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MACHINE FOR GRINDING DRILLS.

APPLICATION FILED OCT. 10, 1910.

1,016,891.

Patented Feb. 6, 1912.

6 SHEETS—SHEET 1.

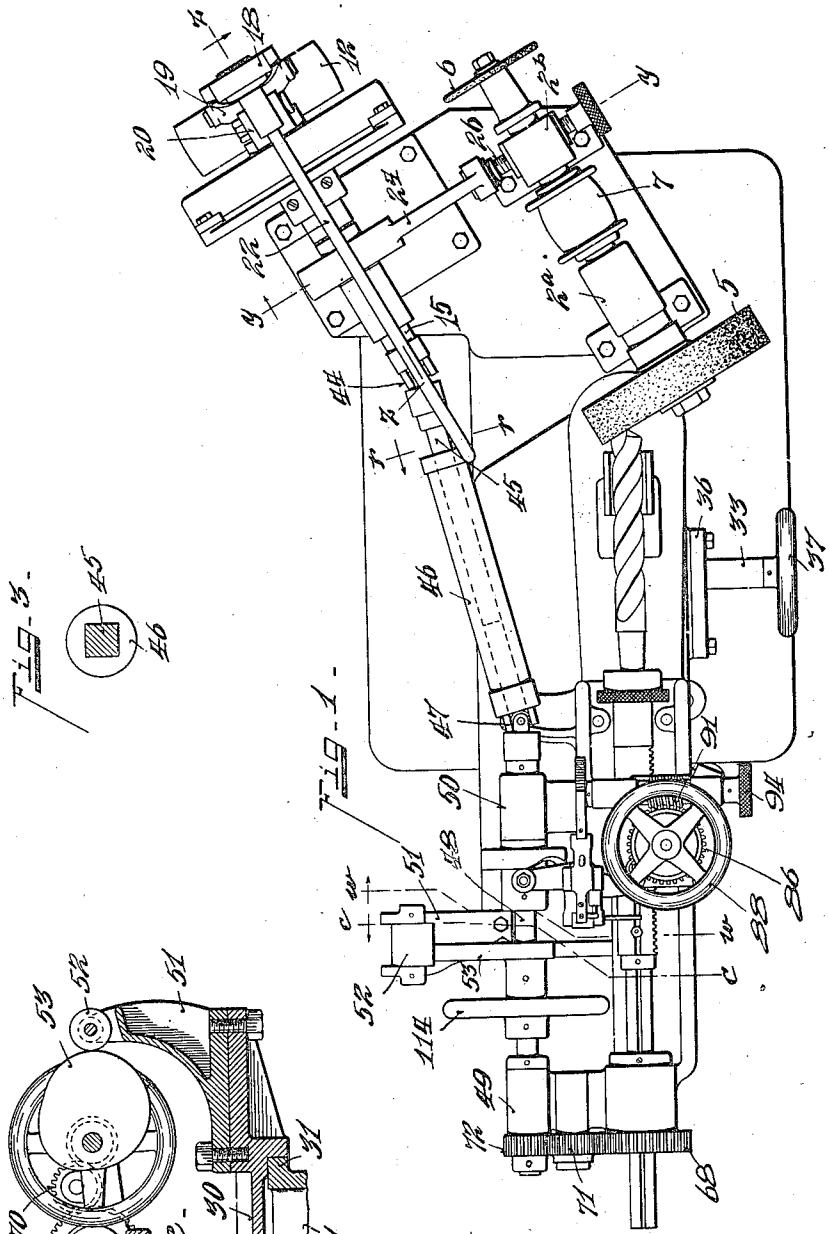

FIG. 1.

FIG. 3.

FIG. 2.

Witnesses

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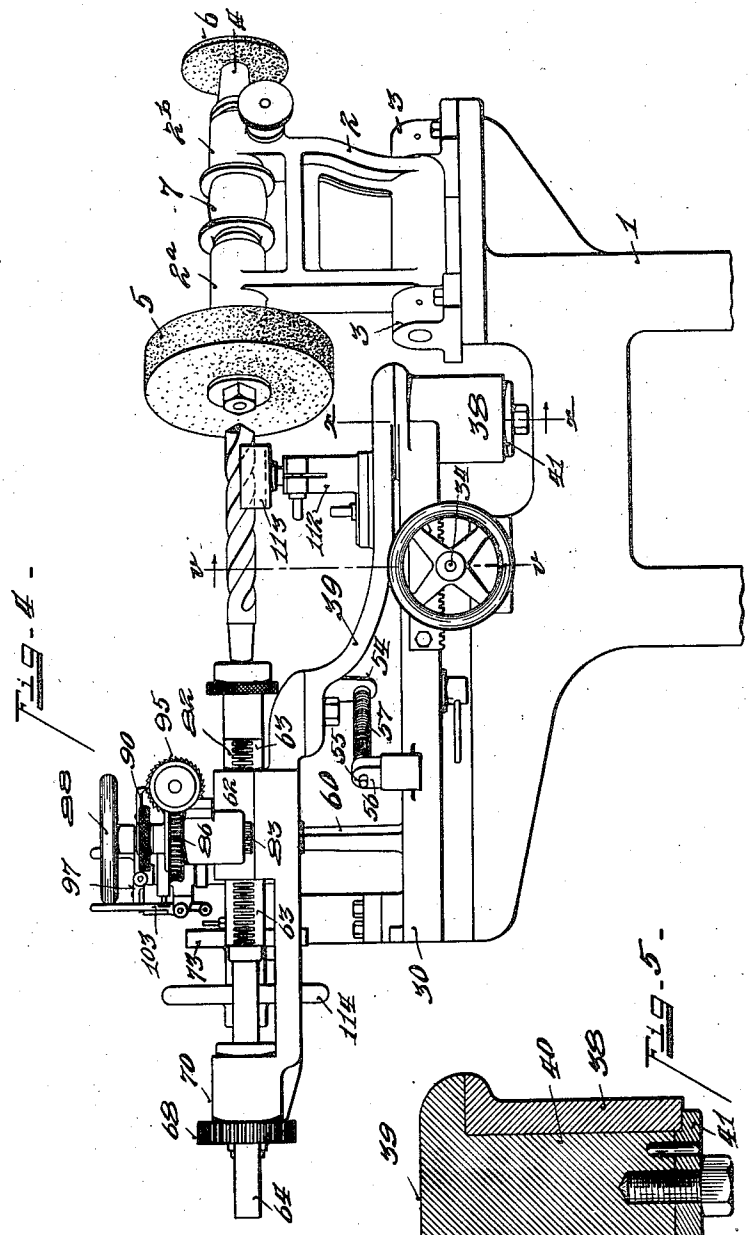

Fig. 4.

Fig. 5.

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Fig. 6.

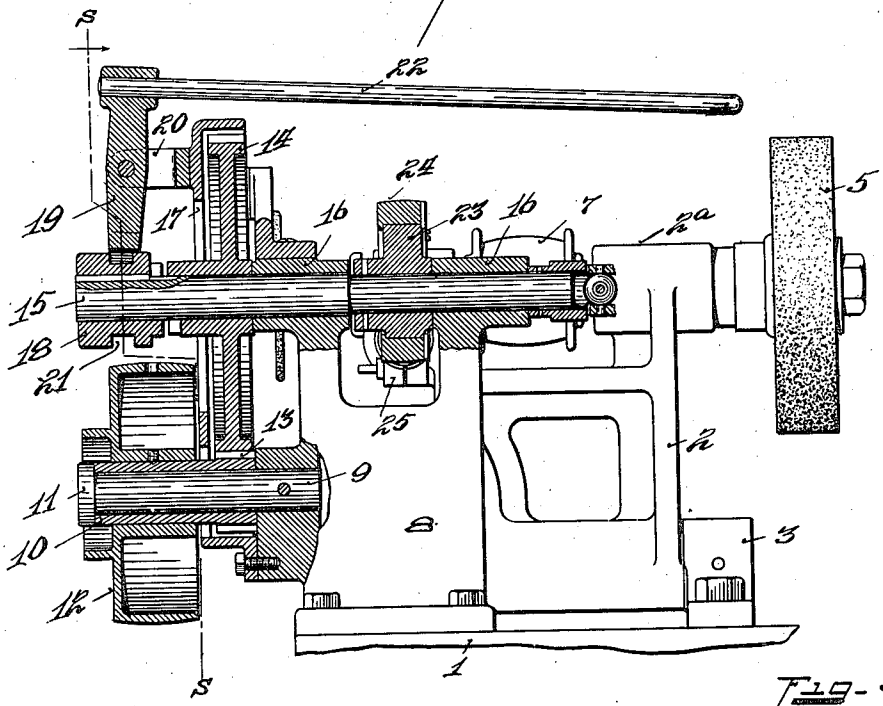

Fig. 7.

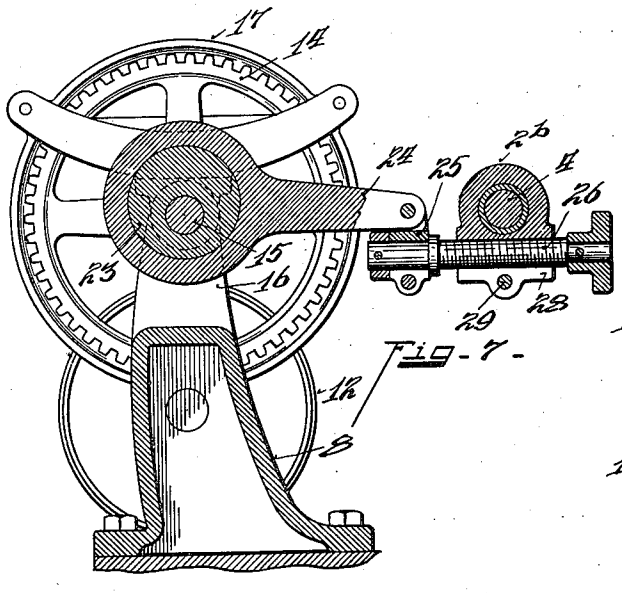

Fig. 8.

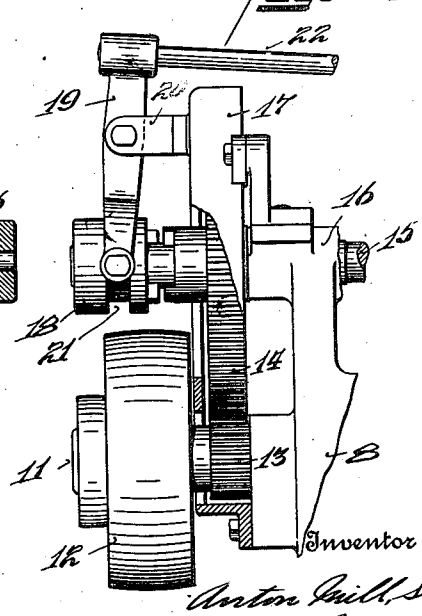

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Fig. 9.

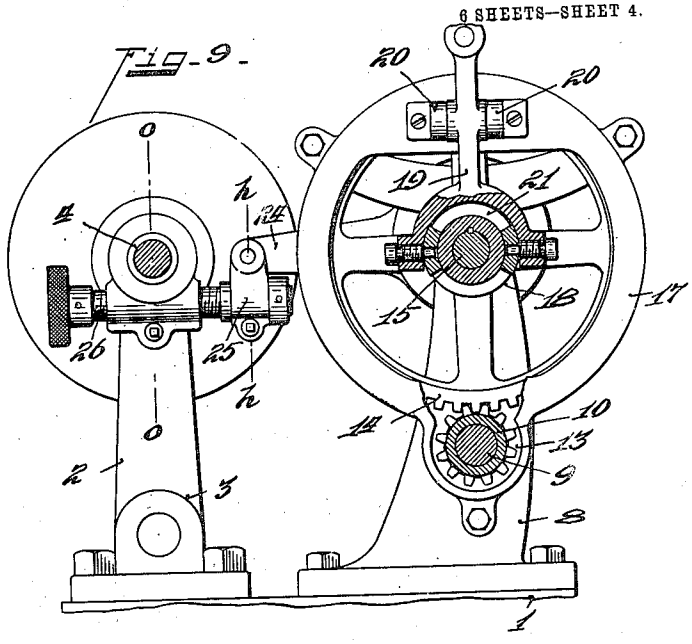


Fig. 11.

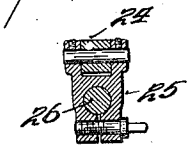


Fig. 13.

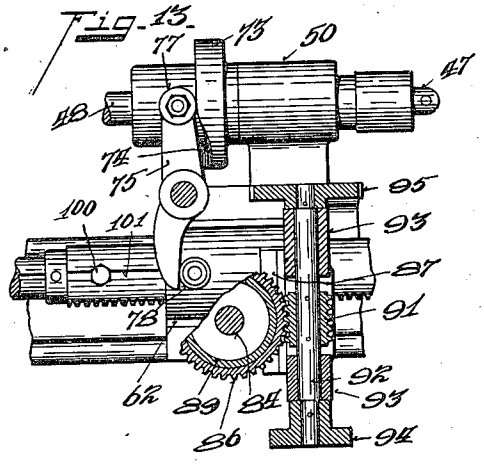


Fig. 10.

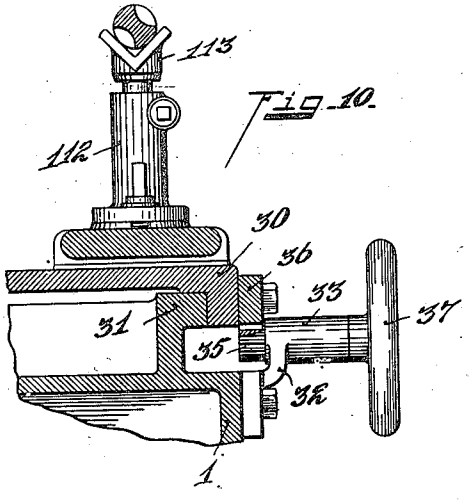
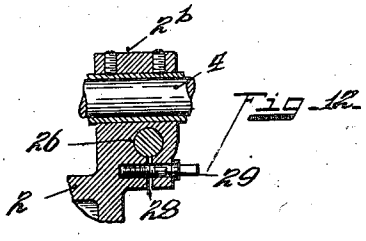


Fig. 12.



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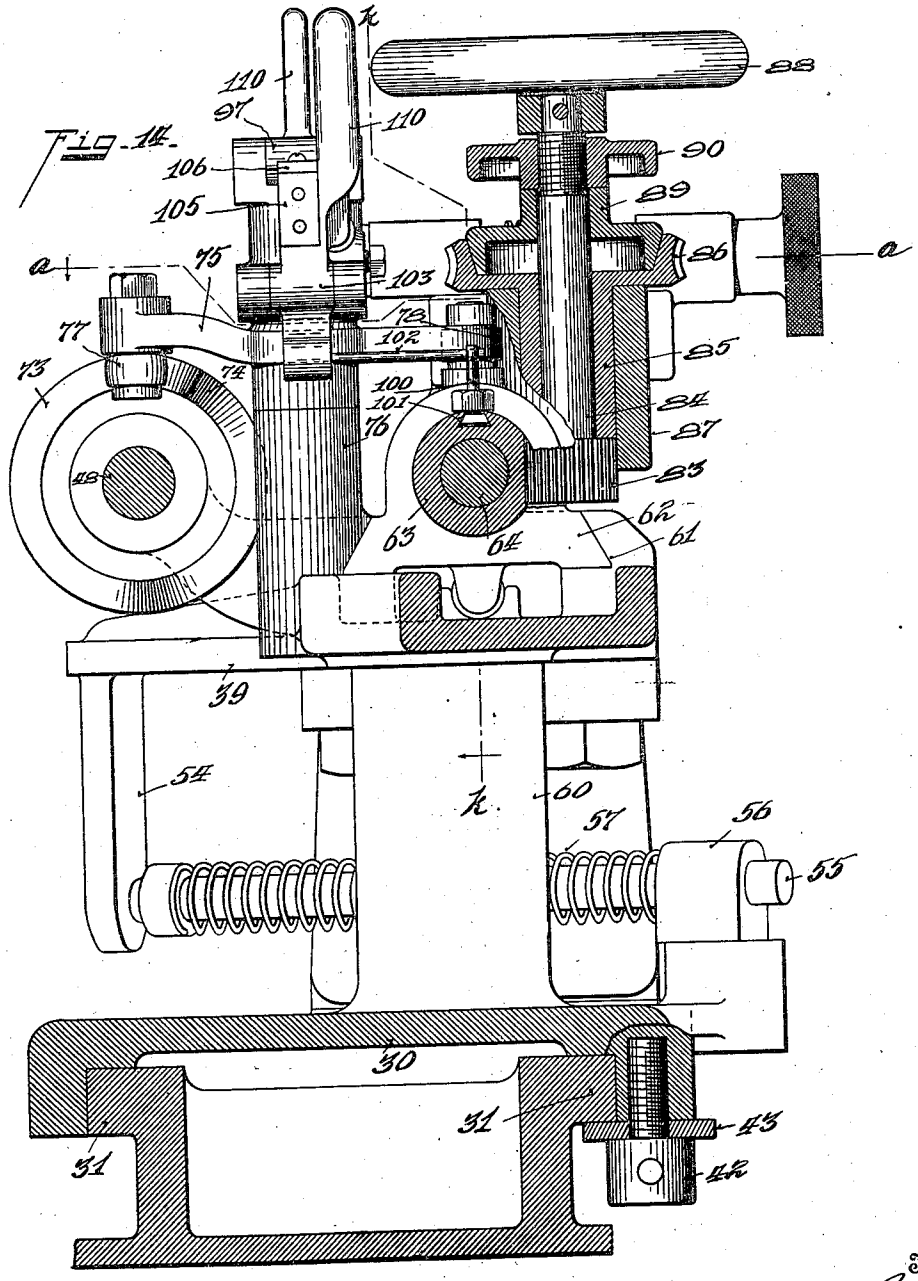
6 SHEETS—SHEET 5.

Fig. 14.



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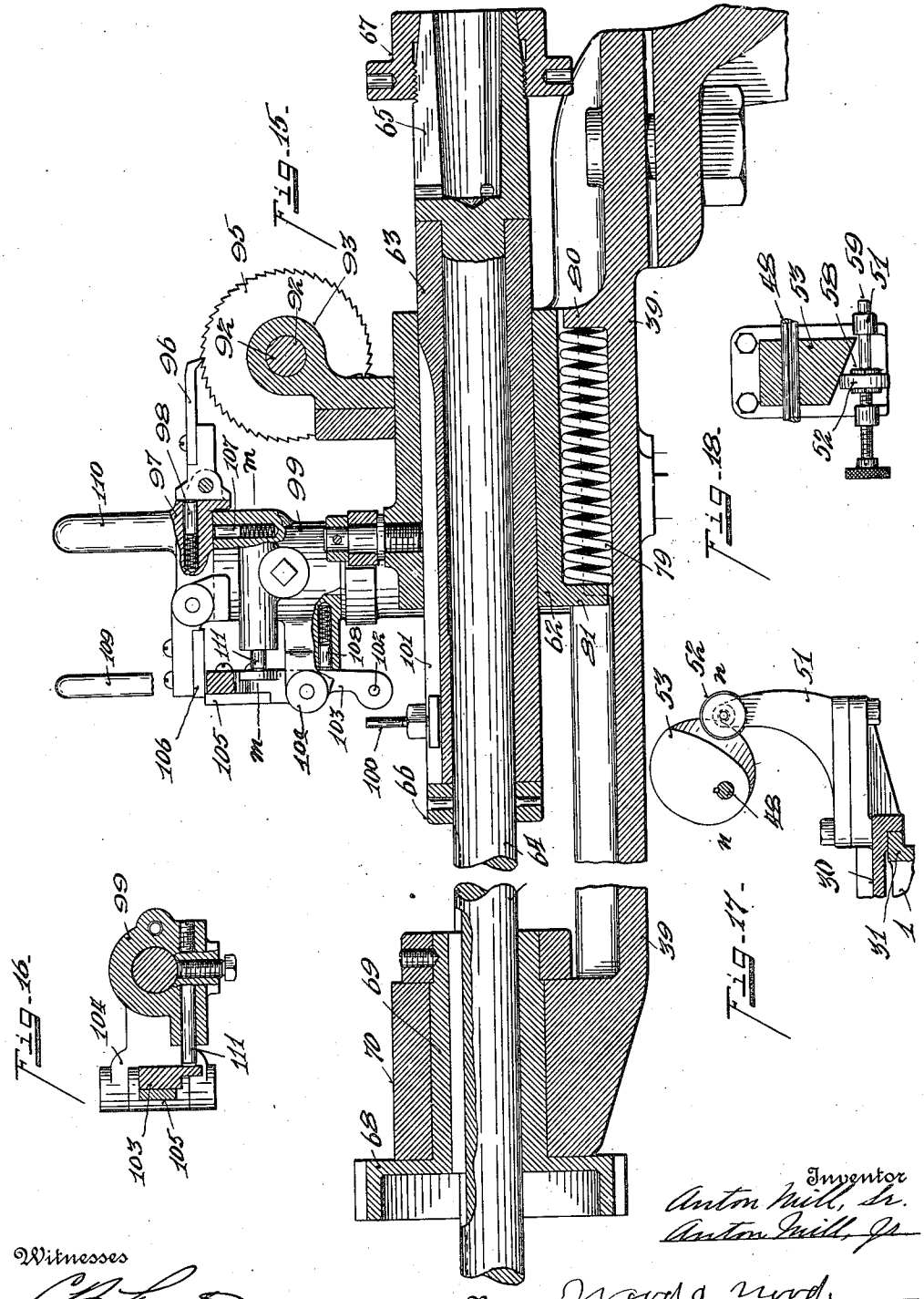
6 SHEETS—SHEET 6.



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UNITED STATES PATENT OFFICE.

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MACHINE FOR GRINDING DRILLS.

1,016,891. Specification of Letters Patent. Patented Feb. 6, 1912.

Application filed October 10, 1910. Serial No. 586,299.

To all whom it may concern:

Be it known that we, ANTON MILL, Sr., and ANTON MILL, Jr., citizens of the United States, both residing at Cincinnati, in the county of Hamilton and State of Ohio, have invented certain new and useful Improvements in Machines for Grinding Drills, of which the following is a specification.

Our invention relates to a machine for grinding drills and the like metal cutting tools.

One of the objects of the invention is to provide means for rotatively presenting a drill to the action of an oppositely rotating grinding wheel.

Another object of our invention is to provide means for rotating and oscillating a drill in an arc relatively to a grinding wheel, for providing the drill with a proper relieving finish in rear or each cutting edge.

Another object of our invention is to provide a drill grinding machine, with means for automatically reciprocating the drill to and from the grinding wheel in time movements for serial grinding actions, commencing at the cutting edge and grinding rearward therefrom, to enable a proper relieving finish to be made.

Another object of our invention is to provide a drill grinding machine, with means for oscillating the grinder relatively to the drill for constantly presenting a new cutting surface of the grinder to the drill.

Another object of our invention is to provide means for changing the relative rotation between the drill and drill reciprocating mechanism for varying the number of reciprocations during a given revolution of the drill according to the number of cutting edges the drill may be provided with.

Another object of our invention is to provide means for manually or automatically feeding the drill to the grinder independent of drill reciprocation.

Another object of our invention is to provide means for changing the angle of oscillation of drill relative to the grinder cutting edge.

Another object of our invention is to provide means for automatically discontinuing the automatic feed of the drill to the grinder.

Another object of our invention is to provide means of adjustment for the grinder wheel relatively to the work to enable the presentation of the entire grinding surface of the grinder wheel to the work.

Another object of our invention is to provide means for supporting the free or cutting end of the drill or work.

Another object of our invention is to provide means for increasing or decreasing the action of oscillation of the drill.

Various other features of our invention are more fully set forth in the description of the accompanying drawings, forming a part of this specification, in which—

Figure 1 is a top view of the machine. Fig. 2 is a section on line *c*, *c*, Fig. 1. Fig. 3 is a section on line *r*, *r*, Fig. 1. Fig. 4 is a front elevation of the machine. Fig. 5 is an enlarged section on line *x*, *x*, Fig. 4. Fig. 6 is an enlarged section on line *z*, *z*, Fig. 1. Fig. 7 is an enlarged section on line *y*, *y*, Fig. 1. Fig. 8 is a detail side elevation of one of the driving elements for operating the drill and oscillating the grinder wheel. Fig. 9 is a section on line *s*, *s*, Fig. 6. Fig. 10 is an enlarged section on line *v*, *v*, Fig. 4. Fig. 11 is a section on line *h*, *h*, Fig. 9. Fig. 12 is a section on line *o*, *o*, Fig. 9. Fig. 13 is a section on line *a*, *a*, Fig. 14. Fig. 14 is an enlarged section on line *u*, *u*, Fig. 1. Fig. 15 is a section on line *k*, *k*, Fig. 14. Fig. 16 is a section on line *m*, *m*, Fig. 15. Fig. 17 is a side elevation of a modified form of cam and carriage frame connection for oscillating the drill. Fig. 18 is a section on line *n*, *n*, Fig. 15.

As illustrated, the machine is provided with a swinging frame upon which is journaled, preferably, two grinding wheels suitably driven, one of which is employed for grinding the cutting edge of the drill. The second grinding wheel is a very thin disk, adapted to grind within the grooves of the drill by a hand operation. The grinder supporting frame is oscillated continuously during the grinding operation in order that the entire surface of the grinding wheel can be presented to maintain the same true. This oscillating action is accomplished by pitman means in connection with the main

driving shaft. The drill is suitably clamped within a spindle, which spindle is adapted to be rotated and fed to and from the grinding wheel, either manually or automatically. The spindle is journaled upon an oscillating frame, which frame is provided with means for adjusting the same to and from the grinding wheel. The means illustrated for oscillating said drill supporting frame comprises a cam engaging an abutment or projection mounted on the frame, the said cam being driven from the main drive. This oscillating movement of the drill supporting frame provides a relieving finish from the cutting edge of the drill rearward.

Drills commonly are provided with two cutting edges and therefore it is desirable to have a relieving cut or finish extended rearward from each cutting edge. This necessitates that the drill be moved to and from the grinder to properly grind the same, and this is accomplished automatically by means of a swinging lever engaging the drill spindle at one end, the opposite end engaging against a cam driven from the main source of power. If, however, the drill is provided with three or more cutting edges, a change of relative actuation and rotation must be made, and this is accomplished in providing interchangeable gears for driving the drill spindle.

With our machine, we are able to grind a drill geometrically correct and adjustable to take in the general standard sizes of drills.

1 represents the main supporting frame.

2 represents a grinder wheel journal frame pivotally supported upon the journal-blocks 3, see Fig. 4, said blocks being secured to the main frame 1. The swinging frame 2 is preferably set at an angle to the horizontal line of the drill, as a preferred form of mounting, to obtain the angular cut required for the cutting edge of the drill.

4 represents a grinder spindle journaled in bearings 2^a, 2^b, formed upon the frame 2, and upon which spindle the main grinder wheel 5 and the supplemental grinder wheel 6 are mounted in any well known or usual manner.

7 represents a pulley fixed to the spindle for rotating the same and grinder wheels.

8 represents a bearing frame fixed to the main frame 1, oppositely disposed to the swinging grinder frame 2, and preferably parallel therewith, see Figs. 1, 6, 7, 8 and 9.

9 represents a stud shaft fixed to and projecting from the bearing frame 8, upon which is loosely mounted a sleeve 10, bearing against a boss formed on the frame 8 at one end, and against the collar 11 or flange formed on the stud shaft 9, for maintaining the sleeve 10 in position.

12 represents a pulley fixed to the sleeve 10 and driven from any source of power.

13 represents a pinion formed on the sleeve 10 or formed integral therewith, in mesh with a gear wheel 14, loosely supported upon the shaft 15, journaled in the bearings 16, formed upon the frame 8.

17 represents a housing for said gears secured to the frame 8, see Fig. 6.

18 represents a clutch sleeve splined upon the shaft 15, provided with clutch teeth adapted to be engaged with clutch teeth formed upon the hub of the gear wheel 14, for engaging said gear in driving relation with said shaft 15.

19 represents a yoke lever pivotally supported between the ears 20, projecting from the housing 17, the yoked end of said lever straddling said clutch sleeve 18, and provided with crescents pivotally mounted upon the limbs of said yoke lever, and engaging into the peripheral groove 21 formed upon the clutch sleeve 18.

22 represents a rod fixed to the lever 19 for actuating the same.

23 represents an eccentric disk fixed to the shaft 15, see Figs. 6, 7, and 24 represents a pitman lever engaged with said disk at one end, the opposite end being pivotally connected to a strap 25, mounted upon an adjusting rod 26, and adapted to be frictionally clamped thereto after an adjustment of the screw rod has been made. The screw rod 26' has a threaded engagement within a bore formed in the bearing 2^b of the swinging frame 2, said bearing is provided with a vertical slit 28, medial of the screw rod 26, see Fig. 7, and a set screw 29 at right angles thereto, for frictionally clamping the screw rod 26 in its adjusted position. Thus, as the driving shaft 15 is rotated, oscillating movement will be imparted to the grinder frame 2, through the eccentric disk 23, pitman 24, strap and screw rod connections with the frame 2.

As shown in the drawings, the angle of oscillation of frame 2 is constant, but the frame 2 can be adjusted to and from the drive shaft by means of the adjusting screw 26, thereby enabling the entire grinding surface of the grinder wheel 5 to be brought into use.

30 represents a horizontally adjustable drill stock supporting frame slidable upon ways 31, formed on the main frame 1, see Figs. 4, 10 and 14.

32 represents a bearing bracket, see Fig. 10, fixed to the frame 1, provided with the bearing sleeve 33, within which is journaled a shaft 34, provided with a pinion 35, engaging with a rack plate 36, fixed to the base plate 30.

37 represents a hand wheel fixed to the shaft 34, the rotation of which transmits motion to the rack pinion 35, for horizontally adjusting the drill stock base plate 30, to and from the grinder wheel 5. 38 repre-

sents a sleeve boss projecting from said base frame 30, forming the axis for the drill oscillating frame 39, which is pivotally mounted to the base plate 30, by means of a stud 40, seated within the sleeve boss 38, see Fig. 5, and maintained in such position by a plate 41, secured to the boss 40, and engaging with the edge or end of the sleeve boss 38.

Adjusting the supporting frame 30 to and from the grinder wheel changes the angle of oscillation of the oscillating frame 39, relative to the grinder, in that the axial line of fulcrum to which the drill point is gaged, is changed relatively to the grinder. This adjustment governs the width of the drill point and its edge. This adjustment also provides means for taking up the wear of the grinder wheel.

42 represents a set nut, see Figs. 2 and 14, having a threaded engagement with the base plate 30, adapted to clamp the gib-plate 43 against one of the slide-ways 31, of the main frame 1, for securely locking the base plate 30 in any adjusted position.

The drill oscillating frame 39 is oscillated by means of the following instrumentalities:—44 represents a universal shaft connection fixed to the shaft 15, see Figs. 1 and 6, and to the slide shaft 45, being preferably square in cross-section and loosely projecting into a square board sleeve 46, forming compensating means for the driving shaft, in making an adjustment of the base plate 30 upon the main frame 1. 47 represents a universal shaft connection connected with the sleeve 46 and the shaft 48, suitably journaled within bearings 49, 50, formed upon the oscillating frame 39. 51 represents a bracket arm fixed to the base plate 30 and projected upwardly, providing a bearing for the roller 52, see Figs. 1 and 2. 53 represents a cam fixed upon the shaft 48, its periphery adapted to engage with the periphery of the roller 52. 54 represents a depending arm projecting from the oscillating drill frame 39, its free end provided with a rod 55, see Fig. 14, said rod engaging with and projecting through a swiveled plug 56, pivotally mounted upon a boss projecting from the base plate 30, see Figs. 2, 4, and 14. 57 represents a coil spring encircling said rod 55 and engaging against said plug for maintaining said oscillating frame 39 under tension in a direction toward the roller 52, and in consequence thereof, maintaining the cam 53 in constant contact with said roller. Thus, upon the rotation of said cam, the oscillating frame will be swung upon its axis to and from the roller 52, according to the outline or configuration of said cam 53.

In Figs. 17 and 18 a modified form of cam and cam engaging mechanism is provided, whereby variable speeds of frame oscillation can be had, the adjustment from one speed to another being easily and conveniently accomplished. The cam 53^a, in this instance, is of elongated form and of varying diameters, but in which the length of oscillating stroke of the frame 39 is constant and not affected by any adjustment made between the cam and roller 52^a, the adjustment merely changing the speed of oscillation upon a given rotation of the cam with the roller in a given position from that of a second position. The same general cam outline is maintained through the entire width of the cam, but merely changing the circumference travel of the cam according to the position of the engagement therewith. In this instance, the roller 52 is journaled upon a sleeve 58, said sleeve in turn being fixed to an adjusting rod 59, adjustably mounted upon the bracket arm 51 and adapted to be adjusted in a transverse or horizontal direction to the rotation of the cam. By this means, varying degrees of relieving finish can be had, as the larger sized drills require a greater degree of relieving cut or finish than the smaller sized drills. For rigidity of the swinging plate 39, a rail 60 is formed upon the base plate 30 and projected upwardly therefrom, upon which rail the swinging frame slides, see Figs. 4 and 14, this being provided owing to the peculiar shape of the swinging frame 39. The rail 60 may be provided with rollers or other suitable anti-friction means for a free oscillation of the frame 39. It is obvious, however, that the design and construction of the various members, forming what may be termed the head-stock of the grinder, may be variously modified without departing from the features of our invention. The swinging frame 39 upon its upper surface is provided preferably with a dove-tailed way 61. 62 represents a carriage slidably mounted within said dove-tailed way 61, provided with a bore through which the spindle sleeve 63 projects and is fed. 64 represents a drill spindle having a chuck head 65, for clamping the drill thereto, said spindle being journaled within the sleeve 63 and projecting beyond the same. The spindle 64 is maintained relatively with the sleeve 63, by means of a shoulder formed thereon, engaging the sleeve 63 at the chuck end, see Fig. 15, and a collar 66 engaging against the opposite end of the sleeve 63, which collar is fixed to the spindle 64. The chuck end of the spindle is preferably formed by a series of slits with a friction clamping collar 67 screw threaded thereon, provided with the internal peripheral inclined surface adapted to engage with the inclined peripheral surface of the spindle 64. Thus, as the collar 67 is fed upon the spindle after the drill has been inserted within the spindle, the same will be frictionally clamped thereto. It is

obvious, however, that the spindle may be provided with any form of chuck of commercial type or otherwise.

The spindle is rotated by the following instrumentalities:—68 represents a gear provided with an elongated sleeve 69, projecting into a bearing 70, formed upon the oscillating frame 39, said sleeve and gear being splined to the spindle, permitting adjustment and reciprocating movement of the spindle during its rotation, see Fig. 15. The gear 68 is in mesh with a gear 71, loose upon a stud shaft supported by the oscillating frame 39, see Fig. 1, said gear in turn being in mesh with a gear 72 fixed to the driving shaft 48. Thus, motion is transmitted from the driving shaft 48, through the gears 72, 71 and 68 to the drill spindle 64.

An interchangeable system of gearing may be provided between the drive shaft 48 and drill spindle 64, for varying the spindle rotation relatively with the other actuating elements of the head-stock. This interchangeability may be accomplished in any of the well known ways common in the art of machine tools, but the possible adherent advantages had, are herein desired to be embodied and form a part of this invention.

The carriage 62 is provided with means for reciprocating the same in step movements to and from the grinder wheel requisite to provide a relieving cut or finish extending from each cutting edge of the drill rearward, in order to move the drill against the grinding wheel during the oscillation in the one direction of the frame 39 and automatically and quickly returning to normal position for a proper presentation of the second cutting edge of the drill to the grinder. This is accomplished by means of the following instrumentalities:—73 represents a cam wheel, see Figs. 1, 13 and 14, provided with a cam surface 74, upon one side thereof, the cam wheel 73 being fixed to the drive shaft 48. 75 represents a lever pivotally mounted upon a boss 76, projected upwardly from the oscillating frame 39, see Fig. 14, one arm of said lever is provided with a roller 77, adapted to engage against the cam surface 74, of the cam wheel 73, while the opposite arm of said lever 75, engages against a roller 78, mounted and journaled upon the carriage 62. 79 represents a spring interposed between the lugs 80, 81, projecting respectively from the oscillating frame 39 and the carriage 62, see Fig. 15, for moving said carriage automatically in one direction or exerting tension upon the lever 75, to maintain the same in contact with the cam surface of the cam wheel 73, thereby moving, upon rotation of the cam, the carriage to and from the grinding wheel according to the outline of said cam surface.

As illustrated, the cam surface is provided with a concave depression and of approximate form to permit of the desired carriage movement to present the drill to the grinder initially from its cutting edge and withdrawing the same therefrom quickly, to enable the proper presentation of the second cutting edge to the action of the grinder.

The drill is adjusted and fed to the grinder for a proper depth of grind manually and automatically by the following instrumentalities:—82 represents rack teeth, see Figs. 4 and 14, formed on the spindle 63, in mesh with a rack pinion 83, fixed to the shaft 84, journaled and projected through a sleeve 85, forming a hub for the worm wheel 86, see Fig. 14. The sleeve 85 is journaled in a bearing 87, formed on the carriage 62. 88 represents a hand wheel fixed to the shaft 84, for rotating said shaft and rack pinion 83, for adjusting by hand or feeding the spindle 63 to and from the grinding wheel. The power feed is transmitted to the shaft 84 through the worm wheel 86, which, as illustrated, is adapted to be frictionally clamped to said shaft. 89 represents a friction clutch member provided with an angular periphery adapted to engage with an angular surface correspondingly provided within the worm wheel 86 and clamped into such position by means of a nut 90 screw threaded upon the shaft 84, see Fig. 14, which will lock the pinion 83, sleeve 85, worm wheel 86, clutch member 89, together. 91 represents a worm fixed to the shaft 92, see Fig. 13, in mesh with the worm wheel 86. Said shaft 92 is journaled in the bearings 93, projecting from the bracket or bearing 87, see Figs. 13 and 14. 94 represents a hand wheel fixed to the shaft 92 for rotating the same, to provide a slow-hand feed for the spindle when the shaft 84 is clutched to the worm wheel 86. 95 represents a ratchet wheel fixed upon shaft 92, and 96 represents a pawl pivotally mounted upon the lever 97, see Fig. 15, the said pawl having but slight pivotal movement in a direction away from the periphery of the ratchet wheel 95, to permit the same to pass over the teeth of the ratchet wheel upon a return stroke, or in other words, for movement of the carriage 62 toward the grinding wheel. 98 represents a spring controlled pin exerting tension upon the pawl 96, for maintaining the same in contact with the teeth of the ratchet wheel during a feed step. The pawl lever 97 is pivotally mounted between ears formed upon the support 99, fixed to a rod projected upwardly from the boss 76, see Figs. 14, 15, and 16. Thus, as the carriage 62 is moved toward the grinder wheel by the cam 73 and lever 75, the pawl 96 will engage with the teeth of the ratchet wheel 95, and rotate the same a given degree or until the pawl becomes disengaged from the teeth of the ratchet wheel 95, in moving beyond the same. This action will

rotate the feed shaft 92, worm 91, worm-wheel 86, shaft 84, rack-pinion 83 and spindle-sleeve 63, provided, however, that the worm-wheel 86 is frictionally clamped or in driving connection with the shaft 84, in which instance, an automatic feed of the drill and its spindle can be had upon each forward reciprocation of the spindle carriage 62.

In order to automatically throw out or discontinue the automatic feed of the drill spindle, the following instrumentalities are provided:—100 represents, see Figs. 14 and 15, a trip dog adjustably secured within the dove-tailed groove 101, formed within the spindle sleeve 63, said dog being adapted to be adjusted to govern the amount of spindle feed of the spindle relative to the grinder wheel, whereby a predetermined length of spindle feed can be had. 102 represents a trip engaging rod fixed to and projecting from a lever 103, pivotally supported upon a bracket arm 104, projected from the support 99. The trip rod 102 projecting from said lever and into the path of dog travel, in order to be engaged thereby to actuate the lever 103. The lever 103 is projected upwardly, provided with a lock-plate 105, adapted to engage beneath the lock-plate 106, fixed to the pawl lever 97, see Fig. 15, to maintain the pawl 96 in a position to engage with the teeth of the ratchet wheel 95 on a forward movement of the spindle carriage 62. When the spindle sleeve 63, carrying the spindle 64, has been fed forward to bring the tripping dog 100 into engagement with the rod 102, it will rock the lever 103, disengaging the lock-plate 105, carried by said lever from beneath the lock plate 106 on lever 97, permitting said lever to drop sufficiently to disengage the pawl 96 from its tooth engagement with the ratchet wheel 95. 107 represents a spring controlled pin mounted in the support 99, adapted to engage the pawl lever 97, and exert upward tension thereon to swing the pawl 96 away from the ratchet wheel, when the lever 103 has been tripped. 108 represents a spring controlled pin supported within the support 99, adapted to engage and exert tension against the lever 103, when the pawl lever 97 has been swung to its automatic spindle feed position, to automatically return the lock plate 105 beneath the lock plate 106, on the pawl lever 97. 109, 110 represent hand holds formed upon and projected from the levers 103 and 97 respectively, for manipulating said lever by hand, for manually disengaging the automatic feed or vice versa. 111 represents a stop pin adjustably mounted in the support 99, to limit the movement of the trip lever 103. 112 represents a drill supporting standard mounted upon the oscillating frame 39, and 113 represents a drill support provided with a V-groove, within which the drill seats, said support being adjustably mounted upon the standard 112, thereby forming a rigid support for the free ends of the drill and preventing downward strains upon the drill or disturbing its axial alinement with the spindle. It is obvious, however, that the construction of the support may be variously modified to produce the same result. 114 represents a hand wheel fixed to the shaft 48, whereby the various actuation and rotation of the drill spindle can be had in order to adjust and mount the drill within the spindle.

It is obvious that the angle of oscillation can be gaged by adjusting the cam roller 53, as well as to provide a fast or slow oscillation to give a more or less relieving or tapering cut.

Having described our invention, we claim:—

1. In a drill grinding machine, a main frame, a grinder wheel rotatively mounted upon said main frame, an oscillating drill stock supporting frame mounted on said main frame, means for oscillating said frame, means for adjusting said frame to and from the grinder, to change its degree of oscillation relatively to the grinder, a drill spindle supported upon said oscillating frame with means for manually and automatically feeding the same to the grinder wheel, means for rotating said spindle, and means for reciprocating said spindle in time movements to and from the grinder wheel relative to the number of cutting edges that a drill is provided with in a given rotation of the drill.

2. In a drill grinding machine, a main frame, an oscillating drill stock supporting frame, means for oscillating said frame, a grinder wheel angularly disposed relative thereto, means for oscillating said grinder wheel, means for adjusting said oscillating frame to and from the grinder wheel for governing the angle of oscillation relative to the grinder wheel, a drill spindle supporting carriage slidably mounted upon said oscillating frame, means for reciprocating said carriage, a drill spindle mounted on said carriage, means for rotating said drill spindle, and means for horizontally feeding said drill spindle independent of its rotation, whereby a drill is fed to and from the work at step periods during a given rotation of the drill and in a continuous arc of movement to the action of the grinder, providing a relieving finish in rear of each cutting edge of the drill.

3. In a machine for grinding a twist drill, a rotary grinder, a drill supporting spindle, means for rotating the spindle in the opposite direction from the grinder, means for reciprocating the spindle longitudinally in time movement to successively present the cutting edges of the drill to the grinder,

means for oscillating the spindle to grind the drill in the arc of a circle, and means for rocking the grinder to bring the entire grinding surface into action on the drill point.

4. In a machine for grinding a twist drill, a rotary grinder, a drill supporting spindle, means for rotating the spindle in the opposite direction from the grinder, means for reciprocating the spindle longitudinally in time movement to successively present the cutting edges of the drill to the grinder, means for oscillating the spindle to grind the drill in the arc of a circle, and means for rocking the grinder to bring its entire grinding surface into action on the drill point, and means for longitudinally feeding the drill to the grinder.

5. In a machine for grinding a twist drill, a rotary grinder, a drill supporting spindle, means for rotating the spindle in the opposite direction from the grinder, means for reciprocating the spindle longitudinally in time movement to successively present the cutting edges of the drill to the grinder, means for oscillating the spindle to grind the drill in the arc of a circle, and means for rocking the grinder to bring its entire grinding surface into action on the drill point, means for longitudinally feeding the drill to the grinder, and means for changing the angle of spindle oscillation.

6. In a machine for grinding a twist drill, a rotary grinder, a drill supporting spindle, means for rotating the spindle, means for reciprocating the spindle longitudinally in time movements to successively present the cutting edges of the drill to the grinder, means for oscillating the spindle, and means for changing the action of oscillation.

7. In a machine of the class described, a rotary grinder, means for oscillating said grinder, a drill supporting spindle, means for reciprocating the spindle longitudinally, means for rotating the spindle relative to its reciprocation to successively present the cutting edges of the drill to the grinder in time movements during a given spindle rotation, means for oscillating the spindle to provide a relieving cut in rear of each cutting edge, means for feeding the spindle to and from the grinder, and a single driving shaft in connection with various spindle operating means and grinder oscillating means provided with intermediate flexible connections to automatically accommodate itself for the spindle actuations.

8. In a machine of the class described, a rotary grinder, a drill supporting spindle, means for rotating said spindle, means for reciprocating said spindle in time movements to successively present the cutting edges of the drill to the grinder, means for oscillating the spindle to grind the work tapering, means for feeding the spindle to the grinder independent of spindle reciprocation, and means manually controlled for reversing said spindle feed.

9. In a machine of the class described, a rotary grinder, a drill supporting spindle, means for rotating the spindle, means for reciprocating the spindle longitudinally in time movement of a given rotation of the spindle, means for oscillating the spindle, and means for feeding the spindle independent of spindle reciprocation with the feeding means automatically actuated through the spindle reciprocation.

10. In a machine of the class described, a rotary grinder, a drill supporting spindle, means for rotating the spindle, means for reciprocating the spindle longitudinally in time movements of a given rotation of the spindle, means for oscillating the spindle, means for manually feeding the spindle to the grinder, means for disengaging said manual forward feed, and means to provide a quick reverse feed of the spindle upon release of said forward manual feed.

11. In a machine of the class described, a rotary grinder, a drill supporting spindle, means for rotating said spindle, means for reciprocating said spindle to serially present initially each cutting edge to the action of the grinder, means for oscillating the spindle to grind the drill tapering from each cutting edge, means for feeding the spindle to the grinder automatically and independent of the spindle reciprocation, and means for automatically disengaging said spindle feed at a predetermined point of spindle feed.

12. In a machine of the class described, a base frame, a rotary grinder mounted thereon, a drill stock supporting frame adjustably mounted on said main frame, means for adjusting the same thereon to and from the grinder, an oscillating frame pivotally supported upon said slide frame, a drill spindle journaled upon said oscillating frame, a main driving shaft journaled upon said oscillating frame parallel with said drill spindle, transmission mechanism intermediate of said shaft and spindle for rotating said spindle, means for reciprocating said drill spindle in operative connection with said main driving shaft, for reciprocating said spindle in each rotation of the spindle with the number of reciprocating movements governed by the number of grooves in the drill, and means for feeding said spindle to and from the grinder independent of its reciprocation or rotation.

13. In a machine of the class described, a rotary grinder, a drill supporting spindle, a main driving shaft, connections between the driving shaft and spindle, for rotating the latter in relative ratio proportionate to the number of grooves in the drill, and means for reciprocating said spindle in successive

movements upon each rotation of the spindle proportionate to the number of grooves in the drill, means for oscillating said spindle to grind the work tapering, the number of oscillations proportionate to the number of grooves in the drill, means for feeding the spindle to the grinder automatically independent of the reciprocatory action of said spindle, and means for disconnecting said automatic feed at any point for manual manipulation.

14. In a machine of the class described, a rotary grinder, a drill supporting spindle, a main driving shaft, connections between the driving shaft and spindle, for rotating the latter in relative ratio proportionate to the number of grooves in the drill, and means for reciprocating said spindle in successive movements upon each rotation of the spindle proportionate to the number of grooves in the drill, means for oscillating said spindle to grind the work tapering, the number of oscillations proportionate to the number of grooves in the drill, means for feeding the spindle to the grinder automatically independent of the reciprocatory action of said spindle, means for automatically discontinuing said feed after a predetermined travel thereof, and means for disconnecting said automatic feed at any point for manual manipulation.

15. In a machine of the class described, a rotary grinder, an oscillating frame, means for adjusting the same relative to the grinder, a carriage movable upon said frame, means for reciprocating the same thereon, a spindle sleeve mounted within said carriage, and means for feeding said sleeve to and from the grinder independent of carriage reciprocation, a drill spindle rotatively mounted within said sleeve, and transversely movable therewith, means for revolving said spindle, and means for oscillating said frame, the number of oscillations proportionate to the number of grooves in the drill.

16. In a machine of the class described, a rotary grinder, an oscillating frame, movable to and from the grinder to change the degree of oscillation relative thereto, means for locking the same in its adjusted position, a main driving shaft journaled upon said oscillating frame, a carriage movable upon said frame, connections between said driving shaft and carriage for reciprocating the latter, the number of reciprocations proportionate to the number of grooves in the drill for each rotation thereof, a spindle sleeve mounted within the carriage movable therewith, and independently adjustable therein to feed the sleeve to and from said carriage, feeding mechanism therefor, manually or automatic, each independent of the other, said automatic feed operative through the reciprocation of the carriage, a drill spindle rotatively mounted within the sleeve and transversely fed therewith, connections between said main driving shaft and spindle for rotating the latter in a relative rotation proportionate to the number of grooves in the drill.

17. In a machine of the class described, a rotary grinder, a drill supporting spindle, means for rotating said spindle, a main driving shaft journaled parallel with said spindle, means in connection with said shaft for reciprocating said spindle in a ratio proportionate to the number of grooves in the drill, means for oscillating said spindle to grind the drill tapering from each cutting edge, means for changing the degree of oscillation, means for changing the speed of oscillation relative to the rotation of the main shaft without effecting the degree of oscillation.

In testimony whereof, we have hereunto set our hands.

ANTON MILL, Sr.
ANTON MILL, Jr.

Witnesses:
Clarence B. Foster,
Louise Beck.