E. RIVETT.

GRINDING MACHINE.

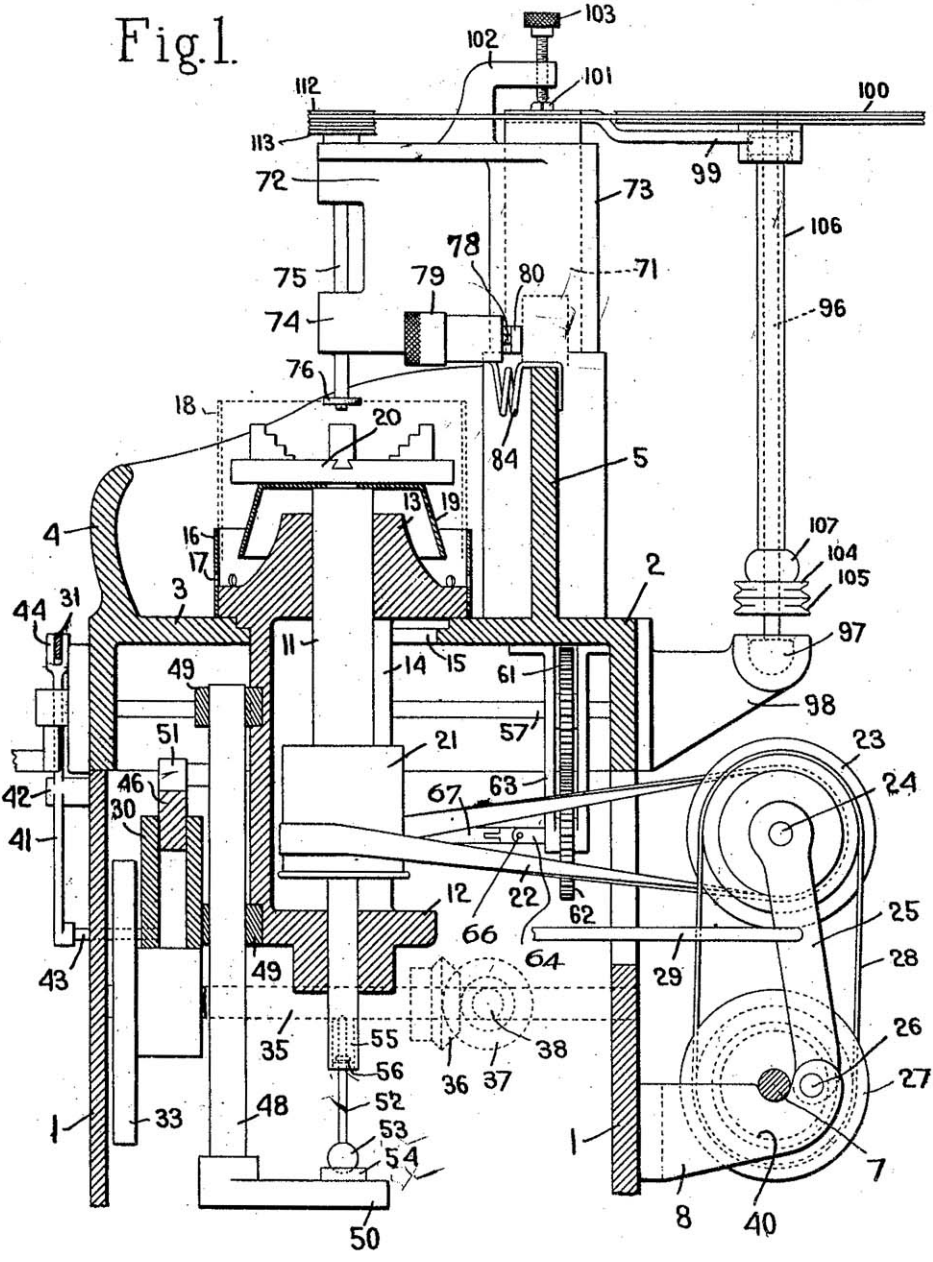
APPLICATION FILED MAR. 29, 1916. RENEWED MAR. 19, 1917.

1,288,998.

Patented Dec. 24, 1918.

4 SHEETS—SHEET 1.

Fig. 1.



Inventor.

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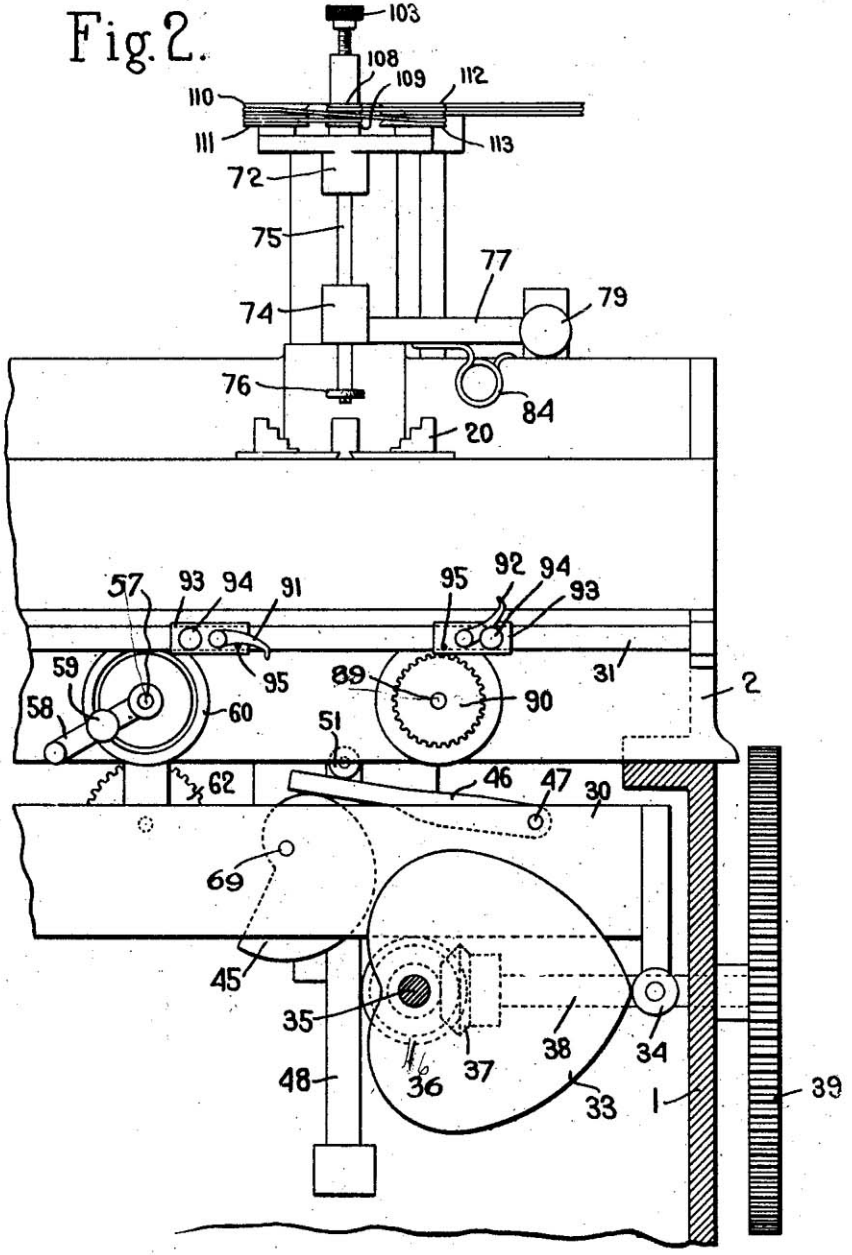
4 SHEETS—SHEET 2.

Fig. 2.



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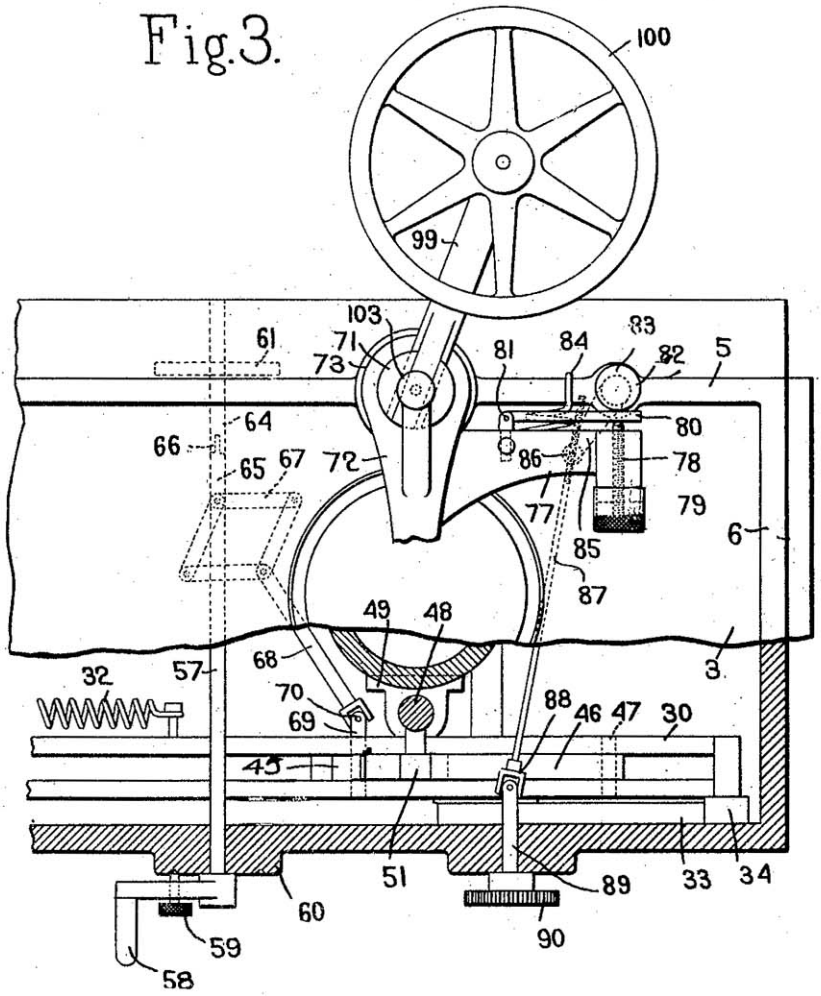
4 SHEETS—SHEET 3.

Fig.3.



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4 SHEETS—SHEET 4.

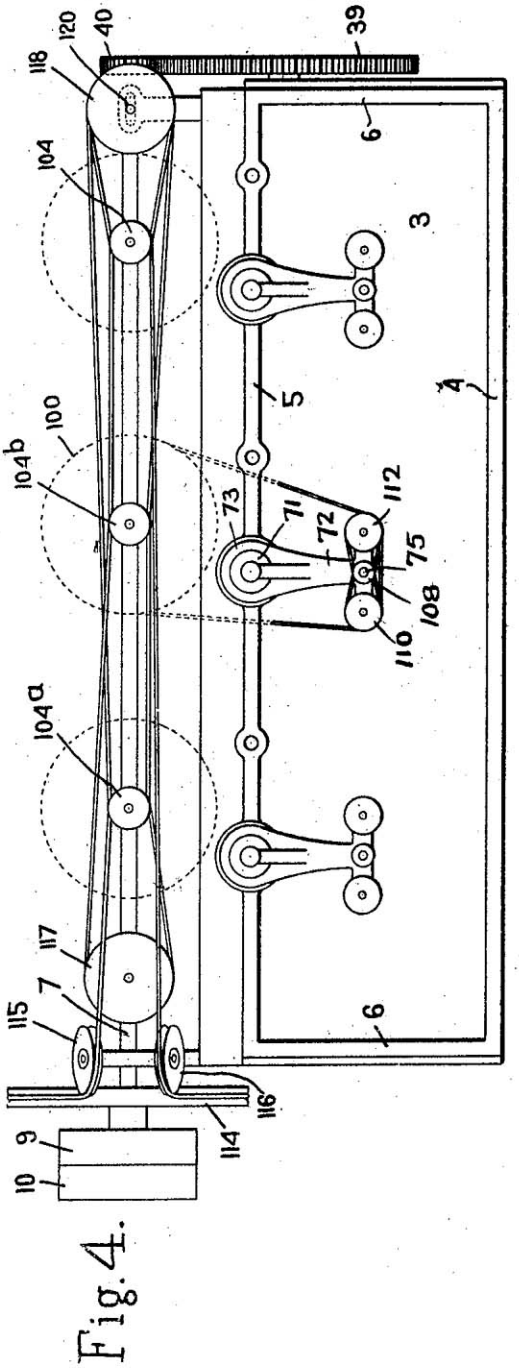

Fig. 4.

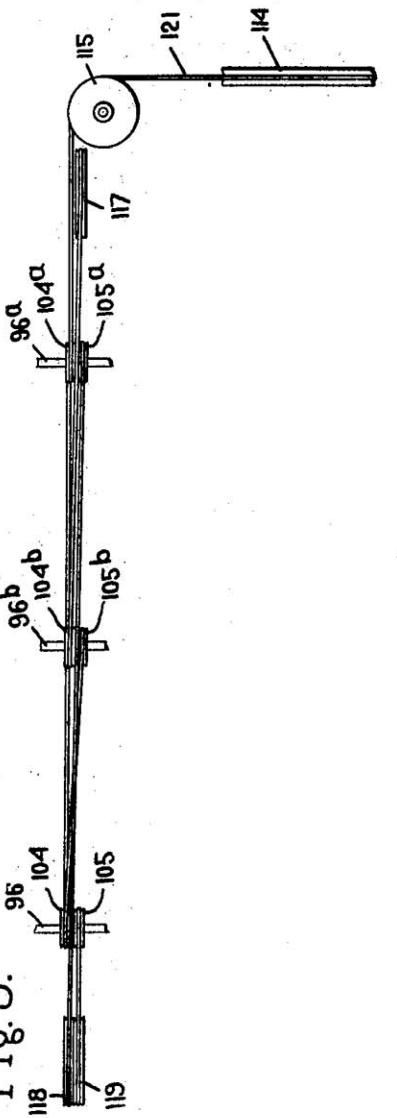

Fig. 5.

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UNITED STATES PATENT OFFICE.

EDWARD RIVETT, OF HULL, MASSACHUSETTS.

GRINDING-MACHINE.

1,288,998. Specification of Letters Patent. Patented Dec. 24, 1918.

Application filed March 29, 1916, Serial No. 87,607. Renewed March 19, 1917. Serial No. 155,946.

To all whom it may concern:

Be it known that I, EDWARD RIVETT, a citizen of the United States, residing at Hull, county of Plymouth, State of Massachusetts, have invented an Improvement in Grinding-Machines, of which the following description, in connection with the accompanying drawing, is a specification, like characters on the drawing representing like parts.

This invention relates to a machine for grinding, polishing or similar purposes.

One object of the invention is to provide a machine in which the grinding tool is mounted upon a vertical spindle and the work is fed vertically thereto thus enabling the machine to be so constructed that the work may be handled and the operations carried on with ease and efficiency.

Another object of the invention is to provide a self-contained machine of this type with all the driven parts operated from a single main shaft so that the machine when set up may have its main shaft directly connected with a line of shafting, motor or other source of power.

Another object of the invention is to provide a machine of this type in which a plurality of grinding tools are located and operated so that a single operator may attend to all of them. A further object is to arrange each of these units so that each may be thrown into or out of operation independently of the others, and so that the relative feeding movements of the work and grinder may be separately varied and adjusted in each unit.

Another object of the invention resides in providing efficient means for controlling and carrying away the water and oil waste in the grinding operations, and in lubrication, and in preventing the splashing of the same from the machine. Another feature of the invention resides in the construction, mounting and adjustment of the swinging head for each grinding tool which is pivoted on a vertical axis and by means of which the relative transverse movement between the tool and the work is secured. Another feature of the invention resides in the means for feeding the work either automatically or manually as desired.

Another feature of the invention resides in the means for driving the grinding tools. Each grinding tool is driven by an endless belt from a pulley with the belt so arranged that its radial thrust on the grinding spindle is balanced, thus preventing any deflection or binding, while at the same time the belt substantially encircles the grinding spindle thus insuring a large and effective driving pull and enabling the spindle to be run at a very high speed with a comparatively small and light belt. The same idea is applied to the drive of the several units of the machine from the main shaft. In both cases the endless belt passes from the driving pulley about comparatively small oppositely located idler pulleys to the pulley to be driven thus insuring the substantial encircling of the driven pulley by the belt.

These and other objects and features of the invention will be more fully set forth in the accompanying description and drawings and defined by the claims.

The drawings illustrate a preferred form of machine embodying the invention with such features thereof as are necessary to an understanding of the invention shown, but with the minor details of construction which will be desirable and which are familiar to those skilled in the art being omitted as unnecessary refinements. The machine is shown as provided with three grinding units, but it is obvious that any number desired may be provided and the repetition or duplication of the parts will be sufficiently understood from a description of a machine embodying the three units illustrated.

In the drawings,

Figure 1 is a view chiefly in vertical cross section taken through one of the grinding units with some of the parts shown in side elevation;

Fig. 2 is a front view of one end of the machine showing one of the units and with a portion of the frame or bed of the machine in vertical cross section;

Fig. 3 is a top plan view of the portion of the machine shown in Fig. 2 with some of the parts broken away, and a portion of the machine in horizontal cross section;

Fig. 4 is a top plan view on a smaller scale with some of the parts removed of the entire machine chiefly for the purpose of showing the driving connections;

Fig. 5 is a rear elevation of the belt drive for the grinding units.

The machine as illustrated is shown as provided with three grinding units although as set forth any number of these units may

be provided as desired. The tool illustrated in each case is a grinding wheel for grinding the interior of cylindrical articles, but it is obvious that these tools may be varied and the character of the work performed upon the machine may be varied within the limits of the invention, and it is also obvious that the machine while described as a grinder may be used for polishing or for any other similar purpose.

The various parts of the machine are supported in, on or from a frame-work, bed or table which as illustrated and for convenience comprises two sections. The lower section 1 may be of a more or less skeleton box-like structure standing upon the floor while the upper section 2 is connected to and rests upon the lower section. This upper section presents the generally horizontal bed 3 and surrounding the front wall 4, back wall 5, and side walls 6. This bed and side walls thus form a long rectangular chamber open at the top and which receives the oil and water used in the grinding operation and in lubrication, and from which this oil and water may be drained or led way to the sources of oil and water supply.

A main shaft 7 is suitably journaled in brackets 8 projecting rearwardly from the lower portion 1 of the machine frame and extends horizontally at the rear of the machine frame. Fast and loose pulleys 9 and 10 mounted at one end of this shaft are illustrated as suitable means by which the main shaft may be connected to and driven from the line of shafting, motor, or other source of power. From this main shaft all the working parts of the machine including its several units are operated so that the machine presents a self-contained structure which when assembled and set up may be connected directly to the source of power in an easy and expeditious manner.

The machine comprises a plurality of operative grinding units and as each of these is similar in its construction and operation it will be necessary in describing the machine for the most part to illustrate and describe but one of these units and its connections and its operation.

Each unit comprises a vertically arranged rotatable and vertically movable chuck spindle 11 mounted in vertical bearings 12 and 13, which bearings for convenience form integral parts of a chuck spindle casing 14. This casing 14 is fitted into a socket 15 in the bed 3 and secured firmly in place with a tight joint. The upper end of this casing 14 where the bearing 13 is formed and which projects upwardly above the bed 3 is formed of generally frusto-conical shape as illustrated.

This projecting bearing 13 is surrounded at its periphery with a vertical guard wall 16 which receives the oil and water and from which it drains through holes 17 to the chamber presented by the bed of the machine. A removable guard wall extension 18 shown in dotted lines extends upwardly from the guard wall 16 to the required height and above the line of operation of the tool. A petticoat guard 19 is supported on the upper end of the chuck spindle and extends downwardly in the guard wall 16. A chuck 20 of suitable form is secured to the chuck spindle on top of the petticoat guard 19. By this construction the water employed in grinding is directed down into the guard 16 and is prevented by the petticoat guard 19 from reaching the bearings of the chuck spindle, and any oil thrown off by centrifugal force is also guided by the petticoat guard into the vertical guard 16. The oil and water are drained or pumped away from the chamber at the bed of the machine, and if desired back to their sources of supply, but as the means for draining and pumping the oil and water away from the machine are old and familiar, it is not necessary that they should be here illustrated.

The chuck spindle is given a vertical movement to feed the work to the grinding tool and a rotary movement to assist in the grinding operation. For this purpose each chuck spindle is provided with a cylindrical pulley 21.

The rotary movement of the chuck spindle is secured by a belt drive comprising a belt 22 extending from the pulley 21 around a horizontally journaled cone pulley 23. This cone pulley is journaled at 24 in bracket arms 25 in turn journaled at their lower ends at 26 eccentrically of the main shaft 7. The main shaft carries a corresponding cone pulley 27 belted at 28 to the cone pulley 23. Hence by shifting the belt 28 the speed of rotation of the chuck spindle may be varied. A connecting rod 29 extends from the bracket 25 through to the front of the machine and by means of it the bracket 25 may be rocked about its pivot 26 to loosen the belt 22 and thus stop the rotation of the chuck spindle, or it may be moved so as to swing the bracket 25 rearwardly to an extent required to take up any slack or tighten both the belt 22 and the belt 28, this latter function being secured by reason of the pivot 26, being eccentric of the shaft 7.

The vertical or work feeding movement of the chuck spindles may take place either automatically or manually and the feeding movement of all or any number of the chuck spindles may take place simultaneously and to varying extents as required.

The mechanism for securing the vertical or work feeding movement as well as certain other movements to be later described may therefore comprise certain parts in common. In the construction illustrated as

a preferable and suitable form of mechanism a slide bar 30 is mounted to move longitudinally across the entire front of the frame while above it a slide rod 31 is mounted for similar movement. The slide bar 30 is given its longitudinal reciprocating movements in one direction by a spring 32 and in the other direction by a heart-shaped cam 33 contacting with a roll 34 journaled on a depending portion of the slide bar 30. This heart-shaped cam 33 is carried and driven by a shaft 35 extending transversely of the lower section 1 of the machine frame. The shaft 35 carries a beveled gear 36 meshing with a beveled gear 37 on a shaft 38 extending at right angles to the shaft 35 and driven by a gear 39 meshing with a pinion 40 on the main shaft 7.

The slide rod 31 receives it reciprocatory movement from the slide bar 30 by means of a lever 41 fulcrumed at 42 on the lower portion 1 of the machine frame work and pivoted at its lower end at 43 to the slide bar 30 and at its upper end 44 to the slide rod 31.

Opposite each grinding unit the slide bar 30 is provided with a spiral cam 45 pivoted therein. A tongue 46 is pivoted at 47 in the slide bar 30 and has its free end resting upon the spiral cam 45. A vertical rod 48 is mounted to slide vertically in bearings 49 at the front of each chuck spindle casing 14 and is provided with a step 50 beneath the chuck pindle. This rod 48 is provided with a roll 51 extending above and adapted to be traversed by the tongue 46 in the reciprocatory movement of the slide bar 30.

In order to secure accuracy of movement of the chuck spindle and provide for any misalinement of the parts a connection such as that illustrated between the chuck spindle and the step 50 may be employed. This connection is shown as a pin 52 having a ball 53 at its lower end seated in a corresponding socket 54 on the step 50. The upper end of the pin 52 enters a chamber 55 in the lower end of the chuck spindle 11 and is provided with a collar 56 by which it is kept from falling out. At its upper end the pin 52 is conical in shape and rests in a conical depression in the spindle.

It will be seen that the extent to which the tongue 46 is elevated above its pivot 47 determines the vertical work feeding movement of the chuck spindle through the connections which have been described, and it will be seen that the inclination of this tongue may be varied in each unit independently of the other units, that the extent of the work feeding movement is independent in each unit of that in every other unit. Furthermore, it is found in practice that in grinding a cylindrical hole by reciprocatory feeding movement that the ends of the hole are apt to flare very slightly. To eliminate this inaccuracy the upper or guiding surface of the tongue 46 may be shaped as illustrated so as to present a sharper inclination at each end of the traverse, thus securing a more rapid feeding movement at each end of the traverse and consequently less grinding action at each end.

If the spiral cam 45 of any unit be so turned about its pivot as to allow the tongue 46 to pass below the top of the slide bar 30, the roll 51 will rest upon the top of the slide bar, and consequently no work feeding movement of the chuck spindle will take place. Consequently by thus moving the spiral cam the work feed may be thrown out of action.

The vertical work feeding movement of the chuck spindle may also be given manually by gradually rotating the spiral cam 45 through manually operated connections to raise and lower the tongue 46 and with it the roll 51. This manually operated means is in the construction illustrated preferably combined with the means for setting the spiral cam 45 to provide for the required range of vertical movement when the machine is feeding automatically. The construction thus illustrated comprises a horizontal shaft 57 journaled in the upper section 2 of the frame-work of the machine and provided at its forward end with a crank 58. A set screw 59 in the crank abutting against a dial plate 60 enables the crank to be locked at any angular position. This dial plate 60 may be graduated and provided with indicia to indicate the position of the crank or the position to which it should be set to provide a given adjustment. At the rear end the shaft 57 is provided with a gear 61 meshing with a gear 62 journaled in a depending bracket 63. This gear 62 operates the spiral cam 45 through an extensible universal joint connection. This connection as illustrated comprises a stub shaft 64 on which the gear 62 is mounted, a stub shaft 65 pivoted at 66 to the stub shaft 64, a link parallelogram 67 pivoted at one corner to the stub shaft 65 and at the other corner to a shaft section 68, the stub shaft 69 on which the spiral cam 45 is mounted, and a universal joint 70 between the shaft section 68 and the stub shaft 69. Thus the rotary motion of the shaft 57 is communicated to the spiral cam 45 independent of any movement of the slide bar 30 in which the spiral cam 45 and its stub shaft 69 is mounted.

It will thus be seen that to give a vertical feeding movement to the chuck spindle manually it is only necessary to turn the crank 58, and through the connections described the spiral cam will be rotated, the tongue 46 moved up or down, and with it the chuck spindle. It will also be seen that to set the spiral cam so as to give a desired ex-

tent of vertical movement it is only necessary to turn the crank 58 and lock it in position with the set screw 59 at a point where the required extent of movement will result. It will also be seen that as each crank 58 and its connections to each spiral cam 45 is independent in a similar mechanism with respect to each unit of the grinder that this manual feed and this manual adjustment may be made independently in each case, according to the character of work being operated upon or the particular conditions existing. In the case of each unit the mechanism for operating, controlling and adjusting the grinding tool itself is the same and each is independent of the other.

In the case of this mechanism it is necessary to have a transverse adjustment and feeding movement of the grinding tool in order to bring it up to the work and to feed it as the grinding operation proceeds. In this invention this result is secured by mounting the grinding tool and its vertical spindle in a swinging head, which swinging head is mounted on a vertical fixed bearing stud. Thus not only can the desired movement of the two be given, but the swinging head can be swung to one side to clear from the work when desired. Furthermore, the swinging head can be adjusted vertically to provide for different conditions of the work.

More specifically considered and as illustrated in the drawings, there is provided rising from the rear wall 5 of the upper section of the frame-work of the machine the large vertical bearing stud 71 in the rear of and in alinement with each chuck spindle. A swinging head 72 is provided at its rear end with a sleeve 73 journaled on the bearing stud 71. This swinging head at its forward end is provided with bearings 74 in which is mounted the vertical grinder spindle 75 carrying at its lower end a suitable grinding tool 76. This grinding tool is rotated by driving mechanism which will be described later.

An arm 77 rigid with the swinging head projects laterally therefrom and is provided at its end with a screw 78 having a milled cap 79 which in conjunction with the arm may be provided with micrometer graduations in a familiar manner. The screw 78 abuts against a plate 80 pivoted at 81 to the arm 77. This plate 80 at its free end abuts against an eccentric 82 carried on a vertical shaft 83 journaled in the rear wall 5 of the frame-work of the machine. A heavy spring 84 connects the arm 77 and the rear wall 5 and acts to hold the arm 77 so as to bring and maintain the plate 80 in contact with the eccentric 82 and the screw 78 in contact with the plate 80. At its lower end the shaft 83 is provided with an arm 85 carrying at its free end and journaled therein a vertical stud 86 screw-threaded horizontally to receive the screw-threaded end of a small shaft or rod 87 which extends forwardly and is connected by a universal joint 88 to a stub shaft 89 journaled in the front wall of the upper section 2 of the frame-work of the machine, and carrying outside of the wall a gear 90. It will be seen that through the medium of this mechanism when the gear 90 is rotated the screw-threaded end of the shaft 87 will swing the arm 85 to the right or to the left carrying with it the shaft 83 and the eccentric 82, and thus in turn swinging the arm 77, and thus the swinging head with the grinding tool. It will also be seen that by the medium of the micrometer screw cap 79 the swinging head can be adjusted to any desired position with respect to the eccentric 82. If now the gear 90 be rotated automatically the swinging head will be swung in one direction or the other gradually and automatically. Thus the grinding tool may be fed automatically up to the work. By setting the parts so that when the desired limit of feeding movement is reached the high point of the eccentric 83 will be in contact with the plate 80, it follows that if the feed continued it would be reversed in direction and thus any danger of grinding the work more than desired is automatically prevented.

As a suitable means for giving automatic movement to the gear 90 and thus automatic feeding movement to the swinging head the slide bar 31 is shown as provided with a pair of pawls 91 and 92. Each of these pawls is pivoted to a sleeve 93 held in place by a set screw 94 at the required point to the slide rod 31. Accordingly, as one or the other of these pawls is swung downwardly to rest upon its stop pin 95 it will engage the gear 90 and move it in one direction or the other according to the pawl in use with each reciprocation of the slide bar. The direction of rotation of the gear will be determined by the pawl which is used and the extent to which the gear 90 is rotated will depend upon the position at which the sleeve 94 carrying the pawl is set on the slide rod 31. Consequently, the gear 90 may be rotated to any desired extent and in either direction automatically, and consequently the grinder tool fed transversely with any desired degree of rapidity and in either direction automatically.

Each grinding tool is rotated by a belt connection with a driver spindle arranged in the rear of the machine opposite the swinging head and as here again the construction is the same with respect to each swinging head it is necessary to describe but one. The driver spindle 96 is provided at its lower end with a ball 97 mounted in a socket in a bracket 98 projecting from the upper section 2 of the machine frame. At its upper end it is journaled in an arm 99

and is provided with a large pulley 100. The arm 99 extends into a slotted guideway at the top of the bearing stud 71 and is locked in place by nut 101 so that the driver spindle may be swung slightly toward or from the bearing stud to tighten or loosen the driving belt. The swinging head is provided with a bracket 102 at its upper end extending over the bearing stud, and a set-screw 103 passing through the bracket 102 bears upon the nut 101, and by means of this set-screw 103 the swinging head may be set at different degrees of vertical adjustment to adjust correspondingly the vertical position of the grinding tool.

The driver spindle 96 is provided at its lower end with a pair of small pulleys or a double grooved pulley 104 and 105. A tubular casing 106 surrounds the driver spindle 96 between the pulley 100 and the pulley 104, has a ball and socket connection with the arm 99 and an enlargement 107 at its lower end abutting the pulley 104, and thus providing for lubrication.

The grinder spindle is provided at its upper end with a pair of pulleys or a double grooved pulley 108 and 109. The swinging head is provided at each side of the grinder spindle with short vertical studs upon each of which is mounted a pair of idler pulleys 110, 111, 112 and 113. A belt extends from the pulley 100 around the idler 112, around the pulley 108, back around the idler 113, across to and around the idler 110, back around the pulley 109, and then around the idler 111, back around the pulley 100. By arranging the belt drive in this manner, there is no tendency to cause the drive to throw the grinder spindle out of alinement because the force exerted by the belt is balanced. Furthermore, by this arrangement a single endless belt is employed for each grinder unit, and any slack in this belt is readily taken up at one time by adjusting the arm 99.

The several driver spindles are also in the preferred form of this invention simultaneously driven by a single endless belt from the main shaft of the machine, and the arrangement is such as to secure a similar balancing of the forces exerted by the belt on each driver spindle so that in the case of each spindle there is no tendency of the belt to throw the spindle out of alinement. This drive as arranged for driving three units is illustrated in the preferred form in Figs. 4 and 5 of the drawings. The pair of small pulleys or the double grooved pulley on the driver spindle at the right of the machine is shown at 104 and 105, at the middle at 104^b and 105^b, and at the left at 104^a and 105^a. These are driven pulleys and act to drive the driver spindles. The endless belt is driven from a main pulley 114 secured to the main shaft 7, and as this shaft is horizontally arranged a pair of horizontally deflecting pulleys 115, 116 are employed to deflect the belt from a vertical to a horizontal run. Idler pulleys are also vertically mounted and located at each end of the row of the driver spindle driver pulleys. The idler pulley 117 adjacent the main pulley 114 requires but one groove while the idler pulley at the opposite end has the double groove 118, 119. Provision is made for controlling the slack in the endless belt by making this idler pulley 118 and 119 adjustable longitudinally of the machine as indicated at 120.

The driving belt 121 leads from the main pulley 114 over the deflecting pulley 115 around the pulley 104^a, back around the idler pulley 117, then around the pulley 104^b, then back around the pulley 105^a, then around the idler 118, then back around the pulley 105, then around the idler 119, then back around the pulley 105^b, then around pulley 104, and then back over the deflecting pulley 116 to the main pulley 114.

The arrangement of the pulleys and the driving belt has thus been described with respect to a machine provided with three units, but its application to a machine provided with a greater number or with but two will be apparent to a skilled mechanic. It will be observed that this disposition of the belt causes the strain of the drive to be balanced upon each driver spindle, thus preventing any interference with the alinement of the spindles, and eliminating any tendency to binding due to the drive.

It will thus be seen that the drive for each grinder spindle has similar characteristics to the drive from the main shaft to the several units of the machine. In each case the arrangement is such that the double engagement of the belt with the driven pulley insures a substantial encircling of the driven pulley by the belt, and thus a very effective driving pull. The idler pulleys employed to guide the endless belt twice about the driven pulley are relatively small so that the belt substantially encircles the driven pulley. By reason of the pull which is thus obtained a relatively small belt may be employed which is necessary when very high belt speed is desired as in grinding machines, and this feature of the invention enables this high speed to be effectively attained.

The invention in the power transmission disclosed herein is also disclosed and made the subject of claims in an application divided out of this application Serial No. 142,087, filed January 12, 1917.

Having fully described my invention, what I claim as new and desire to secure by Letters Patent is:

1. A grinding machine comprising a rotatable vertical grinder spindle with a grinder mounted thereon, a rotatable vertically movable vertical chuck spindle, a

chuck mounted on the upper end of the chuck spindle, means for rotating the chuck spindle, and means for giving a relative vertical feeding movement between the chuck spindle and grinder spindle.

2. A grinding machine comprising a rotatable vertical grinder spindle with a grinder mounted thereon, a rotatable vertically movable vertical chuck spindle, a chuck mounted on the upper end of the chuck spindle, means for rotating the chuck spindle, means for giving a relative vertical feeding movement between the chuck spindle and grinder spindle, and means for giving a relative transverse feeding movement between the chuck spindle and grinder spindle.

3. A grinding machine comprising a rotatable vertical grinder spindle with a grinder mounted thereon, a rotatable vertically movable vertical chuck spindle, a chuck mounted on the upper end of the chuck spindle, means for rotating the chuck spindle, means for giving a relative vertical feeding movement between the chuck spindle and grinder spindle, and means for adjusting the vertical relation of the chuck spindle and grinder spindle.

4. A grinding machine comprising a rotatable vertical grinder spindle with a grinder mounted thereon, a rotatable vertically movable vertical chuck spindle, a chuck mounted on the upper end of the chuck spindle, means for rotating the chuck spindle, and means for giving a variable reciprocating vertical feeding movement to the chuck spindle.

5. A grinding machine comprising a rotatable vertical grinder spindle with a grinder mounted thereon, a rotatable vertically movable vertical chuck spindle, a chuck mounted on the upper end of the chuck spindle, means for rotating the chuck spindle, and means for giving a variable reciprocating vertical feeding movement to the chuck spindle, the said movement being faster at each end of the reciprocation.

6. A grinding machine comprising a rotatable vertical grinder spindle with a grinder mounted thereon, a rotatable vertically movable vertical chuck spindle, a chuck mounted on the upper end of the chuck spindle, means for rotating the chuck spindle, and means for giving a vertical feeding movement to the chuck spindle.

7. A grinding machine comprising a rotatable vertical grinder spindle with a grinder mounted thereon, a rotatable vertically movable vertical chuck spindle, a chuck mounted on the upper end of the chuck spindle, means for rotating the chuck spindle, and means for giving either automatically or manually as required a vertical feeding movement to the chuck spindle.

8. A grinding machine comprising a horizontally swinging head carrying a rotatable vertical grinding spindle with a grinder mounted thereon, a chuck located beneath the grinder spindle, and means for automatically giving a swinging transverse feeding movement to said head.

9. A grinding machine comprising a horizontally swinging head carrying a rotatable vertical grinding spindle with a grinder mounted thereon, a chuck located beneath the grinder spindle, means for automatically giving a swinging transverse feeding movement to said head, and means for adjusting the limiting position of said transverse feeding movement.

10. A grinding machine comprising a horizontally swinging head carrying a rotatable vertical grinding spindle with a grinder mounted thereon, a chuck located beneath the grinder spindle, and means for automatically giving a swinging transverse feeding movement to said head, the said feeding means acting to reverse the direction of feed when the limiting position is reached.

11. A grinding machine comprising a horizontally swinging head carrying a rotatable vertical grinding spindle with a grinder mounted thereon, a chuck located beneath the grinder spindle, means for automatically giving a swinging transverse feeding movement to said head, and means for vertically adjusting the swinging head.

12. A grinding machine comprising a table having front, rear and side walls to present an oil and water receiving chamber, a plurality of vertical, rotatable and vertically movable chuck spindles passing up through said table and provided with chucks, a bearing for each chuck spindle projecting above the table, and a vertical guard wall surrounding each of said projecting bearings.

13. A grinding machine comprising a table having front, rear and side walls to present an oil and water receiving chamber, a plurality of vertical, rotatable and vertically movable chuck spindles passing up through said table and provided with chucks, a bearing for each chuck spindle projecting above the table, a vertical guard wall surrounding each of said projecting bearings, and a petticoat guard on the upper end of each chuck spindle depending within said vertical guard wall.

14. A grinding machine comprising a table having front, rear and side walls to present an oil and water receiving chamber, a plurality of vertical, rotatable and vertically movable chuck spindles passing up through said table and provided with chucks, a bearing for each chuck spindle projecting above the table, a vertical guard wall surrounding each of said projecting bearings, and a removable guard wall extension surrounding the work held in the chuck.

15. A grinding machine comprising a plurality of rotatable vertical and vertically movable chuck spindles provided with

chucks, a corresponding plurality of horizontally swinging heads carrying rotatable vertical grinder spindles with grinders mounted thereon, means for giving relative vertical feeding movements between each chuck spindle and its coöperating grinder spindle, a main shaft, driving connections from said main shaft to each grinder spindle, to each chuck spindle, and to the said feeding means, whereby the entire machine is operated by connecting the main shaft to a suitable source of power.

16. A grinding machine comprising a plurality of rotatable vertical and vertically movable chuck spindles provided with chucks, a corresponding plurality of horizontally swinging heads carrying rotatable vertical grinder spindles with grinders mounted thereon, means for giving relative vertical feeding movements between each chuck spindle and its coöperating grinder spindle, means for giving a transverse feeding movement to each swinging head, a main shaft, driving connections from said main shaft to each grinder spindle, to each chuck spindle, and to each of the said feeding means, whereby the entire machine is operated by connecting the main shaft to a suitable source of power.

17. A grinding machine comprising a horizontally swinging head carrying a rotatable vertical grinding spindle with a grinder mounted thereon, an arm extending laterally from said head, an eccentric mounted for horizontal rotation in the machine frame and in engagement with said arm, and means for automatically rotating said eccentric to give a transverse feeding movement to the grinder.

18. A grinding machine comprising a horizontally swinging head carrying a rotatable vertical grinding spindle with a grinder mounted thereon, an arm extending laterally from said head, an eccentric mounted for horizontal rotation in the machine frame and in engagement with said arm, and means for automatically rotating said eccentric in either direction to give transverse feeding movements to said grinder.

19. A grinding machine comprising a horizontally swinging head carrying a rotatable vertical grinding spindle with a grinder mounted thereon, an arm extending laterally from said head, an eccentric mounted for horizontal rotation in the machine frame and in engagement with said arm, and pawl and ratchet mechanism including reversely acting pawls either of which may be thrown into operation as desired for causing the rotation of said eccentric to give required transverse feeding movement to the grinder.

20. A grinding machine comprising a frame-work presenting a table, a vertical bearing stud mounted at the rear of the said table, a horizontally swinging head mounted on said bearing stud and carrying a rotatable vertical grinder spindle with a grinder mounted thereon, a chuck located in the table beneath the head, and means for automatically giving a swinging transverse feeding movement to said head.

21. A grinding machine comprising a frame-work presenting a table, a vertical bearing stud mounted at the rear of the said table, a horizontally swinging head mounted on said bearing stud and carrying a rotatable vertical grinder spindle with a grinder mounted thereon, a chuck located in the table beneath the head, and means for vertically adjusting the swinging head on its stud.

22. A grinding machine comprising a plurality of rotatable vertical and vertically movable chuck spindles provided with chucks, a corresponding plurality of coöperating vertical grinder spindles with grinders mounted thereon, means for giving vertical feeding movements to the chuck spindles, and means for independently varying the extent of the vertical feeding movement of each chuck spindle.

23. A grinding machine comprising a plurality of rotatable, vertical, and vertically movable chuck spindles provided with chucks, a corresponding plurality of coöperating vertical grinder spindles with grinders mounted thereon, and means for giving either manually or automatically vertical feeding movement to the said spindles.

24. A grinding machine comprising a plurality of rotatable, vertical, and vertically movable chuck spindles provided with chucks, a corresponding plurality of coöperating vertical grinder spindles with grinders mounted thereon, means for automatically giving vertical feeding movements to the said spindles, and means for stopping the feeding movement of any spindle without interfering with that of the others.

25. A grinding machine comprising a plurality of rotatable, vertical, and vertically movable chuck spindles provided with chucks, a corresponding plurality of coöperating vertical grinder spindles with grinders mounted thereon, means for automatically giving vertical feeding movements to the said spindles, and means for varying the extent of the feeding movement of any spindle without effecting the feeding movements of the others.

26. A grinding machine comprising a plurality of horizontally swinging heads carrying rotatable, vertical grinder spindles with grinders mounted thereon, a corresponding plurality of vertical rotatable chuck spindles mounted therebeneath, means for automatically giving swinging transverse feeding movements to each of said heads, and means for independently adjust-

ing the limiting position of the transverse feeding movement of each head.

27. A grinding machine comprising a plurality of horizontally swinging heads carrying rotatable, vertical grinder spindles with grinders mounted thereon, a corresponding plurality of vertical rotatable chuck spindles mounted therebeneath, means for automatically giving swinging transverse feeding movements to each of said heads, and means for independently changing the direction of the said transverse movement of any head independently of the others.

28. A grinding machine comprising a plurality of horizontally swinging heads carrying rotatable vertical grinder spindles with grinders mounted thereon, a corresponding plurality of vertical rotatable chuck spindles mounted therebeneath, means for automatically giving swinging transverse feeding movements to each of said heads, and means for independently adjusting the extent of the transverse movement of any head without effecting that of the others.

29. A grinding machine comprising a grinder member, a chuck member, and means for giving a relative vertical feeding movement to said members, comprising a horizontally reciprocating slide bar, a tongue pivoted in the slide bar and engaging one of said members, and means for adjusting the angular position of said tongue.

30. A grinding machine comprising a grinding member, a chuck member, and means for giving a relative vertical feeding movement to said members, comprising a horizontally reciprocating slide bar, a tongue pivoted in the slide bar, and engaging one of said members, and means mounted on the slide bar for adjusting the angular position of the tongue.

31. A grinding machine comprising a grinder member, a chuck member, and means for giving a relative vertical feeding movement to said members, comprising a horizontally reciprocating slide bar, a tongue pivoted in the slide bar provided with a cam face engaging one of said members, and means for adjusting the angular position of said tongue.

32. A grinding machine comprising a grinder member, a chuck member, and means for giving a relatively variable vertical feeding movement to said members, comprising a horizontally reciprocating slide bar, a tongue pivoted in the slide bar and engaging one of said members, and means for adjusting the angular position of said tongue.

33. A grinding machine comprising a rotatable vertically movable vertical chuck spindle, a horizontally reciprocating slide bar, a tongue pivoted in the slide bar and engaging said spindle, and means mounted on the slide bar for adjusting the angular position of the tongue.

34. A grinding machine comprising a rotatable vertically movable vertical chuck spindle, a horizontally reciprocating slide bar, a tongue pivoted in the slide bar and engaging said spindle, and a spiral cam mounted on the slide bar engaging the tongue and determining the degree of angularity of the said tongue.

In testimony whereof, I have signed my name to this specification.

EDWARD RIVETT.