No. 721,516. PATENTED FEB. 24, 1903.

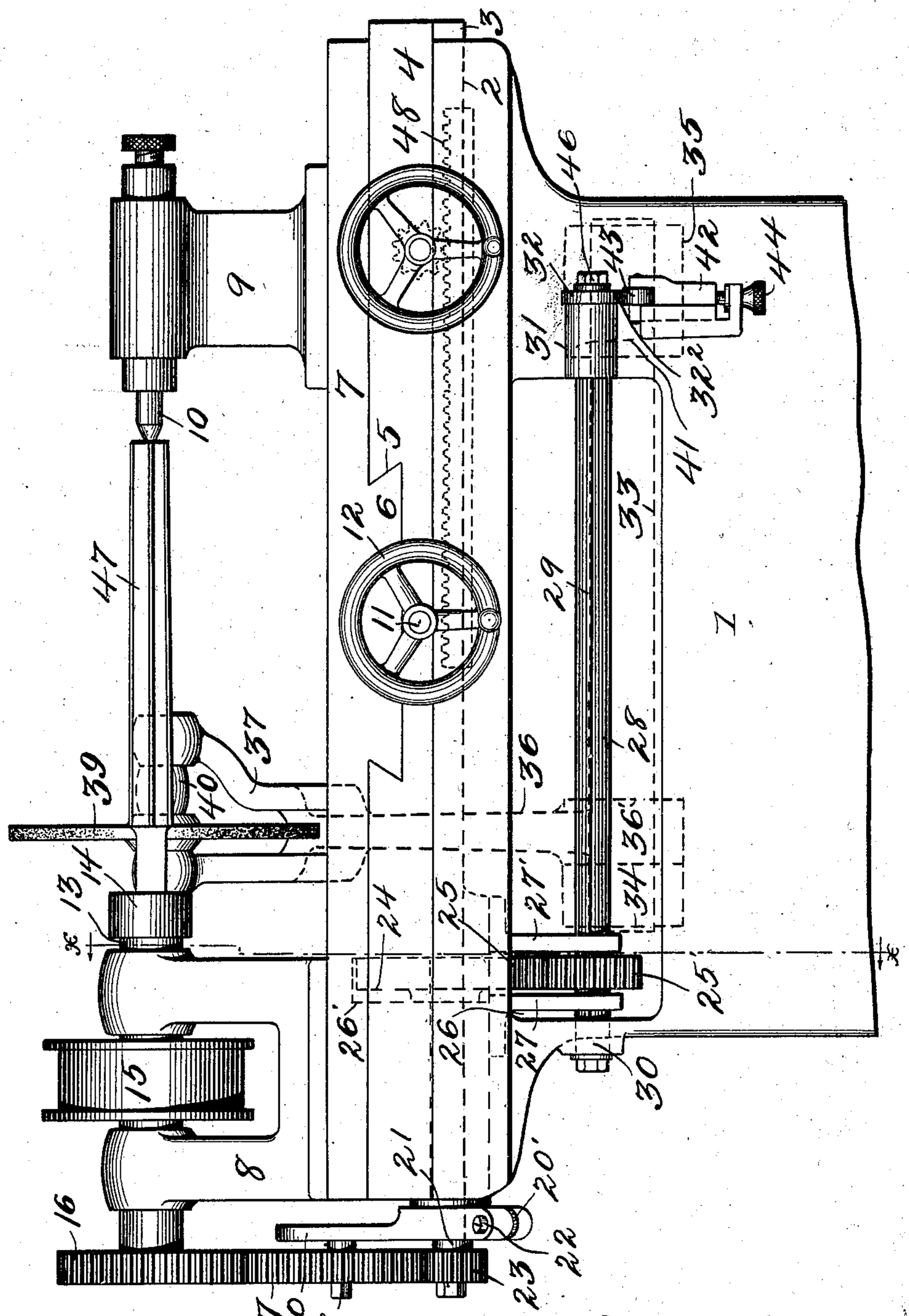
B. M. W. HANSON.

MACHINE FOR RELIEVING FLUTED TOOLS.

APPLICATION FILED JULY 31, 1902.

NO MODEL. 4 SHEETS—SHEET 1.

Fig. 1



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NO MODEL. 4 SHEETS—SHEET 2.

Fig. 2.

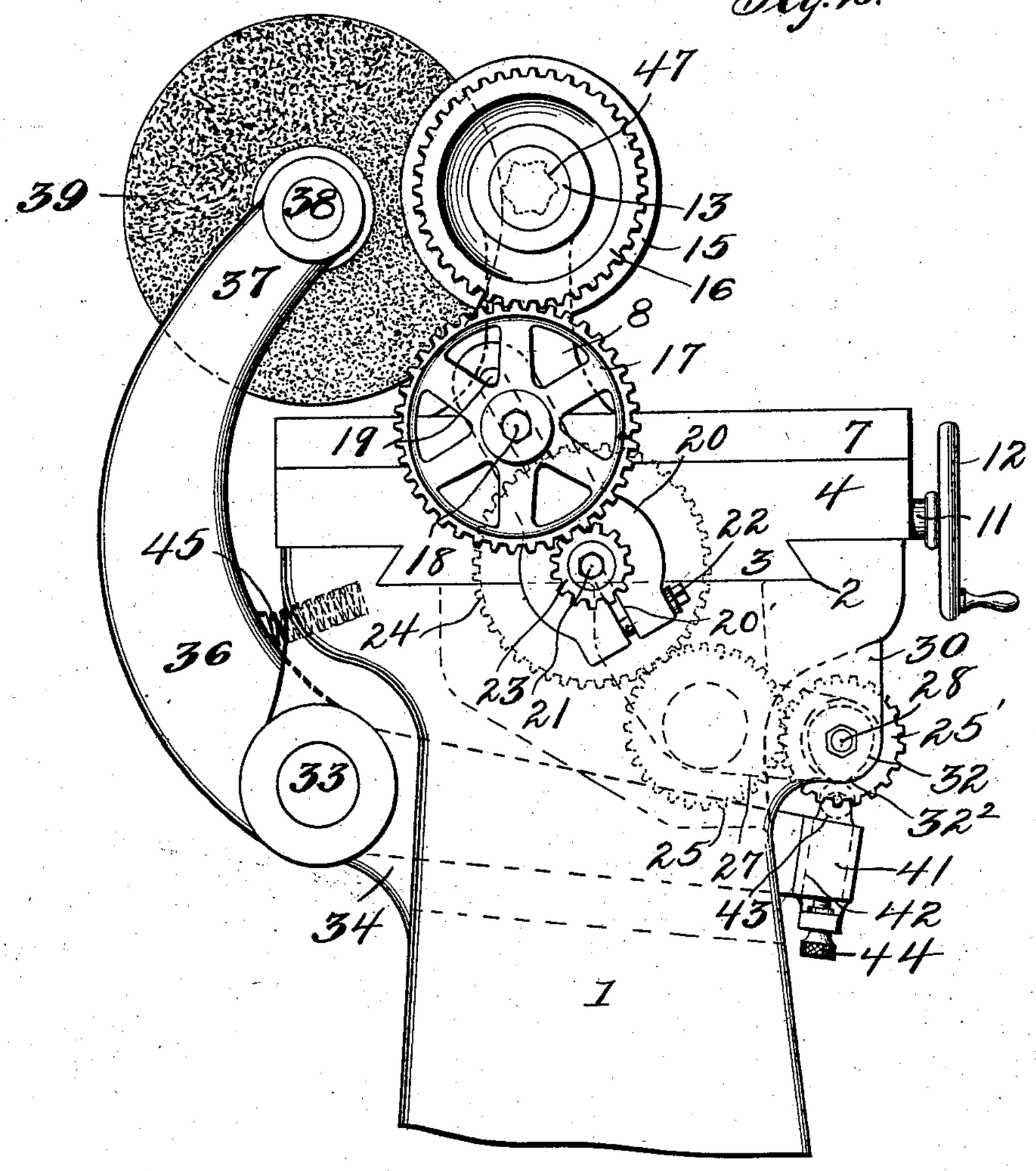
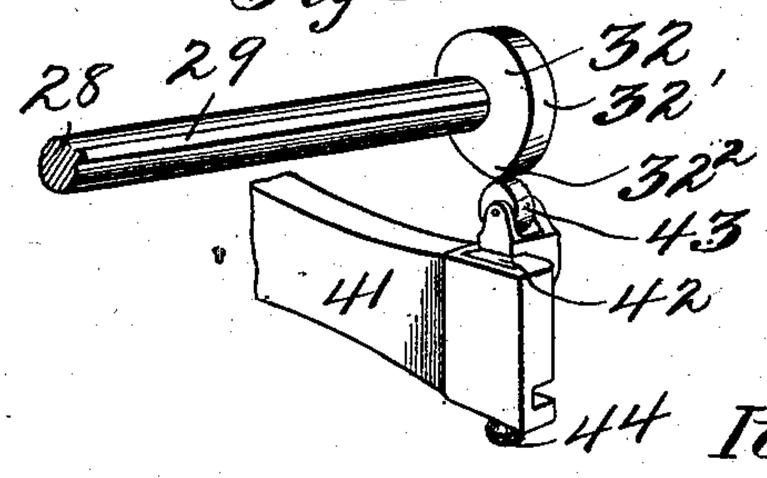


Fig. 3.



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NO MODEL. 4 SHEETS—SHEET 3.

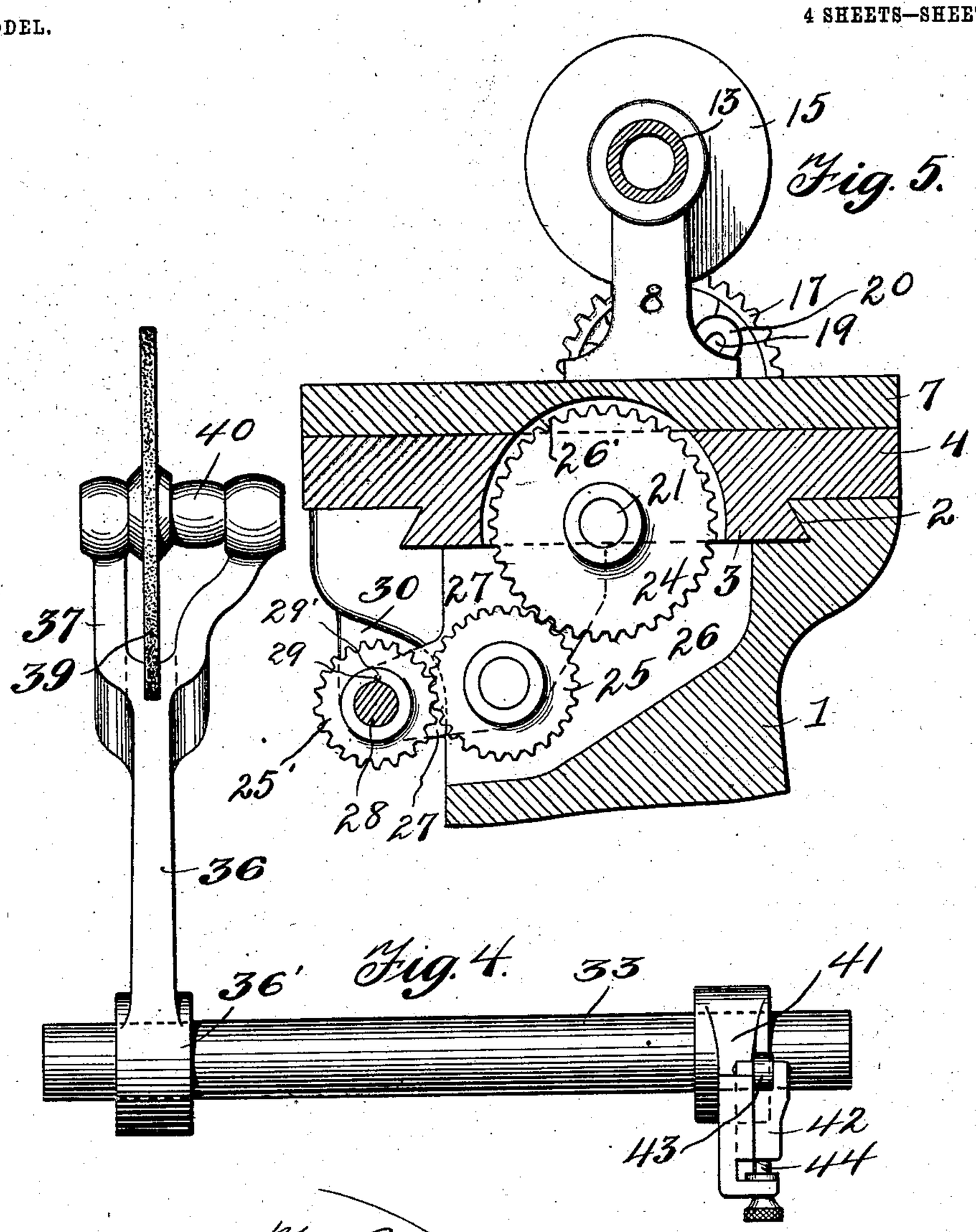

Fig. 5.

Fig. 4.

Fig. 6.

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NO MODEL. 4 SHEETS—SHEET 4.

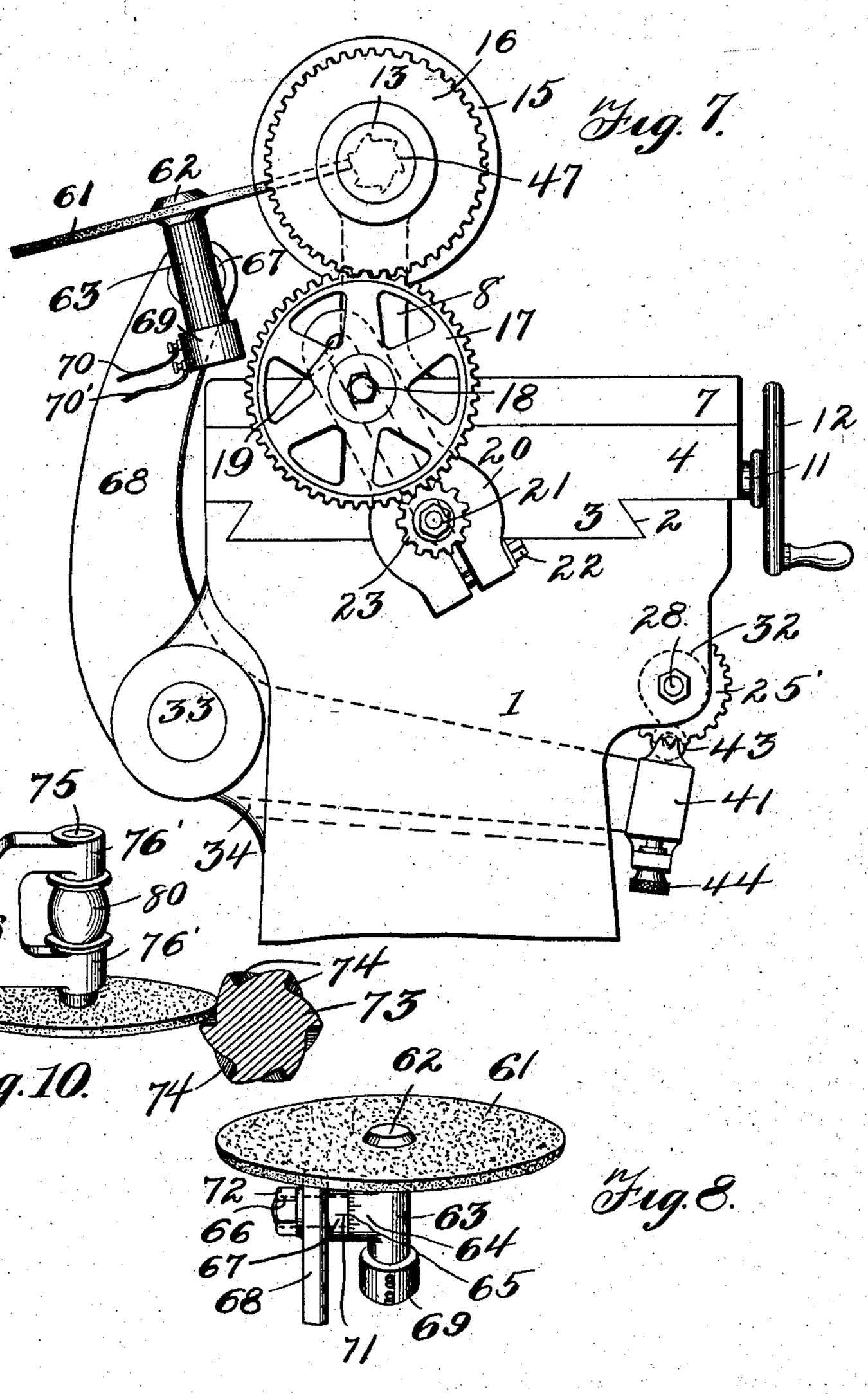

Fig. 7.

Fig. 10.

Fig. 8.

Fig. 9.

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UNITED STATES PATENT OFFICE.

BENGT M. W. HANSON, OF HARTFORD, CONNECTICUT, ASSIGNOR TO THE PRATT & WHITNEY COMPANY, OF HARTFORD, CONNECTICUT, A CORPORATION OF NEW JERSEY.

MACHINE FOR RELIEVING FLUTED TOOLS.

SPECIFICATION forming part of Letters Patent No. 721,516, dated February 24, 1903.

Application filed July 31, 1902. Serial No. 117,815. (No model.)

To all whom it may concern:

Be it known that I, BENGT M. W. HANSON, a subject of the King of Sweden and Norway, residing at Hartford, in the county of Hartford and State of Connecticut, have invented certain new and useful Improvements in Machines for Relieving Fluted Tools, of which the following is a specification.

My invention relates to a machine for relieving the teeth of reamers, taps, and analogous fluted tools. Heretofore machines of this class have been complicated in construction and slow in operation and many of them have been provided with indexing mechanism for setting the tool after each "land" has been relieved. In my invention all of these details of construction are dispensed with and the article to be relieved and the grinder or other tool employed are continuously rotated, the relieving-tool having an oscillatory or equivalent motion toward and from said article.

Primarily the object of the invention is the provision of means for continuously rotating the article to be relieved and the tool for accomplishing the relieving operation and in connection with said means devices for forcing the relieving-tool into engagement with and withdrawing it from such article.

A further object of the invention is the provision of a reciprocatory carriage upon which the tool to be relieved is centered or otherwise supported and in connection with said carriage of mechanism of any suitable kind for continuously rotating the tool and for also continuously rotating the cutter for relieving the teeth of said tool.

A further object of the invention is the provision, in connection with the devices just mentioned, of means for moving the support for the relieving-cutter toward and withdrawing it from the tool.

Other objects of the invention will be hereinafter set forth.

In the accompanying drawings, Figure 1 is a side elevation of my improved machine. Fig. 2 is a view of the left-hand end of said machine. Fig. 3 is a detail in perspective of the cam-shaft, its cam, and a part of the cutter-actuating devices. Fig. 4 is an elevation of the lever-arm in which the grinding-disk is mounted and its rock-shaft detached from the machine. Fig. 5 is a transverse section on line $x\,x$ of Fig. 1 looking in the direction of the arrow. Fig. 6 is a diagram illustrating the operation of the relieving-tool, and Figs. 7, 8, 9, and 10 are views of modifications hereinafter described.

Referring to the drawings, the numeral 1 designates any suitable base—such, for instance, as that of a grinding-machine—and 2 a guide-groove, shown formed in the top of the base, although the location is immaterial, and adapted to receive a projection or guide 3 of dovetail shape on a carriage 4, movable longitudinally of said bed by a pinion and rack or other device. This carriage is provided with a transverse guide-groove 5 for the reception of a dovetail projection 6 of a slide or carriage 7, upon which the head-stock 8 and tail-stock 9, carrying the adjustable center 10, are mounted. This slide 7 is adjustable transversely of carriage 4 by means of a screw 11, operated by a hand-wheel 12 and working in a nut (not shown) carried by said slide in the usual manner.

Journaled in the head-stock 8 is a spindle 13, carrying a chuck or other suitable work-supporting device 14, a pulley 15, and a gear 16, the latter being in mesh with a gear 17, journaled on a stud 18, adjustably mounted in a slot 19 of a swinging link or lever 20, split at 20′ and clamped upon a stud surrounding shaft 21 by a screw 22, as shown in Figs. 1 and 2. Secured to the outer end of shaft 21 is a pinion 23 of small size, and on the inner end thereof is a gear 24 in mesh with an idler-gear 25, which in turn engages a pinion 25′. This shaft 21 is short, and the gear 24, secured to its inner end, is received in a longitudinal recess 26 of the bed 1 and a recess 26′ of carriage 4 and slide 7. Depending from carriage 4 are hangers 27 27′, and located between these hangers are said gear 25 and the pinion 25′, the latter of which is mounted upon and is in sliding engagement with a shaft 28, provided with a longitudinal spline or feather 29, fitting in a groove 29′ in the hub of said pinion, as shown in Fig. 5. Shaft 28 passes through the hangers 27 27′

and is journaled at its ends in bearings 30 and 31 of the bed 1 and adjacent to said bearing 31 is provided with a cam 32, for a purpose hereinafter specified.

Designated by the numeral 33 is a rock-shaft, which is journaled in bearings 34 and 35 on the rear side of the bed 1, and secured to said shaft adjacent to one end thereof is an arm 36, having a hub 36′ sleeved upon and secured to the rock-shaft and a yoke 37 at its opposite extremity. In the arms of the yoke 37 is journaled a shaft 38, carrying in the illustration given a grinding disk or wheel 39, of emery or equivalent material, located, together with a belt-pulley 40, by which said shaft is driven, between the said arms. At its end opposite the arm 36 the rock-shaft 33 carries an arm 41, which extends through an opening in the frame to the front of the machine, where it is provided with a slide 42, carrying an antifriction-roller 43 in engagement with the cam 32, said slide being adjusted by means of a screw 44, as shown in Fig. 3.

Either gravity or the action of a spring 45, seated in the bed 1 and pressing against the inner face of the arm 36, may be employed for normally tending to force the arm away from the bed and, through the rock-shaft 33 and arm 41, the roller 43 against the periphery of the cam 32.

Cam 32 is removably secured to the end of the splined shaft 28 by means of a nut 46, and sets of interchangeable cams may be employed, each of a different configuration, to cause the grinding disk or cutter to be forced toward work of different kinds at the proper times. As will be observed from Fig. 3, the cam is provided with a concentric periphery 32′ throughout the greater part of its circumference and with a nose or active portion 32^2, which will bear against the roller 43 and cause the lever 41 to be actuated once during every rotation of said cam, thereby operating the rock-shaft 33 and throwing the lever-arm 36, carrying the rapidly-revolving grinding-tool 39, toward the work at stated intervals, the spring 45 withdrawing said lever and its grinding-disk immediately after the nose or elevated portion 32^2 of the cam has passed said roller. In virtue of this construction the machine is capable of universal application in relieving the lands of fluted tools, for by substituting the proper cam the movement of the grinding-disk may be controlled to suit the character of the work; but a slight reciprocation of the lever 36 is caused by the cam, and owing to its long arc of movement the grinding-disk 39 is caused to advance toward and recede from the work 47 in substantially a straight line. Other means may be employed for supporting the rotary grinding-disk without departure from the invention, which is not limited to the device shown and described for accomplishing this result.

For slowly moving the carriage 4 back and forth upon the bed any suitable means may be employed, and I have shown for this purpose the usual pinion and rack 48, (see Fig. 1,) which pinion may be driven at the speed required in any desired way.

In operation my improved machine acts as follows: A reamer or equivalent fluted or ribbed blank the teeth of which it is desired to relieve is placed in the chuck 14, and the opposite end of said blank is supported upon the center 10 of tail-stock 9. Power is then applied to the pulley 15 and to the pulley 40 of the shaft 38, carrying the grinding-disk 39, thereby setting the machine in operation, gear 25′ being rotated from the spindle 13 by means of gear 16, change-gear 17, pinion 23, shaft 21, and gears 24 and 25, thereby rotating the shaft 28 and its cam 32. Carriage 4 is then set in motion, and the continuously-rotating blank to be relieved is slowly advanced across the face of the grinding-disk 39, the gearing for driving the splined cam-shaft 28 moving with said carriage and the pinion 25′ sliding along said cam-shaft. As the cam-shaft rotates, the cam 32 acts upon roller 43, and the nose 32^2 of said cam depresses the arm 41, secured to shaft 33, thereby rocking said shaft in its bearings and causing the arm 36, attached to the opposite end of said shaft, to carry the rapidly-revolving grinding-disk 39 against the land of the tool-blank which is then opposite the grinding-disk. It is to be understood that the gearing controlled by the spindle 13 is to be so proportioned that the cam 32 will force the grinding-disk against the blank only at a time when a land of said blank is brought directly opposite the edge of the grinding-disk, and to enable this to be accomplished the desired proportionate rotation of the blank with relation to the movement of the grinding-disk is maintained by providing gears with the number of teeth necessary to rotate the cam-shaft once as each individual land or rib is operated upon by the grinder, the result being that a reciprocatory movement is imparted to said grinder to force it against the tool, and it will then be held away from the blank until the same has been rotated far enough to bring another land in position and then returned, as above stated.

As illustrated in Figs. 2 and 6, the axis of the shaft 38 is slightly below that of the chuck-shaft 13, thereby locating the edge of the grinding-disk eccentrically to that of the axis of the blank, in virtue of which the said disk is enabled to "back off" or relieve the rib or land of the tool to the extent desired, for by adjusting slide 42 the motion of rock-shaft 33 may be so regulated that the relief required may be imparted to the lands of the tool.

Carriage 4 continuously reciprocates while the machine is in action, and the lands are relieved by the grinding-disk during each back-and-forth movement of said carriage.

To enable the lands of blanks of different sizes to be relieved, the change-gear 17 is pro-

vided, and by substituting other gears for said change-gear the desired proportionate rotation of a blank of any desired size or number of lands with relation to the movement of the grinding-disk may be readily attained.

In the diagram Fig. 6 the action of the grinding-disk is clearly portrayed, and in said figure the axis of the grinding-disk is designated by the dotted line 49 and that upon which the blank rotates by a like line 50. As shown in said figure, the grinding-disk 39 is rapidly rotated in the direction of the arrow 51, while the blank the lands or wings of which are to be relieved is slowly rotated in the same direction, as indicated by arrow 52. A blank 47 with eight wings or lands is represented merely for purposes of illustration, for blanks with any desired number of such wings may be relieved, and one of these wings is shown relieved at 53, while the grinder is in operation upon another, as at 54. Upon the conclusion of the relieving operation on wing 54 the disk 39 is withdrawn by spring 45 in the direction of the arrow 60, and by the time that the blank has been rotated to bring one of its plain or unrelieved wings 55 into the position 54 the disk 39 will have been returned in the direction of the arrow 56 by the cam 32 and its connections to the position shown in Fig. 6. By rotating the grinding-disk and the blank in the same direction the surfaces of said devices move in opposite directions at 57, as indicated by the small arrows in the diagram; but while this manner of rotating said devices is preferable the invention is not limited thereto, nor is it limited to any particular kind of gearing upon the carriage for rotating the cam-shaft and cam.

In the modification illustrated in Figs. 7, 8, and 9 the relieving-cutter (shown as a grinding-disk 61) is shown supported on a shaft 62, journaled in a sleeve or bearing 63, having a right-angular extension 64, graduated on its periphery, as at 65, and carrying a stud 66, passing through a perforated boss 67 in a lever-arm 68. To prevent the blow or jar of a belt upon the shaft of the grinding-disk, I mount directly upon said shaft an electric motor 69, driven by a current supplied to and conveyed from it by wires 70 70′, leading to any suitable generator. On the periphery of the tubular boss 67 is an indicating-mark 71, and for adjustably securing the sleeve 63 in the desired angular position a nut 72 is threaded upon the end of stud 66 and bears against the inner side of the lever-arm, as shown in Figs. 8 and 9. In this modification the grinding-disk may be of any desired thickness, and as it revolves in a plane inclined, as may be desired, to a horizontal line it is especially useful not only in relieving the ribs or lands of a fluted tool, such as a reamer or tap, but also in rounding off or curving the land proper and the periphery of the tool back of the same up or adjacent to the point where the next land or rib commences, whereby a sharply-defined projecting cutting edge will be formed. This arrangement of the tool is also very useful when fluted blanks of small size are to be relieved, as will be obvious, and by adjusting the tool in the manner described and then securing it in position the proper angular relation of said tool to the work may be readily attained. In said Figs. 7, 8, and 9 the parts of the machine are, with the exceptions noted, substantially identical with those shown in the other figures and they are designated by the said reference-numerals, and the reciprocatory movement of the continuously-rotating cutter is obtained by the cam and lever mechanism above described.

Should it be desired to relieve spiral reamers, the rotating grinding-disk may be arranged as shown in Fig. 10 and it may be moved toward and from the blank 73 by any desired means, so that it will properly act upon the spirally-arranged ribs or lands 74 thereof. In this form the shaft 75 is journaled in bearings 76′ of a fork 76, having a stem 77 seated in a split bearing 78 of the lever-arm, the said bearing being clamped upon said stem to secure it in position after the relieving-cutter has been adjusted to the proper angle by a screw 79.

For driving the shaft of the grinder a pulley 80 may be located in the space between the bearings 76′ or it may be driven by an electric motor, as in Fig. 7, or in any other desired way.

While a hand-wheel and pinion (the latter meshing with a rack on the bed) are shown in Fig. 1 for reciprocating the carriage, it is distinctly to be understood that the invention is not limited thereto, for well-known devices for automatically actuating and then reversing said carriage may be substituted therefor, if desired.

Having thus described my invention, what I claim is—

1. The combination, with means for continuously rotating a blank, of a reciprocatory carriage upon which said means are mounted; a relieving-tool; and means for advancing said tool toward, and withdrawing it from, said blank.

2. The combination, with means for continuously rotating work, of a reciprocatory carriage; gearing carried by, and movable with, said carriage; a shaft controlled by said gearing; a tool; and means controlled by the shaft for moving said tool toward the work.

3. The combination, with a reciprocatory carriage, of means for continuously rotating work carried by said carriage; a cam-shaft; gearing, mounted upon and movable with the carriage, for rotating said cam-shaft; a cam carried by the cam-shaft; a relieving-tool; a tool-carrier; and means controlled by the cam for actuating said tool-carrier.

4. The combination, with a reciprocatory carriage, of a work-spindle journaled in bearings thereof; a shaft; gearing mounted on the carriage, and controlled by the work-spin-

dle, for actuating said shaft; a rotary tool; a tool-carrier; and means controlled by the shaft for actuating said tool-carrier.

5. The combination, with a bed, of a reciprocatory carriage; a rotary work-spindle; a shaft journaled in the bed; gearing carried by the carriage for rotating said shaft, said gearing being driven from the work-spindle; a cam on the shaft; a tool-carrier; a tool carried by said carrier; and means controlled by the cam for actuating said tool-carrier.

6. The combination, with a bed, of a reciprocatory carriage movable on said bed; a work-spindle, and means for rotating the same mounted on the carriage; a gear secured to said work-spindle; a shaft journaled in bearings of the bed; a train of gearing mounted on said carriage and driven by the gear of the work-spindle; a gear in sliding connection with the shaft, and in engagement with an element of said train; a cam secured to the shaft; a tool-carrier; means controlled by the cam for actuating said tool-carrier; and a rotary tool carried by the tool-carrier.

7. The combination, with a bed, of a reciprocatory carriage; a rotary chuck-spindle carried by the carriage; a center also carried by said carriage; a gear secured to the chuck-spindle; a train of gearing, one element of which is a change-gear, movable with the carriage; a cam-shaft; a gear in sliding connection with said cam-shaft, and in engagement with an element of the gear-train on the carriage; a cam removably secured to the cam-shaft; a tool-carrier; means controlled by the cam for actuating said tool-carrier; and a rotary tool journaled in said tool-carrier.

8. The combination, with a bed, of a carriage; a rotary work-supporting spindle carried by said carriage; means also carried by the carriage for centering the work; a gear secured to the spindle; a change-gear in engagement with the spindle-gear; a pinion in engagement with the change-gear; a shaft journaled in the carriage, and to which said pinion is secured; a gear carried by said shaft; an idler; a shaft journaled in the bed; a gear slidingly connected to said shaft, and in engagement with the idler; a movable carrier; a tool mounted in the carrier; and means controlled by the shaft journaled in the bed for actuating said movable carrier.

9. The combination, with a traveling carriage, of means for supporting and rotating work movable with said carriage; gearing carried by the carriage, and driven by the work-supporting means; a cam-shaft; a pinion driven by the gearing of the carriage, and slidingly connected to said cam-shaft; a cam removably secured to the shaft; a rock-shaft having an arm in engagement with said cam; a carrier secured to the rock-shaft; and a rotary cutter mounted in said carrier.

10. The combination, with a reciprocatory carriage, of a slide movable transversely of said carriage; a rotary chuck-spindle journaled in standards of the slide; a tail-stock carried by the slide; a center in said tail-stock; a train of gearing controlled by the chuck-spindle and carried by, and movable with, the carriage; a cam-shaft driven by an element of the gear-train; a cam on said cam-shaft; a tool-carrier; means actuated by the cam for operating said tool-carrier; and a rotary tool carried by said tool-carrier.

11. The combination, with a movable carriage, of a head-stock supported by said carriage; a rotary work-supporting spindle journaled in the head-stock; a tail-stock also supported by the carriage; a center carried by said tail-stock; a gear-train carried by the carriage; hangers depending from the carriage; a cam-shaft; a pinion in sliding connection with said cam-shaft, located between the hangers, and actuated by an element of the gear-train; a cam on the cam-shaft; a tool-carrier; mechanism controlled by the cam for actuating said tool-carrier; and a rotary tool, the shaft of which is journaled in the tool-carrier.

12. The combination, with a reciprocatory carriage having a transverse guideway, of a slide having a portion fitted in said guideway; means for rotating and supporting work carried by said slide; a gear-train carried by the reciprocatory carriage; a cam-shaft having a longitudinal spline or feather; hangers depending from the carriage; a pinion located between said hangers, and having a groove for the reception of the spline or feather of the cam-shaft, said pinion being in engagement with an element of the gear-train; a cam on the cam-shaft; a rock-shaft; an arm projecting from said rock-shaft and carrying a roller in engagement with the cam; a tool-carrier secured to said rock-shaft at a point thereon opposite the arm; and a rotary grinding-disk, the shaft of which is journaled in said tool-carrier.

13. The combination, with a reciprocatory carriage having a guideway, of a slide movable transversely of said carriage, and having a portion fitted in said guideway; work supporting and rotating means carried by the slide; a gear-train mounted on the reciprocatory carriage, and driven by the work-rotating means of the slide; a change-gear in said gear-train; a cam-shaft journaled in bearings of the bed; a pinion in sliding connection with the cam-shaft, said pinion being driven by an element of the gear-train; means carried by the carriage for moving said pinion along the cam-shaft; a cam secured to the cam-shaft; a movable tool-carrier; means controlled by the cam for actuating said tool-carrier; and a rotary grinding-disk journaled in bearings of the said tool-carrier.

14. The combination, with a reciprocatory carriage, of a slide movable transversely of said carriage; a head-stock carried by the slide; a chuck-spindle journaled in bearings of the head-stock; a tail-stock carried by the slide; a center adjustable in said tail-stock; a gear secured to the chuck-spindle; a re-

movable change-gear in engagement with said gear; a pinion in engagement with said change-gear, and mounted at one end of the shaft in the carriage; a gear secured to the other end of said shaft opposite the pinion and rotating in a recess of said carriage; an idler in engagement with said gear; a cam-shaft having a spline or feather; a pinion in sliding connection with said cam-shaft, said pinion being driven by the idler; means carried by the carriage for reciprocating the pinion along the cam-shaft; a cam also carried by the cam-shaft; a rock-shaft having an arm; a slide carrying an antifriction-roller mounted in said arm, the roller being in engagement with the cam; a tool-carrying arm secured to the rock-shaft, and having a bifurcated end provided with bearings; a rotary tool-shaft journaled in the bearings of said tool-carrying arm; and a grinding-tool secured to said shaft.

15. In a machine of the class specified, the combination, with a chuck-spindle for rotating a fluted blank, of a tail-stock carrying a center for supporting the end of said blank opposite the chuck-spindle; a movable carriage; means for rotating the chuck-spindle; a gear secured to said chuck-spindle; an adjustably-mounted change-gear in engagement with the gear of the chuck-spindle; a shaft journaled in the carriage; a pinion on said shaft in engagement with the change-gear; a gear also carried by said shaft and received in a recess of the carriage; hangers depending from the carriage; an idler in engagement with the gear of the shaft; a pinion located between the hangers; a cam-shaft with which the pinion is in sliding engagement; a cam carried by said cam-shaft; a rock-shaft; an arm projecting from the rock-shaft, and having a guideway; a slide adjustably mounted in said guideway, and carrying an antifriction-roller in engagement with the cam; a cutter-carrying arm secured to the rock-shaft; a rotary cutter journaled in said arm; and means for throwing said cutter-carrying arm away from the chuck-spindle when the cam permits of such movement thereof.

16. In a machine of the class specified, the combination, with a chuck-spindle having a gear, and with means for rotating said spindle, of a gear-train, an element of which is in mesh with the gear of the chuck-spindle; a cam-shaft; a pinion in sliding engagement with said cam-shaft, and in mesh with another element of the gear-train; a reciprocatory carriage, with which the gear-train is movable; a cam on the cam-shaft; a tool-carrier actuated by the cam; a tool rotatively supported in the tool-carrier; and means for rotating said tool in the same direction as the chuck-spindle.

17. The combination, with means for continuously rotating a fluted blank, of a tool-carrier; a relieving-tool rotatively mounted in said tool-carrier, means for rotating said tool in the same direction as the blank; means for reciprocating the blank; and means for advancing and withdrawing the tool-carrier.

18. The combination, with means for supporting and continuously rotating a fluted blank, of a tool-carrier; a rotary relieving-tool journaled in said carrier; means for rotating said tool in the same direction as the blank; and means for reciprocating the blank.

19. The combination, with a carriage, of a spindle, for supporting a fluted blank, rotatively mounted on said carriage; a tool-carrier; a rotary relieving-tool; a cam-shaft and cam; and a gear-train controlled by the spindle and movable with the carriage, the elements of said gear-train being so proportioned that the cam permits the tool-carrier and its relieving-tool to be held away from the work until a "land" of the blank arrives opposite the contact-point of said tool.

20. In a machine of the class specified, the combination, with a machine-bed, of a carriage movable back and forth longitudinally of said bed; a slide transversely movable on the carriage; head and tail stocks carried by the slide; a rotary chuck-spindle journaled in bearings of the head-stock; a center in the tail-stock; a gear secured to the chuck-spindle; a change-gear in engagement with the gear of the chuck-spindle; a support in which the change-gear is adjustably mounted; a pinion also in engagement with the change-gear; a shaft journaled in the carriage, and to which the pinion is secured; a gear carried by the pinion-shaft; an idler journaled in the carriage; hangers depending from the carriage; a cam-shaft journaled in the machine-bed; a pinion located between the hangers, and in sliding connection with the cam-shaft; a cam on the cam-shaft; a tool-carrier; a rotary relieving-tool in said carrier; and means operated by the cam for actuating said tool-carrier.

21. In a machine of the class specified, the combination, with means for rotating a blank, of a reciprocatory carriage upon which said means are mounted; a rotary tool; means whereby said tool may be adjusted to set it at an inclination to the blank; and means for advancing said tool, toward, and withdrawing it from, the blank.

22. In a machine, of the class specified, the combination, with means for rotating a fluted blank, of a reciprocatory carriage; gearing carried by, and movable with, said carriage; a shaft controlled by said gearing; a rotary relieving-tool; means whereby said tool may be set in an inclined position relatively to the blank; a cam on the shaft; and means controlled by said cam for forcing said tool against the work.

23. In a machine of the class specified, the combination, with a reciprocatory carriage, of a work-spindle journaled in bearings of said carriage; a shaft; gearing mounted on the carriage and controlled by the work-spin-

dle for actuating said shaft; a rotary relieving-tool; a tool-carrier; means whereby the tool-carrier may be adjusted to set the tool at an inclination to the work; and means controlled by the shaft for actuating the tool-carrier.

24. The combination, with means for rotating a fluted blank, of a tool-carrier; a relieving-tool rotatively mounted in said tool-carrier; means for reciprocating the blank; a rotary cam-shaft; interchangeable cams adapted to be secured to said cam-shaft; and means, controlled by the cam in use for actuating the tool-carrier.

25. The combination, with a carriage, of a work-holding spindle; a rotary relieving-tool; a tool-carriage; means whereby the tool-carrier may be adjusted to set the tool at an inclination to the blank; a cam-shaft; a cam on said cam-shaft; and a gear-train driven from the work-holding spindle and movable with the carriage, said gear-train actuating the cam-shaft, and the elements thereof being so proportioned that the cam permits the tool-carrier and its relieving-tool to be held away from the work at certain predetermined times, and to be forced toward said work at certain other times.

26. The combination, with a reciprocatory carriage, of means for supporting work upon said carriage; means for continuously rotating the work also mounted on the carriage; a tool for operating upon the work as it is carried past the same; and means for actuating said tool.

27. In a machine of the class specified, the combination, with a reciprocatory carriage, of means for supporting work carried by said carriage; gearing for continuously rotating the work also carried by the carriage; a tool for acting upon the work as it is carried past the same; means for reciprocating said tool toward and from the work; and means for actuating the tool.

28. The combination, with means for supporting work, and with a tool for operating on said work, one of said parts being reciprocatory with relation to the other, of means for continuously rotating the work; and means for actuating the tool toward and from said work.

29. The combination, with means for continuously rotating fluted work, of a relieving-tool, the working surface of which operates in a line longitudinally of the work; and means for advancing said tool toward, and withdrawing it from, the work.

30. The combination, with a reciprocatory carriage, of means for continuously rotating a fluted tool-blank; a rotary relieving-tool, which engages a rib of the blank longitudinally of said rib; means for setting said tool at an angle to the blank; and means for reciprocating the tool toward and from the blank.

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

BENGT M. W. HANSON.

Witnesses:
H. E. BAILEY,
A. J. WEAVER.