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AUTOMATIC MILLING MACHINE.

No. 576,979. Patented Feb. 9, 1897.

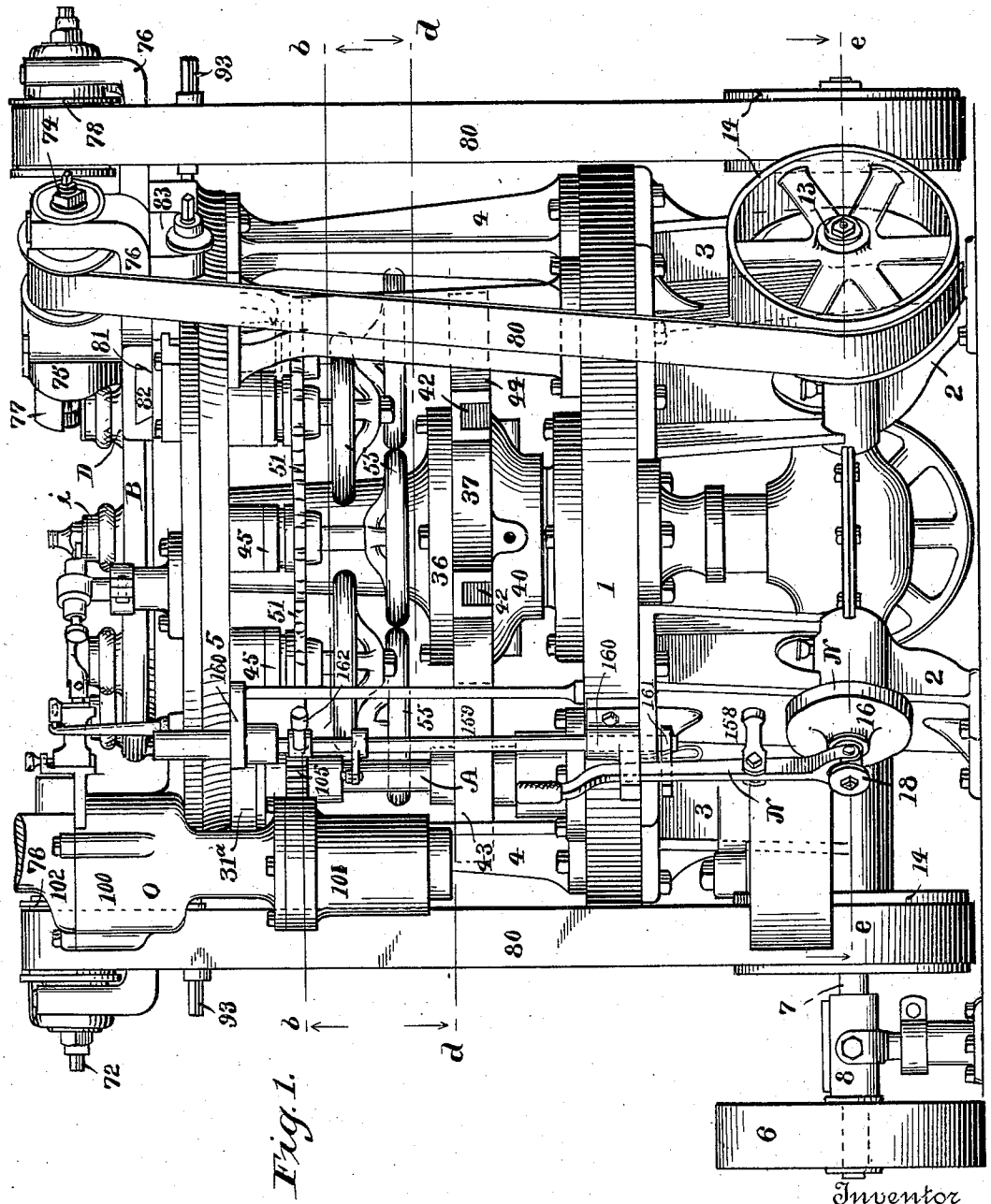

Fig. 1.

Witnesses

R. H. Newman.

Daniel L. Slason.

Inventor

JAMES GREGORY

By

Chamberlain & Newman Attorneys.

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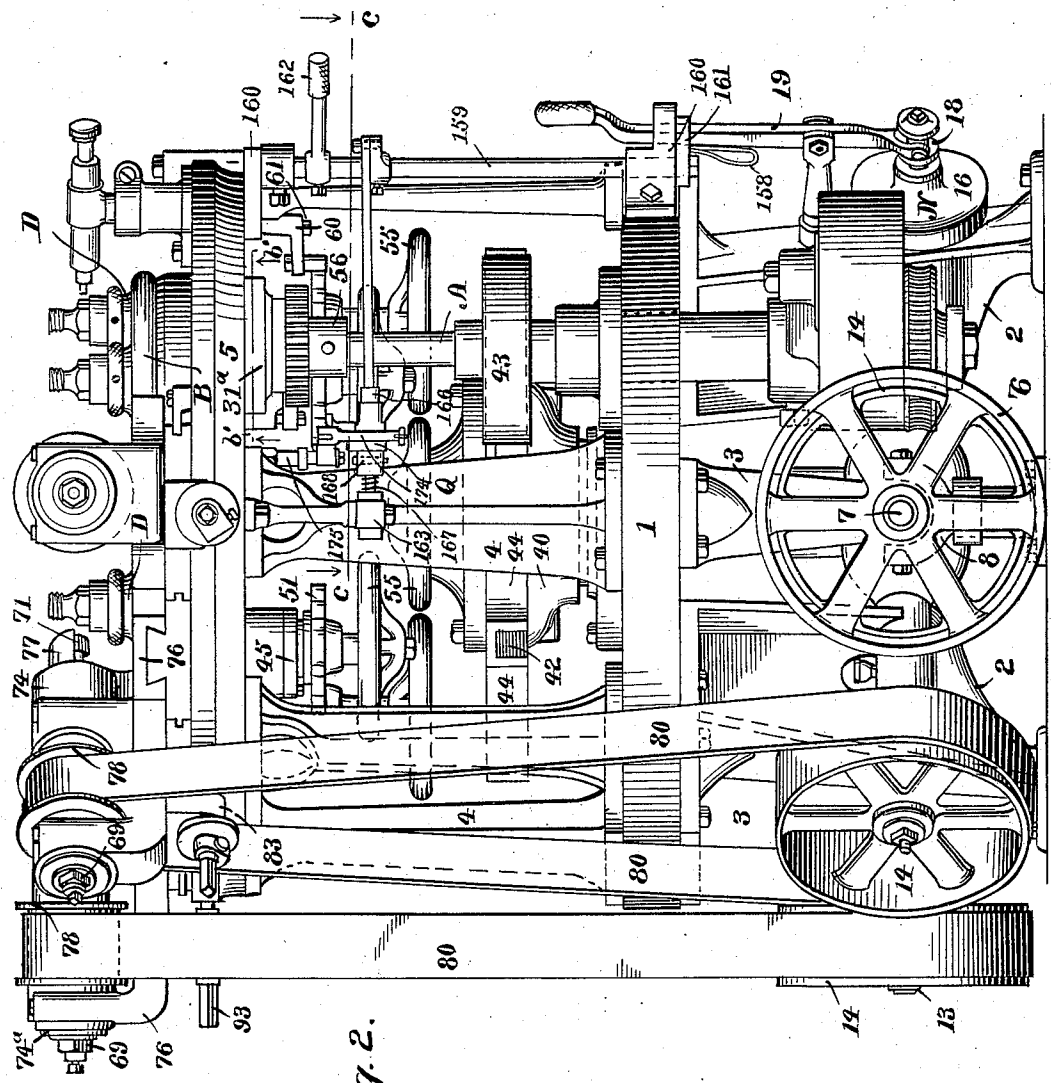

Fig. 2.

Witnesses
R. H. Newman.
Harriet L. Slason.

Inventor
JAMES GREGORY
By
Chamberlain & Newman Attorneys

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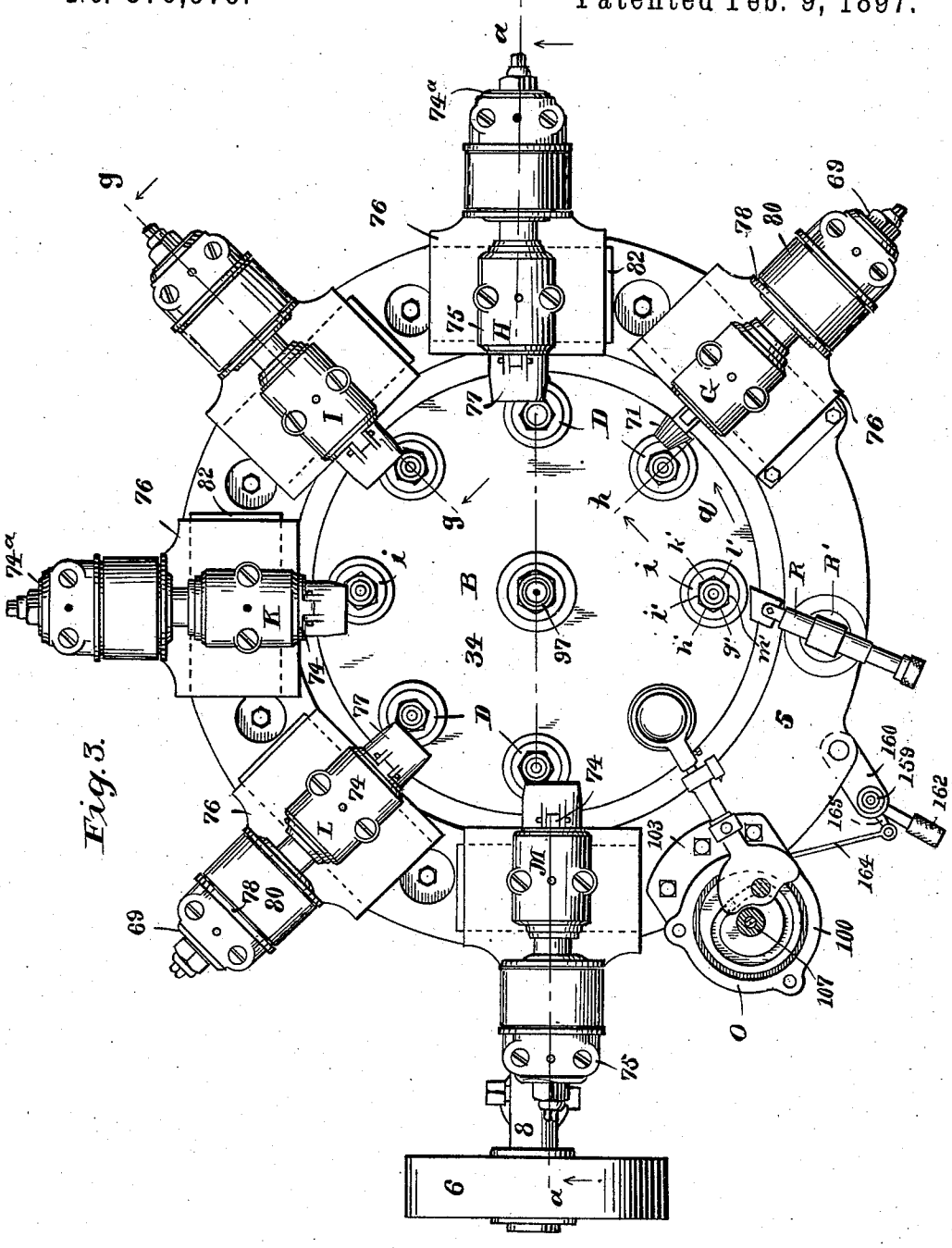

Fig. 3.

Witnesses
R. H. Newman.
Harriet L. Slason.

Inventor
JAMES GREGORY
By
Chamberlain & Newman
Attorneys.

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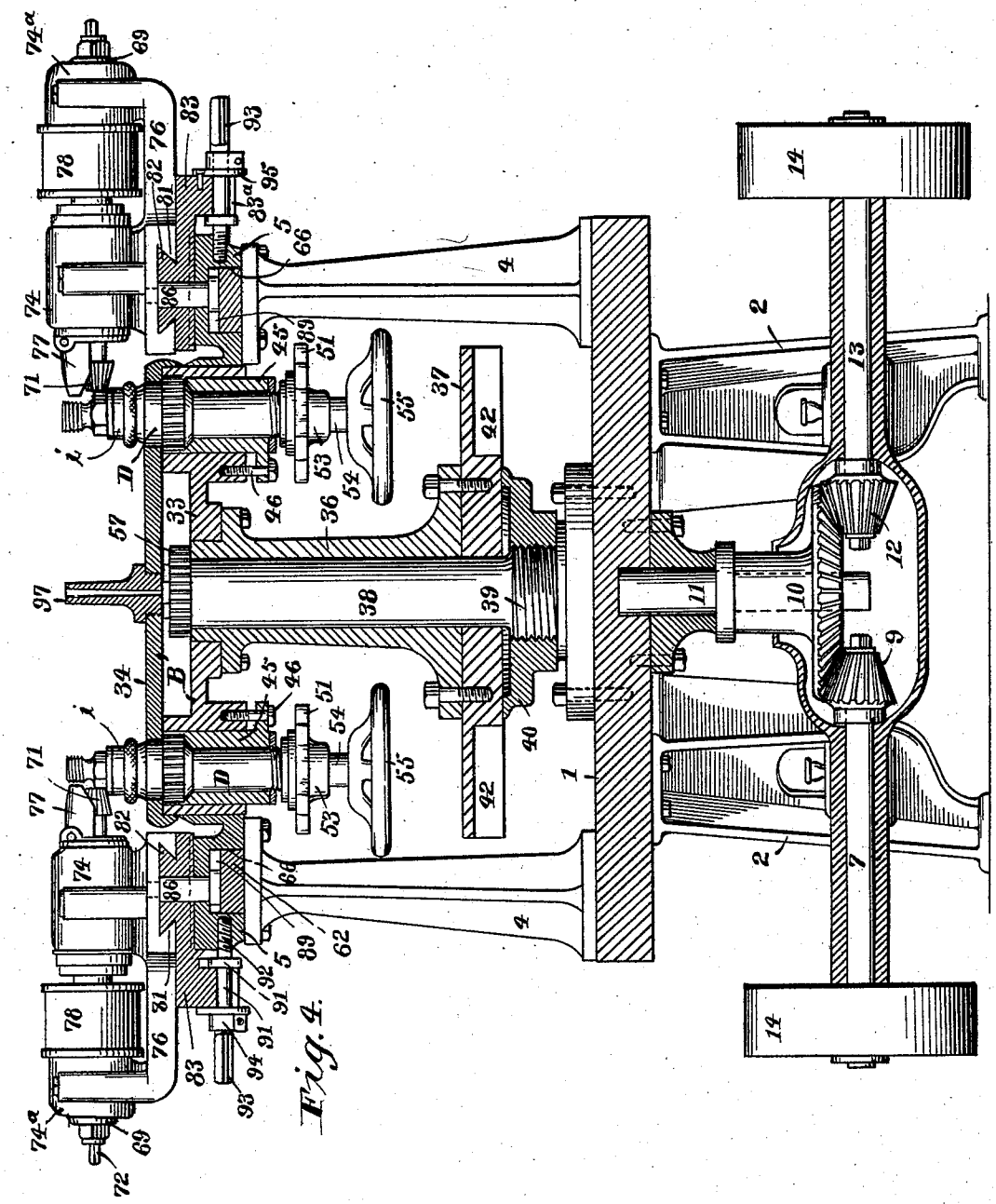

Fig. 4.

Witnesses

R. H. Newman.

Harriet L. Mason.

Inventor

JAMES GREGORY

By

Chamberlain & Newman Attorneys

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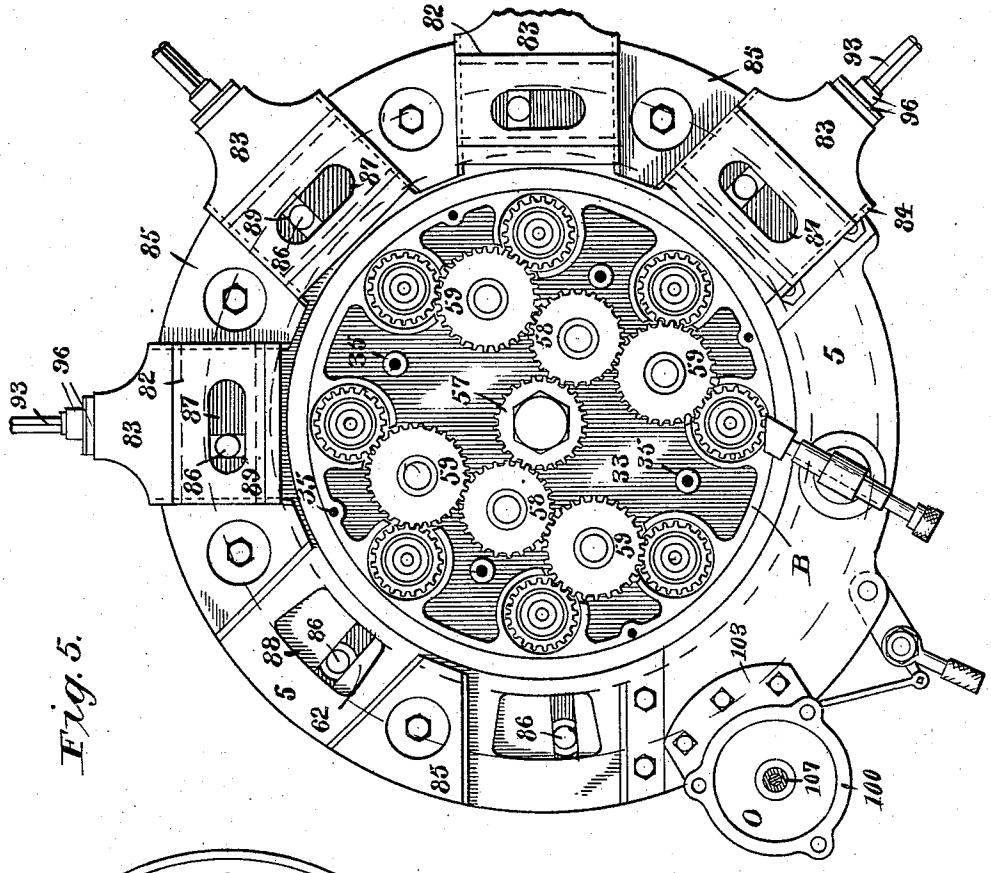
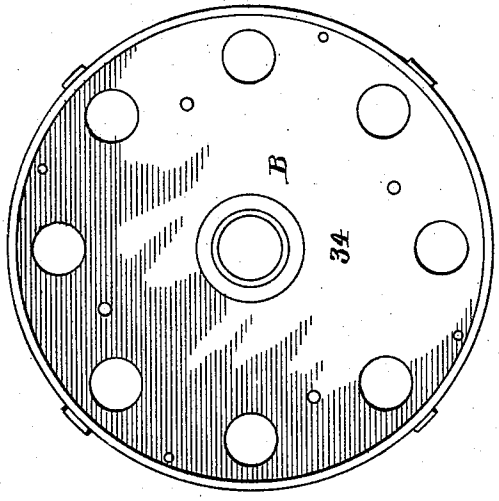


Fig. 5.



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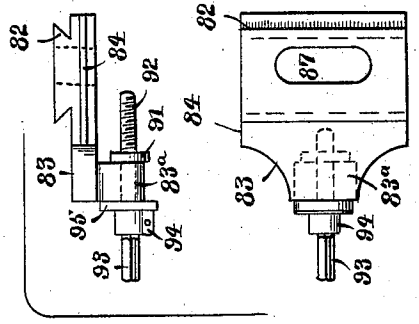

Fig. 7.

Witnesses
R. H. Newman.
Harriet L. Glason.

Inventor
JAMES GREGORY
By
Chamberlain & Newman Attorneys.

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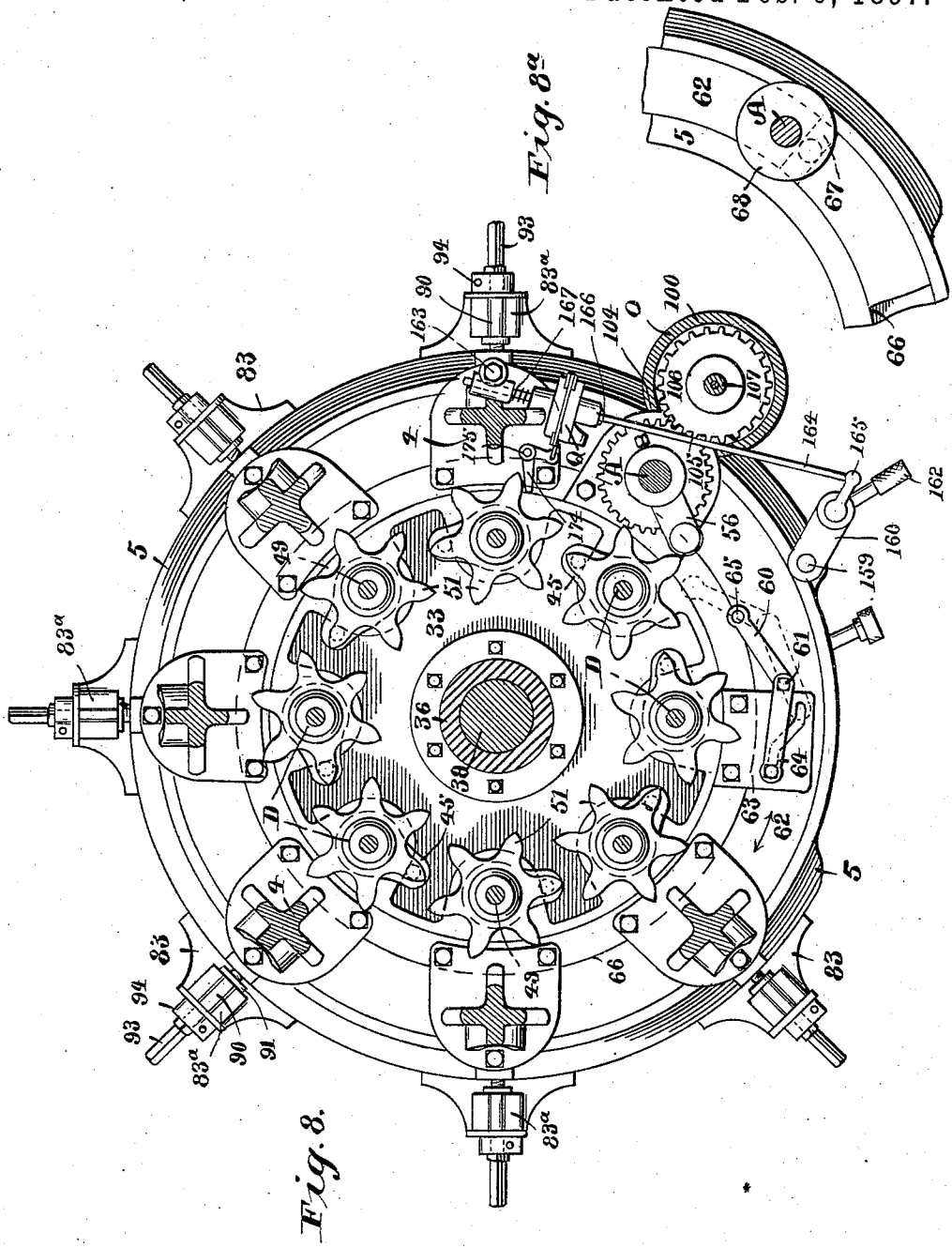

Fig. 8.

Fig. 8a

Witnesses

R. H. Newman.

Harriet L. Slason.

Inventor

JAMES GREGORY

By

Chamberlain & Newman Attorneys

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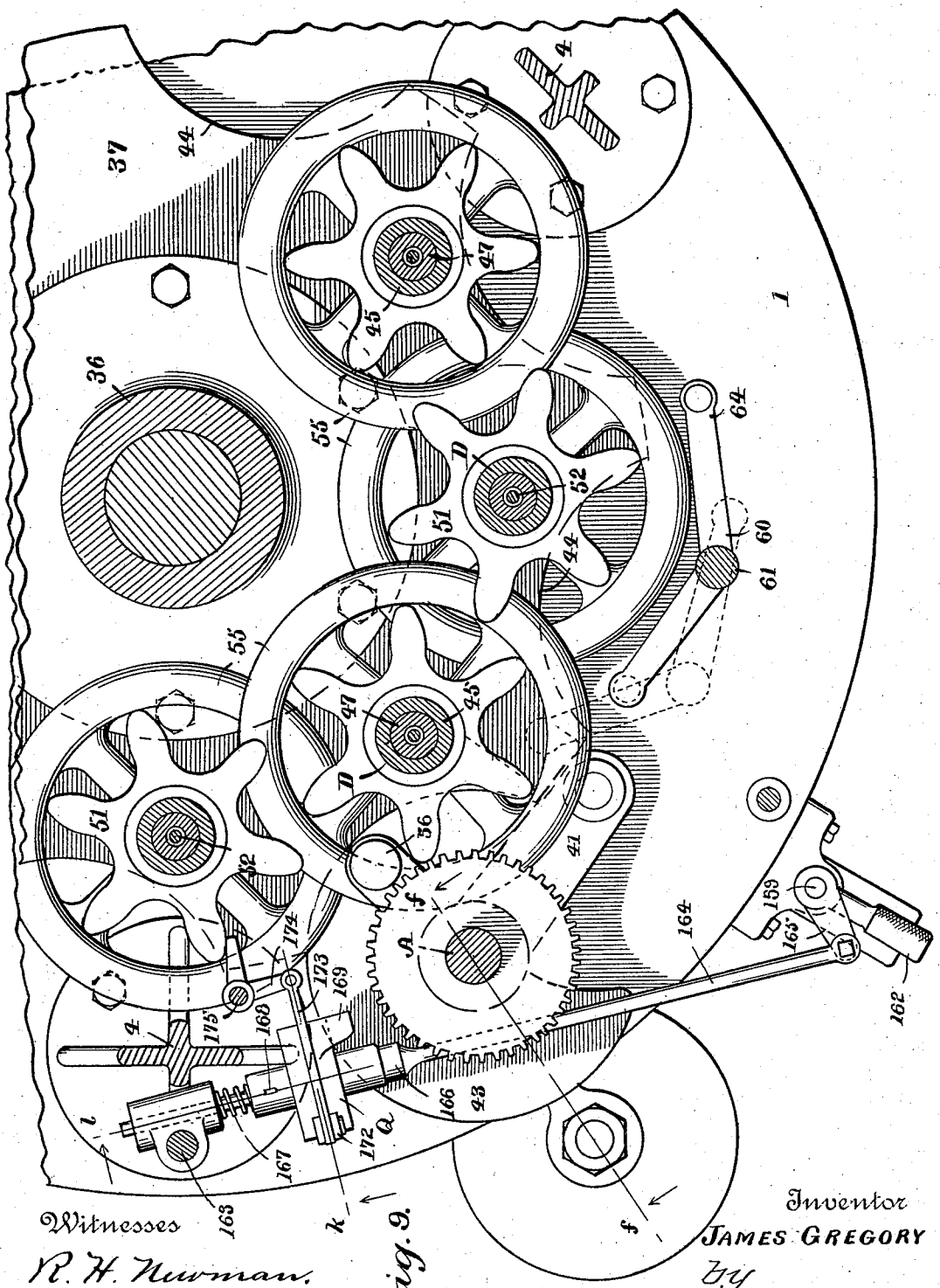

Fig. 9.

Witnesses
R. H. Newman.
Harriet L. Mason.

Inventor
JAMES GREGORY
By
Chamberlain & Newman Attorneys

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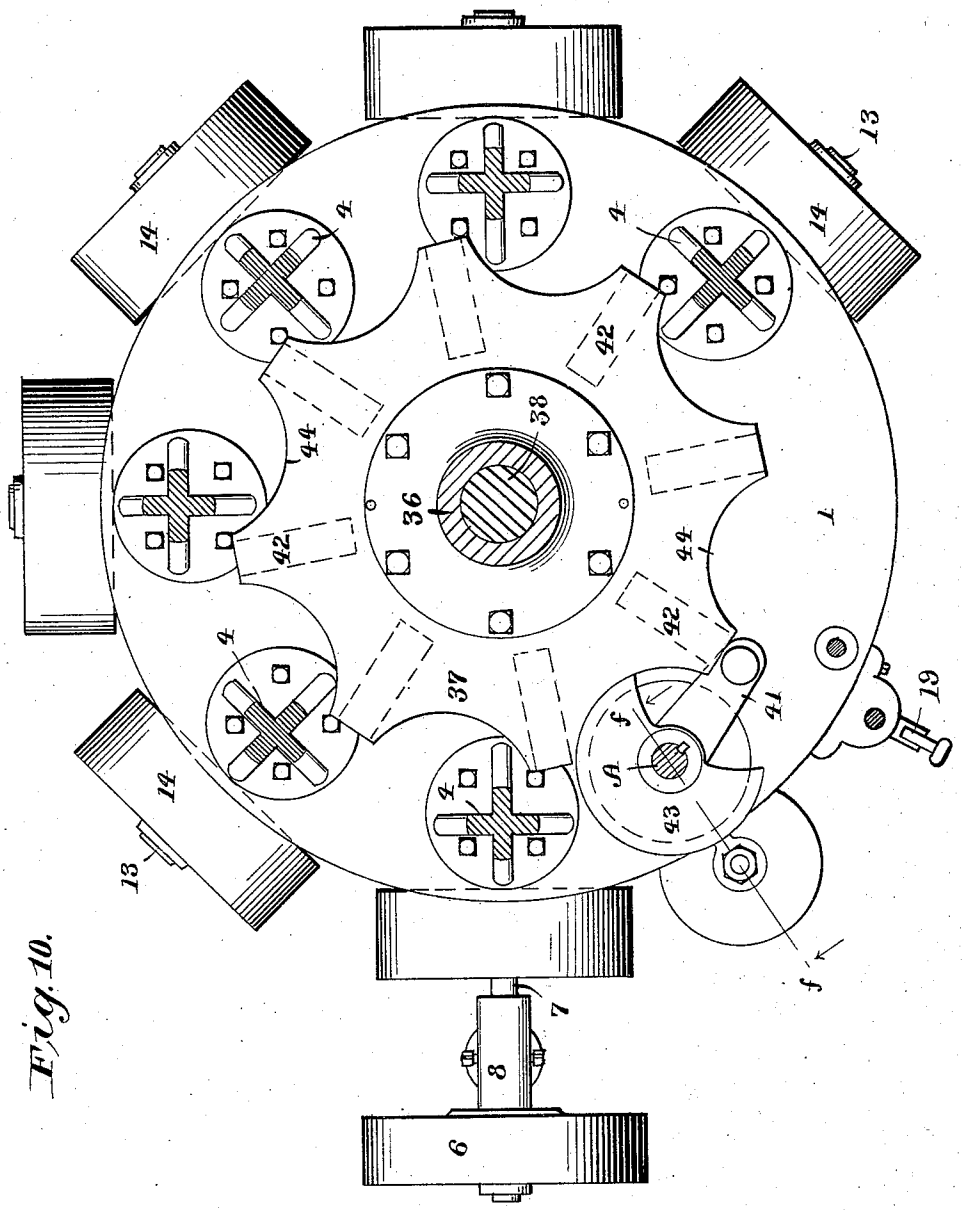

Fig. 10.

Witnesses
R. H. Newman
Harriet L. Slason

Inventor
JAMES GREGORY
By
Chamberlain & Newman Attorneys

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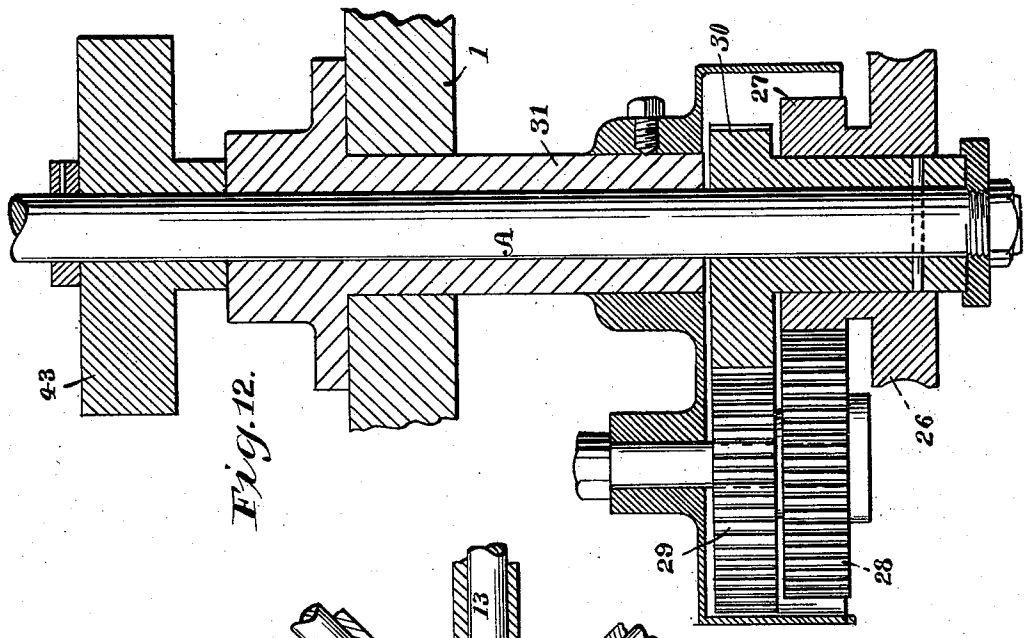

Fig. 12.

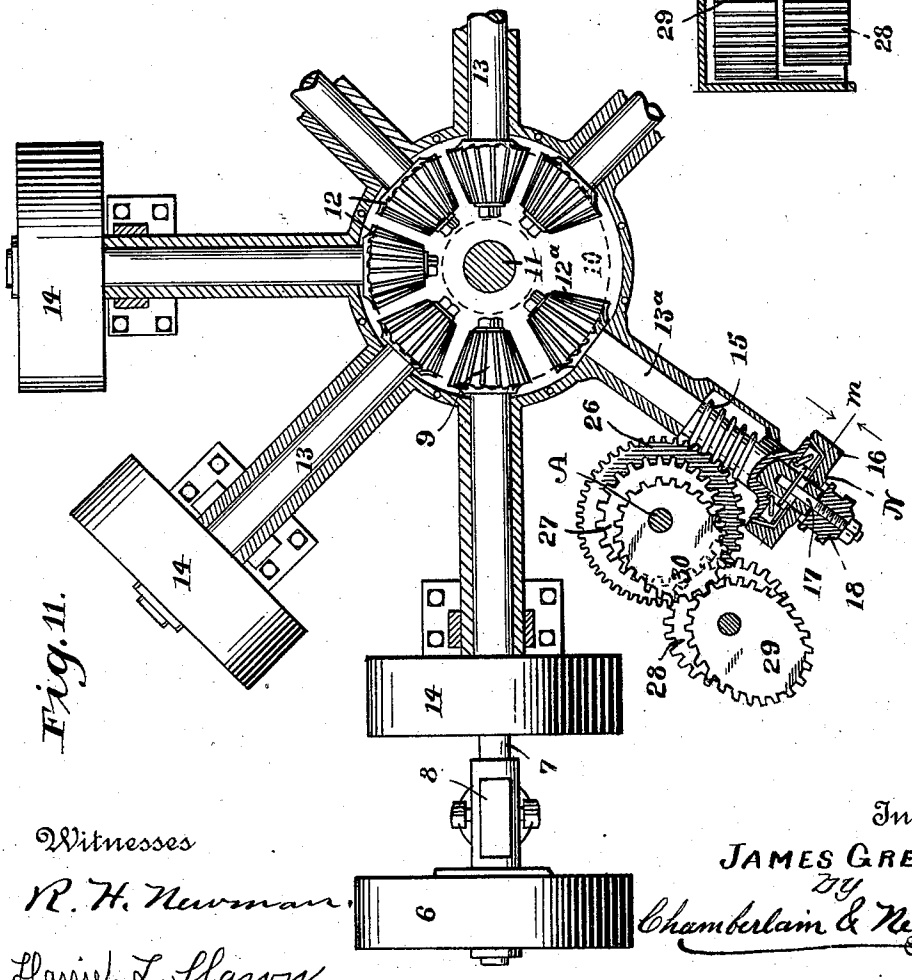

Fig. 11.

Witnesses
R. H. Newman.
Harriet L. Slason.

Inventor
JAMES GREGORY
By
Chamberlain & Newman
Attorneys

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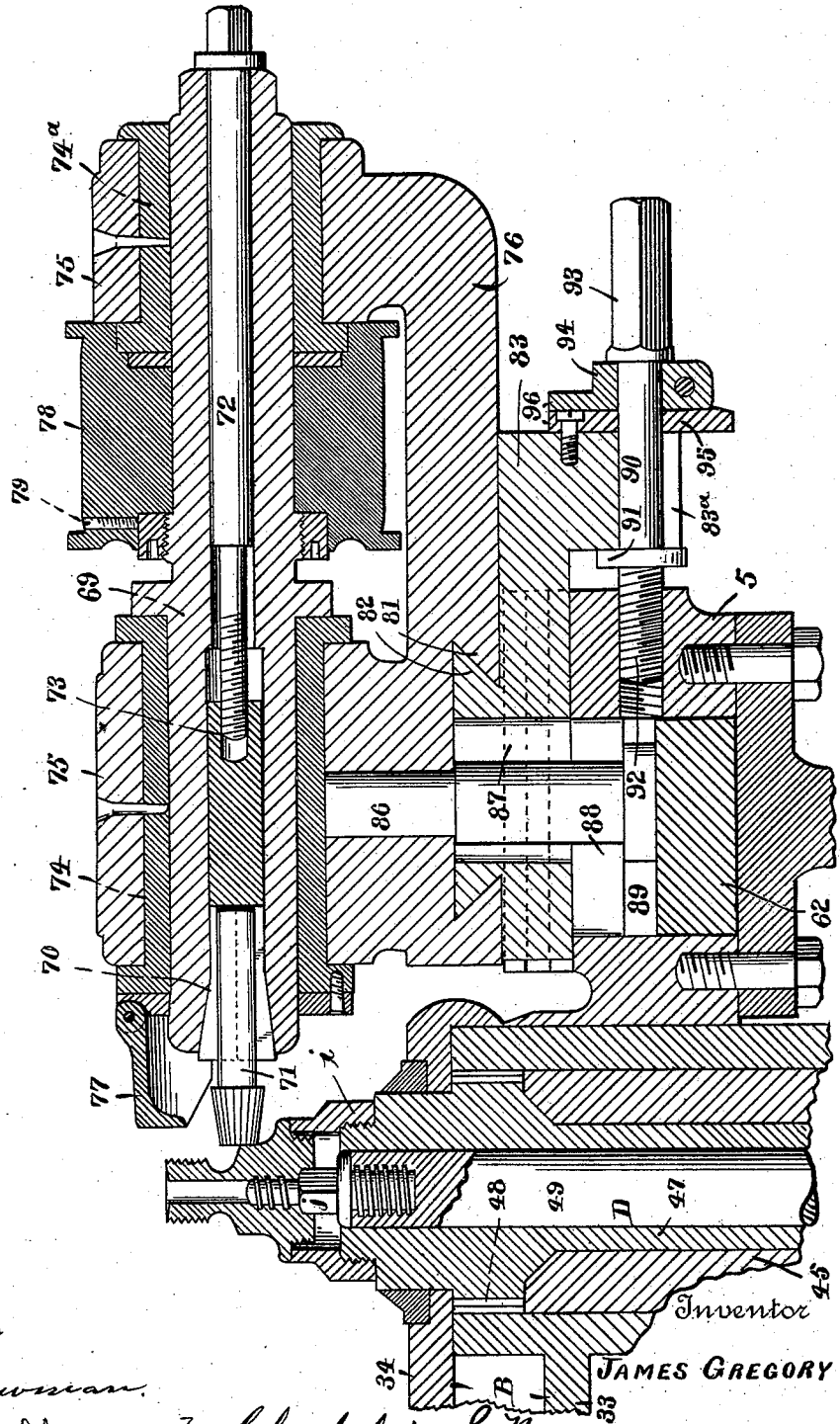

Fig. 13.

Witnesses
R. H. Newman.
Harold L. Sloan

Inventor
JAMES GREGORY
By Chamberlain & Newman. Attorneys

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Fig. 17.

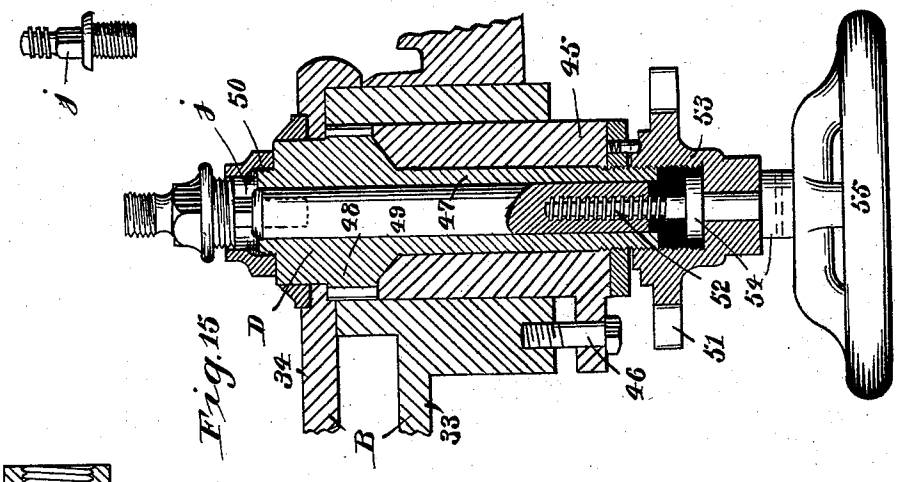
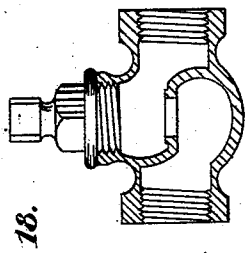


Fig. 15.

Fig. 18.



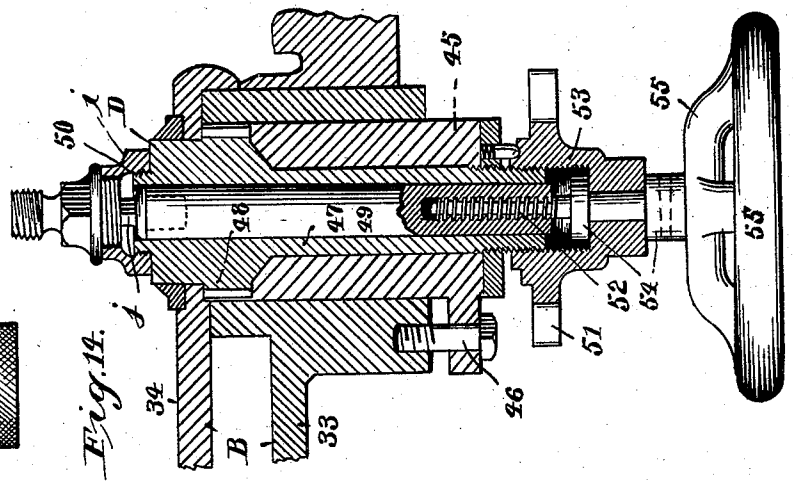
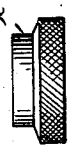


Fig. 14.

Fig. 16.



Witnesses

R. H. Newman.

Daniel L. Slason.

Inventor

JAMES GREGORY

By

Chamberlain & Newman Attorneys

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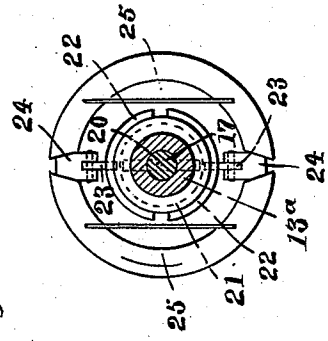


Fig. 22.

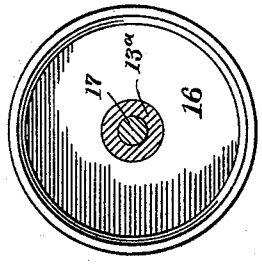


Fig. 21.

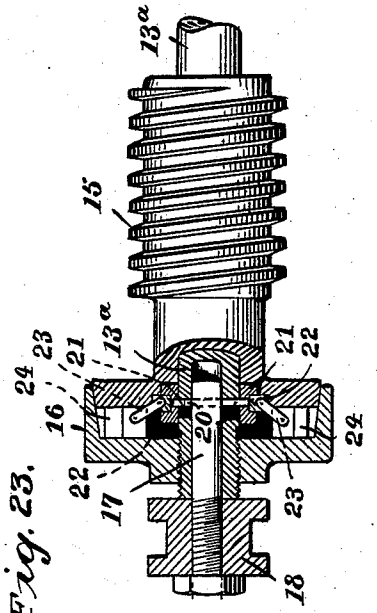
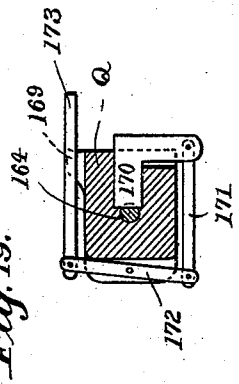


Fig. 23.



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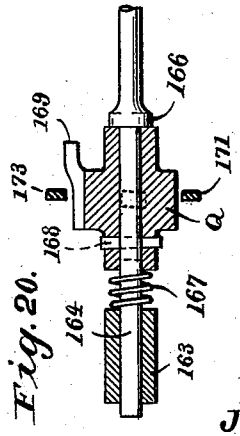

Fig. 20.

Witnesses

R. H. Newman,

Harriet L. Slason.

Inventor

JAMES GREGORY

By

Chamberlain & Newman Attorneys

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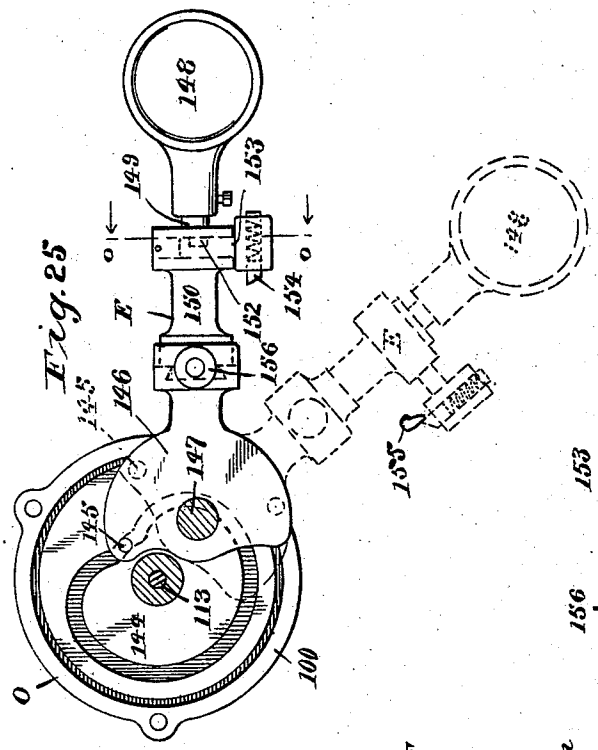

Fig. 25.

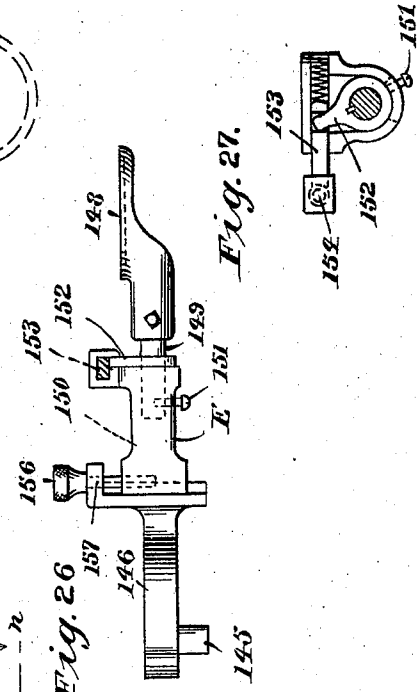

Fig. 27.

Fig. 26.

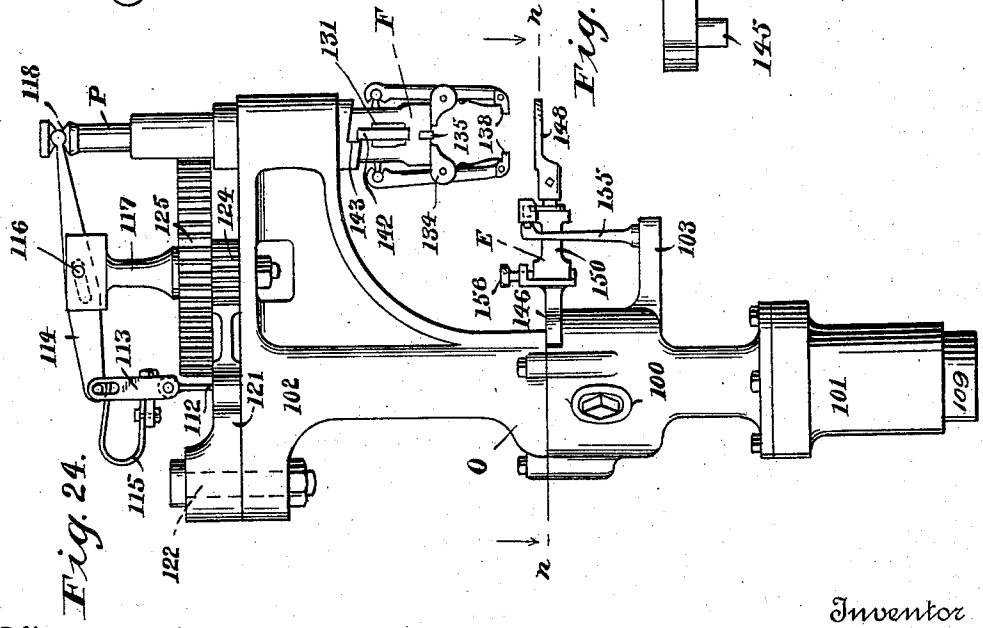

Fig. 24.

Witnesses

R. H. Newman.

Harriet L. Mason.

Inventor

JAMES GREGORY

by

Chamberlain & Newman Attorneys

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J. GREGORY.

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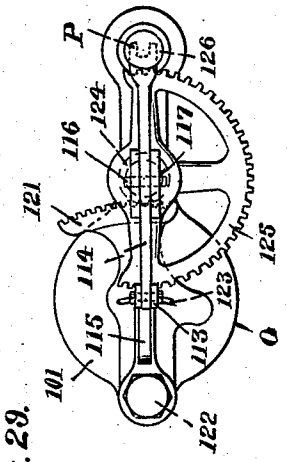

Fig. 29.

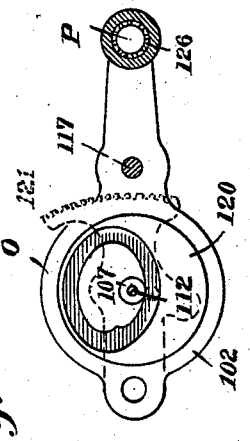

Fig. 30.

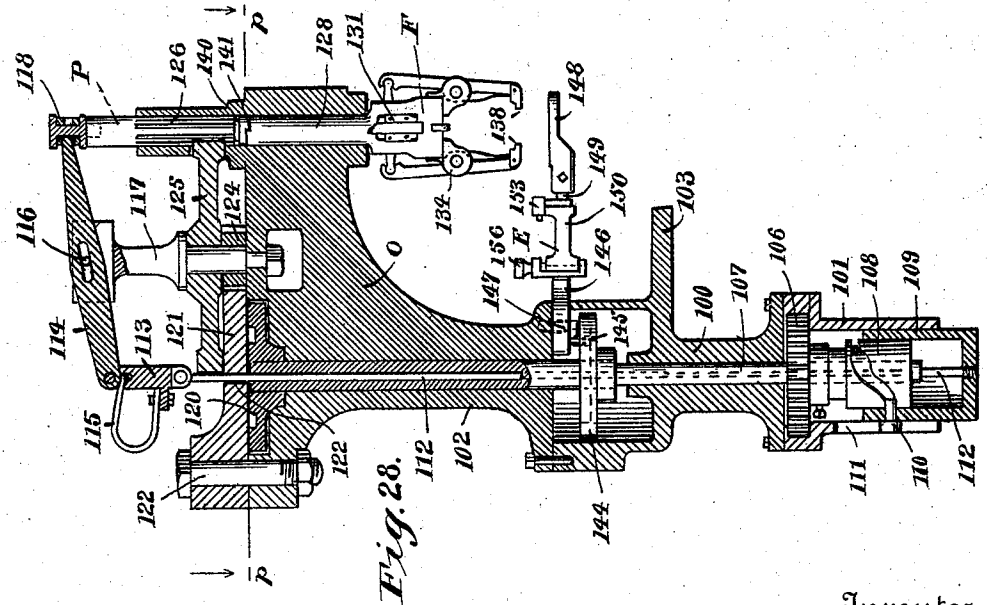

Fig. 28.

Witnesses
R. H. Newman.
Daniel L. Glasson.

Inventor
JAMES GREGORY
By
Chamberlain & Newman Attorneys

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J. GREGORY.

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Fig. 33.

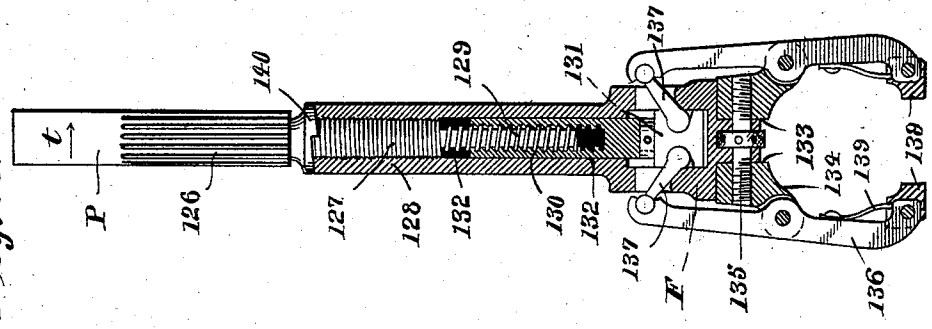


Fig. 32.

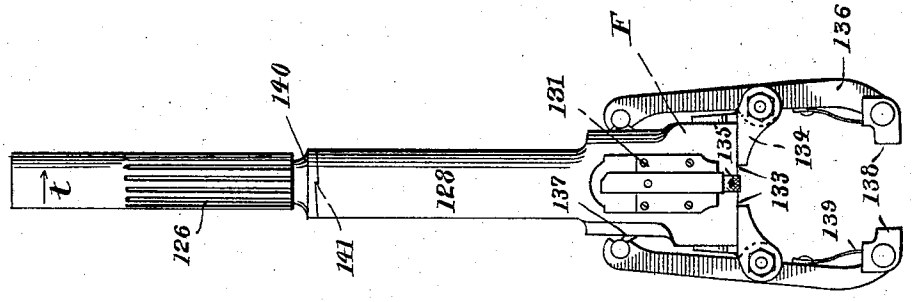
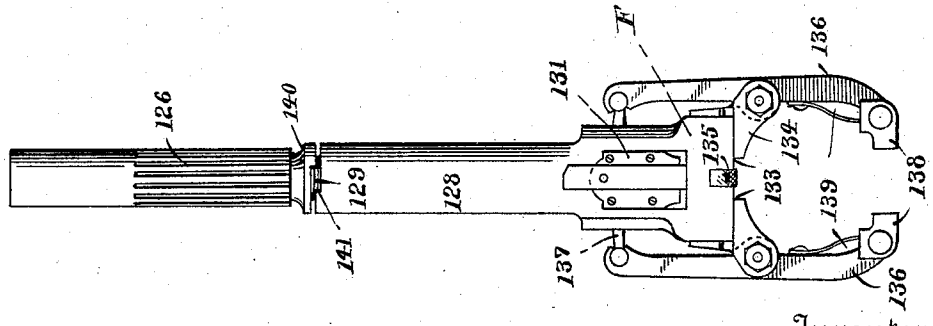


Fig. 31.



Witnesses

R. H. Newman.

Harriet L. Slason.

Inventor

JAMES GREGORY

By

Chamberlain & Newman Attorneys

UNITED STATES PATENT OFFICE.

JAMES GREGORY, OF BRIDGEPORT, CONNECTICUT.

AUTOMATIC MILLING-MACHINE.

SPECIFICATION forming part of Letters Patent No. 576,979, dated February 9, 1897.

Application filed February 12, 1896. Serial No. 579,095. (No model.)

To all whom it may concern:

Be it known that I, JAMES GREGORY, a citizen of the United States, and a resident of Bridgeport, in the county of Fairfield and State of Connecticut, have invented certain new and useful Improvements in Automatic Milling-Machines, of which the following is a specification.

This invention relates to new and useful improvements in automatic milling-machines, such, for instance, as are used to mill the straight sides of valve-bodies, hubs, waste-nuts, and the like.

It is the object of my invention to provide an automatic machine of the class specified which shall be particularly adapted for the milling of six-sided hubs, such, for instance, as are now used in the top of two-way valves and as is shown in Fig. 18 of the accompanying drawings. In the construction of this machine I provide adjustments to accommodate the different sizes of these hubs, means for securely retaining them in position with respect to the cutters for milling the same, means for carrying said hubs from one milling-station to another, and means for automatically removing the hubs from the machine after the same have been finally completed.

Upon the accompanying drawings, forming part of this specification, the same reference-characters denote like or corresponding parts upon the several figures, and of which—

Figure 1 shows a front elevation of my novel machine, the mechanism thereof for removing the hubs being broken away. Fig. 2 is a side elevation of the machine as seen from the left of Fig. 1, the hub-removing mechanism being detached. Fig. 3 is a top plan view of the machine, the hub-removing mechanism O being shown in sectional plan. Fig. 4 is a vertical cross-section on line *a a* of Fig. 3. Fig. 5 is a plan view of the machine with the milling-heads and their slides removed therefrom, the cover of the table B being removed, showing the gearing mechanism. Fig. 6 is an inverted plan view of the top cover 34 of the table B. Fig. 7 shows a detached side elevation and a plan view, respectively, of one of the slides 83, which support the carriage 76 of the milling-head. Fig. 8 is an inverted sectional plan view on line *b b* of Fig. 1, looking in the direction of arrow. Fig. 8ª is an inverted detail sectional plan view through shaft A, taken on line *b' b'* of Fig. 2. Fig. 9 is an enlarged sectional plan view on line *c c* of Fig. 2. (See arrow.) Fig. 10 is a sectional plan view on line *d d* of Fig. 1. (See arrow.) Fig. 11 is a sectional plan view, partly broken away, on line *e e* of Fig. 1. (See arrow.) Fig. 12 is an enlarged vertical sectional view on line *f f* of Figs. 9 and 10. Fig. 13 is an enlarged vertical central sectional view through one of the milling-heads C as taken on line *g g* of Fig. 3. Fig. 14 is an enlarged central vertical sectional view of one of the movable holders D, taken on line *h* of Fig. 3, said holder showing a hub secured therein ready to be milled. Fig. 15 is a similar sectional view, the central post 49 thereof and its hub being in a raised position to permit the free detachment of said hub. Figs. 16 and 17 show a side elevation of a detachable seat *i* and a fitting *j*, which are shown in section in Figs. 14 and 15, said seat and fitting being made in various sizes which are substituted to accommodate different sizes of hubs to be milled. Fig. 18 shows a side elevation of one of the finished hubs, also the valve of which it forms a part. Figs. 19 and 20 show vertical sectional views taken on lines *k* and *l*, respectively, of Fig. 9. Figs. 21 and 22 show enlarged sectional elevations of clutch mechanism, taken on line *m* of Fig. 11, looking in opposite directions. Fig. 23 is a vertical longitudinal sectional plan view of said clutch mechanism shown in Figs. 10, 21, and 22. Fig. 24 is a detached side elevation of the automatic mechanism for removing the hubs from the machine after they have been milled. Fig. 25 is an enlarged sectional plan view on line *n* of Fig. 24, showing in dotted lines the moved position of the arm E, which throws the completed hubs from the machine. Fig. 26 is an enlarged detached side elevation of said arm E. Fig. 27 is a cross-section on line *o o* of Fig. 25, the spring-actuated slide 153 being drawn out. Fig. 28 is a central vertical sectional view of the hub-removing mechanism, the position of the parts agreeing with Fig. 24 of the drawings. Fig. 29 is a top plan view of Fig. 24. Fig. 30 is a sectional plan view on line *p p* of Fig. 28. Figs. 31 and 32 show side elevations of the closed and open

positions of the gripping-head F for removing the hubs. Fig. 33 is a central vertical sectional view of said gripping-head, the position of the parts agreeing with Fig. 32.

Before entering into a detailed description of the construction of my machine I will briefly state the method of operating the same to afford a general idea of its operation and construction.

The machine consists of suitable framework and driving connections whereby the table B is given a number of rotary movements, eight of which constitute a complete rotation. Said table is provided with holders D, which serve to retain the hubs to be milled in their proper position during the several cutting operations thereon by the movable millers G, H, I, K, L, and M. These millers are stationed at equal distances apart upon the frame of the machine and each serve to mill off the respective surfaces g', h', i', k', l', and m' of said hub. By the time the several surfaces of the hub have been milled the same is around at the left of the table (see Figs. 1 and 3) in line with the mechanism for removing the same, which mechanism is shown in Figs. 24 to 27, inclusive, and operates as follows:

The hub is removed by a downward movement of the gripping-head F, after which the jaws thereof are forced together. Then the head is given a rotary movement, which disconnects the hub from its holder D, after which said hub is elevated sufficiently to allow the plate 148 to pass thereunder to receive said hub, whereupon said jaws are opened and the hub allowed to drop, after which the plate is carried to the dotted position shown in Fig. 25, where it is tilted outward, thereby dropping the hub therefrom. The holder then moves downward to receive another hub and the operations are so repeated.

It will be obvious from an inspection of the drawings that the construction and operation of the mechanism of each of the eight holders D, the six cutters, and the mechanism immediately connected therewith are substantially each duplicates of the other in each instance. Therefore I will refer to the like parts of these several sets of mechanism with similar reference-characters throughout the various figures in the drawings.

Frame and Driving Mechanism.

Referring to the reference-characters upon the several figures of the drawings, 1 indicates the bed-plate of the machine, 2 legs supporting the same, and 3 hangers secured to the under side of said bed-plate and which support shafts of the driving mechanism.

4 indicates vertical posts which are screwed to the bed-plate and have bolted to their upper end a circular frame 5, all of which constitute the main frame of the machine.

Referring to Figs. 1, 3, and 10, 6 indicates the main driving-wheel, 7 its shaft, and 8 a bearing for the same. Said shaft 7 is also journaled in one of the hangers 3 of the framework and bears upon its inner end a small beveled pinion 9 to engage with and drive an idler 10 upon the depending stud 11, secured to the under side of the bed-plate. The idler 10, above mentioned, serves to transmit motion to each of the five beveled pinions 12 of the radial shafts 13, journaled in the legs 2 and hangers 3, before mentioned. These shafts are provided with pulleys 14 upon their outer ends, which in turn are provided with belt connections 80 with the cutters C on the top of the machine, which will be later described.

The beveled pinion 12^a of the shaft 13^a (see Fig. 11) serves to drive the worm 15 through clutch mechanism N on said shaft as follows: Referring to Figs. 21, 22, and 23, the shaft 13^a is provided with a disk 16, which is hollowed out to receive clamping mechanism, (shown in Figs. 22 and 23,) the construction of which is as follows: The outer end of the shaft 13^a is bored to receive the shank 17 of the hub 18, which is engaged by the operating-lever 19. The inner end of this shank 17 is provided with a pin 20, which passes through a central slot of the shaft 13^a and engages a ring 21, loose upon said shaft, but which turns with it by reason of the connection just mentioned. This ring is provided with a peripheral groove to receive shoes 22, having link connections 23 with the wedges 24, which serve to simultaneously engage the inclined ends of the semicircular spring-actuated engaging blocks 25.

From the above construction it will be obvious that with each outward movement of the operating-lever 19 and the hub 18 said wedges will be forced outward, spreading the semicircular blocks, which in turn instantly engage the inner surface of the disk 16 of the shaft 13^a, thus completing the connection between said shaft and the worm 15, before mentioned.

Gearing for Driving Shaft A.

The worm 15 upon the shaft 13^a (see Figs. 11 and 12) connects with and drives the gear 26, the hub of which is provided with a gear-face 27 to engage that of an idle-gear 28, which is made integral with an elliptical gear 29, meshing with and driving another elliptical gear 30 on the vertical shaft A. This train of gearing is employed to communicate power to all the machine except the several cutters, and owing to the employment of the elliptical gears 29 and 30 it will be obvious that the shaft A is afforded an irregular rotation—that is to say, one-half of said rotation is accomplished in about one-quarter of the time that it takes to complete the remainder of said rotation. The above movement of said shaft is particularly desirable, inasmuch as it moves the ring 62 slowly in its forward movement while the milling is effected and quickly in its return idle movement. Said shaft A (see Figs. 1, 2, and 12) is suitably journaled in the bearing 31, secured to the

bed of the machine and to the bracket 31ª upon the under side of the frame 5, previously mentioned, and serves to move the millers during their cutting operation, also to rotate the table B and, further, to operate the mechanism for removing the hubs.

Setting-Tool R.

Upon and to the front of the frame 5 (see Figs. 2 and 3) I provide a tool R for setting the hubs with relation to the cutters prior to the beginning of an operation and whereby all of the hubs are set alike upon their holders and with proper relation to the table. Said tool consists of a hollow post secured to the frame 5 and having a vertically-adjustable T-shaped piece R′ secured therein, which piece is bored to receive the spring-actuated setting-tool R, designed to be forced in by the operator until the tip thereof engages the side of the hub and thus retains the same against any rotary movement while being drawn down upon its seat.

Rotary Table B for Supporting the Holders.

The table B, (see Figs. 3, 4, and 5,) which supports the holders D for the hubs, consists of a base 33 and a cover 34, (see Figs. 5 and 6,) which are suitably secured together by means of screws engaging the holes 35 of said base. Said table is secured to and supported upon a short hollow column 36, which in turn is mounted upon a large cam-faced disk 37, journaled upon the stationary post 38, the base of which is suitably bolted to the bed-plate 1 of the machine.

In connection with the above I employ means for adjusting the height of said table with relation to the bed-plate and whereby the proper depth of the cuts in the hubs are secured, which consists as follows: I thread the lower enlarged portion 39 of the post 38 and provide thereon an adjustable nut 40, which, as shown, (see Fig. 4,) serves to support the cam-faced disk 37, which in turn supports the column and table secured thereon. It will be obvious that by turning said adjustable nut 40 to the right, as shown in said Fig. 4, the table will be raised in accordance therewith, while a reverse movement will have an opposite effect. By this means I am not only enabled to secure a very accurate adjustment for raising and lowering the table, but am at the same time able to adjust all of the holders simultaneously.

Operating Connections for Table B.

The table B and the parts secured thereto are operated from the before-mentioned vertical shaft A (see Figs. 4 and 10) by means of an arm 41, secured thereto, bearing a pin to engage the radial slots 42 of the disk 37, the adjustment and operation of which are such as to insure said pin engaging one of said slots with each rotation of the shaft A, thereby moving said disk 37 one-eighth of a turn, which, as will be remembered, is the movement required to carry the hubs from one cutter to another. In order to hold the disk 37 and the parts carried thereon perfectly rigid during the milling operation, I secure a sectional disk 43 to the vertical shaft A, which disk is set in opposite relation to the arm 41 of said shaft and in such a manner that when the pin of said arm 41 becomes disengaged from the slot 42 of its disk 37 said disk 43 will have sufficiently entered one of the concave recesses 44 in the periphery of said disk 37 to retain the same perfectly rigid until the pin of the arm has moved around and entered the next slot 42 in the under side of the disk, thereby moving the same.

The Holders D for Supporting the Hubs.

The mechanism which I have termed as a "holder," and which serves to firmly retain the hubs in position upon the rotary table B during the milling operations, will be best understood with reference to Figs. 4, 14, and 15. In the above connection I provide removable fittings for different sizes of hubs, as shown in Figs. 16 and 17. I also provide means for firmly retaining said hubs in position on said holders, for independently adjusting said holders with relation to the table, for automatically releasing the mechanism for clamping the hubs in position, and, finally, for removing the finished hubs from said holders.

Within the base of the table B, I form a series of bores arranged at an equal distance apart and provide the same with suitable bushings 45, which are adjustably secured therein by means of a set-screw 46 upon the under side. Within said bushings I provide a spindle 47, the upper and enlarged face of which is cut to form a gear 48, said gear having connections for rotating said spindle, which I will later describe. Within this spindle 47 is a vertical post 49. To its upper end is attached the fitting *j*, to which the hubs are screwed. Around this fitting and to the threaded hub 50 of the spindle 47 is attached a seat *i*, upon which the hub is clamped. The means whereby said hub is clamped upon said seat *i* and also whereby the same is freed from such engagement is placed upon the under side of the table, and consists as follows: I thread the lower periphery of the spindle 47 and provide the same with a star-wheel 51, the hub of which is internally threaded to engage those of the spindle, whereby the two become in a measure fixed together. The central post 49, which is adjustably secured within the spindle 47, is provided with a lead-screw 52, journaled in the lower hub 53 of the star-wheel 51 and is provided upon either side of said hub with the collars 54 and to the lower end is attached an operating-wheel 55.

It will be obvious from the construction just outlined that a movement of the hand-wheel 55 will raise or lower the post 49, and thus change the position of the hub. It will further be obvious that a movement of the

star-wheel upon the threaded spindle 47 will in like manner raise or lower the lead-screw 52 and the post attached thereto. Therefore, in the practical operation of my machine, the hubs to be milled are screwed to the upper extremity of the fitting *j*, as shown in Fig. 15, after which the operator manipulates the hand-wheel 55 in a manner to lower the post 49, thus drawing the hub contained thereon down firmly against its seat, as shown in Fig. 14. In this position said hub remains, with relation to its spindle, throughout the several operations and until the star-wheel 51 is engaged by suitable automatic mechanism, which will be later described, and whereby said wheel is given substantially a sixth of a turn upon its spindle 47, which movement is sufficient to slightly raise the post 49, thereby disengaging the hub from its seat and leaving it in a position free to be detached by means of the mechanism provided for that purpose.

Mechanism for Releasing the Hubs.

The mechanism for operating the star-wheel above mentioned, whereby the hubs are automatically released from the spindles of their holders D, is mounted on the vertical shaft A, and consists in an arm 56, secured thereto, bearing a pin to engage one of the recesses of the star-wheel, which is then detained at the station nearest to said vertical shaft A, as clearly appears in Fig. 8 of the drawings. It will be obvious that this engagement and operation will move the star-wheel upon its spindle one-sixth of a turn, thereby raising the vertical post 49 and freeing the hub thereof. At the instant the hub just referred to has been freed from its seat *i* the mechanism for removing the same from the holder is next operated in a manner to unscrew said hub from its fitting *j*, as will be later more fully described.

Mechanism for Setting Star-Wheel.

In order to prevent the complete unscrewing of the star-wheel from the spindle, I provide means for turning said star-wheel in a reverse manner to that described above, which movement insures said star-wheel being set at the beginning of each operation at substantially the same place. This mechanism consists (see Figs. 2, 8, and 9) of a bell-crank lever 60, pivoted at 61 to the ring 62, which is given a remittent oscillatory movement by means of connection with the vertical shaft A, as will be later more fully described. Upon the frame 5 is secured a plate 63, having a cam-groove therein to receive the pin of an arm 64 of the bell-crank lever. It will be understood from this construction that with the forward movement of the ring and its bell-crank lever from the position shown in full lines to that shown in dotted lines (see Fig. 8) the pin of the arm 65 will be brought into line with one of the teeth of the star-wheel and will be engaged thereby during the forward movement thereof and given a turn sufficient to move it back to its original place, after which the ring and bell-crank lever assume their original position.

Mechanism for Rotating the Hubs.

Referring to Figs. 3, 4, and 5, I will next describe the mechanism whereby the hubs and their spindles are partially rotated for each succeeding operation during their movements from one milling-station to another, which rotary movement is necessary in order to properly shift and line up the successive sides of the hub with respect to the cutters. Upon the post 38 I permanently fix a gear-wheel 57, designed to mesh with a pair of idlers 58, which are fixed to suitable studs secured to the base 33 of the table. These two idlers in turn mesh with and drive four secondary idlers 59, secured to the base 33 in a similar manner to the idlers 58. Said idlers 59 mesh with and serve to rotate gears 48 of the spindles 47 of the holders. It will thus be obvious that by reason of the rotary movement imparted to the table the idlers just recited will be carried therewith and thus rotate said spindle by means of their connection with the fixed gear 57, above mentioned. The difference in the size of these gears is such as to rotate the spindles one-sixth of a rotation upon their axes, irrespective of the movement of the table, said movement of the spindles being just sufficient to bring into place the next surfaces of the hubs upon the spindles to be milled.

The Remittent Movable Ring.

The ring 62, above referred to, (see Figs. 4, 5, 8, and 8ª,) is movably fitted into a suitable recess 66 in the under side of the frame 5, previously mentioned, and is supported therein (see Fig. 4) by resting upon the top finished surface of the posts 4. Said ring is given a remittent oscillatory movement from the shaft A by means of a connection consisting of a slot 67, cut radially upon the under side of said ring, (see Fig. 8ª,) which slot is engaged by a pin in the top side of the disk 68, secured to the upper end of the shaft A. Shaft A is provided with an uneven rotation through its driving connection and accordingly imparts to the ring, through mechanism just recited, a slow forward feeding movement and a fast return movement, thus moving the cutters quickly when idle and slowly when operating upon the hubs, as will be later more fully described.

Milling-Heads C.

The cutters of the milling-heads, of which there are six, are provided with a rotary movement, a remittent oscillatory movement, and suitable adjusting mechanism, whereby the same may be set to accommodate the varying diameters of the different sizes of hubs, the adjustment for the varying heights of said hubs being secured, as before stated, by rais-

ing and lowering the table by means of the adjustable ring 40. The construction of said milling-heads consists as follows, (see Figs. 2, 3, 4, 8, and 13:) I provide a spindle 69, bored to receive an inclined split collet 70, which in turn is provided with a recess to receive the cutter 71 and which is firmly secured in said recess by means of the inclined surfaces of said collet being engaged and pinched together by corresponding inclined surfaces of the inner end of said spindle 69, said engagement of the inclined surfaces being effected by reason of a lead-screw 72, entering a bore of the outer end of the spindle and engaging a suitable thread of a corresponding recess 73 of the collet before mentioned.

It will be obvious from the construction thus far described that to effect the firm clamping of the cutter within the spindle the attendant simply inserts said cutter into the recess of the split end of the collet, after which the screw 72 is turned with a suitable wrench, whereupon said collet is drawn inward, thus firmly clamping said cutter therein. The spindle 69 is journaled in boxes 74 and 74^a, which are housed in uprights 75 of the movable carriage 76. The box 74 is provided with a suitable chip-guard 77, which extends inward over the top of the cutter 71. Said spindle 69 is provided with a belt-pulley 78, which is firmly secured thereto by means of a set-screw 79, said pulley being connected and driven by the belt 80 of the before-mentioned pulleys 14.

Mechanism for Moving and Adjusting the Milling-Heads.

The carriages 76 of the cutting-heads above described are provided on their under side with dovetail ways 81, cut at a right angle to the spindle and into which fit corresponding dovetails 82 of the slides 83. This construction permits to said carriages a cross movement on said adjustable slides. The adjustable slides 83 are fitted on the top of the frame 5 and made radially movable thereon by means of a groove 84 in each side of said slide, which groove snugly fits into suitable tongues of the intermediate plates 85, screwed to the top of frame 5.

Within the carriage 76 (see Fig. 13) is firmly secured a depending pin 86, which extends through an orifice 87 in the adjustable slide 83 and through a second orifice 88 in the top of the frame 5, engaging a cross-slot 89 in the top of the before-mentioned movable ring 62. It will thus be observed that the movements of the carriage 76 of the milling-head are secured from said ring 62 through the medium of the pin 86. The slides 83 are each made adjustable upon the frame 5 by means of a screw 90, passing through the outer depending end 83^a of said slide, and is provided upon the inside with a fixed collar 91 and a threaded portion 92 to engage a corresponding tap in the face of the frame 5, the outer end of said screw 90 being provided with a shouldered square head 93, whereby the same is engaged and turned with a suitable wrench. Adjacent to said head I firmly clamp a suitable collar 94, a portion of the peripheral face being finished flush with a plate 95, secured to the slide 83. These adjoining faces or peripheral surfaces 96 may be provided with suitable graduation-marks, whereby the amount of turning of the screw 90 and its collar or pointer 94 will be easily determined, and whereby the several screws and the cutters may be accurately adjusted with relation to each other.

In connection with the adjusting operation I preferably employ a tool provided for the purpose by placing the same against the post 97 of the table and between the cutters to be adjusted, then turning said screw until the cutter is brought up against the tool, which accurately indicates the space between the two points of engagement.

From the above it will be obvious that the cutters may be easily adjusted for the different sizes of hubs by simply turning this screw 90 in the direction desired, whereupon the slide 83, the carriage mounted thereon, and its cutter are readily shifted in or out, according to the way said screw has been turned.

It will further be obvious that by reason of the slots 89 in the ring 62 the posts 86, which are engaged thereby, move freely therein with said adjustment.

Mechanism for Removing the Hubs.

The mechanism whereby the hubs are automatically removed from the holders after they have been properly milled will be best understood with reference to Figs. 1, 3, 8, and 24 to 33, inclusive. In order to properly support the gripping-head F and mechanism for operating the same, I provide a suitable framework O, consisting of three parts 100, 101, and 102.

The part 100 serves as the main support and is provided with a flange 103, which fits upon the top of the frame 5 and is secured thereto by means of screw-bolts, as shown. Beneath the section 100 is bolted the cylindrical section 101, which is suitably cut away, (see Fig. 8,) as at 104, to admit of the introduction of the driving-gear 105 on the vertical shaft A, before mentioned. Said gear 105 meshes with and drives a gear 106, secured to the shaft 107, journaled within the several sections of the frame O, above mentioned.

Secured to the lower end of the shaft 107 is a groove-cam 108, around which I fit an intermediate cup-shaped piece 109, and through the side thereof I insert a pin 110 to engage the groove of said cam 108 and a vertical slot 111 in the before-mentioned cylindrical section 101. This construction insures a remittent vertical movement to said piece 109 with the rotation of said cam and its shaft, which movement is for the purpose of vertically reciprocating the rod 112, fitted in a bore of the shaft 107. To the upper end of this rod

112 is connected a link 113, the opposite end of which is yieldably connected to the lever 114 by means of a slot in said link, and a spring 115, designed to engage said lever and firmly hold the pin in the end thereof against the upper end of the slot of the link. The lever 114 is pivoted to the pin 116 of the post 117, which post is secured to the section 102 of the frame. The outer end of this lever (see Figs. 24 and 28) engages a suitable collar 118 on the vertical spindle P of the gripping-head F. From the connections thus far described it will be apparent that the gripping-head is afforded a vertical reciprocating movement by means of the cam 108 and its connections with the rod 112.

In addition to the vertical reciprocating movement above mentioned it is necessary to provide a rotary movement and also means for closing and opening the jaws at the proper time. Said movements are accordingly secured through the following mechanism: Upon the upper end of the shaft 107 I provide a cam 120, bearing a groove to receive a pin of the segment 121, which is pivoted at 122 to the frame and which is provided with a semicircular slot 123 to allow the free movement of the rod 112 therethrough. The segment 121 meshes with and operates the pinion 124 of the segment 125, both of which are pivoted upon the before-mentioned post 117. The movable segment 125 meshes with the teeth 126 of the spindle P, transmitting thereto a rotary remittent movement. Thus it will be apparent that with each complete rotation of the shaft 107 the cam 120 thereof will cause the segment 121 to be thrown to and fro, which in turn will rock the segment 125, and it in turn will remittently rotate the spindle P, it being obvious that in the first of said rotary movements said gripping-head acts to unscrew the hub from its bolder, after which the spindle of said head is elevated to the position shown in Fig. 28, whereupon the second and opposite rotary movement is imparted to the spindle of the head and the hub thus freed.

Mechanism for Operating the Jaws.

The mechanism whereby the jaws are operated will be next described and consists as follows, (see Figs. 24, 28, 31, 32, and 33): The spindle P is provided with a finely-threaded reduced portion 127, which engages a correspondingly-threaded bore in the shank 128 of the gripping-head. The spindle P is further provided with a reduced lower threaded extremity 129, which, as will be observed, is not only a coarser thread, but is a left-hand thread, the upper thread being a finer and a right-hand thread. This lower threaded extremity 129 engages a correspondingly-threaded shank 130 of a square toggle-block 131. Said shank is movably fitted in the bore 132 and is moved vertically therein by the turning of said threaded extremity 129.

The gripping-head proper is provided with a recess 133 in each side thereof, in which are fitted slidable pivotable blocks 134, made adjustable therein by means of a screw 135, retained central with said head, the two free outer ends being provided with right and left threads, respectively, to engage correspondingly-threaded taps in said slidable pivotable blocks. To these blocks 134 I pivot the clamping-jaws 136, which are connected at their upper ends by toggle connection 137 with the toggle-block 131 before mentioned. The lower extremity of these jaws 136 is provided with suitable yieldable tips 138, which are held in their normal position by means of the springs 139, as will be readily understood with reference to Fig. 33. From this it will be perfectly understood that an upward movement of the toggle-block 131 and the connection thereof with the jaws will spread the upper end, thus closing the lower, thereby firmly clamping therein the hub, and that a reverse movement of said toggle-block will in like manner release the hub.

Mechanism for Operating the Gripping-Head F.

The connection between the spindle P and the gripping-head, whereby its jaws are actuated irrespective of the rotary movement of said head, will be best understood with reference to Figs. 24, 31, and 33 and is as follows: The shank P is provided with a collar 140, having a shoulder to engage a corresponding shoulder 141 on the upper end of the shank of the gripping-head. Said shoulders are engaged, as in Figs. 32 and 33, when the gripping-head is lowered and ready to grasp a hub. At this instant the spindle P is rotated in the direction of arrow *t*, (see Fig. 33,) which movement will cause the threaded portions 127 and 129 to turn in their respective engagements. The portion 129, being a coarse thread, operates faster and closes the gripping-jaws through their toggle connection, during which operation the threaded portion 127 has been screwed out about two turns and substantially as shown in Fig. 31. The gripping-head in this position is raised vertically by means of the connections previously described with the cam 108. The gripping-head is thus raised, together with the hub clamped therein, to the position shown in Fig. 24, which shows the spring-actuated pawl 142 of said gripping-head in engagement with the shoulder 143 of the section 102 of the frame. The gripping-head thus positioned, an opposite rotation is imparted to the spindle P thereof, which causes the threaded portions 127 and 129 to turn in their shanks, the latter acting faster than the former, thus serving to open the jaws and drop the hub, while the former thread 127 screws into the shank until the shoulder 141 is engaged, at which instant the lowering mechanism begins to operate to again lower the gripping-head, the jaws of which are then

in an open position and at a proper angle with respect to the sides of the hub which is next to be engaged.

Mechanism for Removing the Hubs from the Machine.

As the hub is freed from the gripping-head I provide further mechanism for receiving the same and dropping it into any suitable receptacle which may be placed beside the machine. This mechanism is illustrated and will be best understood with reference to Figs. 3, 24, 25, 26, 27, and 28. Referring to the latter figure, it will be observed that I provide upon the shaft 107 and within the section 100 a cam 144, bearing a groove to engage a pin 145 of the lever 146, pivoted to the section 102, as at 147. It will thus be seen from the construction thus far described that the lever 146 is given an outward movement, (see dotted lines, Fig. 25,) in which position the receptacle 148, which receives the hub, is tilted to one side by the following mechanism:

The receptacle 148 is provided with a shank 149, which is movably fitted into a bore of the adjustable section 150 of said lever 146, which section is provided upon its under side with a radial slot in which is fitted a screw 151 to engage the shank 149 before mentioned. Thus it will be seen that said shank is prevented from being drawn from its bearing and is free to turn substantially one-quarter of a rotation therein. Upon the shank 149 I provide an arm 152, which serves as a connection for turning said shank and is actuated as follows: The end of said arm 152 enters a recess of the spring-actuated slide 153, which is fitted in the section 150 of the arm and provided upon its outer end with a spring-actuated pawl 154 to engage the post 155 when the arm is thrown in the outer direction, as shown in dotted lines. Thus it will be apparent that when said arm is thrown to its outer position the spring-actuated pawl 154 will pass by and engage the upper end of the post 155, and that when said arm begins its return movement said engagement of the pawl with the post will cause the slide 153 to be drawn outward, as shown in Figs. 25 and 27, in such a manner that the plate 148 will be tilted sufficiently to cause the hub to be dropped therefrom. In connection with this mechanism I have provided means for adjusting the height of the receptacle 148 by means of a screw 156, which passes freely through a bore 157 of the lever 146 and engages the vertically-dovetailed end of the section 150.

Safety Mechanism.

As before stated, I provide means consisting of the bell-crank lever 60 for setting the star-wheels 51 in substantially the same position at the beginning of each operation. At the same time it is obvious that if by accident or otherwise the star-wheels should be turned upon the spindle, and thus be out of position to be properly engaged by the arm 56 of the vertical shaft A, the safety device which I have provided will insure the stoppage of the machine in case said wheels are not in their proper position at the time the same are brought around to the station where the hubs are released. Said safety device (see Figs. 2, 8, 9, 19, and 20) consists in part of the operating-lever 19, which is provided with a spring 158, designed to throw said lever and its clutch member out of operative engagement, thus stopping the machine. Said lever is further provided with means for holding it in an engaged position, consisting of a rock-shaft 159, fitted into bearings 160, secured to the bed 1 and frame 5, which shaft has an arm 161 thereon to engage the arm of the lever 19. It is also provided with a handle 162, by means of which the operating-lever 19 is released by hand and its spring allowed to act in a manner to throw the same out of engagement.

To the under side of the frame 5 I secure a depending support 163, the lower end of which has a bore to receive the free end of the cross-rod 164, the opposite end being connected to an arm 165 upon said rock-shaft 159. Against the collar 166 of said rod 164 is normally held a block Q by means of a spiral spring 167, said block being held against any rotary movement by reason of a key 168 being secured in said block and passing freely through an orifice in said rod, which construction permits a lengthwise movement of the block upon the rod.

The block Q is provided upon its inner side with a cam-lug 169, which is engaged by the arm 56 on shaft A at each rotation of said shaft. From the construction thus far described it will be seen that with each rotation of said shaft and its arm the block Q will be engaged thereby and moved upon its rod against the action of its spring, thus not affecting the rod 164. In addition to the pin connection above described I provide a removable connection, (see Figs. 19 and 20,) which is normally held in engagement, as shown in Fig. 19, during which time it is obvious that the rod will be moved with the block unless the same is drawn out of its engagement. This removable connection consists of an engaging slide 170, having a depending arm provided with a link connection 171 with the pivotal lever 172, the upper end of which is in turn provided with a link connection 173 with the outer arm of a bell-crank lever 174, pivoted to a stud 175. It will be observed that the inner arm of this bell-crank lever is in line with the movement of the outer tooth of the star-wheel and that if said star-wheel is in its proper position said outer tooth will engage the arm of said bell-crank lever, and thus draw out the slide and allow the block to move upon its rod against the action of the spring 167 by reason of the engagement of the arm 56 with said block, thus not affecting the running of the machine, but if said tooth is not in line the arm will not be

engaged and the arm 56 will engage the block Q, thus operating the rod 164 in a manner to trip the operating-lever to release the clutch.

Having thus described the construction of my machine, I will briefly describe its operation, in which attention is particularly called to Figs. 1, 2, and 3. The operator in charge stands in front of the machine and places the hubs upon the holders D one at a time when said holders are at the front station and sets said hubs at a proper angle with respect to the cutter by means of the tool R, provided for that purpose, attached to the frame 5, after which the operator manipulates the hand-wheel 55, thereby drawing the hub down upon its seat *i*, firmly clamping the same with relation to the holder. After the hub has been seated the operator manipulates the handle 19 in a manner to engage the clutch mechanism, thereby operating the upper portion of the machine through vertical shaft A. Said operation serves to rotate the table and carry the hub to the first milling-station G, where the cutter operates to mill off the outer surface *g'* of the hub, during which time the operator has placed a second hub on the holder, then at the front station, after which the table rotates automatically an eighth of a turn, carrying the first hub to the station H and slightly turning said hub during said movement in a manner to insure the proper engagement of the cutter with the next surface *h'* of said hub. During this operation the third hub has been placed upon the holder D at the front station, and the machine in its continued movements rotates the table another eighth movement, carrying the first hub to the station I, where the surface *i'* of said hub is milled, making the third operation thereon.

The operations are continued in the above manner upon the successive hubs until the remaining surfaces *k'*, *l'*, and *m'* thereof have been properly milled at their successive stations K, L, and M, respectively, thus completing said hub. The further movement of the table brings the first hub beneath the gripping-head of the mechanism for removing said hub, whereupon the same operates simultaneously with the cutting operations of the several cutters in a manner to remove the hub from the holder and drop it from the machine. This operation being completed, the successive hubs are in like manner removed, leaving the holders free to be immediately supplied with additional hubs. Thus the machine may continue in its operations at a rapid speed and produce in the course of about an hour three hundred and fifty milled hubs.

Having thus described my invention, what I claim, and desire to secure by Letters Patent, is—

1. In a milling-machine as described, the combination with an intermittently-rotary table, holders carried thereby, adjustable slides fitted laterally in the frame, radially-moving reciprocating carriages mounted in said slides and bearing rotary cutters, means for operating said slides, a movable ring fitted in said frame, connections between said ring and carriages, whereby the latter are reciprocated.

2. In a milling-machine as described, the combination with an intermittently-rotary table having holders, of a series of slides bearing rotary cutters mounted in the frame, means for adjusting said slides with respect to the holders, means for accurately determining the amount of said adjustment.

3. In a machine of the class described, the combination of the frame, a ring movably fitted thereto, means for reciprocating said ring, slides fitted to the frame, cutters mounted upon said slides, connections between said ring and cutters, whereby the latter are reciprocated by the former, means for holding the work in a stationary position while being milled, and means for moving said work from one cutter to another.

4. In a machine of the class described, the combination of the frame, a ring fitted within said frame and provided with means for reciprocating the same, slides fitted in ways of the frame, means for adjusting said slides, cutters mounted upon said slides, connections between said ring and cutters whereby the latter are reciprocated by the former, means for holding and advancing the work to successive cutters and means for so changing the work as to present a new surface of the work to the cutter aforesaid, at each successive advancement of the former.

5. In a milling-machine, the combination with a rotary table, of a spindle journaled therein, a post within said spindle and adapted to retain the work thereon, a lead-screw engaging said post and adapted to be operated, to clamp the work to said spindle, mechanism connected with said lead-screw and spindle, whereby they are automatically operated in a manner to release said work.

6. The combination in a milling-machine with the table, of a rotatable spindle having a threaded extremity, a star-wheel threaded to engage said spindle, a post movably fitted in said spindle and adapted to retain the work on its upper end, a lead-screw journaled within the hub of the star-wheel and engaging the post, whereby the same is adjusted with relation to the spindle.

7. The combination in a milling-machine, of a rotatable spindle having a threaded extremity, a star-wheel 51 to engage said spindle extremity, a post movably fitted in said spindle and adapted to retain the work to be milled, a lead-screw journaled within the hub of the star-wheel and engaging the post for adjusting the same, means for operating the wheel 51, whereby the post is raised or lowered with respect to the spindle.

8. The combination with the table of a milling-machine, of a rotary spindle having a threaded extremity, a star-wheel fitted to said threaded extremity, a vertically-movable post

fitted in said spindle and adapted to retain the work on its upper end, connections between said post and star-wheel, whereby said post is raised and lowered by a movement of the wheel, and means for imparting to said wheel a rotary movement.

9. The combination in a milling-machine, of the bed, a post secured thereto and provided with a threaded portion 39, a hollow column pivoted on said post and supporting a table, a disk secured to said column and bearing a series of radial slots, means for intermittently engaging one of said slots and transmitting to said column and table a remittent rotary movement, an adjustable ring attached to said threaded portion and adapted to support said column and table, substantially as described.

10. The combination in a milling-machine, of the bed, a post secured thereto and provided with a threaded portion 39, a hollow column pivoted on said post, a table mounted upon said column and bearing a series of work-holders, an adjusting-ring attached to the threaded portion and adapted to support said column and table, substantially as described.

11. The combination in a milling-machine, of the bed, a post secured thereto and provided with a threaded portion 39, a hollow column pivoted on said post, a table mounted upon said column, an adjustable ring attached to the threaded portion and adapted to support said column and table, posts 4 secured to the bed, a frame 5 secured to said posts and encircling the table aforesaid in a manner to brace the same, substantially as described.

12. The combination of the bed, a post secured thereto, a hollow column pivoted to said post, a table mounted upon said column and bearing a series of rotary work-holders, a fixed gear 57 secured to said post, idle-gears 58 secured to the table and adapted to travel around said fixed gear with the movement of said table, idlers 59 meshing with the idlers before mentioned and the gear-face of the rotary holders, thus intermittently rotating the same by the movement of the table.

13. In a machine of the class described, the combination of the fixed post 38, the table mounted thereon and provided with means for intermittently rotating the same, a gear 57 fixed to said stationary post, idlers 58 journaled on studs of said table and meshing with said fixed gear, idlers 59 secured to said table and meshing with the before-mentioned idler 58 and the gear of the rotatable holders, holders carried by and journaled within the table and intermittently rotated by said table through the connections above recited.

14. In a milling-machine, the combination with an intermittently-rotary table suitably journaled upon a post and carrying work-holders, a disk secured to a hollow column supporting said table and bearing radial slots, a driven shaft adjacent to said table and bearing an arm to engage the radial slots thereof at each rotation, and a series of slides bearing rotary cutters mounted in the frame, means for adjusting the slides with respect to the holders, means for accurately determining the amount of said adjustment.

15. In a milling-machine, the combination with an intermittently-rotary table suitably journaled upon a post and carrying work-holders, a disk secured to a hollow column supporting said table and bearing radial slots, concave recesses in said disk between said slots, a driven shaft adjacent to said disk and bearing an arm to engage one of said slots with each rotation, thereby intermittently rotating said table, slides fitted laterally in the frame, radially-moving reciprocating carriages mounted in said slides, means for operating said slides, a movable ring fitted in said frame, connections between said ring and carriages whereby the latter are reciprocated, substantially as described.

16. In a milling-machine, the combination with the main driving-shaft 7, of bevel-gear 10, radial shafts bearing pinions meshing with said bevel-gear, connections with said radial shafts, cutters operated through said connections, connections of one of said radial shafts with an elliptical gear, a second elliptical gear meshing with the elliptical gear aforesaid and secured upon an intermediate shaft A, whereby the latter is given an irregular rotation, connections with said shaft and the cutters, whereby the same are advanced slowly in their cutting operation, and rapidly in their return movement.

17. In a milling-machine, the combination with the driving-shaft, of elliptical gear connections thereof with an intermediate shaft A, whereby the latter is afforded an irregular rotation, a table and connections with said shaft A for intermittently rotating said table, cutters mounted upon said table and having connections with said shaft whereby the former are simultaneously reciprocated slowly in their cutting operation, and rapidly in their return movement.

18. In a machine of the class described, the combination with the main driving-shaft 7, of bevel-gear 10, radial shafts bearing pinions meshing with said bevel-gear, connections with said radial shafts whereby the cutters are operated, connections with one of said radial shafts, with a vertical shaft A for operating the table of the machine, clutch mechanism interposed between said radial shaft and the vertical shaft whereby the movement of the latter is controlled.

19. The combination in a milling-machine, of holders and means for rotating the same, clutch mechanism interposed in the driving connection and adapted to be normally held in operative engagement, a device for retaining said clutch out of such engagement, automatic trip mechanism interposed between

said retaining device and the holders aforesaid, whereby the clutch is operated by the movement of the holders.

20. The combination with the rotary table and its driving mechanism, of clutch mechanism interposed in said driving mechanism, a spring-actuated lever whereby said clutch is operated, means for engagement with said lever, whereby the same is held to lock the clutch, automatic safety mechanism operated by the movement of the table for releasing the engagement of said lever.

21. The combination with the rotary table and its driving mechanism, of a clutch interposed in said driving mechanism, a lever for operating said clutch, holders journaled in the rotatable table, means whereby said holders and their work are rigidly held with relation to the table, an automatic safety device interposed between said holders and the operating-lever, whereby the latter is operated to disengage the clutch in case of imperfect registration of the holders with said safety device.

22. The combination with the rotary table and driving mechanism of a milling-machine, of a clutch interposed therein, consisting of a disk 16 secured to the shaft, engaging blocks adjacent to said disk, a movable shank fitted in a bore of the shaft, toggle connections between said blocks and movable shank, a spring-actuated lever connected to the shank, means for engaging said lever and holding it against the action of its spring, automatic safety trip mechanism operated by the movement of the table, whereby the lever is released to engage the clutch.

23. In a milling-machine of the class described, the combination with the rotary table, holders carried thereby, a star-wheel secured to said holders, a clutch interposed in the driving mechanism, a rod 164 operatively connected with the lever of the clutch mechanism and whereby the same is disengaged, a block Q splined to said shaft, an arm to engage said block and operate its rod, connections between the star-wheel of the holder and said rod, whereby the block is disengaged therefrom.

24. The combination in a milling-machine, of holders journaled in the rotatable table thereof, means for clamping work to said holders, a driving-shaft and connections thereof with driven shaft A, an arm on said driven shaft adapted to engage and operate said holders in a manner to release said work with each rotation of the table.

25. The combination in a milling-machine, of holders journaled in the rotary table thereof, means for clamping work to said holders, a driving-shaft and connections with driven shaft A, an arm on said driven shaft adapted to engage and operate said holders in a manner to release said work, means for removing said work from said holders, means for resetting said holders with relation to the table aforesaid and to receive additional work, to be milled.

26. The combination in a milling-machine, of holders journaled in the rotary table thereof, means for clamping work to said holders, a driving-shaft and connections with driven shaft A, an arm on said driven shaft adapted to operate said holders to release said work, a movable ring fitted in the frame, a cam-actuated bell-crank lever 60 pivoted to said ring and adapted to operate the holders in a manner to reset the same to receive additional work, substantially as described.

27. In a milling-machine, the combination in a work-removing attachment, of a frame, a vertical shaft journaled therein, a cam upon said shaft, connections between said cam and a vertical rod, whereby the latter is given a reciprocating movement, connections between said rod and the gripping-head whereby said gripping-head is given a vertically-reciprocating movement, connections between said vertical shaft and said gripping-head, for imparting thereto a rotary movement.

28. In a milling-machine, the combination in a work-removing attachment, of a vertical driving-shaft 107, connections thereon with the gripping-head, whereby the same is afforded a vertically-reciprocating movement, a cam 120 upon said shaft, a segment operatively connected with said cam for imparting to the former a reciprocating movement, connections between said segment and the gripping-head for imparting thereto a reciprocating rotary movement, means whereby the jaws of said head are opened and closed by said reciprocating movement, substantially as described.

29. In a milling-machine, the combination in a work-removing attachment, of a driving-shaft, connections thereof with the gripping-head whereby the same is operated to detach the work from the machine, of a cam 144 upon said shaft, an arm E pivoted to the frame and operated by said cam, in a manner to receive the work from gripping-head, and remove the same from the machine.

30. In a milling-machine, the combination in a work-removing attachment, of the driving-shaft, connections thereof with the gripping-head, whereby the same is operated to remove the hubs from their holders, a cam upon said shaft, connections thereof with the laterally-swinging arm bearing a receptacle to receive the work, means for tilting said receptacle in a manner to drop the work therefrom, when said arm is in its extreme position.

31. The combination with a milling-machine of a work-removing attachment, consisting in part of a spindle P, means for imparting thereto a rotary and vertical movement, a gripping-head carried by said spindle and provided with a pair of jaws, means for opening and closing said jaws, by the initial rotary movements of said spindle.

32. The combination with a milling-ma-

chine of a work-removing attachment, consisting in part of the spindle P, a gripping-head carried by said spindle and provided with a pair of jaws, means for adjusting said jaws to accommodate different sizes of work, connections of said jaws with the spindle, whereby they are operated by the rotary movements of said spindle.

Signed at Bridgeport, in the county of Fairfield and State of Connecticut, this 30th day of January, A. D. 1896.

JAMES GREGORY.

Witnesses:
C. M. NEWMAN,
ELBERT O. HULL.