylinder A and with the journal of the thread-guide G' , so that the thread-guide stops, bumpers, and selvage-tension cams maintain their proper relationship to the knitting-cam B and its cylinder B' and thread-guide G' in whatever position the carriers G^8 of the bumpers, stops, and cams may be moved in the operation of the machine. Each of the said carriers G^8 is connected by a post-bracket G^9 with the picker-carrier L at the same side of the machine, so that whenever a picker-carrier is moved, as before described, to set the picker to remove a needle from the gang at work or to replace a needle the corresponding carrier G^8 of the thread-guide stops G^6 and bumpers G^5 is correspondingly moved to vary the travel of the thread-guide G' . The cams H of the selvage-tension being connected with the same carriers G^8 are also correspondingly moved.

In order that the slides g^{10} may be readily inserted in the ring-groove g^{11} , the upper rim of the latter is cut away at the back of the machine to form a gate g^{12} , Figs. 1, 1^a, 5, and 5^a, for the insertion of the slides.

After the narrowing of the work has been completed there will be, as usual, on each of the needles thrown out of operation not only its proper stitch, but an additional thread drawn against the outer side of the same, so that on its again taking the thread to form a new stitch there is double the usual amount to be cast off—namely, the stitch and thread. When widening has been commenced, it is therefore desirable that the work being knit should be pulled downward to insure the casting off of the two threads. In order that the pulling down of the work may be effected automatically, I have provided the pull-hook C^4 , Fig. 21, Sheet 17, and Fig. 8, Sheet 14, which is raised when the change is made from reciprocating work to circular work, and is then held automatically above the work.

When the machine is changed back from circular work to reciprocating work, the hook is permitted to strike outward toward the work and is held in that outward and raised position, and when the narrowing is completed the hook is permitted to descend and engage in the work and pull it downward. For these purposes the hook C^4 is connected with the rod C^5 or hook-stock, which is fitted to slide vertically in a hook-guide C^6 , whose upper portion is a slotted tube and is supported within the knitting-cylinder, and the lower end of the said hook-stock has a weight C^7 applied to it of the required size to make the desired downward pull upon the work. The

hook is pivoted, as at c^4 , Figs. 21 and 2, to the hook-stock C^5 , so that the hook may be withdrawn from the inner wall of the knitting-cylinder toward the axis thereof and that the hook point may be free of the knitted work, and that the hook-point may also be permitted to strike outward to engage with the knitted work. The hook-stock is fitted with a pin c^6 , by which it and the hook may be raised, and a raising-lever C^9 , Figs. 21, 22, 4, 6, and 6^a, is provided to act upon this pin and raise the hook. The outer arm of this raising-lever C^9 is combined (by a rod c^7) with an arm j , Fig. 33, protruding from the clutch-lever J , so that when the clutch-lever is operated to shift the clutch F' for the change from reciprocating work to circular work the hook and its hook-stock and weight are raised.

A hook-holder C^{10} , Figs. 22, 2^a, 4, and 6, operating as hereinafter described, is provided to hold the hook when slightly below its highest position, this holder being pivoted to the guide C^6 of the hook-stock. When the hook is raised to its highest position the heel c^8 , Figs. 21 and 2, of the shank of the hook comes in contact with the hook-stop c^9 , projecting from the guide C^6 of the hook-stop, so that the hook is prevented from striking outward when in its highest position. The hook is held in its highest position by the clutch-lever J , which is then held by the engagement of a projecting pin with one of the shoulders j' , Fig. 33, of a spring-holder J^2 , which holds the clutch-lever while the clutch is in the proper position for circular work. When this clutch-lever is shifted to make the change of the clutch from circular work to reciprocating work, it releases the hook C^4 and permits it to descend; but when the hook is thus permitted to descend the first short portion of the descent relaxes the strain of the hook-heel c^8 against the hook-stop c^9 , so that the hook may turn on the pivotal connection of the hook-shank with the hook-stock C^5 sufficiently to strike outward over the work, and this outward striking is insured by the action of the spring c^{10} , Figs. 21, 22, 2, and 2^a, which is connected with the lower end of the hook-shank, while the distance to which the hook-point is moved outward is limited by the contact of the toe c^{11} , Fig. 21, of the hook-shank with the head of the hook-stock C^5 .

When the hook has attained the short portion of the descent required to cause its point to strike outward, the further descent of the hook is stopped by the hook-holder C^{10} , which is pivoted to the guide of the hook-stock and engages beneath a pin c^{12} , Figs. 22 and 2^a, which projects from the hook-stock. The hook then remains at rest while the machine is narrowing the work. In order that this movable hook-holder C^{10} may be disengaged automatically when the widening of the work is commenced, the hook-holder is combined with the picker-carrier. The mode in which I prefer to make this combination is through the intervention of one of the change-wheels, which

determines the extent of movement of the picker-carriers, and for this purpose one of the change-wheels l^{15} is fitted with an arm C^{11} , Fig. 6, which, when the widening of the work is to be commenced, is engaged with an arm C^{12} secured to and projecting from the hook-holder C^{10} , and moves it so as to release the hook-stock C^5 and its hook C^4 and permit the hook to act upon the knitted work.

In order that the hook-holder C^{10} may be held in its engaged position with the pin of the hook-stock C^5 , the former is connected with a spring C^{13} , and I prefer to connect this spring with the pivotal hook-holder C^{10} , as represented in Fig. 22, so that the spring shall be extended or strained less when the hook-holder is in either of its extreme positions than when the hook-holder is turning from one extreme position to the other, and consequently that the holder-spring will hold the hook-holder in each of the extreme positions in which it may be placed and will complete the disengaging movement of the hook-holder when that movement is commenced by the action of the disengaging-arm C^{11} of the change-wheel l^{15} upon the arm C^{12} of the hook-holder C^{10} .

The machine represented in the drawings is provided with belt-shippers $P P'$ for shifting the respective driving-belts from the loose pulleys $d^{10} d^{12}$ to the fast pulleys $d^{11} d^{13}$ of the respective driving-shafts $D D'$, and these belt-shippers are operated (substantially as described in my previous Patent No. 408,180) by means of shipper-rods $p p'$, which are fitted with hook-nibs $r r'$, that may be engaged by the shipper-lever R . The shipper-rods $p p'$ are permitted to have a limited amount of movement upward and downward crosswise of their length, so that they with their hook-nibs constitute movable hooks as well as shipper-rods, and may be moved within the range of motion of the shipper-lever R or out of that range of motion, as required, to enable one or the other of the belt-shippers to be operated separately by the shipper-lever, substantially as described in my said previous patent.

In order that each of the belt-shippers may be operated separately from the other, a shifting-pin s^4 is provided to move one of the hook-nibs $r r'$ within the range of the end of the shipper-lever simultaneously with the movement of the other hook-nib out of that range, and a shifting-rod S is provided to move the shifting-pin s^4 , substantially as described in my previous Patent No. 408,180. The ends of the shifting-pin s^4 work in inclined slots in the bodies of the hooks formed by the shipper-rods $p p'$, substantially as described in my said previous patents. By this construction I am enabled to dispense with the hooks pivoted to the shipper-rods. When each belt-shipper is moved to the position for guiding its belt upon its respective fast pulley, it is held there by means of a latch p^4 and p^5 , Figs. 2^a, 4, and 7. These latches engage with supplementary hook-nibs $s s'$, with which the

shipper-rods are fitted, and the latches are within the control of the shipper-lever R , substantially as described in my said previous patents, and operate in substantially the same manner, springs $p^2 p^3$ being provided to move the shipper-rods $p p'$ and belt-shippers, and thereby transfer their respective belts from their respective fast pulleys to their respective loose pulleys.

In order that the transfer of the belt of the driving-shaft D' for reciprocating work may be effected automatically when the reciprocating work is completed, the change-wheels $l^{14} l^{15}$ are combined with the latch p^4 for the belt-shipper for reciprocating work through the intervention of a stop u , Figs. 4^a and 6, which effects the disengagement of the latch when the required extent of reciprocating work has been completed. For this purpose the stop u is secured to a hub u' on the shaft l^{17} of the change-wheels, so that the said stop is moved with them. This stop operates upon an arm P^2 , which is secured to a rock-shaft P^3 , having a second arm P^4 , which is connected with an arm P^6 of the latch p^4 by means of a rod P^5 . When therefore the stop u comes in contact with the arm P^2 , the latter is rocked and the latch p^4 is raised to release the sliding rod or shipper-rod p' .

In order that the required extent of circular work may be readily determined without counting the rows of stitches, the driving-shaft D for circular work is combined with a counting device of substantially the same construction as that described and represented in my said Patent No. 408,180. The count-wheel U , Figs. 3 and 7, of this device is provided with an index-pin t , and the latch p^5 for the belt-shipper for circular work is fitted with an arm t^2 , which is within the range of motion of this index-pin. Consequently when the index-pin is forced against the latch-arm t^2 by the movement of the count-wheel the latch p^5 is raised, the shipper-rod p is released by the latch, and the belt-shipper P is moved by the appropriate spring p^2 to shift the driving-belt from the fast pulley of the driving-shaft D for circular work to the loose pulley thereof, thus stopping the machine. The index-pin t is set in the proper hole of the count-wheel U to operate upon the latch p^5 when the requisite number of rows of stitches of circular work have been completed, and, if desired, the count-wheel may have two index-pins t applied to it to act successively upon the latch to determine the extent of the circular knitting effected before widening and narrowing and afterward.

For convenience in setting the count-wheel so that the index-pin shall be at the proper distance from the latch-arm when circular knitting is commenced, the shaft of the index-wheel is provided with a hand U' , and a zero mark or pin t^3 is applied to the frame of the machine to indicate to the attendant the proper position of the said hand.

In a machine such as that hereinbefore de-

scribed, which is adapted to knit in different modes by a change in the conditions of the members which operate upon the work, and in which various parts of the machine have to be connected in different ways at different times while the work is being knitted, it is expedient that the changes of the machine required to change from circular work to reciprocating work and back again should be effected in the shortest possible time and with the least manipulation on the part of the attendant of the machine. In order that this may be effected, I have combined those parts of the machine which have to be shifted with a single change device, which is preferably the clutch-lever J, controlling the clutch F', that connects and disconnects the cam-gear shaft E with and from the driving-shaft D for circular work, so that by the movement of this change-lever alone the various parts of the machine which have to be moved in making the change may be simultaneously shifted. Thus the shifting-pin s^4 is combined with the said change-lever through the intervention of the rod S, (which carries the shifting-pin s^4), the lever S', the rod S², the bell-crank S³, and the rod S⁴. The stop-mover F⁴, also, which operates upon the stops G⁶ and bumpers G⁵, that determine the operation of the thread-guide for reciprocating work, is combined with the said clutch or change-lever J through the intervention of the rock-shaft F⁵ of the said stop-mover, the slotted arm F⁶ of the said rock-shaft, and a pin F⁷, projecting from the said clutch-lever or change-lever J. The slotted arm F⁶ of the stop-mover rock-shaft F⁵ is curved in such manner that the forward movement in the slot of the pin F⁷ by the clutch-lever J forces the slotted arm F⁶ to move the stop-mover F⁴ to change the positions of the stops and bumpers of the thread-guide from the positions required in reciprocating work to those required for circular work, while the backward movement in the slotted arm of the said pin F⁷ by the change-lever J withdraws the stop-mover F⁴ from the stocks of the stops G⁶ and permits the stops and bumpers to be restored to their positions for reciprocating work.

The circular-knitting cam clutch F, which connects and disconnects the driving gear-wheel E² (that transmits motion to the cam-cylinder of the circular-knitting cam B², which is operated for circular work only and remains at rest during reciprocating work) with and from the cam-gear shaft E, is operated by an arm F⁸, Fig. 2, projecting from the stop-mover rock-shaft F⁵, so that this clutch also is combined with the change-lever J through the intervention of the clutch-arm F⁸, the stop-mover rock-shaft F⁵, the slotted arm F⁶ of that rock-shaft, and the pin F⁷, which is carried by the change-lever J. The pull-hook C⁴ also is combined with the said change-lever J, as hereinbefore described; hence when the desired extent of circular work has been com-

pleted, the several parts of the combining mechanism of the machine, whose positions have to be changed to enable the machine to do reciprocating work, may be simultaneously operated for the change by the movement of a single lever, which in this case is the clutch-lever J, constituting the change-lever for that purpose. The movement of the same device also in the reversed direction effects the changes which are necessary when the desired extent of reciprocating work has been completed and the machine is to commence upon circular work.

In order that a change of the machine from circular work to reciprocating work and back again at times when the parts are not in their proper positions for the change may be prevented, I have combined the pickers and their operative mechanism with a guard, which prevents the change from being effected unless the pickers and picker-carriers are in the proper positions to permit the change to be effected without risk of deranging the picker mechanism. I prefer to construct this picker-guard in the form of a notched disk I, Figs. 3^a and 13, and to secure it to the picker cam-shaft K². This guard I operates upon the shifting-pins s^4 of the shipper-rod hooks through the intervention of the lever S', which is fitted with a guard-pin I', adapted to pass through the notch i of the guard I. Consequently the movement of the shifting-pin s^4 , for the purpose of enabling one or other of the shipper-rods p p' to be operated by the shipper-lever R, can be effected only at the time when the guard I is in the position required to permit the guard-pin I' of the lever S' to pass through the notch of the guard, which time is when the one picker is at the upper end of its stroke and the other picker is at the lower end of its stroke, and is before whichever picker-carrier is to be moved begins to move the picker to operate upon the next needle of the gang. The same picker-guard I controls the movement of the change-lever J and of all the other changeable members which are connected with it, as before described, and the picker-guard does this by reason of the fact that the guard-lever S', which carries the guard-pin I', that operates in connection with the guard I, is combined with the change-lever J through the intervention of the rod S², bell-crank S³, and rod S⁴, as previously described.

Provision is made in the machine described in this specification, as it is the machine described in my said Patent No. 408,180, for stopping the reciprocating movement of the cam and cam-cylinder for reciprocating work at a particular time in the operation of the machine. The provision for this purpose is the stop-lever Q', which is pivoted to the frame of the machine, and the stop-cam Q², which is secured to the crank-shaft D³. The stop-lever has an arm q , which may be moved within the range of the tooth of the stop-cam Q², and the tendency of the weight of this arm is to

rock it within range of that cam-tooth. The lower end of the stop-lever Q' is within the range of motion of a pin q' , (dotted in Fig. 4^a), which is secured to the shifting-rod S , controlled by the clutch-lever or change-lever J ; so that while the shifting-pin s^4 and shifting-rod S are in the positions which they occupy during reciprocating work the arm of the stop-lever is held by the action of the pin q' out of the range of the tooth of the stop-cam Q^2 ; but when the shifting-pin s^4 is shifted by the change-lever J the arm of the stop-lever Q' is permitted to drop within range of the tooth of the stop-cam Q^2 and stop the revolution of the crank-shaft D^3 , and consequently of the knitting-cam B and cam-cylinder B' , which are caused to reciprocate through the intervention of the crank-shaft and its crank d^7 .

Those of the gang of needles, Fig. 31, which are not used as fashioning-needles may have their shanks cut off at the line xx of that figure and given the form shown in Fig. 32. The slightly-reduced portions of the needles below the inclined or curved shoulders come opposite the ring needle-holder, and the shoulders 1^* prevent the needles from being raised by accident or otherwise unless the needle-holder is withdrawn for that purpose.

The general operation of the machine is the same as that of the machine described in the specification of my said previous patents, to which reference may be had, and the differences in operation due to the improvements herein described have been described in connection with the description of those improvements.

What I claim, and desire to secure by Letters Patent, is—

1. The combination, substantially as before set forth, of the knitting-cylinder, needles having nibs for the action of a needle-cam and provided with shoulders in addition thereto, and a needle-holder.

2. The combination, substantially as before set forth, of the knitting-cylinder, the sectional needle-holder, and needle-holder cams by which a needle-holder section may be moved crosswise of the knitting-cylinder.

3. The combination, substantially as before set forth, of the knitting-cylinder, the sectional needle-holder, and the cam-ring by which all the sections of the sectional needle-holder may be moved simultaneously from and toward the knitting-cylinder.

4. The combination, substantially as before set forth, of the knitting-cylinder, the sectional needle-holder, the cam-ring, and the holding-spring.

5. The combination, substantially as before set forth, of the cam for circular knitting with the driving-shaft for circular work through the intervention of connecting mechanism included, the disconnectible drivers, and two gear-wheels of unequal diameters.

6. The combination, substantially as before set forth, of the knitting-cylinder, two knit-

ting-cams, the driving gear-wheels for said cams, and the clutch through which motion is transmitted from one of said driving gear-wheels to the other, with the capacity of disengagement.

7. The combination, substantially as before set forth, of the knitting-cylinder, two knitting-cams, two concentric driving gear-wheels, the clutch, the cam-gear shaft, and the tubular bearing for one of said gear-wheels.

8. The sectional picker-carrier constructed, substantially as before set forth, of two sections, which are adjustably secured to each other.

9. The combination, substantially as before set forth, of the knitting-cylinder, the picker-carrier, and concentric V-formed bearings for said carrier surrounding the knitting-cylinder.

10. The combination, substantially as before set forth, of the knitting-cylinder, the picker-carrier, the picker, and the picker-cam arranged upon a shaft independently of the knitting-cylinder, the said cam and picker being operatively connected.

11. The combination, substantially as before set forth, of the picker-carrier, the picker having its body of dovetailed cross-section, and the set-screw by which the picker-body is held in place.

12. The combination, substantially as before set forth, of the picker-carrier, the worm-segment, the screw, and the cam-collars arranged upon a sleeve independently of the bearings of the screw-shaft.

13. The combination, substantially as before set forth, of the picker-carrier, the worm-segment, the screw, cam-collars arranged upon a sleeve independently of the bearings of the screw-shaft, and the adjusting-screws for said sleeve.

14. The combination, substantially as before set forth, of the picker-carrier, the worm-segment, the screw, the cam-collars, and the adjusting-screw by which the bearing of the lug of the screw-shaft against one of said cam-collars may be adjusted.

15. The combination, substantially as before set forth, of the knitting-cylinder, the picker-carrier, and the change-wheels arranged upon a shaft independently of the knitting-cylinder, said change-wheel and picker being operatively connected.

16. The combination, substantially as before set forth, of the change-wheels, the shifting-pin, the shaft from which said shifting-pin receives motion, the gear-wheels which intervene between said shifting-pin and said shaft, and the differential adjusting-pin by which two of said intervening wheels are connected.

17. The combination, substantially as before set forth, of the knitting-cylinder, the knitting-cam for reciprocating work, the picker-carriers, the pickers, the driving-shaft for reciprocating work, and connecting mechanism, including a clutch, through the inter-

vention of which the picker-carriers and pickers are combined with said shaft.

18. The combination, substantially as before set forth, of the knitting-cylinder, the knitting-cam cylinder for reciprocating work, the scalper, and the spring-gates at the ends of said scalper.

19. The combination, substantially as before set forth, of the knitting-cylinder, thread-guide, thread-guide drivers, movable thread-guide stops, and stop-mover.

20. The combination, substantially as before set forth, of the knitting-cylinder, thread-guide, movable thread-guide drivers, movable thread-guide stops, stop-mover, and movable bumpers.

21. The combination, substantially as before set forth, of the knitting-cylinder, movable thread-guide, a tension device, thread-guide stops, and tension-operating cams.

22. The combination, substantially as before set forth, of the knitting-cylinder, movable thread-guide, tension device, spring thread-arm, movable thread-guide stops, tension-operating cams, and the picker-carriers.

23. The combination, substantially as before set forth, of the knitting-cylinder, pull-hook, hook-stock, hook-heel, and hook-stop.

24. The combination, substantially as before set forth, of the knitting-cylinder, pivotal pull-hook, weight, and clutch-lever operatively connected with said pull-hook.

25. The combination, substantially as before set forth, of the knitting-cylinder, the pull-hook, narrowing and widening devices, hook-holder, hook-stock, and an automatic trip for said hook-holder.

26. The combination, substantially as before set forth, of the knitting-cylinder, hook-partitions for holding down and casting off the work, narrowing and widening devices, a pull-hook, and automatic devices for applying said hook to assist in casting off the work during widening.

27. The combination, substantially as before set forth, of the knitting-cylinder, pull-hook, hook-holder, and holding-spring.

28. The combination, substantially as before set forth, of the two driving-shafts, the belt-shippers, two shipper-rods constructed with hook-nibs, and the shipper-lever with which the hook-nib of each shipper-rod is fitted to engage.

29. The combination, substantially as before set forth, of two driving-shafts, belt-shippers, two shipper-rods, each constructed with two hook-nibs, the shipper-lever, and the latches.

30. The combination, substantially as before set forth, of the clutch of the cam-gear shaft, and the shifting-pin with the same change-lever, said change-lever being operatively connected with the clutch and shifting-pin, whereby both may be moved by the same lever.

31. The combination, substantially as be-

fore set forth, of the movable thread-guide stops and the circular-knitting cam-clutch with the same change-lever, said change-lever being operatively connected with said stops and clutch.

32. The combination, substantially as before set forth, of the clutch of the cam-gear shaft, the shifting-pin of the shipper-rods, the stop-mover of the thread-guide stops, the circular-knitting cam-clutch, and the pull-hook with the same change-lever, said change-lever being operatively connected with said clutches, thread-guide stops, shifting-pin, and pull-hook.

33. A knitting-machine organized for circular and reciprocating work, having combined therewith a change-lever for shifting from one motion to the other, narrowing and widening devices, including pickers, and a picker-guard adapted to engage a part operatively connected with said change-lever and permitting its movement only when the pickers are in proper position, substantially as described.

34. A knitting-machine organized for circular and reciprocating work, having combined therewith a change-lever for shifting from one motion to the other, narrowing and widening devices, including pickers, belt-shippers, a pin connected with said change-lever controlling said rods, and a picker-guard adapted to engage a part connected with said change-lever and permitting the shifting and belt-shipping only when the pickers are in proper position, substantially as described.

35. The combination, hereinbefore set forth, of the knitting-cylinder, needles having nibs for action of the operating devices and additional shoulders, needle-operating devices, and a needle-holder whereby the needles are held against movement out of range of the moving devices.

36. The combination, as hereinbefore set forth, of the knitting-cylinder needles, needle-operating devices, and a needle-stop whereby the needles are given a rebound from their lowest position.

37. The combination, as hereinbefore set forth, of the knitting-cylinder, shouldered needles, needle-operating devices, a needle-holder, and a needle-stop whereby the needles are held and given a rebound from their lowest position.

38. The combination, substantially as before set forth, of the knitting-cylinder, pivotal pull-hook, hook-stock, and hook-holder.

39. The combination, substantially as before set forth, of the knitting-cylinder, change-wheels, pull-hook, hook-stock, hook-holder, and a trip-arm connected with said holder.

40. The combination, substantially as before set forth, of the knitting-cylinder, the change-wheels, pull-hook, hook-stock, hook-holder, trip-arm connected to said holder, and the hook-holder spring.

41. The combination, substantially as be-

fore set forth, of the knitting-cylinder, pull-hook, hook-stock, hook-guide, hook-spring, hook-heel, and hook-stop.

42. The combination, substantially as before set forth, of the pickers, their operative mechanism, picker-guard, guard-pin and lever, and the change-lever operatively connected therewith.

43. The combination, substantially as before set forth, of the pickers, picker-guard,

guard-pin and lever, shifting-pin, and the same change-lever operatively connected therewith.

In testimony whereof I affix my signature in presence of two witnesses.

EDWARD ELISHA KILBOURN.

Witnesses:

J. H. WHITAKER,

L. B. WHITAKER.

Corrections in Letters Patent No. 432,946.

It is hereby certified that in Letters Patent No. 432,946, granted July 22, 1890, upon the application of Edward Elisha Kilbourn, of New Brunswick, New Jersey, for an improvement in "Circular Knitting Machines," errors appear in the printed specification requiring the following corrections, viz: In line 64, page 13, the word "included" should read *including*, and the comma after said word should be stricken out; and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed, countersigned, and sealed this 29th day of July, A. D. 1890.

[SEAL.]

CYRUS BUSSEY,
Assistant Secretary of the Interior.

Countersigned:

C. E. MITCHELL,
Commissioner of Patents.