F. E. BRIGHT.

GRINDING MACHINE.

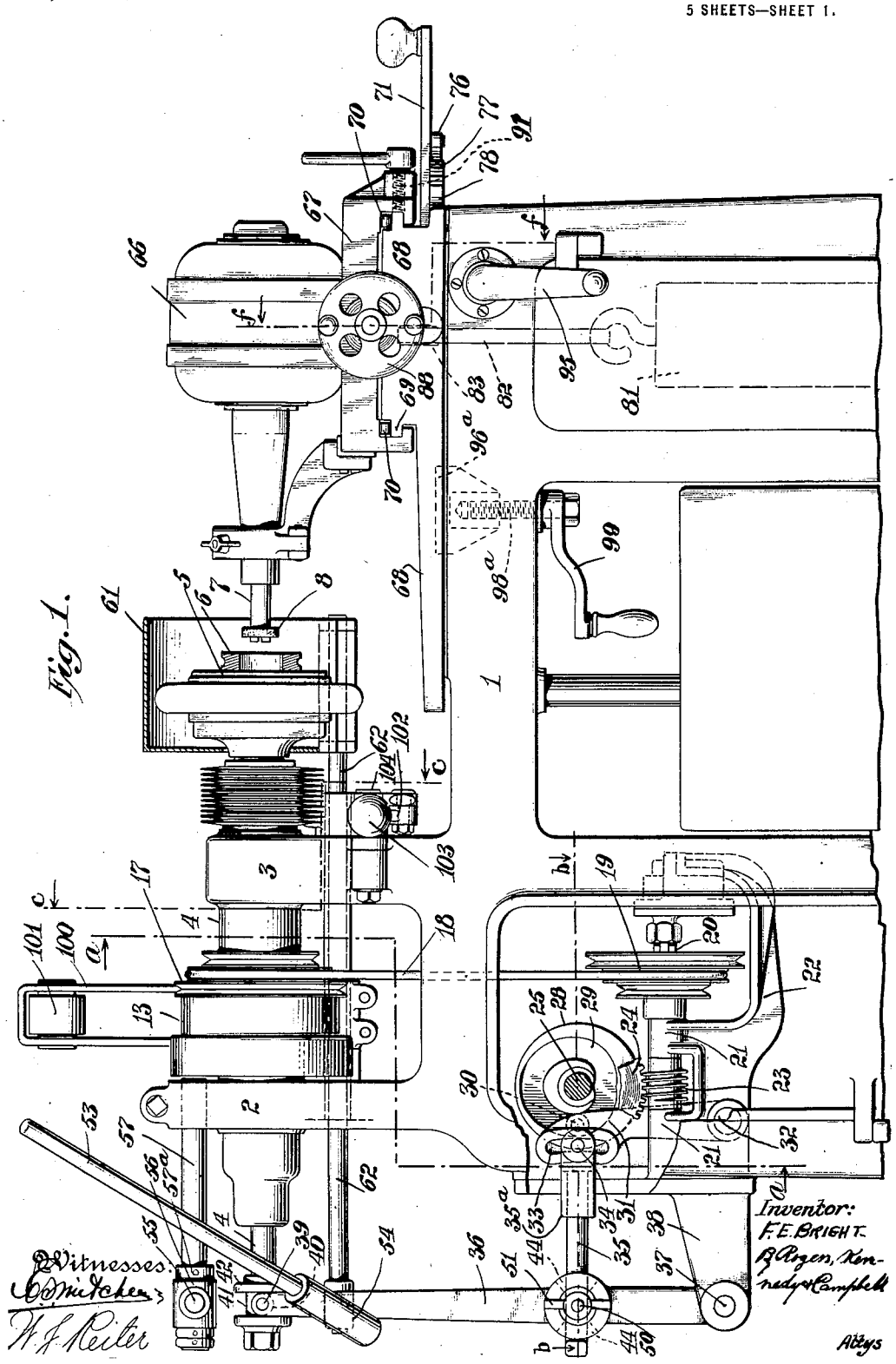
APPLICATION FILED FEB. 20, 1915.

1,198,613.

Patented Sept. 19, 1916.

5 SHEETS—SHEET 1.

Fig. 1.



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5 SHEETS—SHEET 2.

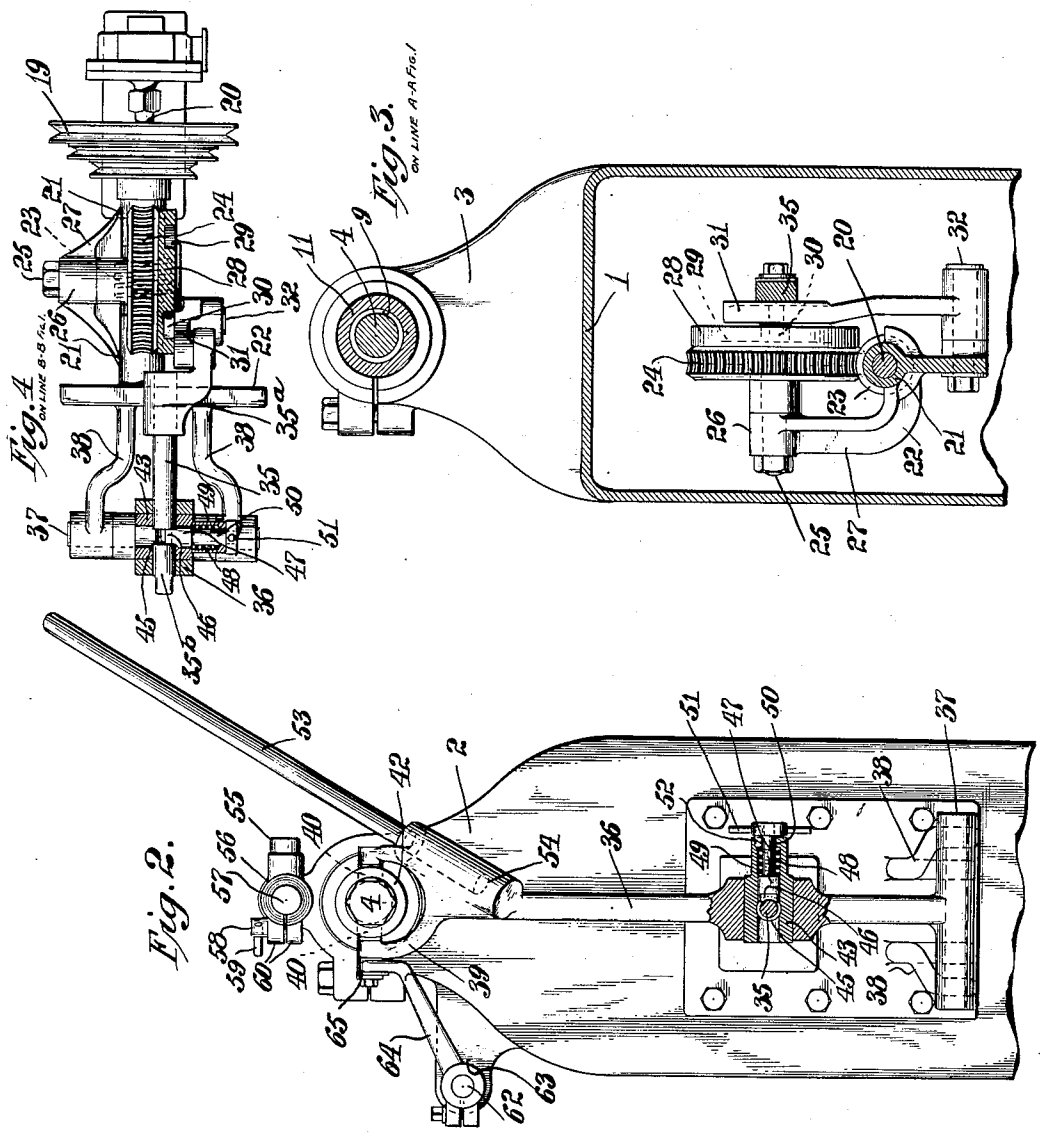


Fig. 4 ON LINE B-B FIG. 1

Fig. 5. ON LINE A-A FIG. 1

Fig. 2.

Attest:

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5 SHEETS—SHEET 3.

Fig. 7.

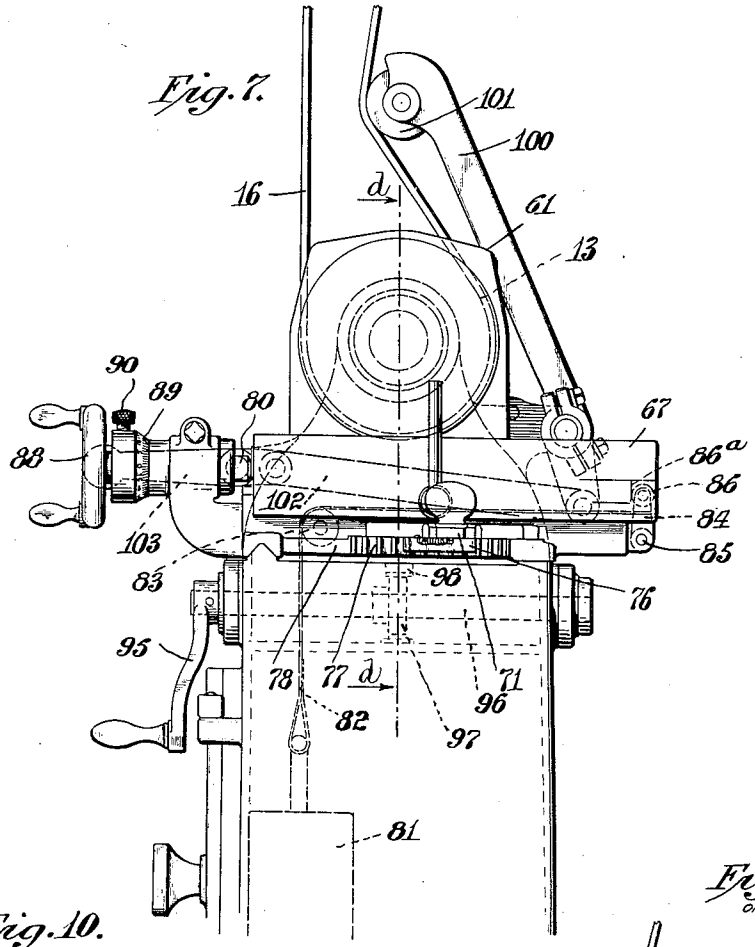


Fig. 10.

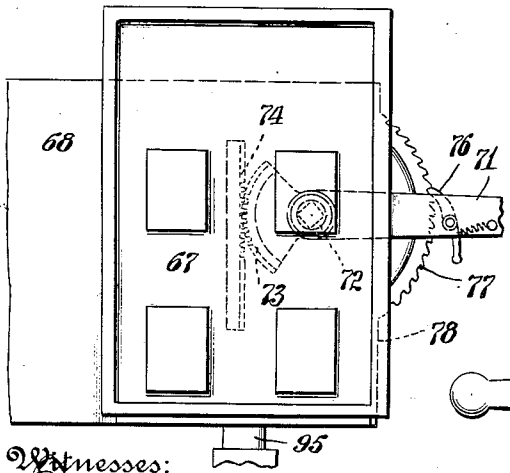
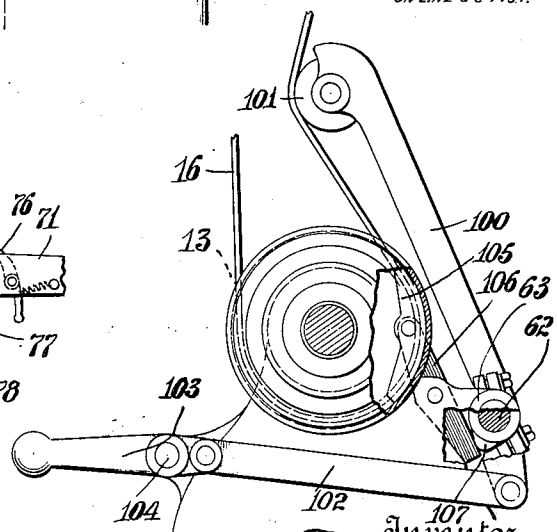


Fig. 5.

ON LINE C-C. FIG. 1.



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5 SHEETS—SHEET 4.

Fig. 6.

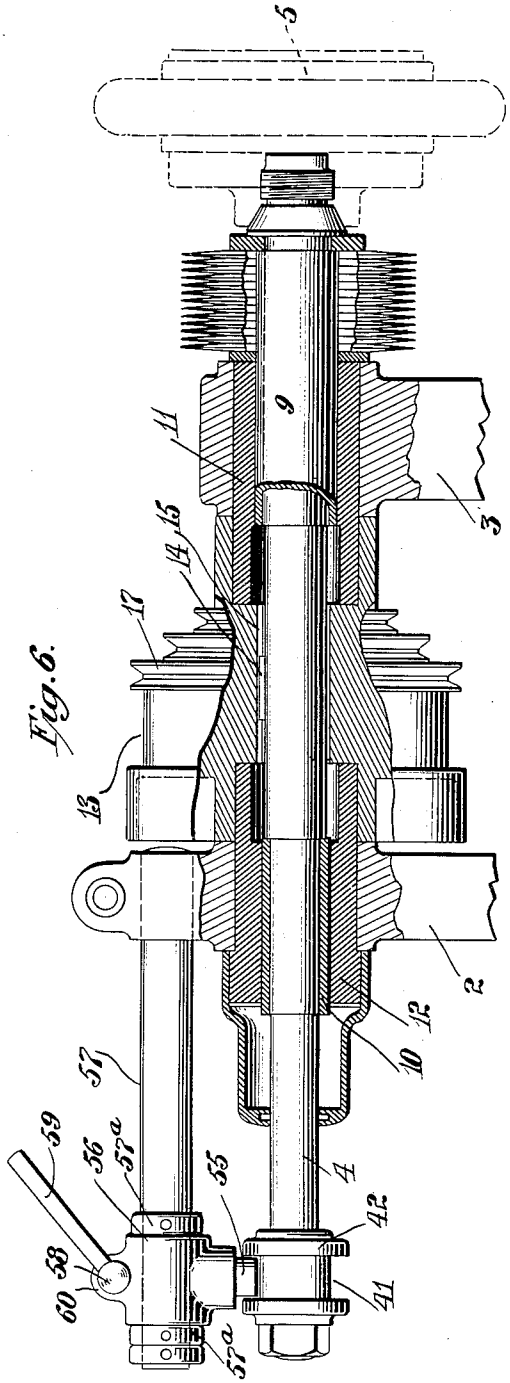
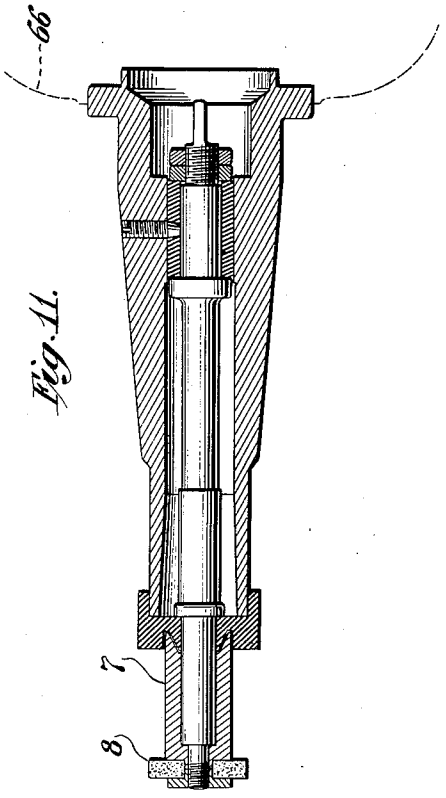


Fig. 11.



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5 SHEETS—SHEET 5.

Fig. 8ª
ON LINE E-E FIG. 8.

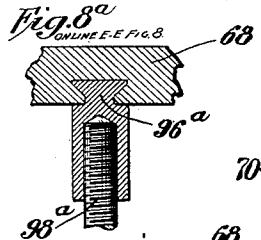
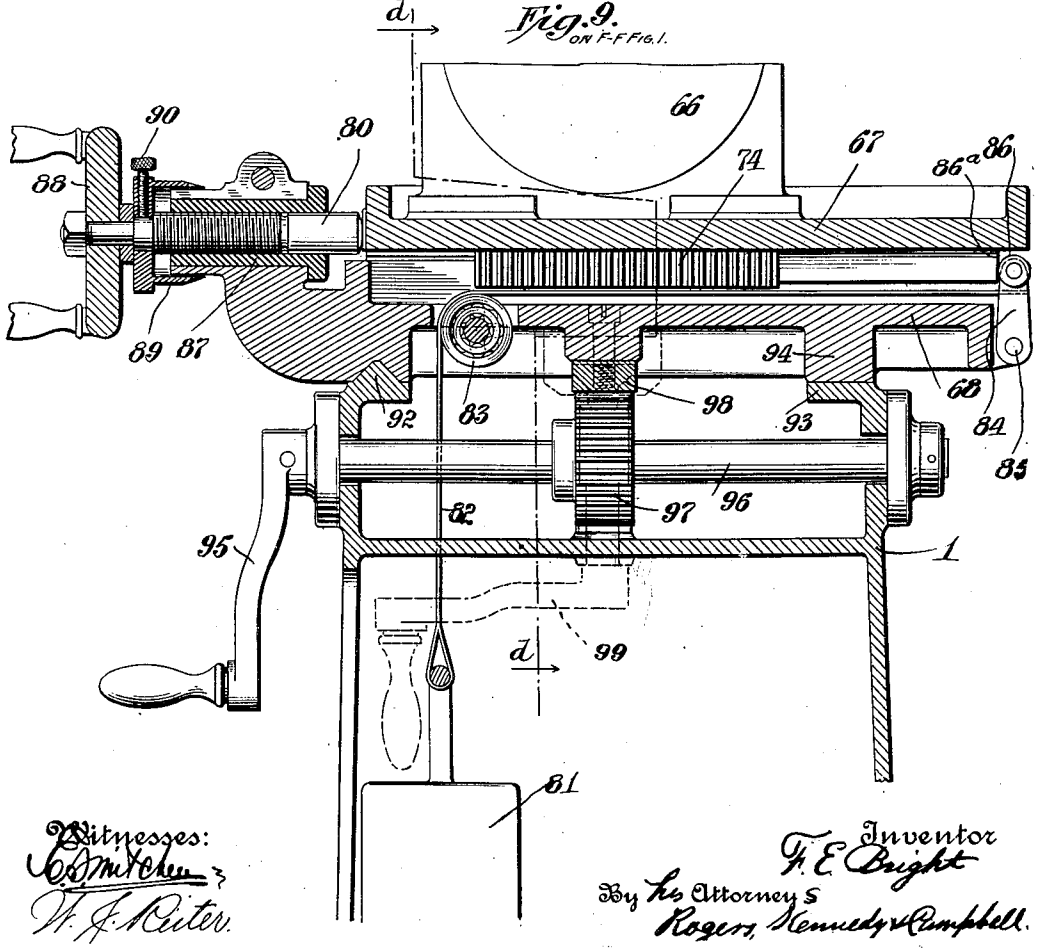


Fig. 8.
ON LINE D-D OF FIGS. 7 & 9

Fig. 9.
ON F-F FIG. 1.



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UNITED STATES PATENT OFFICE.

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GRINDING-MACHINE.

1,198,613. Specification of Letters Patent. Patented Sept. 19, 1916.

Application filed February 20, 1915. Serial No. 9,498.

To all whom it may concern:

Be it known that I, FRED E. BRIGHT, a citizen of the United States, residing at Philadelphia, in the county of Philadelphia and State of Pennsylvania, have invented certain new and useful Improvements in Grinding-Machines, of which the following is a specification, reference being had therein to the accompanying drawing.

This invention relates to grinding or finishing machines, and has reference more particularly to that type of machine in which the work is rotated while being subjected to the action of an operating tool.

The invention is designed with special reference to the operation on annular forms or shapes, such for instance as the casing-members or bearing-rings of antifriction bearings, the particular form of mechanism here shown as embodying my invention, being adaptable for operating on the bores of inner casing members of antifriction bearings, in order to give to the bore its proper and accurate finished condition.

In its general organization the mechanism embodying my invention comprises a holder for the work, in the present instance the inner casing-member of an antifriction bearing, which holder is adapted to be rotated so as to impart a corresponding motion to the work about its longitudinal central axis, and which holder is adapted to be reciprocated in a direction axially of the work in order that the bore of the latter may be presented throughout its longitudinal extent to the action of the operating tool; a rotary operating tool adapted to act on the interior of the bore, and means for imparting to the tool a feeding motion transversely of the axis of the bore, in order that the tool may cut more deeply into the material.

In the more specific embodiment of the invention, the work-holding device is in the form of a chuck carried on the end of a rotary work spindle, which spindle is reciprocated through the medium of mechanism operated by the rotary drive of the spindle; and the operating tool is in the form of a grinding wheel carried by a rotary tool spindle which is mounted on a carriage sustained for transverse movement on a slide, which in turn is movable longitudinally of the spindle; whereby the tool, after being initially positioned with respect to the work, may be fed transversely so as to enter more deeply therein, and may be moved away from and wholly free of the work in order to enable the finished work-piece to be removed and another one substituted.

The mechanism shown in the accompanying drawings illustrates one form of embodiment of my invention, which is shown by way of example, and which in practice has been found to answer to a satisfactory degree the objects to be attained. It will be manifest, however, that the constructional details thereof may be variously modified and changed by the skilled mechanic, without departing from the spirit of my invention; and it will be understood that the invention is not limited to any particular form or construction of the parts, except in so far as such limitations are specified in the claims.

In the accompanying drawings:

Figure 1 is a side elevation of my improved grinding machine with parts broken away to expose other parts to view. Fig. 2 is an end elevation of the machine looking toward the front of the machine, with certain parts in section. Fig. 3 is a vertical transverse sectional elevation on the line *a*—*a* of Fig. 1. Fig. 4 is a horizontal sectional plan view, partly in elevation, on the line *b*—*b* of Fig 1. Fig. 5 is a vertical transverse sectional elevation on the line *c*—*c* of Fig. 1, looking toward the rear and showing particularly the form and construction of the belt tightener and coöperating brake. Fig. 6 is an enlarged view of the work-carrying spindle and connected parts, with portions broken away to expose the internal construction. Fig. 7 is an end elevation of the machine looking toward the rear. Fig. 8 is a vertical longitudinal sectional elevation on an enlarged scale, through the front portion of the machine, on the line *d*—*d* of Figs. 7 and 9. Fig. 8ª is a transverse section on the line *e e* of Fig. 8. Fig. 9 is a transverse vertical sectional elevation, on an enlarged scale, on the line *f*—*f* of Fig. 1. Fig. 10 is a top plan view of the transverse carriage on which the tool carrying spindle is sustained, a portion of the underlying longitudinally movable slide being shown. Fig. 11 is a longitudinal sectional elevation of the tool-carrying spindle and its supporting housing.

Referring to the drawings: The operative parts of my improved machine are mounted in and sustained by a suitable frame, embodying a horizontal platform 1 from one end of which rise two standards 2 and 3,

Mounted in suitable bearing in the standards, is a horizontal rotary work-carrying spindle 4, having on its end a work-holding device in the form of a chuck 5. The chuck in the present instance is of a form and construction adapted to firmly hold the inner casing-member 6 of an antifriction bearing, so that when rotary motion is imparted to the spindle, the casing member will be rotated about its horizontal longitudinal axis. Sustained by the platform 1, in the manner to be more fully described hereinafter, is a horizontal rotary tool-carrying spindle 7, extending in line with the spindle 4, and carrying on that end adjacent the work-holding device, an operating tool, in the present instance in the form of a grinding wheel 8. The work-carrying spindle is adapted to be reciprocated longitudinally, in order to impart to the work, a traversing feeding movement, and the tool-carrying spindle is adapted to be shifted transversely of the axis about which the work is rotated, the result being that when the operating tool is initially positioned to act on the interior of the bore, the traversing feeding movement of the work, will present the interior of the bore to the action of the operating tool, and the latter, by its transverse feeding movement, may be caused to enter more deeply into the material to effect the proper grinding and finishing of the bore.

The work-carrying spindle 4 is surrounded at its front, and near its rear, with bushings 9 and 10 respectively, which are fixed to said spindle, and which rotate within bearing sleeves 11 and 12, the bearing sleeve 11 being firmly fixed in the standard 3, and the bearing sleeve 12 in the standard 2, the construction being such that the spindle, with its bushings, may rotate within the bearing sleeves, and may also be reciprocated longitudinally therein. Rotary motion is imparted to the spindle 4 by means of a pulley 13 surrounding the spindle and journaled at its ends on the adjacent ends of the bearing sleeves 11 and 12, the spindle being provided with a spline 14 which slides freely longitudinally in a key-way 15 formed on the interior of the pulley, whereby the rotary motion of the pulley will be imparted to the spindle, while at the same time the latter will be capable of a longitudinal reciprocating motion within the pulley. The pulley is driven by belt 16, which may receive its motion from a suitable source of power.

The reciprocating motions of the spindle 4 are imparted to it automatically by suitable mechanism actuated by the rotary drive of the spindle, this mechanism consisting of the following parts: Fixed to the pulley 13, is a grooved pulley 17, which is connected by an endless driving belt 18, with a grooved wheel 19 carried by a short horizontal longitudinally extending shaft 20, situated below the spindle 4, and mounted in suitable bearings 21 in a bracket 22, bolted to the main frame of the machine at its rear end. The short shaft 20 carries a worm 23, which engages a vertical worm wheel 24 mounted on a horizontal transverse shaft 25, extending above shaft 20, and mounted in a bearing 26 on the upper end of an arm 27, extending upwardly from the bracket 22. Connected with the worm wheel, is a cam wheel 28 provided in its face with a cam groove 29, in which extends a roller 30 on the side of a vibratory member, in the form of an upright arm 31 pivoted at its lower end to the bracket 22 on a horizontal transverse axis 32. The upper end of the arm 31 is provided with a vertical slot 33, in which extends a pin 34 projecting laterally from the forward end of a horizontal rod 35, which extends rearwardly and is jointed to an upright fore-and-aft reciprocating member in the form of a movable lever 36, in the manner to be more fully described later on. The lower end of the lever is pivoted on a horizontal transverse axis as at 37, between arms 38 extending rearwardly from the bracket 22, and its upper end is provided with parallel arms 39 which carry at their inner sides, rotary rollers 40 engaging in a peripheral groove 41 in a sleeve 42 fixed to the rear end of the spindle 4. As a result of the construction described, the rotary motion of the pulley 13 will be transmitted, by means of the belt 18, to the short shaft 20, the rotation of which will, through the medium of worm 23 and worm wheel 24, impart a rotary motion to the cam 28, and this, through the action of the arm 31, and connecting rod 35, will impart a fore-and-aft reciprocating motion to the lever 36, which will cause the spindle 4 to be reciprocated back and forth in its bearings in the standards 2 and 3, whereby a traversing feeding movement will be imparted to the rotating work carried by the work-holder.

The connection between rod 35 and lever 36 is such that these parts may be released from each other, in order to enable the spindle 4 to be moved back and forth by hand, if for any reason it is desired to quickly move the work endwise relatively to the operating tool. The form of connection provided for this purpose is shown more particularly in Fig. 2, and is of the following construction: The rod 35 extends through an opening in the lever, and loosely through a guiding opening in a cylindrical bushing 43 mounted loosely in a correspondingly shaped hole extending parallel with the axis of the lever and intersecting the opening therein, the ends of the opening in the lever being flared as at 44. Where the rod extends through the bushing, it is provided with a peripheral groove 45 which is adapted to receive a lock-

ing block 46 carried by a plunger 47 slidingly mounted in the center of the bushing and movable axially thereof so as to engage the block in the groove or disengage the same therefrom. The plunger is acted on by a spring 48, mounted within a neck 49 projecting outwardly from the bushing, which spring bears at one end against a shoulder on the neck, and at its opposite end against the plunger, the tendency of the spring being to urge the plunger inwardly and seat the block in the peripheral groove in the rod, but permitting the plunger to be drawn outwardly, in order to disengage the block from the groove. The plunger is provided with a stem 50 extending through the spring, and having fixed to its outer end, a handle 51, by which means the plunger may be moved in and out. With the plunger in its inner position, and with the block thereon engaged in the peripheral groove in the rod, driving connection is effected between the rod and the lever 36, whereby the endwise movement of the rod will reciprocate the lever 36. When, however, the plunger is moved outwardly, and the locking block disengaged from the groove in the rod, the latter will be permitted to slide idly back and forth through the bushing and lever, and will thus fail to operate the lever. The block may be maintained, for the time being, out of engagement with the groove in the rod, by means of a pin 52 extending inwardly from the handle on the plunger, and normally, when the parts are engaged, seated in a socket in the neck on the bushing. When the handle is operated to withdraw the plunger and disengage the block from the rod 35, it is given a partial turn to carry the pin out of register with its socket, and the handle being released, the spring will cause the pin to seat on the outer end of the neck, and the block will be thus held out of engagement with the rod. With the parts disengaged and held, the lever 36, and consequently the work-carrying spindle connected thereto, may be moved by hand, through the medium of a handle 53 removably seated in a socket 54 on lever 36, so that when not in use it may be removed therefrom. The purpose in forming the end of the opening through the lever, with flared ends, is to admit of the relative movements of the rod and lever in a vertical direction during the operation of the parts, the bushing 43 in such movements, rocking in its guiding opening on its central axis.

In certain kinds of work the reciprocating motions of the work-carrying spindle are not required, and therefore it is desirable, when such work is being operated on, to hold the spindle against reciprocating motion, while permitting its rotation to rotate the work relatively to the operating tool. I propose to effect this object by a device which, when the rod 35 is released from lever 36, as just described, may be moved into coöperative relation to the spindle, and which will hold the same against endwise movement. This device in its preferred form, is shown more particularly in Figs. 1 and 2, and consists of a stop pin 55 projecting radially from a collar 56 rotatably mounted on a rod 57 fixed to and projecting rearwardly from the standard 2, above and in proximity to the projecting end of the spindle. The relation of the pin, to the groove 41 in the spindle, is such, that, by the oscillation or rotary motion of the sleeve on rod 57, the stop pin may be engaged in or disengaged from said groove. Normally, and in the ordinary use of the machine, where the spindle is reciprocated, the pin is adjusted free of the groove; but when the spindle is to be held against reciprocating motion, as when the rod 35 is released from the lever 36 for special work, the sleeve 56 is turned on its sustaining rod 57, and the stop pin on the sleeve caused to enter the groove in the spindle, in which position of the parts, the spindle will be held by the pin against reciprocating motion, but, due to the engagement of the stop pin in the groove, the spindle may be rotated as before. The sleeve 56 is mounted on the rod between fixed collars 57^a, in order to maintain the sleeve against endwise movement on the rod, and it is adapted to be clamped in different circumferential positions, to hold the pin into or out of engagement with the groove in the spindle, by means of a clamping screw 58 operated by handle 59 and threaded in ears 60 on the sleeve.

In order that the position of the work-carrying spindle may be varied in a longitudinal direction, I construct the rod 35, by which motion is transmitted from vibratory arm 31 to lever 36, so that the position of the lever relative to the arm may be changed. This is effected by forming the rod 35 in two sections, an inner front section 35^a, in the form of a tube having an interiorly threaded opening, and a rear section 35^b, which is screwed into the tube and which is connected with the lever 36 as heretofore described. By screwing the section 35^b in or out, the length-over-all, of the rod, made up of these two sections, may be increased or diminished. When the length is increased, the effect will be to adjust the work-carrying spindle in a rearward direction, and when the length of the rod is diminished, the effect will be to adjust the sleeve in the opposite direction. The extent of reciprocating movement of the spindle will, however, be the same as before, the change due to these adjustments, affecting only the position of the path in which the spindle reciprocates.

The length of throw of the lever 36, and

consequently the extent of reciprocating movement of the work-carrying spindle, may be varied by connecting the forward end of rod 35, to the vibratory arm 31, at different distances from the pivotal axis of said arm. This is provided for by the slot 33 in arm 31, in which pin 34 extends, a clamping screw 34ª being screwed on the end of the pin and adapted to bear against the side of the arm, and serving to hold the pin in the different positions in the slot to which it may be set.

The chuck 5 in which the work is carried, is surrounded by a hood 61, in order to prevent the dust or ground particles from being thrown outwardly, and in order that the hood will, in the reciprocating movements of the chuck, maintain its proper relation thereto, means are provided for reciprocating the hood with the chuck. In the present instance this is effected by connecting the hood to the forward end of a horizontal fore-and-aft extending rod 62, which rod extends rearwardly at the side of and below the spindle 4, and through a tubular guiding casing 63 sustained in the frame of the machine. At its rear end the rod has connected with it, the lower end of an arm 64, the upper end of which is forked and embraces a roller 65 extending outwardly from one of the arms of the lever 36, whereby operative connection is made between arm 64 and lever 36. As the lever 36 is moved back and forth to reciprocate the spindle, and consequently the work chuck, its motions are transmitted to the rod 62, through the medium of the arm 64, with the result that the hood carried by rod 62, will be likewise reciprocated and its relation to the chuck will be preserved.

The tool-carrying spindle may be rotated in any suitable manner and by any appropriate means. I show, in the present instance for this purpose, a high-speed electric motor 66, which is mounted on the transversely movable carriage before alluded to, indicated in Fig. 1 by the numeral 67. This carriage, as before stated, is movable transversely in a horizontal direction, on the slide before alluded to, indicated by the numeral 68, which is movable longitudinally on and sustained by the bed plate 1 of the frame. The carriage 67 consists of a flat plate extended downwardly at its edges and then inwardly beneath front and rear, transversely extending, guiding ribs 69, projecting outwardly from the slide, antifriction rolls 70 being interposed between the upper sides of the ribs 69 and the under side of the carriage, in order to relieve the latter of friction in its transverse movements. By the transverse movements of the carriage, the grinding wheel may be fed radially so as to enter more deeply into the bore of the work, and also in order that the grinding wheel may be shifted from in front of the work to permit the latter to be removed when the grinding operation is finished. Different mechanisms are employed for effecting these movements, one, a quick-acting adjusting mechanism, by which the carriage may be quickly shifted along the slide when the grinding wheel is set for working position, or when the work is to be removed, and the other, a slow-acting feeding device, capable of operation to advance the carriage after it has been initially set by the other mechanism, predeterminate and definite degrees, so as to cause the wheel to feed gradually into the material of the work.

The quick acting adjusting mechanism consists of a horizontal forwardly extending hand lever 71, fixed at its inner end to the lower end of a vertical stud 72 journaled in a bearing in the slide 68. The upper end of the stud extends above the slide, and has fixed to it a segment gear 73 which engages a rack 74 fixed to the under side of the carriage. The lever carries a spring-actuated dog 76, which engages ratchet teeth 77 on a segment frame 78 fixed to and projecting forwardly from the slide 68. By disengaging the dog 76 from the ratchet teeth, the lever may be moved back and forth, and by such movement, the carriage will be shifted transversely on the slide in opposite directions. When the lever is moved to adjust the carriage so that the grinding wheel will be in position to act on the bore of the work, one end of the carriage will bank against a horizontal feed screw 80, carried by the slide and extending in the direction of transverse movement of the carriage, the carriage being held in this position in yielding engagement with the screw, by means of a weight 81 attached to a band 82 passing over an idler pulley 83, in the form of an annular ball-bearing, carried by the slide. The end of the band is connected to an arm 84 pivoted at its lower end, as at 85, to the slide, and carries on its upper end, a roller 86 in position to engage a shoulder 86ª depending from the under side of the carriage. With the carriage held by the weight up against the screw 80, it is adapted, by the rotation of the screw, to be fed transversely in order to effect the transverse feeding movement of the grinding wheel, the lever 71 in this gradual feeding movement, moving in the direction indicated by the arrow in Fig. 10, the ratchet teeth 77 pointing in such direction relatively to the spring dog 76, that the dog will click over the teeth in such movement of the lever. The screw 80 is threaded in a nut 87 fixed in a boss projecting outwardly from the slide, and the outer end of the screw has fixed to it, an operating wheel 88 carrying a micrometer sleeve 89, which surrounds the outer end of the boss and which is provided with a scale

properly graduated to thousandths or ten thousandths of an inch, and adapted to be read in connection with a pointer on the boss, to enable the screw to be advanced known and definite degrees in order to impart a corresponding transverse feeding movement to the grinding wheel. The micrometer sleeve is mounted loosely on the screw, and is adapted to be clamped fixedly thereto, by means of a set screw 90 so that by loosening the set screw, the sleeve may be set to zero for the next grinding operation. The carriage may be clamped firmly and fixedly to the slide, to hold it in fixed position thereon, by means of a clamping screw 91, threaded into the forward edge of the carriage, with its inner end in position to bear against the edge of the guiding shoulder 69 on the slide, the screw being provided with a handle for turning it. When the handle is moved to turn the screw in, its end binding against the rib on the slide, will clamp the carriage firmly in position, the release of the carriage being effected by loosening the screw.

The slide 68 is guided longitudinally on the platform 1 by a V-shaped guide rib 92 projecting upwardly from the platform at one edge, and engaging in a correspondingly shaped groove in the under side of the slide, the platform being provided at its opposite edge with a horizontal supporting ledge 93, on which a rib 94, depending from the under side of the slide, bears. The longitudinal movement of the slide is effected by means of a hand crank 95 fixed to the end of a horizontal transversely extending shaft 96 mounted in suitable bearings in the platform. The shaft has fixed to it between its ends, a pinion 97 engaging a horizontal longitudinally extending rack 98 fixed to the under side of the slide, the arrangement thus being such that by turning the hand crank, the slide may be moved toward the work-holder, in order to initially position the grinding wheel with reference to the work, or it may be moved in the opposite direction in order to carry the wheel free of the work to permit access thereto for removal or for other purposes.

In the operation of the parts in effecting the initial positioning of the grinding wheel, and in feeding the latter transversely, the hand crank 95 and the hand lever 71 are moved relatively so as to bring the grinding wheel to a point substantially in axial alinement with the work in the chuck, and in such relative proximity to the same, that, as the work is reciprocated back and forth by the reciprocating movements of the work-carrying spindle, the surface of the wheel will act on the interior of the bore in the work. In this position of the parts, the carriage will be held by the weight, banked against the feeding screw 80, and as the work is rotated and reciprocated by the spindle 4, and is presented to the action of the grinding wheel, the latter is fed by gradual degrees in a transverse direction radially of the axis of the work, by means of the operating wheel 88, the feeding action being by slow and by definite degrees, as determined by the micrometer scale. When the grinding operation is completed, and the bore has been given its final and accurate shape and dimensions, the slide 68 is moved rearwardly by the hand-crank 95, in order to remove the wheel from the work, and then the carriage is shifted transversely by the hand lever 71 in order to carry the grinding wheel and associated parts, wholly from in front of the work. The latter is now free to be measured or examined or entirely removed, and a new piece of work may be readily inserted, and the parts adjusted to repeat the foregoing operation.

In order that, after the slide has been moved forward to effect a proper positioning of the grinding wheel in a longitudinal direction with reference to the work, the slide may be firmly locked in such position during the grinding operation, and during the transverse feed of the carriage, I provide a locking device for the slide in the form of a head 96^a, having on its upper end a dove-tail which fits loosely in a dove-tail groove extending longitudinally in the under side of the slide. The head contains a vertical interiorly threaded opening, in which is screwed the upper end of a vertical screw 98^a, journaled for rotation in the frame of the machine and provided with a turning handle 99. After the slide has been adjusted as before described, to bring the grinding wheel to its proper position for action, the dove-tail groove on the under side of the slide, sliding on the dove-tail in such action, the handle 99 is turned so as to draw the head 96^a downwardly, which will bind the dove-tail against the sides of the groove, and will firmly lock the slide in its adjusted position. After the grinding operation is completed, and the slide is to be moved forward to free the work, the handle 99 is operated to release the clamping action on the slide, and the latter is then free to be moved forwardly by its hand crank 95.

In order that the operation of the work-carrying spindle may be conveniently started and instantly arrested, I provide a device adapted to act on the driving belt of the pulley 13, in order to apply sufficient tension to the belt to cause it to rotate the pulley, which device coöperates with a brake for the driving pulley, in such manner, that when the said device is operated to tighten the belt, the brake will be automatically thrown out of action to release the pulley, and when the said device is operated to relieve the belt of tension, the brake will be

automatically thrown into action, the result being that simultaneously with the loosening of the belt and the cessation of its driving action on the pulley, the latter will be subjected to a braking action and its motion instantly arrested. This mechanism is shown more particularly in Figs. 1, 5 and 7. In these figures it will be seen that an arm 100 is fixed near its lower end to the tubular casing 63, before alluded to as inclosing the hood-carrying rod 62, which casing is mounted loosely in the frame of the machine so that it may rock therein. The arm extends upwardly and carries a roller 101, adapted, when the arm is swung toward the work-carrying spindle, to engage the driving belt and apply tension to the same. The lower end of the arm extends beyond the casing, and has pivoted to it, one end of a link 102 which extends transversely below the work-carrying spindle to the opposite side of the machine. At this point, the end of the link is jointed to the inner end of a hand lever 103, pivoted on a horizontal longitudinal axis, as at 104, to the standard 3 of the frame, the outer end of the lever being in position to be operated by the attendant. The relation of this hand lever to the arm 100 is such, that, when the hand lever extends at an upward inclination, as shown by dotted lines in Fig. 5, the arm will be in its outer position and the driving belt free of driving tension. When, however, the lever is swung downwardly, the link 102 will be thrust endwise, and will swing the arm inwardly, and cause the roller thereon to engage the belt and apply sufficient tension to drive the pulley. Coöperating with the inner surface of the rim of the pulley 13, is a segmental brake shoe 105, pivoted between its ends on the upper end of a lever 106, which is in turn pivoted between its ends to the machine framing. The lower end of the lever 106 is in position to be acted on by a cam 107 on the tubular casing 63, when said casing is rocked by the operation of the hand lever to move the arm 100 outward to release the belt, the cam acting when thus engaged with the lever 106, to rock the latter on its axis and cause the brake shoe, carried thereby, to engage with the rim of the pulley. When the lever is operated in the opposite direction to swing the arm inwardly so as to apply driving tension to the belt, the casing carrying the cam, will be rotated and will disengage from the lever carrying the brake shoe, with the result that the brake shoe will be disengaged from the pulley. From this construction, it will be noted that normally, with the machine at rest, and the belt slack, and with the arm 100 in its outer position, the cam will hold the brake shoe against the pulley and the latter will be held against movement. When the machine is to be started, the hand lever is swung down, with the result that the arm 100 will be swung inwardly at its upper end, and will apply driving tension to the belt. Simultaneously with this action, the brake will be released, and the pulley will be free to receive rotation from the belt, and the machine will be operated. When, now, the operation of the machine is to be arrested, the hand lever 103 is swung up, which action will throw the arm 100 outwardly, thereby releasing the belt, and simultaneously with this action, the cam will act on the brake shoe carrying-lever, and engage the brake with the pulley, whereby the latter will be instantly arrested and the machine stopped.

When the boring wheel acts at the ends of the bore in the grinding wheel, for a time but a portion of the surface of the wheel is in grinding engagement with the material, and consequently at such time the wheel meets with less resistance to its grinding action, than at intermediate points in the work, where the entire surface of the wheel is in action. If, therefore, the longitudinal feeding movement of the work-piece is uniform, there is danger of producing a "bell-mouthed" bore. To minimize this liability, I propose to so form the mechanism, by which the work-carrying spindle is fed or reciprocated longitudinally, that its movements will be accelerated when the ends of the bore are presented to the action of the grinding wheel, and consequently will be slower intermediate these points. I prefer to effect this object by the shaping of the cam 29, which is of such contour, as shown in Fig. 1, that a comparatively quick longitudinal movement will be given to the work, as one end of the bore is presented to the wheel, a slower motion, as the middle portion of the bore traverses the wheel, and then a quick motion again as the other end of the bore reaches the wheel, these variations being of course repeated on the return movement of the work.

An important feature of my invention is the longitudinal reciprocating motion which is imparted to the work-carrying spindle to cause the work-piece to correspondingly feed to the grinding wheel. This insures extreme accuracy in the shaping of the work; and in the casing member of an antifriction bearing, enables the walls of the bore to be ground in exact parallelism, and this regardless of the inaccuracy or misalinement of the parts of the machine other than the work-carrying spindle. In other words, extreme accuracy of the construction may be restricted to the work-carrying spindle and its bearings, whereas in other forms of machines known to me, other and additional parts must be mounted in very delicate and accurate alinement, and must, with more or less difficulty, be so maintained, in order to produce that degree of trueness and accu-

racy in the shaping of the parts, as is required in high class ball bearing manufacture.

Another feature of importance is the provision of the clamping devices for the parts sustaining the grinding wheel in its various movements. These clamping devices insure rigidity of the parts during the period of actual grinding, while by their release, full freedom of movement is permitted. This will enable the rapid initial positioning of the wheel for the grinding operation, and the quick movement of the wheel to free the work and clear the space in front of the chuck when the work is to be examined or removed, and a new piece is to be inserted.

In the accompanying drawings and foregoing description I have shown my invention as particularly adapted for the operation on and shaping of the bores of the casing-members of antifriction bearings. It will be manifest, however, that the invention is not restricted in its use for such purposes, but is applicable as well to the grinding and shaping of work pieces of other forms, provided the operation of the parts is substantially as above described.

Having thus described my invention, what I claim is:

1. In a machine of the type described, the combination of a sustaining frame provided with bearings, a work-carrying spindle rotatably mounted within said bearings, a rotary tool-carrying spindle, means for moving the work-carrying spindle in its bearings in the direction of its axis of rotation and in relation to said bearings to cause the work to traverse the tool and means for effecting a feeding motion of the work-carrying spindle and tool-carrying spindle one transversely relatively to the other to cause the tool to enter the material of the work.

2. In a machine of the type described, the combination of an operating tool, a rotary work spindle adapted to carry a work holder and mounted for endwise reciprocation to feed the work to the tool, a driving pulley surrounding the work spindle and adapted to be driven from a suitable source of power, mechanism operatively connected with the work spindle for reciprocating the same, said mechanism including a driving shaft parallel with the work spindle, a driving pulley on said shaft for operating it, and a driving belt connecting said pulley with the pulley on the work spindle.

3. In a machine of the type described, the combination of an operating tool, a rotary work spindle adapted to carry a work-holder and mounted to reciprocate endwise, driving means for rotating the spindle, a rotary member operated by said driving means, and a vibratory member actuated by the rotary member and operatively connected with the spindle for reciprocating the same.

4. In a machine of the type described, the combination of an operating tool, a rotary endwise reciprocating work spindle adapted to carry a work-holder, driving means for rotating the spindle, a rotary member operated by said driving means, a vibratory member operated by the rotary member, a reciprocating member operatively connected with the spindle, and a connection between the vibratory member and the reciprocating member.

5. In a machine of the type described, the combination of an operating tool, a rotary endwise reciprocating work spindle adapted to carry a work-holder, driving means for rotating the spindle, a worm operated by said driving means, a worm wheel operated by the worm, and a vibratory member operated by the worm wheel and operatively connected with the spindle for reciprocating the same.

6. In a machine of the type described, the combination of an operating tool, a rotary endwise reciprocating work spindle adapted to carry a work-holder, driving means for rotating the spindle, a worm operated by said driving means, a worm wheel driven by the worm, a vibratory member operated by the worm wheel, a reciprocating member operatively connected with the spindle for reciprocating the same, and a connection between the reciprocating member and the vibratory member.

7. In a machine of the type described, the combination of an operating tool, a rotary endwise reciprocating work spindle adapted to carry a work-holder, mechanism for imparting a reciprocating motion of a predetermined extent to the spindle, and means for varying the position of the path of reciprocating motion of the spindle without varying the extent of its movement.

8. In a machine of the type described, the combination of a frame, an operating tool, a rotary endwise reciprocating work spindle mounted in the frame and provided with a work-holder, a reciprocating member sustained by the frame and operatively connected with the spindle for reciprocating the same, a vibratory member sustained by the frame, and means connecting the vibratory member operatively with the reciprocating member, said means being adjustable to vary the position of the reciprocating member relatively to the vibratory member; whereby the position of the path of reciprocating movement of the spindle may be changed.

9. In a machine of the type described, the combination of a frame, an operating tool, a rotary endwise reciprocating work spindle mounted in the frame, a vibratory member sustained by the frame, means for vibrating said member, a reciprocating member sustained by the frame and operatively con-

nected with the spindle, a rod connected with the vibratory member, and releasable means for connecting the rod with the reciprocating member.

10. In a machine of the type described, the combination of a frame, an operating tool, a rotary endwise reciprocating work spindle mounted in the frame and adapted to carry a work-holder, a reciprocating member sustained by the frame and operatively connected with the spindle for reciprocating it, a vibratory member sustained by the frame, means for operating the same, a rod connected with the vibratory member and slidable through the reciprocating member, and releasable means for locking the rod to said reciprocating member; whereby when said means are released, the rod will be free to slide idly through the reciprocating member without imparting motion thereto.

11. In a machine of the type described, the combination of a frame, an operating tool, a rotary endwise reciprocating work spindle mounted in the frame and adapted to carry a work-holder, a reciprocating member sustained by the frame and operatively connected with the spindle for reciprocating it, a vibratory member sustained by the frame, means for operating the same, said reciprocating member being formed with an opening extending therethrough, a bushing mounted loosely in said opening and having an opening therethrough intersecting the opening in the reciprocating member, a rod connected with the vibratory member and extending loosely through the opening in the bushing and through the opening in the reciprocating member, and releasable means for locking the rod to said bushing.

12. In a machine of the type described, the combination of a frame, an operating tool, a rotary endwise reciprocating work spindle mounted in the frame and adapted to carry a work-holder, a reciprocating member connected with the spindle for reciprocating the same, operating mechanism operatively connected with the reciprocating member, means for disconnecting the operating mechanism from the reciprocating member to permit the spindle to be moved endwise by hand, and a handle connected with the reciprocating member.

13. In a machine of the type described, the combination of a frame, an operating tool, a rotary endwise reciprocating work spindle mounted in the frame and adapted to carry a work-holder, mechanism connected with the spindle for reciprocating it endwise, means for disconnecting the mechanism from the spindle, and means for holding the spindle against endwise movement when the said mechanism is disconnected.

14. In a machine of the type described, the combination of a frame, an operating tool, a rotary endwise reciprocating work spindle mounted therein and adapted to carry a work-holder, mechanism operatively connected with the spindle for reciprocating the same, means for disconnecting said mechanism from the spindle, and a locking device normally disengaged from the spindle and movable into locking engagement therewith to prevent endwise movement of the spindle when the operating mechanism is disconnected.

15. In a machine of the type described, the combination of a frame, a rotary endwise reciprocating work spindle mounted in the frame and provided with a peripheral groove, mechanism operatively connected with the spindle for reciprocating the same, means for disconnecting said mechanism from the spindle, and a locking pin normally disengaged from the groove in the spindle and movable therein to lock the spindle against endwise movement.

16. In a machine of the type described, the combination of a frame, an operating tool, a rotary endwise reciprocating work spindle mounted in the frame and adapted to carry a work-holder, and a hood surrounding the work-holder and movable with the spindle in its reciprocations.

17. In a machine of the type described, the combination of a frame, an operating tool, a rotary endwise reciprocating work spindle mounted in the frame and adapted to carry a work-holder, a hood surrounding the work-holder and movably sustained by the frame, mechanism for reciprocating the spindle, and operative connections between said mechanism and the hood for reciprocating the latter with the spindle.

18. In a machine of the type described, the combination of a frame, an operating tool, a rotary endwise reciprocating work spindle mounted in the frame, a rotary driving pulley mounted in the frame and splined to the spindle, operating mechanism sustained by the frame and operatively connected with the spindle for reciprocating the same, and operative connections between the driving pulley and said operating mechanism, for actuating the latter.

19. In a machine of the type described, the combination of a frame, an operating tool, a rotary endwise reciprocating work spindle mounted in the frame and adapted to carry a work-holder, a driving pulley mounted in the frame and splined to the spindle, mechanism sustained by the frame and operatively connected with the spindle for reciprocating the same endwise, said mechanism including a driving wheel, and a driving belt driven by the pulley and passing around the wheel, for rotating the latter.

20. In a machine of the type described, the combination of a frame, an operating tool, means for rotating the work about the

axis of its bore, means for imparting to said work a feeding motion in the direction of the axis of the bore to present the latter to the action of the tool, and means for accelerating said feeding motion of the work when the tool is operating at the end of the bore.

21. In a machine of the type described, the combination of a frame, an operating tool, a rotary work spindle provided with a work-holder adapted to rotate the work about the axis of its bore, said spindle being mounted to reciprocate endwise to cause the bore of the work to traverse the operating tool lengthwise of the bore, and operating mechanism for reciprocating said spindle, said operating mechanism including a cam shaped to accelerate the endwise movement of the work spindle when the ends of the bore are presented to the operating tool.

22. In a machine of the type described, the combination of a frame, a work-holding device, a rotary tool spindle adapted to carry an operating tool, a slide supporting said spindle and movable on the frame to and from the work-holder to set the tool in working position relatively to the work, and releasable means for locking the slide fixedly in position on the frame, to hold the operating tool in working position.

23. In a machine of the type described, the combination of a frame, a work-holder, a rotary tool spindle adapted to carry an operating tool, a carriage movably sustained by the frame and giving support to the tool spindle, adjusting mechanism for moving said carriage to set the operating tool in working position or for moving the tool free of the work, and a feeding device acting on the carriage, to impart a feeding movement to the operating tool.

24. In a machine of the type described, the combination of a frame, a work-holder, a rotary tool spindle adapted to carry an operating tool, a carriage movably sustained by the frame and giving support to the tool spindle, a quick-acting mechanism for moving the carriage to set the operating tool in working position or to carry the same free of the work, and a slow-acting feeding device operating on the carriage, to impart a feeding movement to the operating tool.

25. In a machine of the type described, the combination of a frame, a work-holder, a rotary tool spindle adapted to carry an operating tool, a carriage movably sustained by the frame and giving support to the tool spindle, adjusting mechanism for moving said carriage to set the operating tool in working position or to carry the tool free of the work, and a feeding device acting on the carriage, to impart movement thereto in the same direction as the movement imparted by the adjusting mechanism, in order to feed the tool to the work.

26. In a machine of the type described, the combination of a frame, a work-holder, a rotary tool spindle adapted to carry an operating tool, a carriage movably sustained by the frame and giving support to the tool spindle, a rack on the carriage, a segment gear sustained by the frame and engaging the rack, for shifting the carriage to position the operating tool, and a feeding screw sustained by the frame and engaging the carriage, to impart a feeding movement thereto.

27. In a machine of the type described, the combination of a frame, a work-holder, a rotary tool spindle adapted to carry an operating tool, a slide sustained by the frame and movable to and from the work-holder, means for moving the slide, a carriage sustaining the tool spindle and movable on the slide in a direction transversely of the movement of the latter, and mechanism sustained by the slide and acting on the carriage, to move the same thereon.

28. In a machine of the type described, the combination of a frame, a work-holder, a rotary tool spindle adapted to carry an operating tool, a slide sustained by the frame and movable to and from the work-holder, means for moving the slide, a carriage sustaining the tool spindle and movable on the slide in a direction transversely of the movement of the slide, adjusting mechanism sustained by the slide and engaging the carriage for adjusting the same to position the operating tool, and a feeding device sustained by the slide and engaging the carriage, to impart thereto a feeding movement.

29. In a machine of the type described, the combination of a frame, a work-holder, a rotary tool spindle adapted to carry an operating tool, a carriage movably sustained by the frame and giving support to the tool spindle, a feeding screw sustained by the frame and against which the carriage is adapted to bank, and means acting on the carriage and holding the same in yielding engagement with the screw.

30. In a machine of the type described, the combination of a frame, a work-holder, a rotary tool spindle adapted to carry an operating tool, a carriage movably sustained by the frame and giving support to the tool spindle, adjusting mechanism sustained by the frame and acting on the carriage to position the same relatively to the work-holder, a feeding screw sustained by the frame and engaging the carriage to impart a feeding movement thereto in the direction of the movement imparted by the adjusting mechanism, and means acting on the carriage, to hold the same in yielding engagement with the feeding screw.

31. In a machine of the type described, the combination of a frame, a work-holder, a rotary tool spindle adapted to carry an op-

erating tool, a carriage movably sustained by the frame and giving support to the tool spindle, a movable feeding device sustained by the frame and against which the carriage is adapted to bear, and means acting on the carriage and operating to hold the same in yielding engagement with the feeding device.

32. In a machine of the type described, the combination of a frame, a work-holder, a rotary tool spindle adapted to carry an operating tool, a slide movable on the frame to and from the work-holder, means sustained by the frame and engaging the slide to move the same, a carriage movable on the slide transversely of the movement of the slide and supporting the tool spindle, adjusting mechanism sustained by the slide for shifting the carriage thereon to position the operating tool relatively to the work-holder, and a feeding device carried by the slide and acting on the carriage to impart thereto a feeding movement.

33. In a machine of the type described, the combination of a frame, a rotary tool spindle adapted to carry an operating tool, a rotary work spindle adapted to carry a work holding device, one of said spindles being reciprocable endwise relatively to the other, mechanism operatively connected with the reciprocating spindle for reciprocating the same, and means for disconnecting said mechanism from the spindle at will to permit the latter to be reciprocated by hand.

34. In a machine of the type described, the combination of a frame, a rotary tool spindle adapted to carry an operating tool, a rotary work spindle adapted to carry a work holding device, one of said spindles being reciprocable endwise relatively to the other, mechanism operatively connected with the reciprocable spindle for reciprocating it, means for disconnecting said mechanism from the spindle at will to permit the spindle to be operated by hand, and a handle applied to the spindle for operating it when so disconnected.

35. In a machine of the type described, the combination of a rotary tool spindle adapted to carry an operating tool, a rotary work spindle adapted to carry a work holder, one of said spindles being mounted for endwise reciprocation, a rotary member, and a vibratory member actuated by the rotary member and operatively connected with the reciprocating spindle for reciprocating the same.

In testimony whereof, I have affixed my signature in presence of two witnesses.

FRED E. BRIGHT.

Witnesses:
CHARLES S. BUTLER,
A. THEO. BRUEGEL.