

No. 666,326.

Patented Jan. 22, 1901.

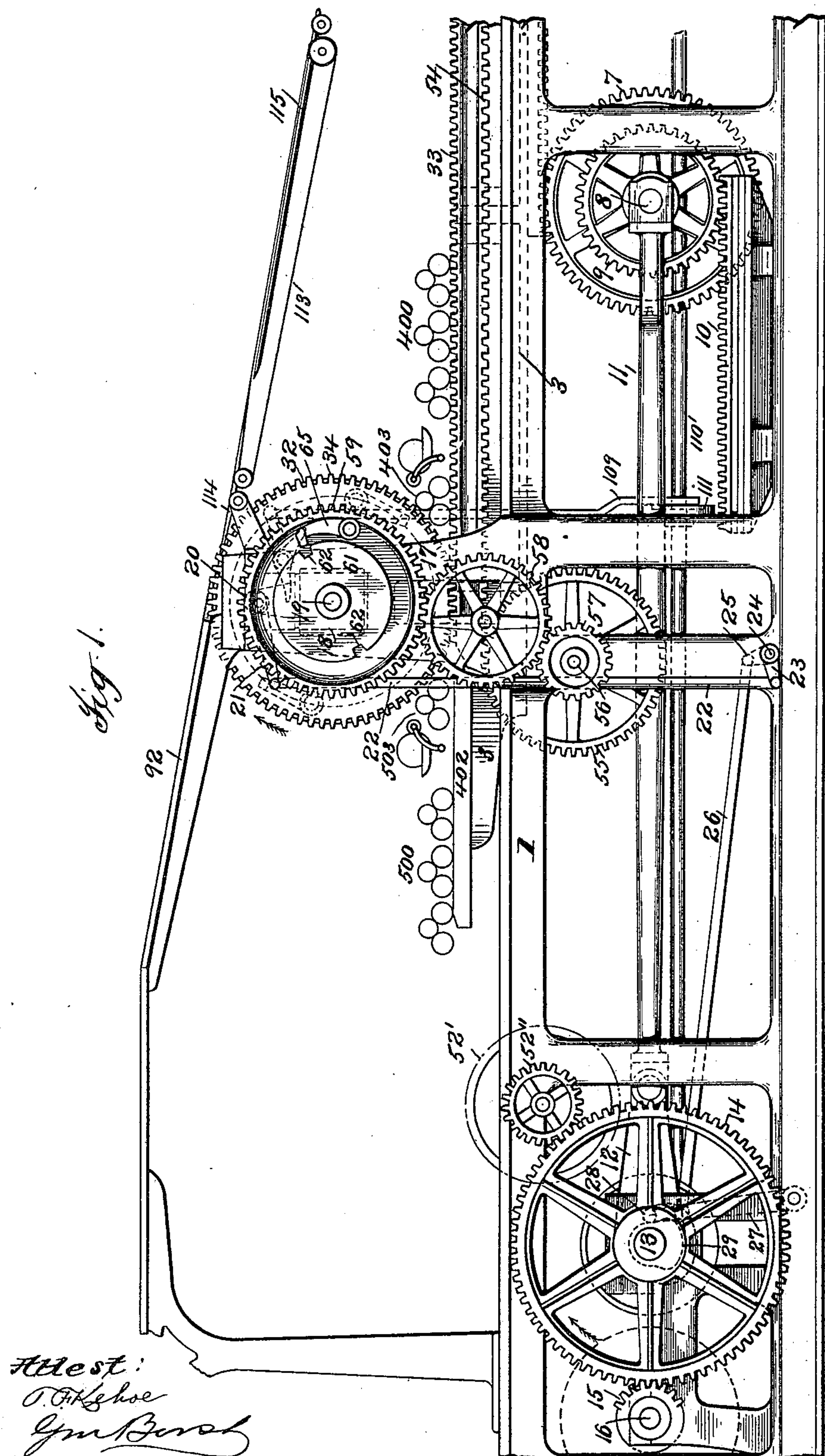
T. M. NORTH.

MULTICOLOR BED AND CYLINDER PRINTING MACHINE.

(Application filed June 19, 1899.)

(No Model.)

8 Sheets—Sheet 1.



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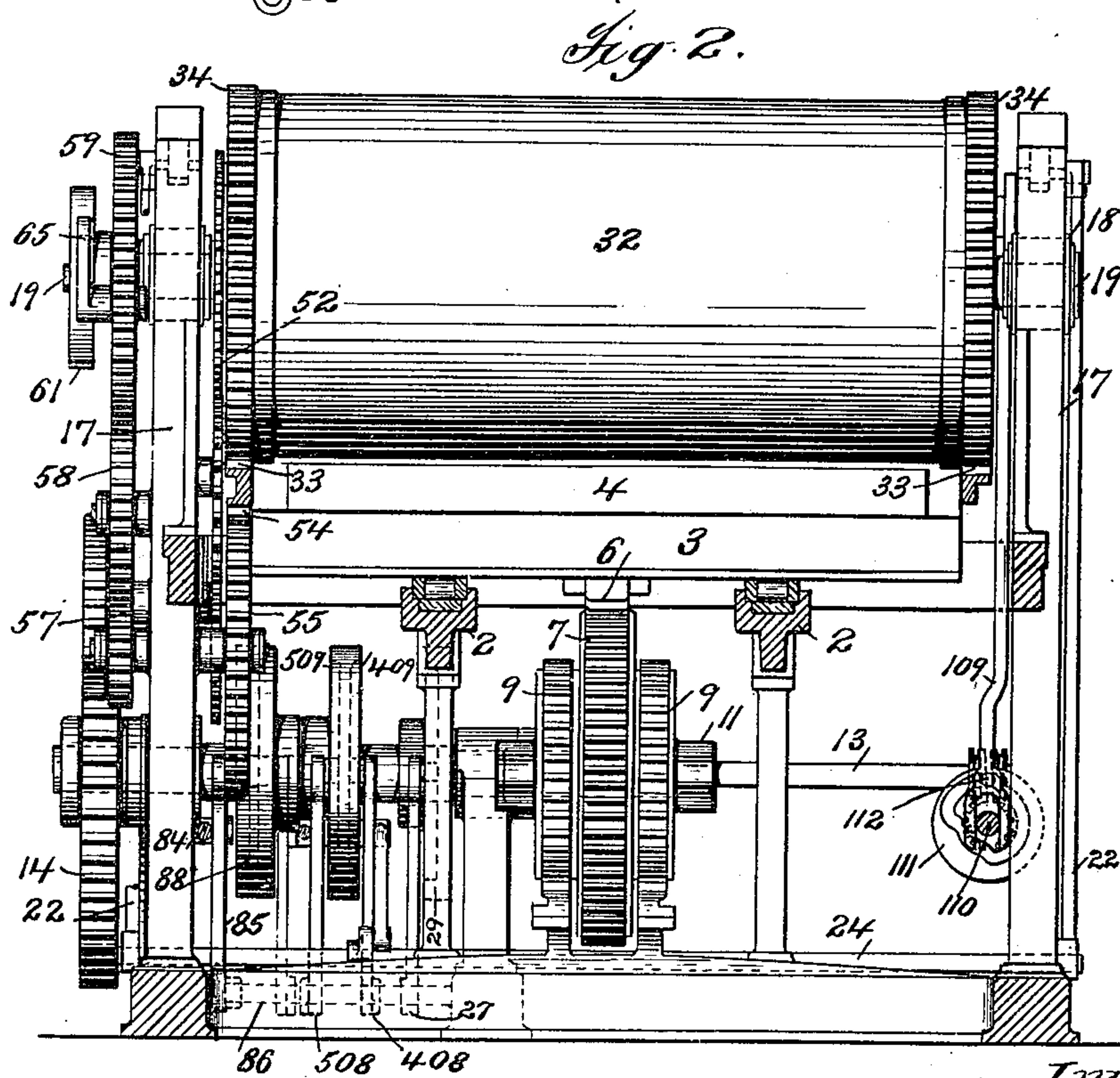
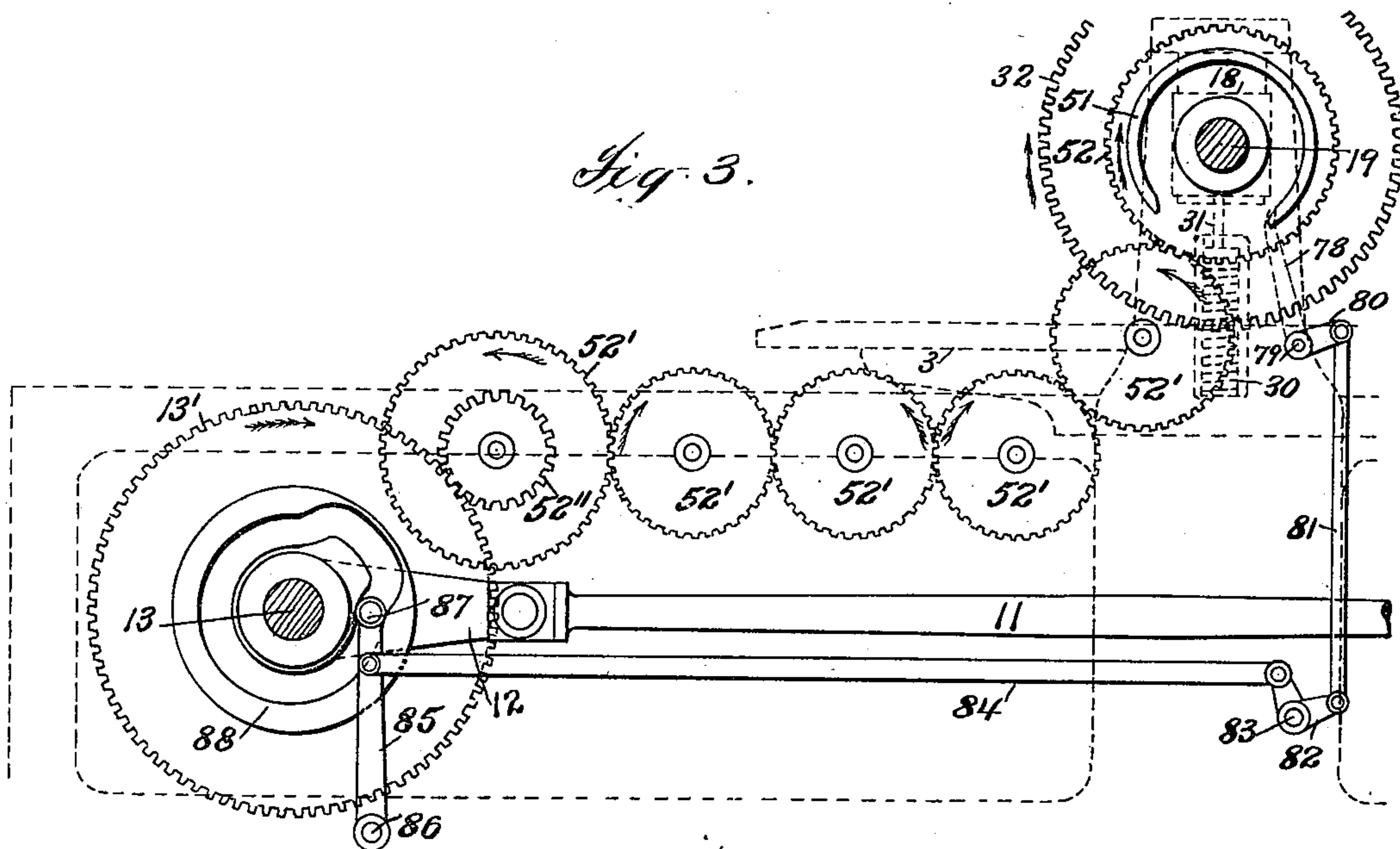
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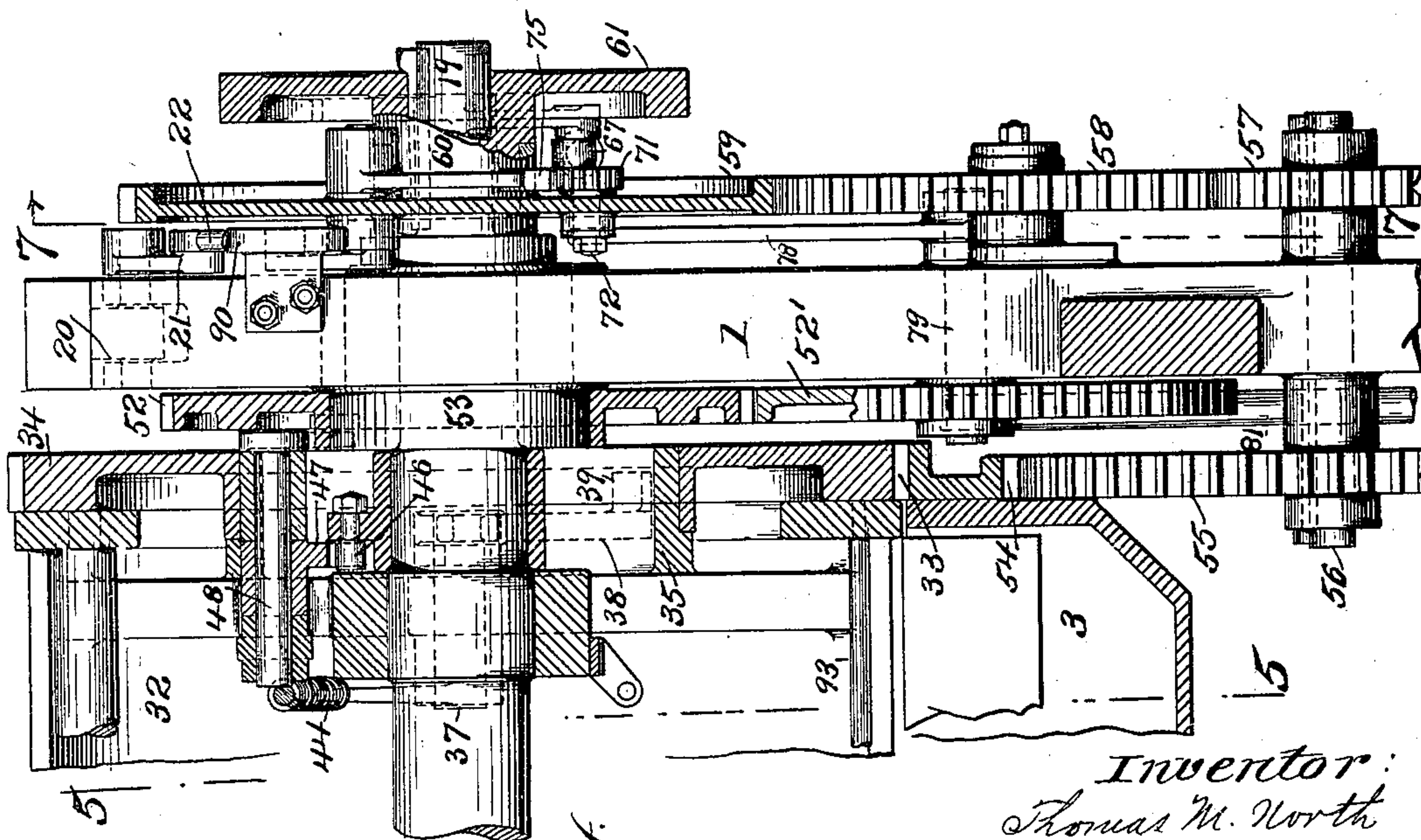
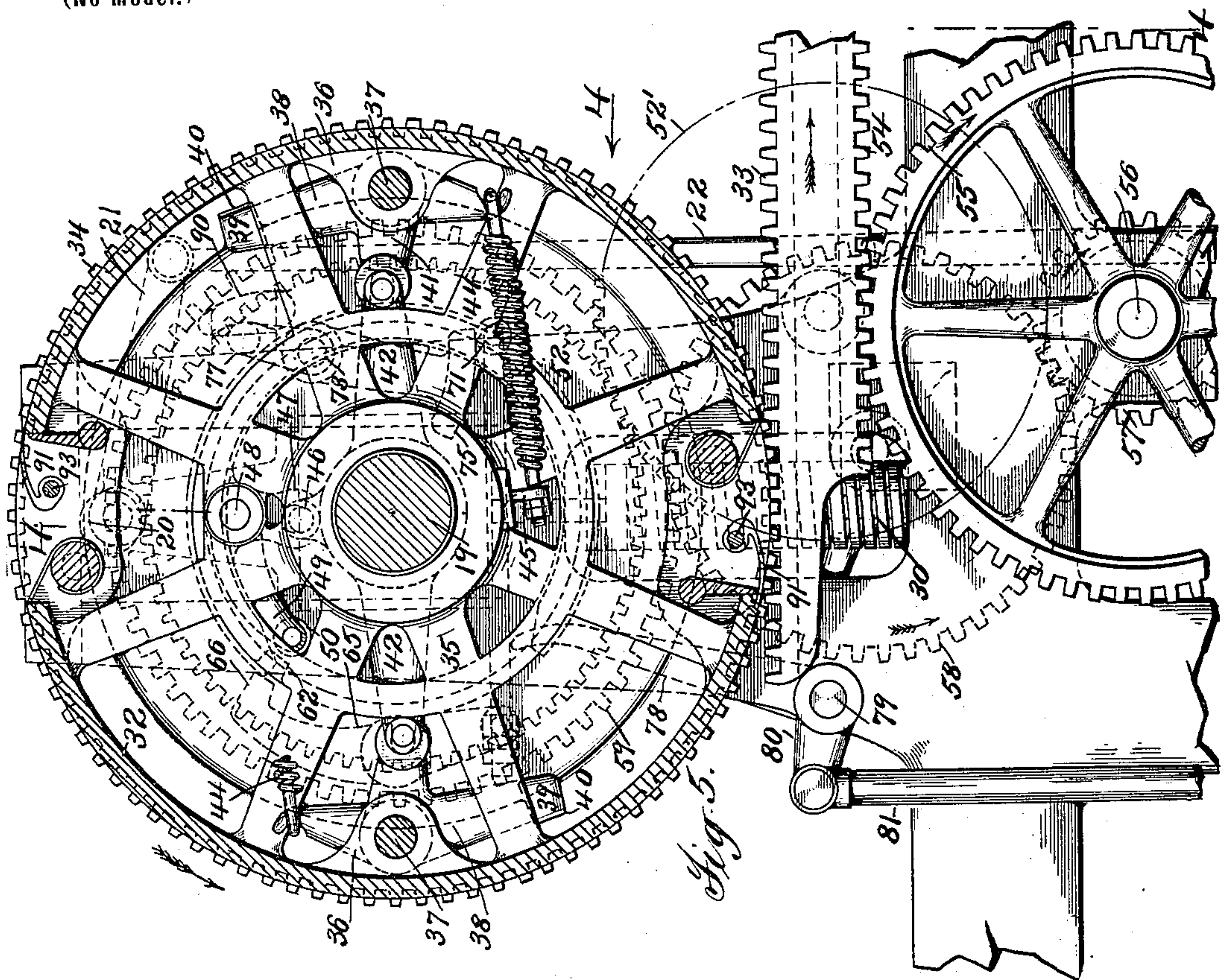
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Fig. 14.

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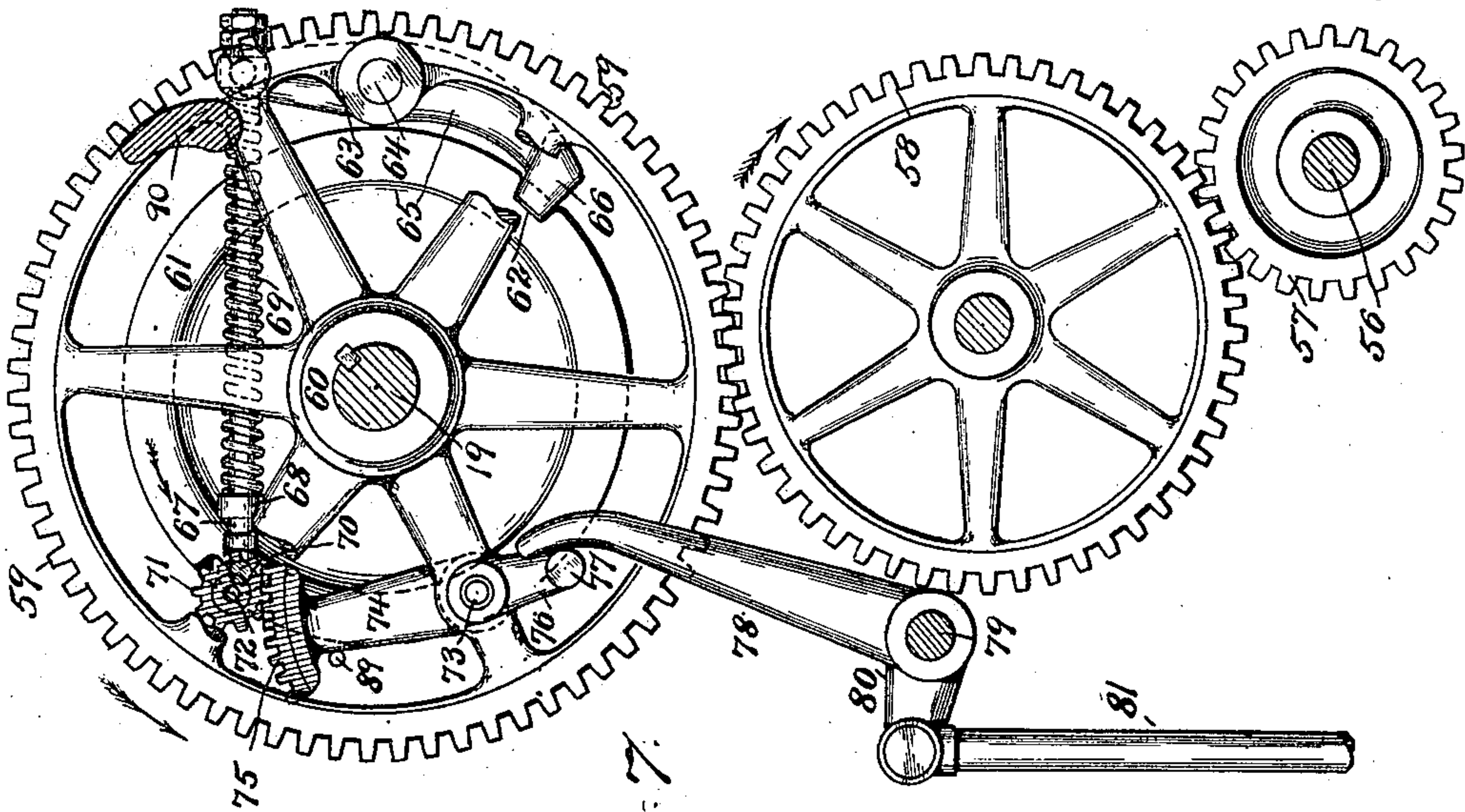


Fig. 7.

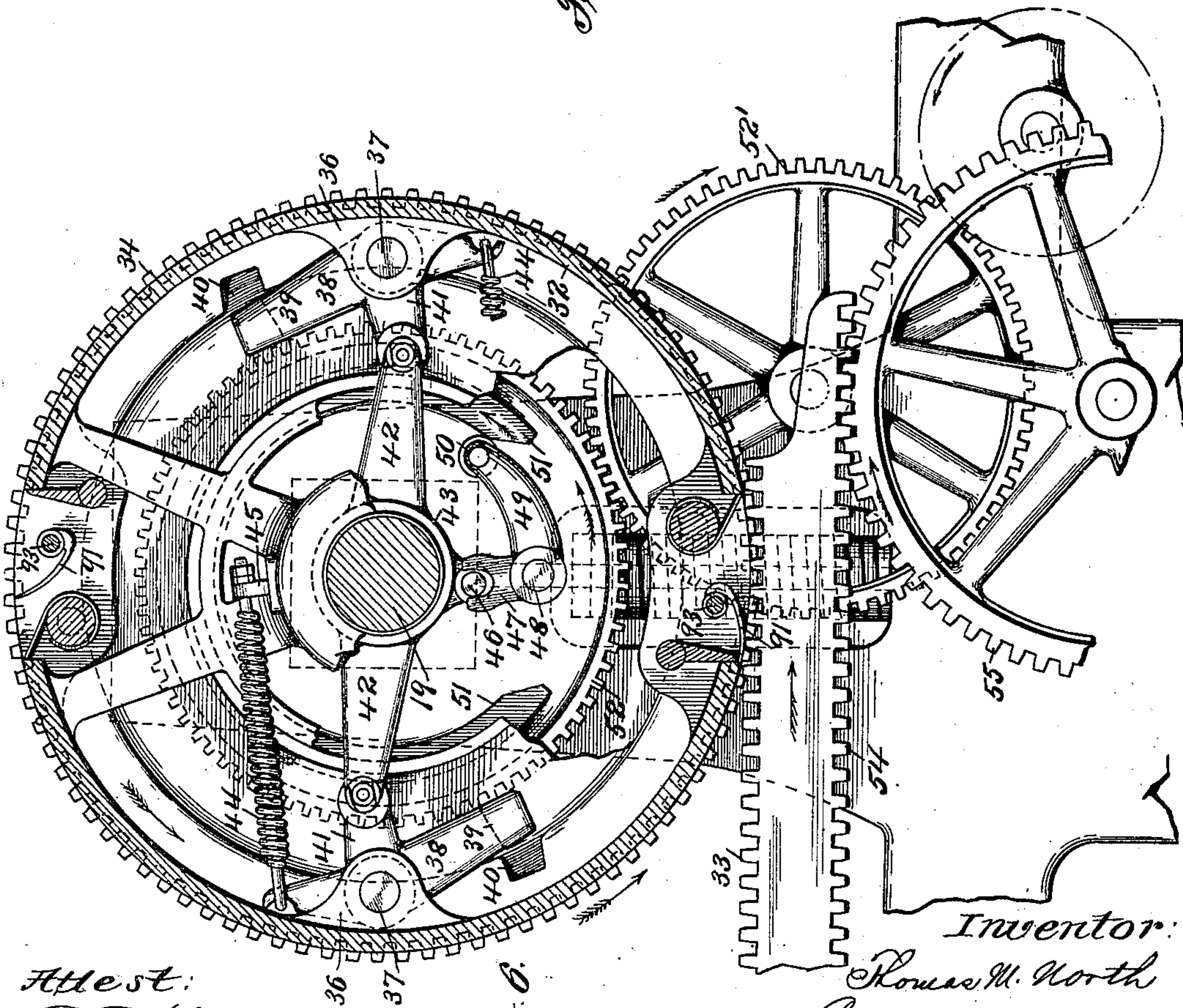


Fig. 6.

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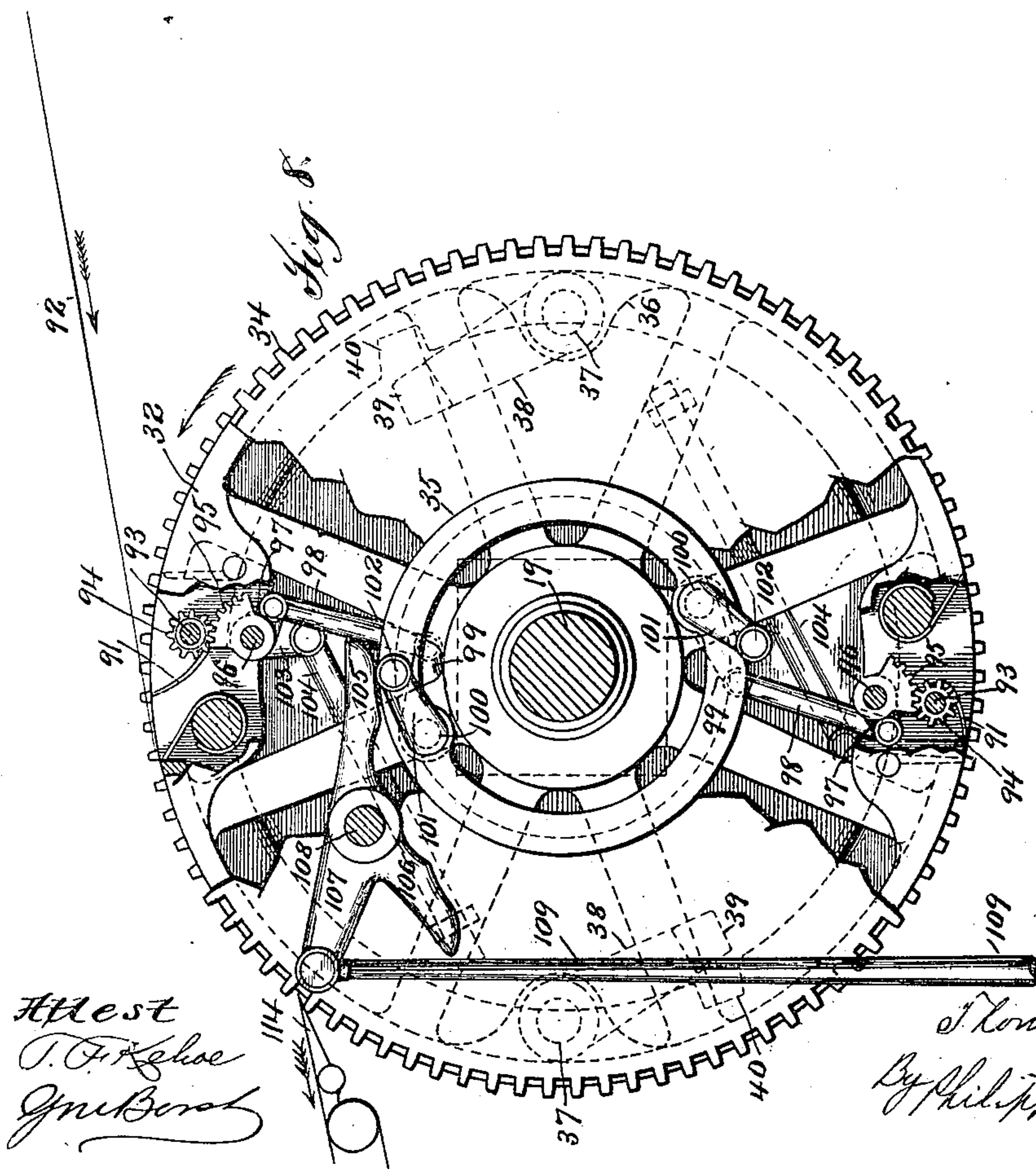
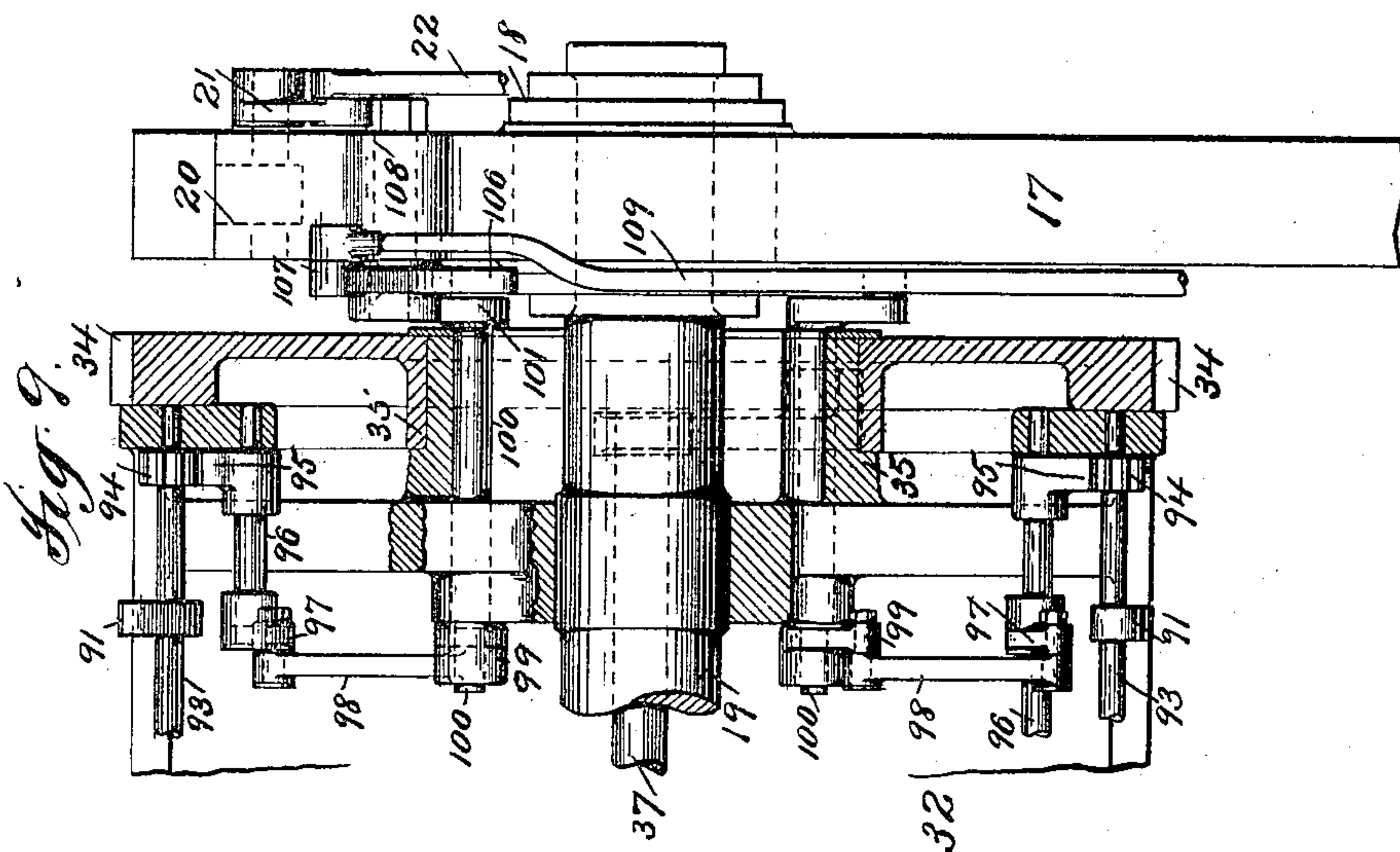
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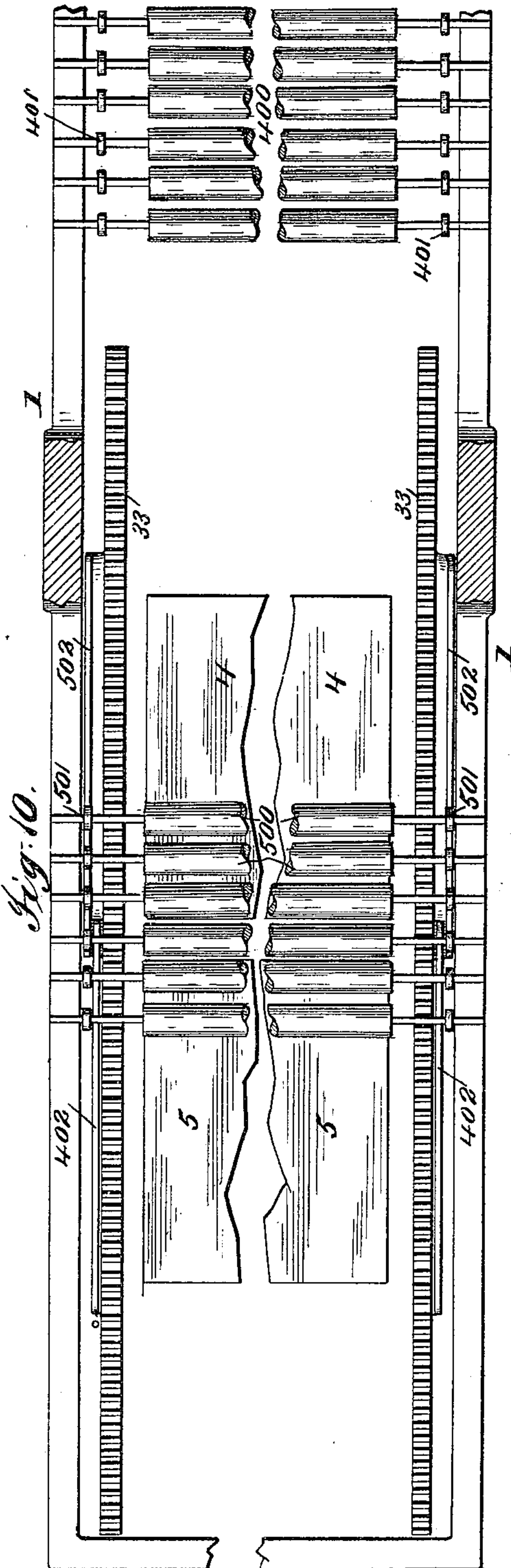
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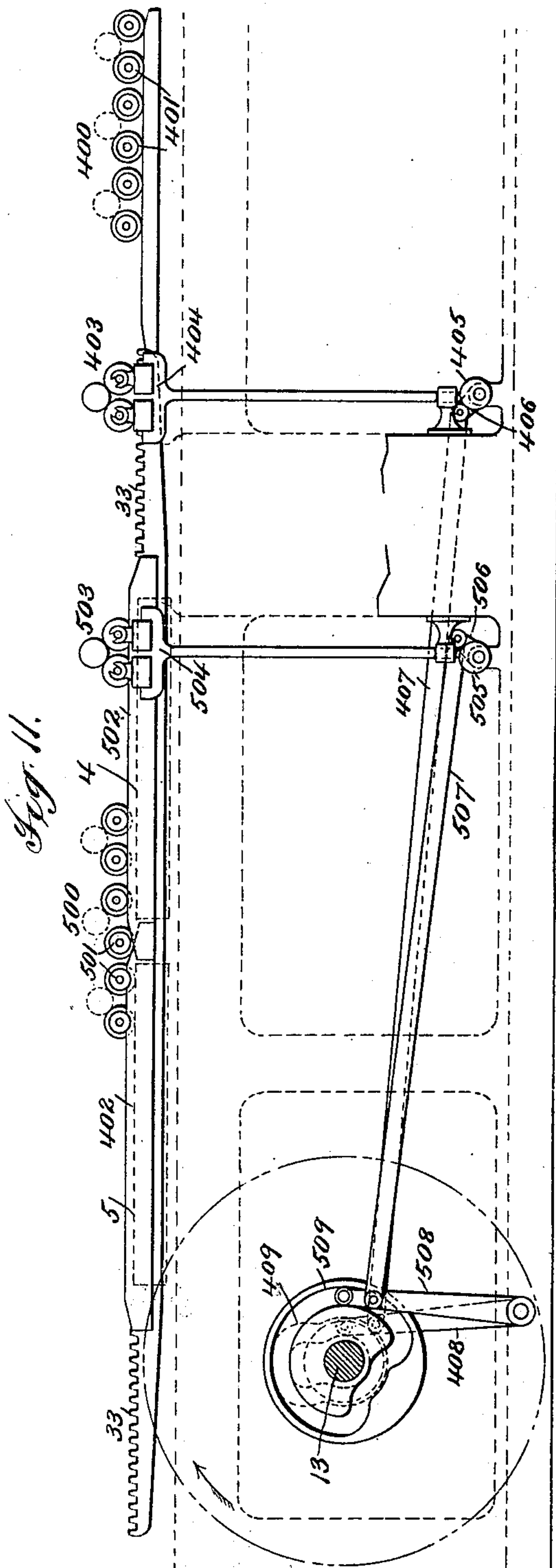
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(No Model.)

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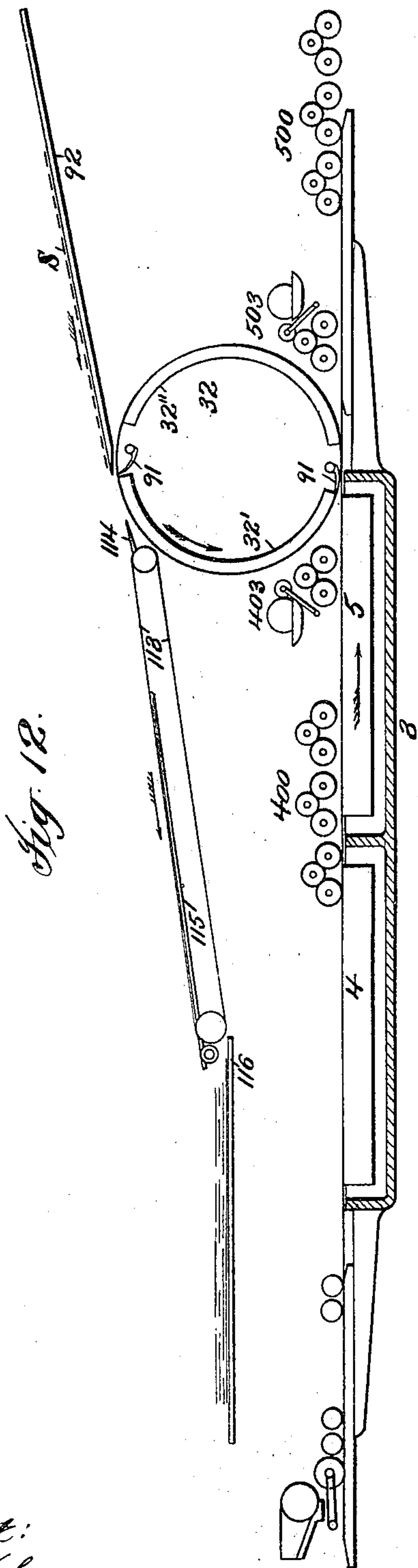
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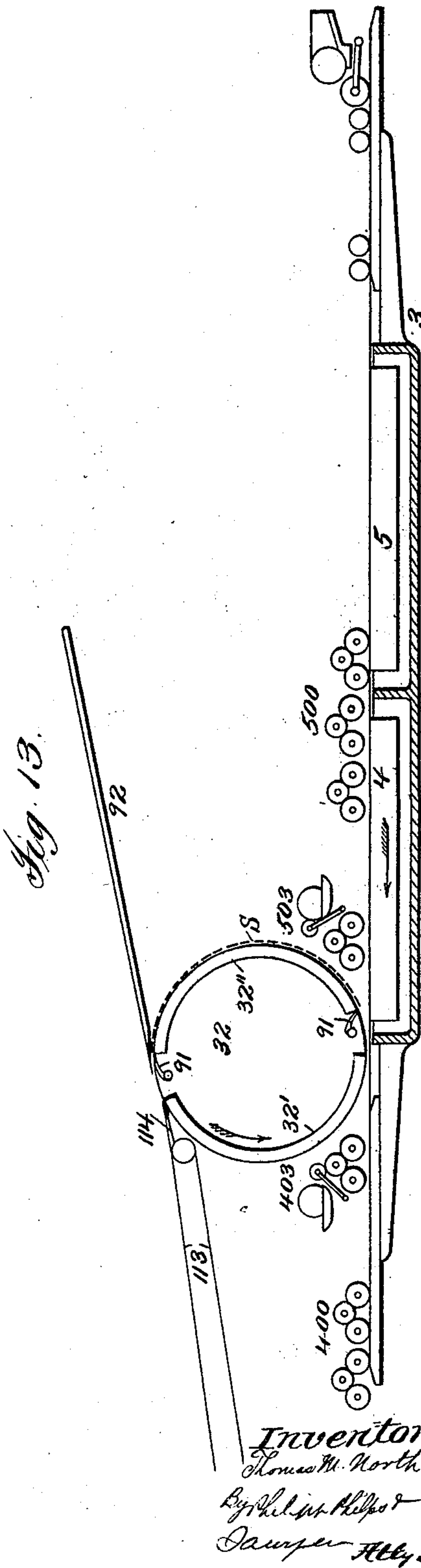
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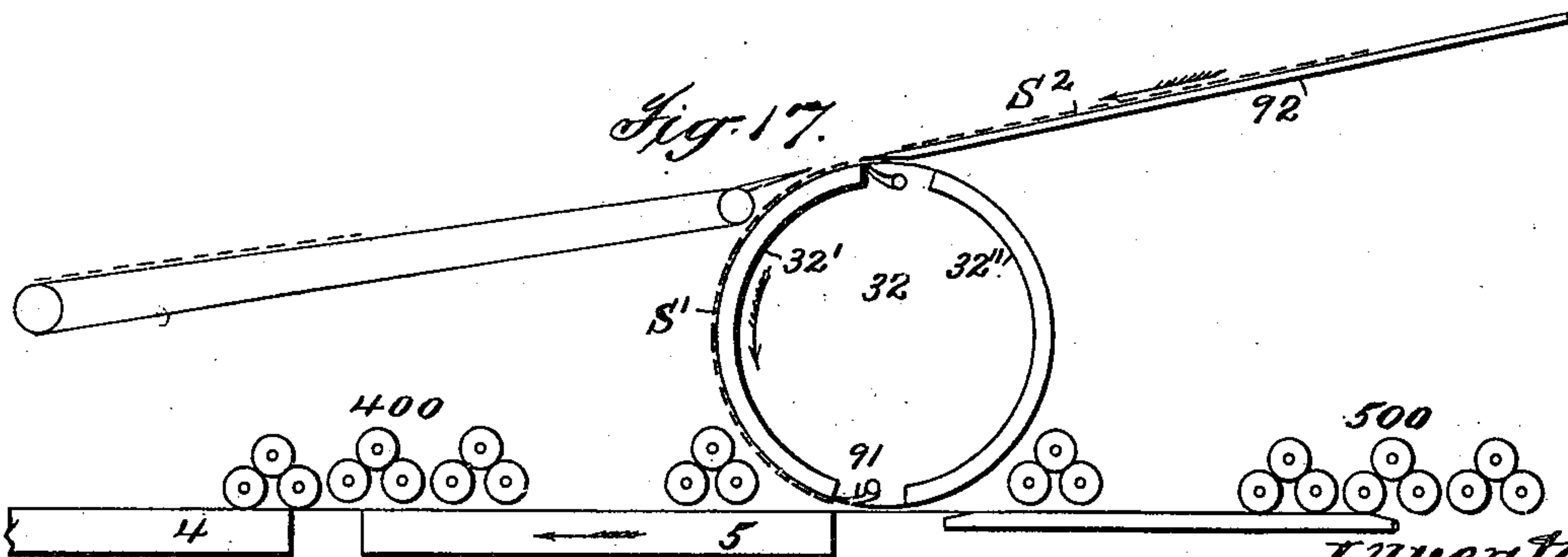
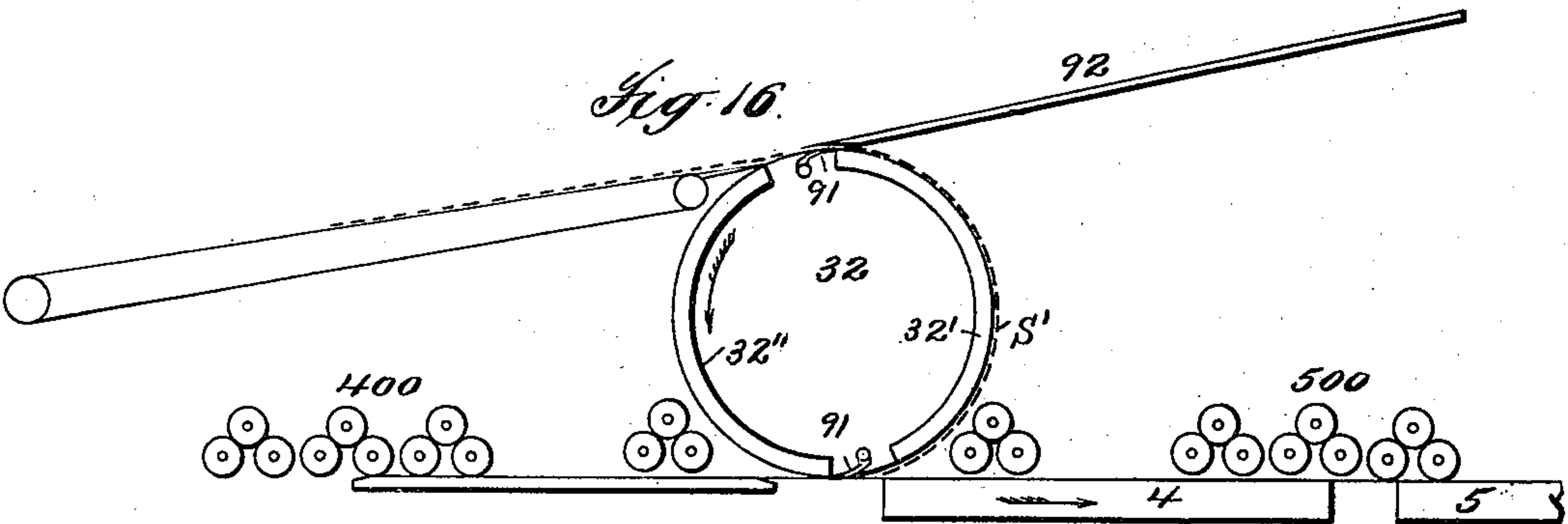
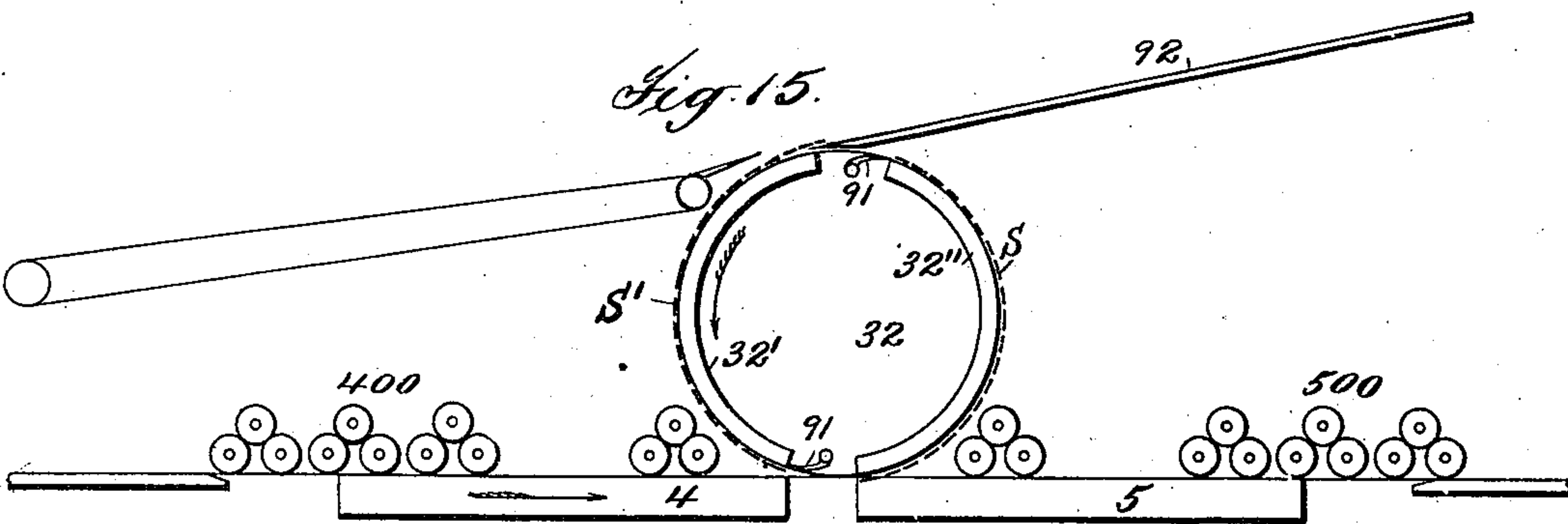
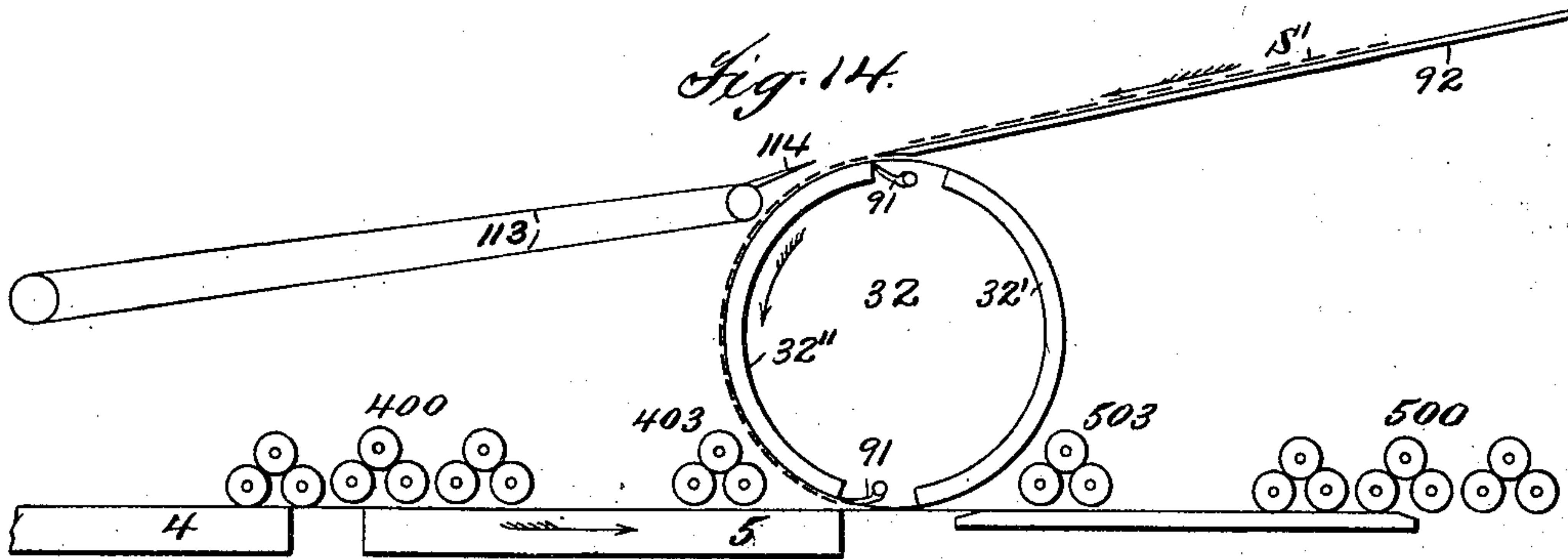
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(No Model.)

8 Sheets—Sheet 8.



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UNITED STATES PATENT OFFICE.

THOMAS M. NORTH, OF NEW YORK, N. Y., ASSIGNOR, BY DIRECT AND MESNE ASSIGNMENTS, TO ROBERT HOE AND CHARLES W. CARPENTER, OF SAME PLACE.

MULTICOLOR BED-AND-CYLINDER PRINTING-MACHINE.

SPECIFICATION forming part of Letters Patent No. 666,326, dated January 22, 1901.

Application filed June 19, 1899. Serial No. 721,046. (No model.)

To all whom it may concern:

Be it known that I, THOMAS M. NORTH, a subject of the Queen of Great Britain and Ireland, residing at New York city, county of Kings, and State of New York, have invented certain new and useful Improvements in Multicolor Bed-and-Cylinder Printing-Machines, fully described and represented in the following specification and the accompanying drawings, forming a part of the same.

This invention relates to certain improvements in printing-machines, and more particularly to bed-and-cylinder machines employing planographic printing-surfaces and printing in a plurality of colors.

Many attempts have been made to adapt bed-and-cylinder machines to multicolor-printing. Such machines have been constructed with a plurality of beds and a plurality of cylinders, one for each bed, the sheet being fed first to one cylinder and printed by it and its coöperating bed and then being transferred directly or indirectly to the next cylinder, which, with its coöperating bed, gives it a second impression in a different color. Machines of this character are expensive to build, because of the number of impression-cylinders and because of the complicated mechanisms necessary to operate the cylinders, and are also exceedingly bulky. Furthermore, exceedingly-accurate register is necessary for good color-printing, and great difficulty has been found in successfully transferring the sheets from cylinder to cylinder either directly or by intermediate devices and at the same time preserving that absolute accuracy of register which is necessary for fine work. Attempts have also been made to employ a single cylinder having a plurality of impression-surfaces which coöperate with a plurality of printing-surfaces on the bed. In some of these machines the sheet after receiving an impression from one impression-cylinder and the coöperating printing-surface on the bed has been transferred to a second cylinder, which receives it and returns it to the next impression-surface on the cylinder in position to receive a second impression from the next impression-surface and printing-surface on the bed. In these ma-

chines the same difficulties heretofore referred to have been experienced. The machines are complicated and expensive, and, furthermore, the accurate register which must be maintained for successful results is lost in transferring the sheets from one cylinder to the other.

In endeavoring to avoid the difficulties which have been referred to the use of machines employing a continuously-revolving cylinder having a plurality of impression-surfaces coöperating with a plurality of printing-surfaces on the bed, the sheet remaining on the impression-surface and being successively presented to the printing-surfaces, has also been suggested. In these machines, however, as it has been proposed to construct them the impression-surfaces have been separated from each other a distance at least equal to the length of each surface, and the printing-surfaces on the bed have been similarly separated, such separation of the surfaces having been considered necessary in order to bring the impression-surfaces into contact with the printing-surfaces in the proper sequence. The printing-surfaces in bed-and-cylinder machines are, however, of considerable length, sometimes reaching forty inches. In a machine of the type referred to the circumference of the cylinder having two impression-surfaces must be at least four times the length of the impression-surface and the travel of the bed must be equal to three-quarters of the circumference of the cylinder. It follows, therefore, that such constructions are not adapted for printing except from the very smallest forms on account of the necessarily great diameter of the cylinder and the great length of travel which must be given to the bed. This class of machines, therefore, has little or no practical value. Attempts have been made to remedy one of the difficulties—namely, the length of travel of the bed—by giving the printing-surfaces an independent movement with respect to the reciprocating bed. In these constructions, however, the cylinder must still be of excessive diameter if forms of any considerable length are to be printed from, and the mechanism necessary to give the printing-surfaces the necessary

independent movement has been of a very complicated nature. These machines are therefore open to as many practical objections as the machines which they were devised to replace.

It is the object of this invention to produce a bed-and-cylinder machine for multicolor-printing in which a plurality of impression-surfaces on a single cylinder shall cooperate with a plurality of printing-surfaces on a bed to give a sheet a plurality of impressions, usually in different colors, and to do this without removing the sheet from the impression-surface until it has received the desired number of impressions, and at the same time to produce a machine in which the circumference of the cylinder shall be no greater than the combined length of the impression-surfaces plus the necessary space for the openings in which the sheet-taking devices operate and in which the length of travel given the bed is substantially only equal to the combined length of the two surfaces.

The invention consists in certain parts, improvements, and combinations, which will be hereinafter described, and fully pointed out in the claims hereunto appended.

In the accompanying drawings, which represent a printing-machine constructed according to the present invention, and in which like characters of reference indicate the same parts, Figure 1 is a side view of a bed-and-cylinder machine embodying the invention. Fig. 2 is an end view of the machine, certain parts being shown in section. Fig. 3 is a detail view illustrating the arrangement of gearing for operating certain cam mechanism which forms a part of the invention. Fig. 4 is an enlarged sectional detail view taken through one end of the impression-cylinder on line 4 4 of Fig. 5 and illustrating the connections by which the cylinder is driven. Fig. 5 is a sectional detail view, also on an enlarged scale, taken on the line 5 5 of Fig. 4 and looking in the direction of the arrow 5 in said figure. Fig. 6 is an enlarged detail sectional view similar to Fig. 5, but with certain parts broken away to show the construction more clearly and with the bed at the opposite end of its stroke from that shown in Fig. 5. Fig. 7 is a sectional view taken on the line 7 7 of Fig. 4. Fig. 8 is a detail view, on an enlarged scale, illustrating more particularly the construction of the gripper-operating mechanisms. Fig. 9 is a side view of the construction shown in Fig. 8, certain parts being shown in section. Fig. 10 is a plan view of the bed, the cylinder and its cooperating parts being removed, the purpose of this view being to illustrate the operation of the inking-rollers. Fig. 11 is a side view of the construction shown in Fig. 10 and showing also the damping-rollers. Fig. 12 is a diagrammatic view illustrating the position of the parts when the bed is at one end of its stroke. Fig. 13 is a diagrammatic side view illustrating the position of the parts when the

bed is at the other end of its stroke. Figs. 14 to 17, inclusive, are diagrammatic views illustrating various positions of the bed, cylinder, and inking mechanisms during a complete reciprocation of the bed.

The machine which has been selected to illustrate the invention is a two-color machine printing from planographic surfaces. It is to be understood, however, that the invention is not confined to planographic machines or necessarily to machines printing in two colors, as the machine might be arranged to print in more than two colors or the invention might be embodied in a machine which could be used to produce successive impressions in a single color.

Referring to the drawings, 1 indicates the frame of the machine, the frame being provided with the usual ways 2, which support the bed 3. The bed is shown as provided with planographic printing-surfaces 4 and 5.

The bed may be reciprocated in any desired way and by any usual construction. In the machine shown the bed carries a rack 6, which meshes with a railroad-gear 7, said gear being mounted on a short shaft 8. The shaft 8 also carries two gears 9, said gears being located on each side of the gear 7 and meshing with stationary racks 10. The gears 7 and 9 are caused to reciprocate by means of a yoked connecting-rod 11, which is connected to a crank-arm 12, said arm being mounted on a shaft 13, suitably journaled in the frame. The shaft 13 carries a gear-wheel 14, said wheel meshing with a pinion 15 on the power-shaft 16 of the machine.

The frame is provided with a pair of standards 17, in which are located suitable sliding boxes 18, in which boxes the cylinder-shaft 19 is journaled, said shaft carrying the impression-cylinder 32.

It is necessary that the bed and cylinder be separated during the return stroke of the bed, so that the forms on the bed will not contact with the impression-surfaces on the cylinder during that stroke. While this separation may be effected in various ways, in the machine shown the cylinder is raised and lowered, being lowered to cooperate with the form-surfaces on the bed during the printing stroke of the bed and being raised during the return stroke of the bed. The cylinder may be raised and lowered by any suitable or preferred mechanism. In the machine shown the boxes 18 are provided with upward extensions, and in these extensions are journaled eccentrics 20. (See dotted lines in Figs. 1 and 4.) These eccentrics are operated from arms 21, which are connected by rods 22 to arms 23, said arms being carried on a shaft 24, suitably journaled in the frame of the machine. The shaft 24 is provided with an arm 25, and to this arm is connected a rod 26, the other end of said rod being connected to a lever 27, suitably journaled in the frame of the machine. Said lever 27 carries at its upper end a roll 28, which engages a groove in a

cam 29, said cam being mounted on the shaft 13, before referred to. Suitably supported in the frame below the cylinder-boxes are springs 30, said springs serving to operate the plunger-rods 31, which bear against the undersides of the boxes 18. (See dotted lines in Fig. 3.) It is obvious that as the eccentrics 20 are operated through the connections before described they and the springs 30 will raise and lower the boxes. It may be here remarked that in the present machine the movement given the boxes is very slight, being only sufficient to throw the cylinder 32 off impression.

As the machine shown is arranged to print in two colors, the cylinder 32 is provided with two impression-surfaces 32' and 32'' and two sets of sheet-taking devices, which in the present instances are grippers, though any form of sheet-taking devices may be used, there being one set for each impression-surface. It is to be understood, however, that the invention is not necessarily limited to a cylinder provided with two impression-surfaces.

In the machine shown the cylinder is caused to run at the same speed as the bed during the printing operation. While the cylinder may, if desired, be rotated during the printing operation by mechanism which is entirely independent of the bed, it is preferably rotated from the bed, as perfect register is thus secured. The means by which the cylinder is rotated from the bed during the printing operation may be widely varied. In the machine shown, however, the bed is provided with racks 33, which mesh with gears 34, said gears being loosely mounted on hubs 35, which are preferably cast with the cylinder-arms.

It is obvious in order to rotate the cylinder through the loose gears before described that the gears must be connected to and disconnected from the cylinder at specified periods. The connections by which the gears are connected to and disconnected from the cylinder may be of various kinds. In the machine shown the cylinder is provided with suitable bearings in the shape of ears 36. Two sets of such ears 36 are preferably provided on each end of the cylinder; but more or less may be used, if desired. In these ears 36 are mounted shafts 37, said shafts serving to support locking-levers 38. These locking-levers 38 carry locking projections 39, (see dotted lines in Fig. 4,) and these projections engage notches 40 in the rim of the gears 34. (See Fig. 6.) It is apparent that when the locking-levers 38 are thrown so that their locking projections 39 engage the notches 40 the cylinder and the gears will be locked together and the cylinder will be rotated by the gears. When, however, the locking-levers 38 are shifted so that the locking projections 39 are disengaged from the notches 40, the gears may rotate independently of the cylinder.

Various means may be provided for operating the locking-levers at predetermined times. In the machine shown the locking-

levers 38 are provided with extensions 41, the ends of which are formed to provide semicircular recesses. These semicircular recesses in the extensions 41 are engaged by arms 42, said arms extending from a collar or hub 43, which is loosely mounted on the cylinder-shaft. The tails of the levers 38 are connected by pull-springs 44 to projections 45, projecting from the cylinder-hubs, and these pull-springs tend to throw the locking-levers 38 so that their projections 39 will engage the notches 40, before referred to. The arms 42 operate through the extensions 41, before referred to, to rock the levers 38 against the tension of the springs 44 and cause the locking projections 39 to become disengaged from the notches 40.

The arms 42 are rocked at suitable times and may be rocked by mechanism which is widely varied in character. In the machine shown the collar 43 is provided with a projection in which is mounted a stud 46, said stud being engaged by an arm 47, which is carried on a shaft 48, preferably journaled in apertures in a web formed between the cylinder-spokes. The shaft 48 is provided with an arm 49, carrying a roller 50. This roller 50 engages at suitable times a segmental controlling-cam 51, preferably formed on or secured to a gear 52, said gear being loosely mounted on a hub 53, preferably formed on the cylinder-box. When the roller 50 engages the cam 51, (see Fig. 6,) the shaft 48 is rocked, so that the levers 38 have their projections 39 disengaged from the locking-notches 40, and these levers are held with their locking projections so disengaged as long as the roller 50 remains in contact with the cam 51. When, however, the roller 50 slips off the cam 51, the pull-springs 44 operate the levers and cause their locking projections to engage the notches 40 in the gears, thus locking the gears and cylinder together. While this controlling-cam 51 may be variously located, arranged, and controlled, in the construction shown it is so operated that the opening between its ends will be opposite the roller 50 on the arm 49, while the bed and cylinder are in printing relation, and at other times the roller 50 is running on the surface of the cam, and thus holding the locking projections 39 out of the notches 40. While the movement of the controlling-cam 51 may be accomplished in various ways, in the machine shown the gear 52, which carries the cam 51, is rotated at a constant speed from a train of gears 52', the last one of which has connected to it a pinion 52'', which is in mesh with a gear 13' on the shaft 13. The cam 51 is constantly driven by this train of gearing at a speed which is equal to one and a quarter times the speed which the cylinder has when it is being driven by the bed. The segmental cam in this machine is arranged so that the opening between its ends is equal to ninety degrees. Inasmuch as the cylinder and the cam are rotating in the same direc-

tion, it follows that when the cylinder has made a complete revolution the cam will have made a revolution and a quarter or will have gained a quarter of a revolution on the cylinder.

Referring to Fig. 6, which shows the parts in the position they occupy just before the cylinder begins its printing stroke, or rather just before the bed reaches the point of reverse, it will be seen that the roller 50 is just leaving the segmental cam 51. The slight additional movement of the cam and cylinder which takes place as the bed reverses causes the roller 50 to slip off the end of the cam 51, and the cylinder starts on its printing revolution. During this revolution, however, the cam is rotating in the same direction and at a speed which is a quarter faster per revolution than that of the cylinder, so that at the time the cylinder has completed its printing stroke the other end of the cam 51 will have come under the roller 50 and will have thrown the levers 38 and withdrawn the projections 39 from the notches 40. The cylinder is now unlocked from the gear 34, which preferably is always in mesh with the rack 33 and is free to be locked to and rotated by a slow-speed mechanism, which will be hereinafter described.

As before stated, the cylinder in this machine is provided with two impression-surfaces, and these impression-surfaces coact alternately with the form-surfaces 4 and 5, carried by the bed on alternate printing strokes of the bed. In other words, the impression-surface which coacts with the form-surface 4 on one printing stroke of the bed coacts with the form-surface 5 on the next printing stroke of the bed, the purpose being, as has been stated, to cause the sheets which are held on the impression-surfaces to receive two impressions before they are delivered.

It is obvious that each impression-surface will coact with one form-surface during one printing stroke of the bed, and in order to effect the alternate operation before described it is necessary that the cylinder have its position shifted while the bed is making its return stroke, and in a machine printing from two forms this shifting must be equal to a half-revolution of the cylinder or to one or any number of revolutions plus a half in order that on the second printing stroke of the bed the impression-surfaces will not contact with the same forms that they did on the preceding stroke. Inasmuch as in the present machine the cylinder is a continuously-revolving cylinder, in order to effect this shifting of the position of the cylinder with relation to the forms on the bed it is necessary to change the speed at which it is revolved while the bed is returning. Various mechanisms may be employed to revolve the cylinder at the changed speed necessary to bring about the alternation of the impression-surfaces with the form-surfaces. In the machine

shown the bed is provided with a rack 54, which rack engages a gear 55, mounted on a short shaft 56, suitably journaled in the frame of the machine. This shaft 56 also carries a reducing-pinion 57, which meshes with an intermediate 58, the intermediate meshing in turn with a gear 59, which is loosely journaled on a hub 60, said hub being keyed to the cylinder-shaft 19. Extending from the hub 60 and preferably formed in one piece therewith is a disk 61, provided with notches 62. It will be understood that the reducing train of gearing 55 57 58, before described, is in the present machine so proportioned as to give the cylinder a half-revolution while the bed is making its return stroke, and during this time the gear 59 is locked to and rotates the cylinder. The locking of the gear 59 to the cylinder may be effected in various ways. Preferably, however, the said gear is provided with bearings in the shape of ears 63, in which is journaled a short shaft 64, and mounted on said shaft is a locking-lever 65, having a locking projection 66. Connected to the tail of the locking-lever 65 is a spring-rod 67, said rod being provided with a collar 68, against which bears a spring 69, the other end of the spring bearing against the tail of the lever. The end of the rod 67 opposite to that which is connected to the locking-lever 65 is connected to a stud 70, mounted on a pinion 71, which is journaled on a stud 72, mounted on one of the spokes of the gear 59. Mounted in another one of the spokes of the gear 59 is a short shaft 73. This shaft has mounted on one end a segment-lever 74, which carries a segment 75, the said segment gearing with the pinion 71, before referred to. On the other end of the short shaft 73 is an arm 76, carrying a roller 77, which lies in the path of a tappet-lever 78. The tappet-lever 78 is mounted on a short shaft 79, suitably journaled in the frame, and this shaft 79 is provided with an arm 80, which is connected by a link 81 to a bell-crank lever 82, which is mounted on a stud 83, located on the inside of the frame. The bell-crank lever 82 is connected by a link 84 to a lever 85, which is also mounted on a shaft 86, located in the lower part of the frame, and this lever 85 is provided with a roller 87, which engages a cam-groove in a cam 88, which is mounted on the shaft 13. As the shaft 13 rotates, the cam 88 will, through the connections described, rock the tappet-lever 78. This lever striking the roller 77 on the arm 76 will rock the segment-lever 74, rotate the pinion 70, and cause the projection 66 to be withdrawn from the notch 62 in the disk 61. A suitable back-stop 89 is provided to limit the movement of the lever 74.

A suitable cam 90 is secured to one of the standards in which the cylinder-boxes are mounted, and this cam lies in the path of the roller 77 on the arm 76 and is so located that the roller 77 will strike the cam and operate the segment-lever to cause the projection 66 on the lever 65 to engage the notch 62 at the

time when the cylinder has completed its full revolution at full speed and is to be disengaged from the gear 34 and rotated at half speed by the gear 59.

5 In Fig. 7 the parts are shown in the position they occupy just before the cylinder has completed its half-revolution at the slow speed and the tappet 78 is just about to be operated to disengage the projection 66 from the notch 62.

10 Inasmuch as the cylinder is to take a sheet on one revolution and on this revolution present it to one of the forms, so that it can be printed therefrom, and then retain it, so as to present it to the next form on the next revolution and after it has been printed by this form deliver it, suitable sheet-taking devices must be provided and suitable means must be used to control the sheet-taking devices, so as to cause them to properly manipulate the sheet. While any suitable form of sheet-taking devices may be used, in the machine shown there are provided two sets of grippers 91, to which the sheets are fed in any suitable manner, as from a feed-board 92. These grippers 91 may be operated by any suitable mechanism. Preferably, however, they are carried on shafts 93, said shafts being provided with pinions 94, which mesh with rack-segments 95. These rack-segments 95 are mounted on shafts 96, which have their bearings at one end in the cylinder-head and are suitably supported at their other ends either in the opposite cylinder-head or in suitable bearings secured to one of the cylinder-spokes. These shafts 96 are provided with arms 97, which arms are connected by links 98 to arms 99, which are secured to short shafts 100, suitably supported in the hubs 35 of the cylinder. These shafts 100 are provided with arms 101, which carry rollers 102. The shafts 96 also have arms 103, to which are connected the usual spring-rods 104.

45 It is obvious that by suitably manipulating the arms 101 the grippers 91 may be opened at proper times and that after being opened they may be closed by the spring-rods 104. While various devices may be used for manipulating the arms 101, in the machine shown there is provided a lever 107, having two projections 105 and 106. This lever 107 is journaled on a stud 108, suitably journaled in the frame, and it is connected to a rod 109, which is forked at its lower end and straddles a way cam-shaft 110. This shaft 110 carries a cam 111, the groove of which is engaged by a pin 112 on the rod 109. The configuration of the cam 111 is such that as one pair of the grippers is about to take a sheet the lever 107 will be rocked, so that the projection 105 will stand in the path of the roller 102 on the arm 101, which is connected to the grippers that are to be operated. As the roller 102 strikes the arm 105 it operates, through the connections described, to rock the segment 95 and cause the shaft 93 to rotate, and thus open the grippers, so that they

will be in position to take the sheet. As soon as the cylinder is rotated sufficiently far to bring the grippers into the sheet-taking position the roller 102 rides out from under the projection 105, and the spring-rod 104 operates in the usual manner to close the grippers which thus take the sheet. After this has happened the cam 111 operates to raise the projection 105 and depress the projection 106, so that this arm will be in the path of the roller 102 on the operating-arm 101 of the next pair of grippers and will open the grippers, so that the sheet which they hold will be delivered. After the sheet has been delivered the roller 102 rides from under the projection 106, and the grippers close and remain closed until they open to take a fresh sheet. The cam 111 now operates to swing the lever 107 into such a position that when the grippers which are holding the sheet come opposite the projections 105 106 they will pass them without being operated. After the grippers holding the sheet have passed the lever the cam then operates to swing the projection 105 into position to open the next pair of grippers to take a sheet, and the cycle of operations which has been described will be repeated.

Any suitable form of delivery mechanism may be used to take the sheet from the cylinder 32 after it has received its second impression. In the machine shown a set of tapes is employed, these tapes being suitably mounted and driven. A switch 114 acts to bridge the necessary space between the tapes and the cylinder, and this switch is operated from any suitable mechanism. (Not shown.) The printed sheets are taken from the tapes 113 in any suitable manner, as by a fly 115, said fly delivering the sheets to a suitably-arranged table 116.

When the form-surfaces 4 and 5 are to print with different-colored inks, each surface must be provided with its own set of inking-rollers, and in case the surface is, as shown in the present machine, a planographic surface, with its own set of wetting-rollers also. Furthermore, devices must be provided whereby the inking-rollers, which are intended to ink one form, and the wetting-rollers, which are to damp that form, can be held away from the other form while it is passing them, any suitable mechanism being employed for this purpose. In the machine shown the form-rollers 400, which coöperate with the form-surface 4, have their shafts provided with rolls 401, which rolls are so arranged as to come in contact with cam-surfaces 402, which are located alongside the form-surface 5. When, therefore, in the travel of the bed the form-surface 5 reaches the rollers 400, the rollers will be raised by the cam-surfaces 402 and held out of contact with the form-surface 5. In the same manner the form-rollers 500, which coöperate with the form 5, have their shafts provided with rollers 501, which are arranged so as to come in contact with cam-surfaces

502, which are located alongside the form-surface 4 and which operate to hold the rollers 500 away from this surface when said surface is passing under it. Wetting-rollers 403 are provided, the function of which is to dampen the planographic surface 4, and these rollers are raised so as not to contact with the surface 5 when it passes thereunder. In the same way wetting-rollers 503 are provided, which dampen the surface 5. Inasmuch as the damping-rollers are allowed to come in contact with the form only during one stroke of the bed—that is, the return or non-printing stroke—and are held out of contact with the form-surfaces during other times, suitable means must be provided to so manipulate them. Many suitable mechanisms exist in the art by which these rollers may be controlled and any suitable mechanism may be adopted. In the machine shown the rollers 403 are shown as journaled in slides 404, said slides being controlled from oscillating cams 405, the shaft of which is connected through an arm 406 and a link 407 to a lever 408, which lever is operated in an obvious manner from a cam 409 on the shaft 13. In the same manner the damping-rollers 503 are mounted in slides 504, which are similarly controlled through cams 505 and connections 506 and 507 to a lever 508, which is operated by a cam 509, also mounted on the shaft 13.

The construction being as before described, the operation is as follows, special reference being had to the diagrams illustrated in Figs. 12 to 17, inclusive: Assuming the parts to be started and the cylinder in position to take its first sheet from the feed-board 92, the position of the cylinder with relation to the bed is shown in Fig. 12. The lever 107 has been moved so that the projection 105 has been struck by the roller 102 on the arm 101 and the grippers 91 have been opened. A sheet S has been placed in position on the feed-board, and as the cylinder revolves, so that the roller 102 runs out of contact with the arm 105, the grippers close on the sheet and take it from the feed-board, the cylinder being held tripped by any suitable form of tripping mechanism (not shown) in order to hold the impression-surface 32', which at this time has no sheet on it, out of contact with the form-surface 5 until this form-surface has passed the cylinder. When this has happened, the cylinder is allowed to descend into printing position and the surface 4 delivers an impression on the sheet S which is held on the impression-surface 32'' by the grippers. During this movement of the bed the racks 33 have been in engagement with the gears 34, and these gears have been locked to the cylinder by the engagement of the projections 39 on the levers 38, these projections having entered the notches 40 in the rim of the gears. During this movement of the cylinder the cam 51, it will be remembered, is operated from the train of gears 52' and at a speed which causes it to gain a quarter of a revolu-

tion on the cylinder when the cylinder is running at full speed. When this impression is completed, the other end of the cam 51, which has overtaken the cylinder, runs under the roller 50 on the arm 49 and rocks the hub 43 and the arms 42, so as to throw the levers 38 and release their projections 39 from the notches 40. As this occurs, the roller 77 on the arm 76 runs in contact with the cam 90 and throws the lever 65, so that its projection 66 engages a notch 62 on the disk 61. It will be remembered that the gear 59, which is operated from the rack 54 on the bed through the train of gears 55 57 58, is running at only half the speed of the gear 34, and consequently will give the cylinder only a half a revolution while the bed is returning. This half-revolution will, however, bring the cylinder into position so that the sheet S which lies on the impression-surface 32'' will be in position to receive an impression from the form-surface 5. At the same time the cam 29 operates, through its connections 27, 26, 25, 22, and 21, to turn the eccentric 20 and permit the springs 30 to raise the cylinder enough so that it will be off impression, but not enough to disengage the teeth of the gear 34 from the rack 33. The bed now reverses and makes its return stroke and the cylinder completes its half-revolution at slow speed. Just as the bed completes its return stroke and again reverses, the gear 59 rotates into the position shown in Fig. 7, bringing the roller 77 on the arm 76 into position to be struck by the tappet-arm 78, and the cam 88, operating through the connections before described, rocks the tappet-arm 78, thereby swinging the segment-carrying lever 74 and rotating the gear 71. The rotation of the gear 71 throws the locking-lever 65 and withdraws its projection 66 from the notch 62. As this occurs the segmental cam 51, which runs at a constant speed, which is, as before stated, one and one-quarter times the high or printing speed of the cylinder, and consequently two and a half times its slow speed, has gained three-quarters of a revolution on the cylinder and runs out from under the roller 50. (See Fig. 6.) This allows the springs 44 to throw the levers 38 and lock the cylinder to the gear 34, which gear is constantly in mesh with the rack 33. At about this time the eccentric 20 operates to depress the cylinder-boxes and bring the cylinder into its printing position. During the half-revolution before referred to the grippers which coöperate with the surface 32'' have passed the gripper-operating lever 107; but it will be understood that the cam 111, which controls this lever, is of such a contour that the lever has been moved so that the roller 102 has passed under the projections 105 106 without touching them. The position of the cylinder and impression-surfaces in relation to the beds at this time is shown in Fig. 14. In this figure it will be seen that the impression-surface 32'' has the sheet S, which has received one impression and is about to pre-

sent it to the form-surface 5 to secure a second impression. A sheet S' is lying on the feed-board 92 ready to be taken by the grippers which coöperate with the surface 32', and the cam 111 has swung the lever 107 so that the projection 105 has struck the roller 102 on the arm 101 of that pair of grippers which coöperates with the surface 32' and has operated, therefore, to open the grippers. As the cylinder continues its rotation the grippers close on the sheet and take it from the board. Referring to Fig. 15, it will be seen that the sheet S on the surface 32'' has received its second impression and the sheet S' on the surface 32' is about to receive its first impression from the form-surface 4. As the rotation of the cylinder continues the sheet on the surface 32' is presented to the form-surface 4 and receives its first impression. In the meantime the cam 111 operates to swing the gripper-operating lever 107 so that its projection 106 comes in contact with the roller 102 on the arm 101 of that pair of grippers which coöperates with the surface 32'' and opens the grippers, so that the sheet may be delivered. In Fig. 16 the sheet S is shown as lying on the tapes and the sheet S' has received its first impression, the bed having arrived at the point of reverse. The cylinder is at this moment released from the gear 34 through the mechanism which has been before described and is locked to gear 59. While the bed is moving from the position indicated in Fig. 16 to the position indicated in Fig. 17, the cylinder has made its half-revolution, bringing the sheet S' on the surface 32' in position to receive its second impression from the form-surface 5 and bringing the impression-surface 32' in position to take another sheet S² from the feed-board.

It will be seen that by the construction which has been before described the entire surface of the impression-cylinder has been utilized for impression purposes, with the exception of the slight space necessary for gripper-gaps. Furthermore, a machine is produced which prints from two form-surfaces alternately and with a run of the bed which is substantially only equal to the combined length of the form-surfaces plus the necessary spacing between the forms.

It is to be understood that the various mechanisms by which the several operations which are performed in this machine are effected may be widely varied. The invention is not, therefore, to be limited to the specific constructions which have been heretofore described, but is to be regarded as generic in its nature and as embracing all changes and modifications which fall within the spirit and scope.

What I claim is—

1. In a printing-machine, the combination with a continuously-rotating cylinder having sheet-retaining devices and a plurality of impression-surfaces, said surfaces being arranged close together, of a bed carrying a

plurality of forms, means for causing the impression-surfaces on the cylinder to coöperate with alternate form-surfaces on alternate strokes of the bed, and means for causing the retaining devices for each impression-surface to take and retain a sheet until it has been brought into contact with each printing-surface, substantially as described.

2. In a printing-machine, the combination with a continuously-rotating cylinder having sheet-retaining devices and a plurality of impression-surfaces, said surfaces being arranged close together, of raising and lowering devices for the cylinder, a bed carrying a plurality of forms, means for causing the impression-surfaces on the cylinder to coöperate with successive form-surfaces on successive strokes of the bed, and means for causing the retaining devices for each impression-surface to take and retain a sheet until it has been brought into contact with each printing-surface, substantially as described.

3. In a printing-machine, the combination with a continuously-rotating cylinder having sheet-retaining devices and a plurality of impression-surfaces, said surfaces being arranged close together, of means for raising and lowering the cylinder, a bed carrying a plurality of forms, means for rotating the cylinder at the same speed as the bed during the printing stroke of the bed, means for rotating it at a different speed during the return stroke of the bed, and means for operating the retaining devices for each impression-surface to take and retain a sheet until it is brought into contact with each printing-surface, whereby the impression-surfaces on the cylinder are caused to coöperate alternately with the form-surfaces on the bed during successive strokes of the bed, substantially as described.

4. In a printing-machine, the combination with a continuously-rotating cylinder having a plurality of impression-surfaces, of means for raising and lowering the cylinder, a bed having a plurality of forms, means for rotating the cylinder at the same speed as the bed during the printing stroke of the bed, and means for rotating it at a different speed during the return stroke of the bed, whereby the impression-surfaces on the cylinder are caused to coöperate with alternate form-surfaces on the bed during alternate strokes of the bed, substantially as described.

5. In a printing-machine, the combination with a continuously-rotating cylinder having sheet-retaining devices and a plurality of impression-surfaces, said surfaces being arranged close together, a bed carrying a plurality of forms, means for reciprocating it, means for separating the bed and cylinder during the return stroke of the bed, means for rotating the cylinder from the bed and at the same speed as the bed during its printing stroke, means for rotating it at a different speed during the return stroke of the bed, and means for operating the retaining devices for

each impression-surface to take and retain a sheet until it is brought into contact with each printing-surface, whereby the impression-surfaces on the cylinder are caused to coöperate with alternate form-surfaces on the bed during alternate strokes of the bed, substantially as described.

6. In a printing-machine, the combination with a cylinder having a plurality of impression-surfaces, of means for raising and lowering the cylinder, a bed having a plurality of forms, means for rotating the cylinder from the bed and at the same speed as the bed during its printing stroke, and means for rotating it at a different speed during the return stroke of the bed, whereby the impression-surfaces on the cylinder are caused to coöperate with alternate form-surfaces on the bed during alternate strokes of the bed, substantially as described.

7. In a printing-machine, the combination with a cylinder having a plurality of impression-surfaces, of a bed having a plurality of forms, means for rotating the cylinder from the bed and at the same speed as the bed during its printing stroke, and means for rotating it at a different speed during the return stroke of the bed, whereby the impression-surfaces on the cylinder are caused to coöperate with alternate form-surfaces on the bed during alternate strokes of the bed, substantially as described.

8. In a printing-machine, the combination with a cylinder having a plurality of impression-surfaces, of a bed having a plurality of forms, means for rotating the cylinder from the bed and at the same speed as the bed during its printing stroke, and means for rotating the cylinder from the bed but at a different speed therefrom during the return stroke of the bed, whereby the impression-surfaces on the cylinder are caused to coöperate with alternate forms on the bed during alternate strokes of the bed, substantially as described.

9. In a printing-machine, the combination with a cylinder having two impression-surfaces, of a bed having two forms thereon, means for rotating the cylinder at the same speed as the bed during its printing stroke, and means for rotating it at a different speed during the return stroke of the bed, whereby the impression-surfaces on the cylinder are caused to coöperate with alternate form-surfaces on the bed during alternate strokes of the bed, substantially as described.

10. In a printing-machine, the combination with a cylinder having two impression-surfaces, of a bed having two forms thereon, means for rotating the cylinder from the bed and at the same speed as the bed during its printing stroke, and means for rotating it at a different speed during the return stroke of the bed, whereby the impression-surfaces on the cylinder are caused to coöperate with alternate form-surfaces on the bed during alternate strokes of the bed, substantially as described.

11. In a printing-machine, the combination with a cylinder having two impression-surfaces, of a bed having two forms thereon, means for rotating the cylinder from the bed and at the same speed as the bed during its printing stroke, and means for giving the cylinder a half-revolution during the return stroke of the bed, whereby the impression-surfaces on the cylinder are caused to coöperate with alternate form-surfaces on the bed during alternate strokes of the bed, substantially as described.

12. In a printing-machine, the combination with a cylinder having two impression-surfaces, of a bed having a plurality of forms, means for rotating the cylinder from the bed and at the speed of the bed during its printing stroke, and means for rotating the cylinder from the bed and at half the speed of the bed during its return stroke, whereby the impression-surfaces on the cylinder are caused to coöperate with alternate form-surfaces on the bed during alternate strokes of the bed, substantially as described.

13. In a printing-machine, the combination with a cylinder having two impression-surfaces, of raising and lowering devices for the cylinder, a bed having two forms thereon, means for rotating the cylinder from the bed and at the same speed as the bed during its printing stroke, and means for giving the cylinder a half-revolution during the return stroke of the bed, whereby the impression-surfaces on the cylinder are caused to coöperate with alternate form-surfaces on the bed during alternate strokes of the bed, substantially as described.

14. In a printing-machine, the combination with a cylinder having two impression-surfaces, of raising and lowering devices for the cylinder, a bed having a plurality of forms, means for rotating the cylinder from the bed and at the speed of the bed during its printing stroke, and means for rotating the cylinder from the bed and at half the speed of the bed during its return stroke, whereby the impression-surfaces on the cylinder are caused to coöperate with alternate form-surfaces on the bed during alternate strokes of the bed, substantially as described.

15. In a printing-machine, the combination with a cylinder having a plurality of impression-surfaces, of a bed having a plurality of forms, a gear for driving the cylinder at the speed of the bed during its printing stroke, means for connecting the cylinder to and disconnecting it from said gear, a second gear for driving the cylinder at a different speed from the speed of the bed during its return stroke, means for connecting the cylinder to and disconnecting it from said second gear, and means for driving the gears, substantially as described.

16. In a printing-machine, the combination with a cylinder having a plurality of impression-surfaces, of a bed having a plurality of forms, a gear for driving the cylinder at the

speed of the bed during its printing stroke, means for connecting the cylinder to and disconnecting it from said gear, a second gear for driving the cylinder at a different speed from the speed of the bed during its return stroke, means for connecting the cylinder to and disconnecting it from said second gear, and means for driving each gear from the bed, substantially as described.

10 17. In a printing-machine, the combination with a cylinder having a plurality of impression-surfaces, of raising and lowering devices for the cylinder, a bed having a plurality of forms, a gear for driving the cylinder at the speed of the bed during its printing stroke, means for connecting the cylinder to and disconnecting it from said gear, a second gear for driving the cylinder at a different speed from the speed of the bed during its return stroke, means for connecting the cylinder to and disconnecting it from said second gear, and means for driving the gears, substantially as described.

15 18. In a printing-machine, the combination with a cylinder having a plurality of impression-surfaces, of raising and lowering devices for the cylinder, a bed having a plurality of forms, a gear for driving the cylinder at the speed of the bed during its printing stroke, means for connecting the cylinder to and disconnecting it from said gear, a second gear for driving the cylinder at a different speed from the speed of the bed during its return stroke, means for connecting the cylinder to and disconnecting it from said second gear, and means for driving each gear from the bed, substantially as described.

20 19. In a printing-machine, the combination with a cylinder having two impression-surfaces, of a bed having two forms, a gear for driving the cylinder at the speed of the bed during its printing stroke, means for connecting the cylinder to and disconnecting it from said gear, a second gear for driving the cylinder at half the speed of the bed during its return stroke, means for connecting the cylinder to and disconnecting it from said second gear, and means for driving the gears, substantially as described.

25 20. In a printing-machine, the combination with a cylinder having two impression-surfaces, of raising and lowering devices for the cylinder, a bed having two forms, a gear for driving the cylinder at the speed of the bed during its printing stroke, means for connecting the cylinder to and disconnecting it from said gear, a second gear for driving the cylinder at half the speed of the bed during its return stroke, means for connecting the cylinder to and disconnecting it from said second gear, and means for driving the gears, substantially as described.

30 21. In a printing-machine, the combination with a cylinder having two impression-surfaces, of a bed having two forms, a gear for driving the cylinder at the speed of the bed during its printing stroke, means for connect-

ing the cylinder to and disconnecting it from said gear, a second gear for driving the cylinder at half the speed of the bed during its return stroke, means for connecting the cylinder to and disconnecting it from said second gear, and means for driving each gear from the bed, substantially as described.

35 22. In a printing-machine, the combination with a cylinder having two impression-surfaces, of raising and lowering devices for the cylinder, a bed having two forms, a gear for driving the cylinder at the speed of the bed during its printing stroke, means for connecting the cylinder to and disconnecting it from said gear, a second gear for driving the cylinder at half the speed of the bed during its return stroke, means for connecting the cylinder to and disconnecting it from said second gear, and means for driving each gear from the bed, substantially as described.

40 23. In a printing-machine, the combination with a cylinder having a plurality of impression-surfaces, of a bed having a plurality of forms, a gear for driving the cylinder at the speed of the bed during the printing stroke, a gear for driving the cylinder at half the speed of the bed during the return stroke of the bed, means for connecting the cylinder to and disconnecting it from said gears, two racks on the bed, means for driving the full-speed gear directly from one of the racks, and means for driving the other gear from the other rack, substantially as described.

45 24. In a printing-machine, the combination with a cylinder having a plurality of form-surfaces, of a bed having a plurality of forms, a gear, a rack on the bed with which said gear is constantly in mesh, a second gear, a second rack on the bed, a train of reducing-gearing between the second rack and the second gear, and means for connecting the cylinder to and disconnecting it from each of the gears, substantially as described.

50 25. In a printing-machine, the combination with a cylinder having a plurality of form-surfaces, of raising and lowering devices for the cylinder, a bed having a plurality of forms, a gear, a rack on the bed with which said gear is constantly in mesh, a second gear, a second rack on the bed, a train of reducing-gearing between the second rack and the second gear, and means for connecting the cylinder to and disconnecting it from each of the gears, substantially as described.

55 26. The combination with a cylinder, of a gear, locking devices between the cylinder and the gear, a rotating cam operating to unlock the locking devices at predetermined times and to hold them unlocked for a specified period, and means for rotating the cylinder while it is unlocked from the gear, substantially as described.

60 27. The combination with a reciprocating bed having a rack, of a gear in mesh with said rack, a cylinder cooperating with the bed, locking devices between the cylinder and the gear, a rotating cam operating to unlock the lock-

ing devices at predetermined times and to hold them unlocked for a specified period, and means for rotating the cylinder while it is unlocked from the gear, substantially as described.

28. The combination with a cylinder, of a gear, locking devices between the cylinder and the gear, a second gear, means for locking the cylinder to and unlocking it from said second gear, means for driving the gears at different speeds, and a cam operating to release the locking devices which lock the cylinder to the first gear and hold them released while the cylinder is locked to the second gear, substantially as described.

29. The combination with a cylinder, of a gear, locking devices between the cylinder and the gear, a second gear, means for locking the cylinder to and unlocking it from said second gear, means for driving the gears at different speeds, and a rotating cam operating to release the locking devices which lock the cylinder to the first gear and hold them released while the cylinder is locked to the second gear, substantially as described.

30. The combination with a cylinder, of a gear for rotating the cylinder at a given speed, a second gear for rotating the cylinder at a lower speed, locking devices between the cylinder and each of the gears, and a constantly-rotating cam operating to release the locking devices which secure the cylinder to the high-speed gear and hold them released while the cylinder is locked to the low-speed gear, substantially as described.

31. The combination with a cylinder, of a reciprocating bed, racks moving with the bed, a gear for driving the cylinder at the speed of the bed, a gear for driving the cylinder at a lower speed, means whereby each of these gears is driven from the racks on the bed, locking devices between the cylinder and each of the gears, and a rotating cam operating to release the locking devices which secure the cylinder to the high-speed gear and hold them released while the cylinder is locked to the low-speed gear, substantially as described.

32. The combination with a reciprocating bed carrying two forms, of an impression-cylinder having two impression-surfaces, racks moving with the bed, a gear for driving the cylinder at the speed of the bed and operating to drive the cylinder during the printing stroke of the bed, a gear for driving the cylinder at half the speed of the bed and operating to drive the cylinder during the return stroke of the bed, locking devices between the cylinder and each of the gears, a segmental cam operating to release the locking devices which secure the cylinder to the high-speed gear and hold them released while the cylinder is locked to the low-speed gear, and means for rotating the cam at a constant speed, substantially as described.

33. The combination with a reciprocating bed carrying two forms, of two racks moving

with the bed, an impression-cylinder having two impression-surfaces, two gears loosely mounted on the shaft of the cylinder, locking devices between the cylinder and these gears, means whereby one of the gears is driven by one of the racks at the speed of the bed, means whereby the other gear is driven by the other rack at half the speed of the bed, a segmental cam operating to release the locking devices which secure the cylinder to the high-speed gear and hold them released while the cylinder is locked to the low-speed gear, and means for rotating the segmental cam at a constant rate of speed, substantially as described.

34. The combination with a reciprocating bed carrying two form-surfaces, of an impression-cylinder having two impression-surfaces, two racks moving with the bed, a gear in mesh with one of the racks and operating to drive the cylinder at the speed of the bed, locking devices between the cylinder and said gear, a second gear operating to drive the cylinder at half the speed of the bed, a train of gearing between the other rack and this second gear, locking devices between the cylinder and said second gear, a rotating segmental cam operating to release the locking devices which lock the cylinder to the high-speed gear and hold them released while the cylinder is locked to the low-speed gear, and means for driving the segmental cam at a constant speed, substantially as described.

35. The combination with an impression-cylinder having two impression-surfaces, of a gripper-operating mechanism cooperating with each surface, an arm for operating each gripper mechanism, a lever for operating the arm to open the grippers, said lever having two projections for operating the grippers at different points, means for so positioning the lever that the gripper-operating arms may strike either of the projections or may pass the lever without striking the projections, and means for closing the grippers, substantially as described.

36. The combination with an impression-cylinder having a plurality of impression-surfaces, of a set of grippers cooperating with each surface, a gripper-operating arm for each set of grippers, a lever having projections which operate to open the grippers at two points, means for positioning the lever so that its projections may operate to open the grippers or the grippers may pass the lever without being operated, and means for closing the grippers, substantially as described.

37. The combination with an impression-cylinder having two impression-surfaces, of a set of grippers operating in connection with each surface, an operating-arm for each set of grippers, connections between the arms and the grippers, a lever having two operating projections which operate to open the grippers at two points, means for closing the grippers, means for setting the lever so that either of its projections may operate the grip-

persor so that the grippers may pass the lever without being operated, and means for closing the grippers, substantially as described.

5 38. The combination with a cylinder and its shaft, of a notched disk carried by the shaft, a gear loosely mounted on the shaft, a locking-lever carried by the gear, a pinion mounted on the gear, connections between the pinion and the locking-lever, a segment
10 also mounted on the gear, and means for operating the segment to throw the locking-lever, substantially as described.

39. The combination with a cylinder and its shaft, of a notched disk carried by the
15 shaft, a gear loosely mounted on the shaft, a

locking-lever carried by the gear, a pinion mounted on the gear, connections between the pinion and the locking-lever, a segment also mounted on the gear, a tappet-arm mounted on the frame of the machine, and means 20 for rocking the tappet-arm to operate the segment, substantially as described.

In testimony whereof I have hereunto set my hand in the presence of two subscribing witnesses.

THOMAS M. NORTH.

Witnesses:

F. W. H. CRANE,
L. ROEHM.