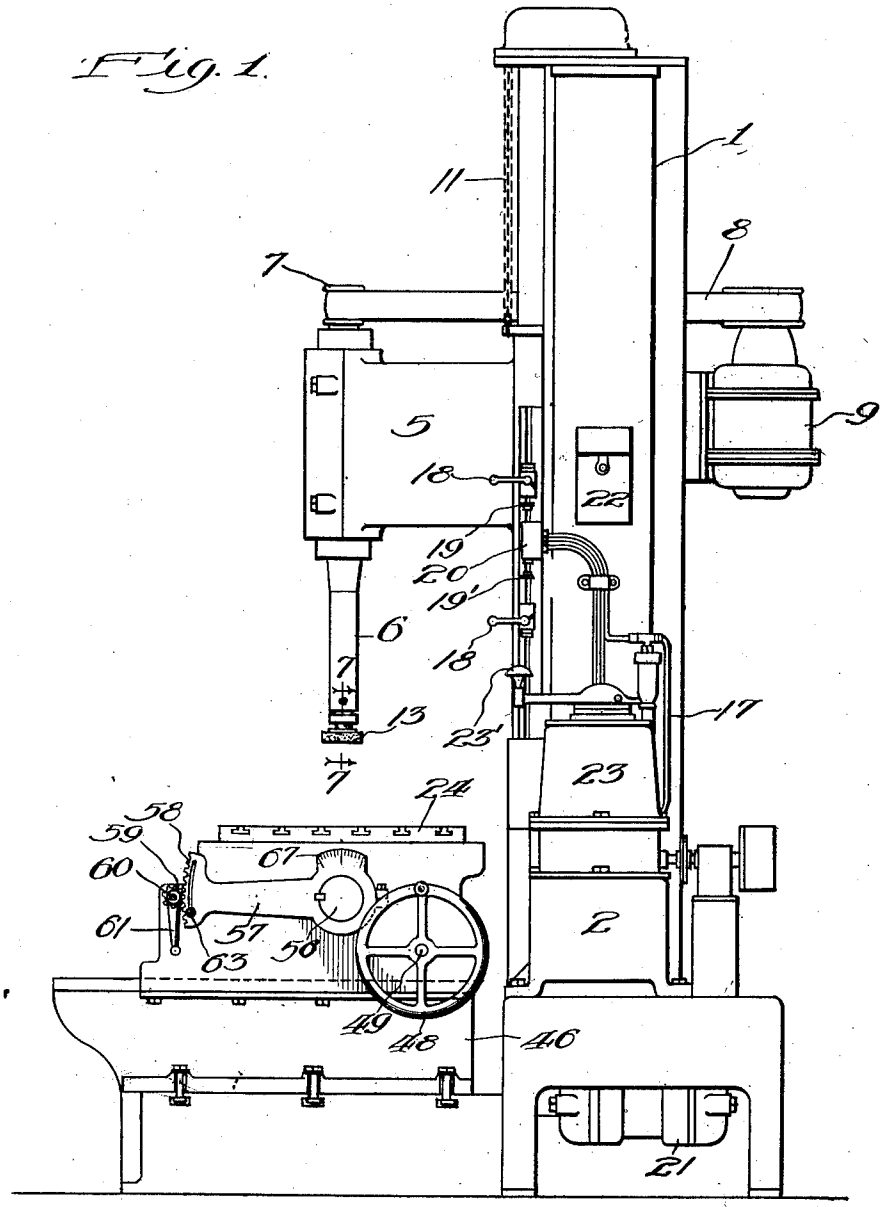
Feb. 14, 1928. 1,659,228

M. L. WILLIAMS

VERTICAL GRINDING MACHINE

Original Filed June 5, 1924 5 Sheets-Sheet 1

Fig. 1.



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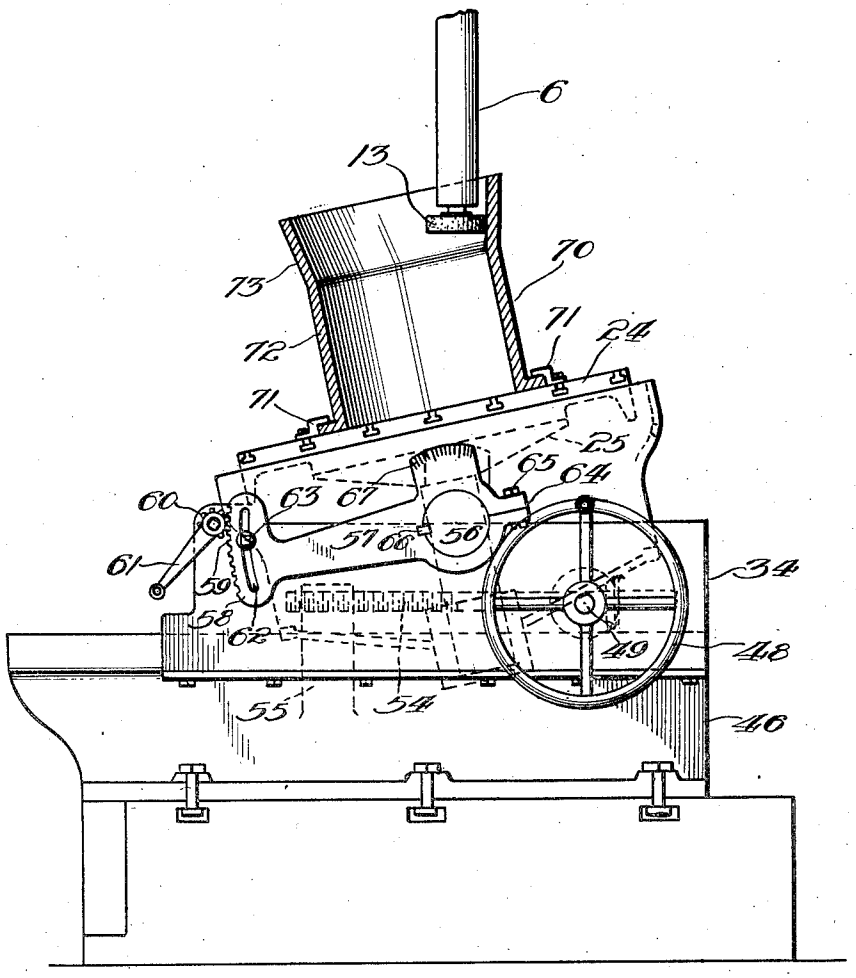
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Fig. 2.



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VERTICAL GRINDING MACHINE

Original Filed June 5, 1924 5 Sheets-Sheet 3

Fig. 3.

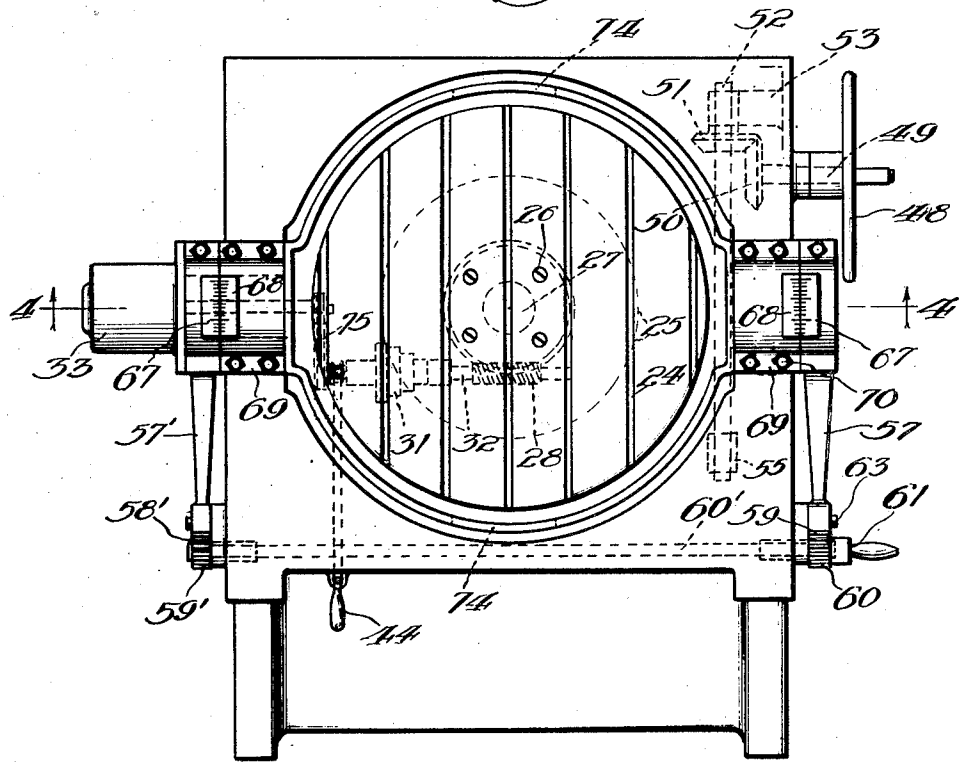
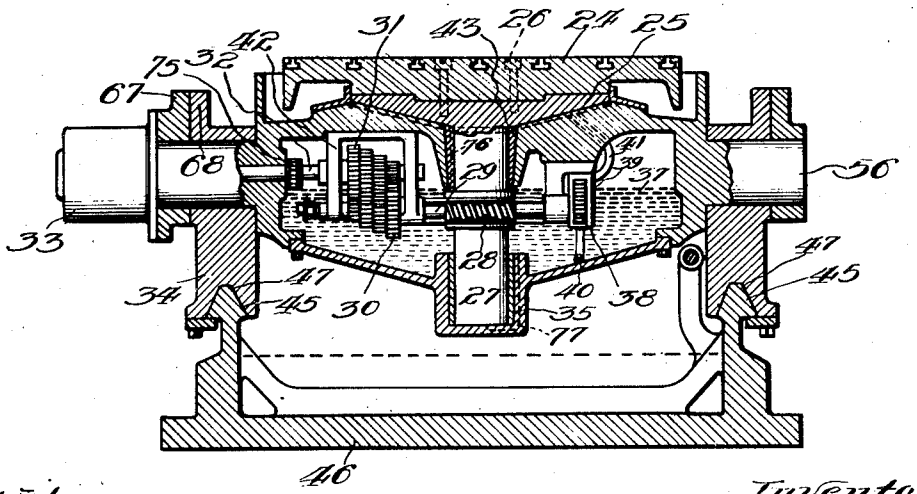


Fig. 4.



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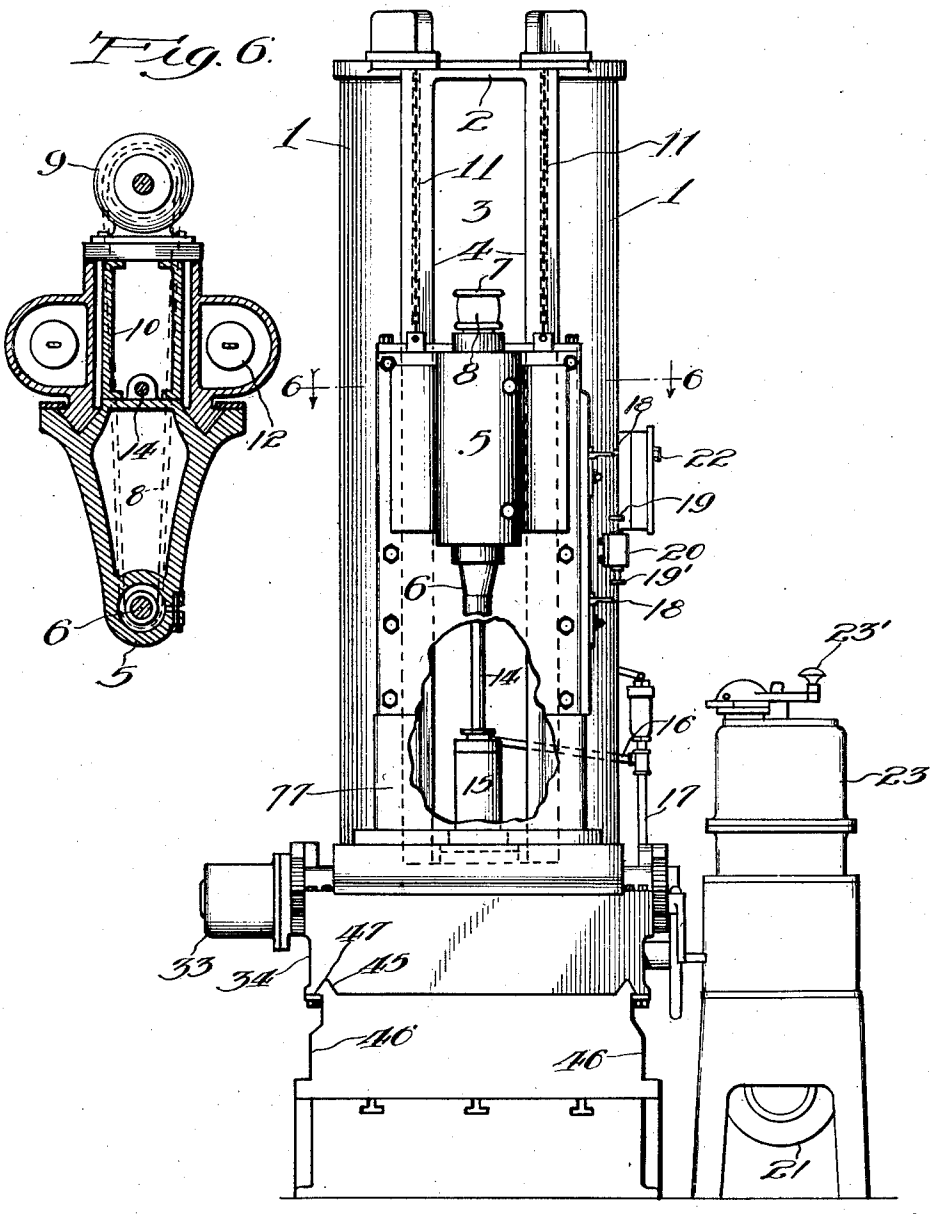
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VERTICAL GRINDING MACHINE

Original Filed June 5, 1924 5 Sheets-Sheet 4

Fig. 5.

Fig. 6.



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VERTICAL GRINDING MACHINE

Original Filed June 5, 1924 5 Sheets-Sheet 5

Fig. 7.

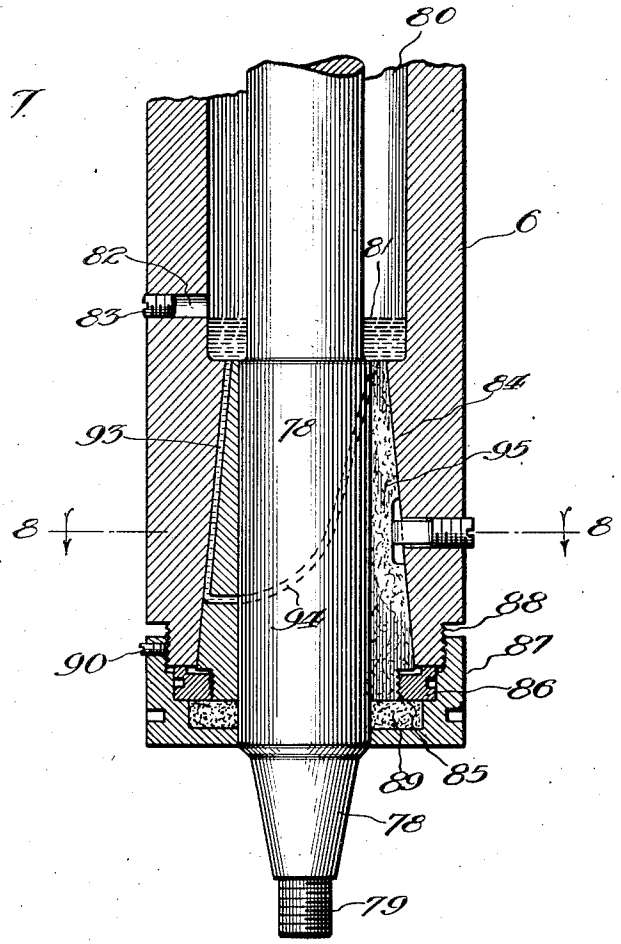
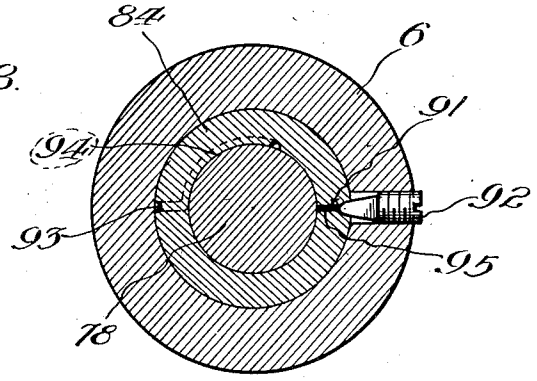


Fig. 8.



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UNITED STATES PATENT OFFICE.

MARTIN L. WILLIAMS, OF SOUTH BEND, INDIANA.

VERTICAL GRINDING MACHINE.

Application filed June 5, 1924, Serial No. 717,952. Renewed June 13, 1927.

This invention relates to improvements in vertical grinding machine and refers more particularly to a machine especially designed for vertically grinding interior and exterior metal surfaces, whether straight or tapered.

Among the salient objects of the invention are to provide a vertical grinding machine in which the table supporting the work being ground is adapted to be rotated; to provide a construction of the character described in which the table can be rotated while lying in a horizontal plane or inclined from the horizontal; to provide a machine adapted for vertically grinding either straight or tapered interior or exterior surfaces; to provide mechanism for tilting the table and supporting mechanism to any desired angle from the horizontal without interfering with the rotation of the table; to provide a machine which can be adjusted to grind either vertical or tapered surfaces and which can be locked in that position to avoid accidental displacement; to provide a machine especially adapted for grinding the cylindrical walls of irregular castings, such as hubs, cylinders, tapered cones, gear blanks, etc. To provide a machine which is readily adjustable, certain in operation, easy to manipulate and one which will vertically grind either straight or tapered surfaces with a mere adjustment of the position of the table on which the work is supported.

In the drawings:

Fig. 1 is a side elevational view of a vertical grinding machine.

Fig. 2 is an enlarged side elevational view, illustrating the mechanism for tilting the table with the table and support therefor locked in tilted position.

Fig. 3 is a top plan of the table and mechanism shown in Fig. 2.

Fig. 4 is a cross sectional view taken on lines 4—4 of Fig. 3, looking in the direction of the arrows.

Fig. 5 is a front elevational view of the grinder, with parts broken away for the sake of clearness.

Fig. 6 is a cross sectional view taken on lines 6—6 of Fig. 5.

Fig. 7 is an enlarged vertical sectional view, illustrating one form of tapered bearing in which the lower portion of the grinding spindle is adapted to rotate.

Fig. 8 is a cross sectional view taken on the lines 8—8 of Fig. 7.

Referring in detail to the drawings:

1 designates the vertical columns of which there are two in this instance, which are substantially hollow as shown in Fig. 6, connected by the cross bar 2, to provide a central vertical opening between columns as shown at 3 and vertical slide ways 4 on the front face of the columns, the vertical slide ways being V-shaped or pointed to assist in their use. A head 5 on which the grinding spindle 6 is mounted is adapted to be reciprocated on the pointed slide ways 4. The upper end of the grinding spindle is provided with a pulley wheel 7 engaging the pulley belt 8 communicating with the motor 9; the latter is connected to the head 5 by means of the connecting brackets 10, the arrangement being such that the brackets 10 and belt 8 extend through the central opening 3. One of the particular advantages of this arrangement is that it permits of a counterbalance of the head construction with the motor on one side of the columns and the head on the opposite side. The head may be attached by means of the chain 11 to the counterweights 12 within the column, the chain passing over sheaves (not shown) at the top of the columns. The motor 9 is the medium for rotating the grinding spindle 7 on which the grinding wheel 13 is mounted. The mechanism for reciprocating the head in this instance is of a hydraulic nature, the particular arrangement of which may take any form, for instance as follows: the hydraulic ram 14 may have its upper end connected to the bracket 10 and its lower end having a piston (not shown) within the oil cylinder 15. The oil cylinder 15 has inlet and outlet pipes 16, the outlet pipe not being shown in this particular instance. It may be well to here point out that the particular arrangement of the hydraulic mechanism forms no part of the present invention as any commercial hydraulic mechanism may be used, the details of which are well known to those skilled in the art, therefore, a very brief description will be given.

The operation of the cylinder 15 is more or less automatic. When the ram carrying the piston descends the oil is forced out through the outlet pipe in the lower portion of said cylinder and into the communicating pipe 17, this oil then passing into the upper portion of the master cylinder 15 through the inlet pipe 16. When the head has descended to the desired low grinding point,

which has been regulated by setting the fingers 18, the upper finger 18 will contact the valve 19 on the hydraulic control box 20 and will automatically cause a reversal of the flow of liquid and result in the liquid being introduced into the lower portion of the cylinder 15 causing the piston and ram 14 and head 5 to be forced upwardly, the liquid above the piston escaping through the pipe 16 which has now the outlet pipe into the communicating pipe 17, which upward movement of the head will continue until the lower finger 18 contacts the valve 19′, which automatically reverses the flow of liquid resulting in an upward movement of the head.

By reference to Fig. 1, the connections to the control box 20 will be clearly seen and the communication between the master cylinder and its inlets and outlets will be understood. The mechanism for placing pressure on the liquid used in the hydraulic mechanism consists, in this instance, of a motor 21 operated by control box 22. Within the housing 23 is the pump construction for the liquid, the speed of flow, which regulates the travel, being controlled by controller 23′, this connection being standard and requiring no detailed description.

Referring now to some of the novel features of this invention, the table 24 having a bottom tapered plate 25 connected thereto by the screws 26, is provided below the head. The tapered plate 25 may be more or less fixedly attached to the vertical shaft 27 having a worm (not shown) on its periphery, the latter meshing with the worm gear 28 on horizontal driving shaft 29. The latter shaft communicates through differential gearing 30 with differential gearing 31 on a similar horizontal shaft 32 mounted substantially above shaft 29. The shaft 32 in turn communicates with the motor 33, mounted on the movable supporting structure 34 below the table. The motor 33 imparts the power for rotating the drive shaft 32 and, through the differential gearing, this drive is transmitted to the lower drive shaft 29 at the desired speed, and the latter in turn connected with the vertical shaft 27 causes the table 24 and plate 25 to rotate at any desired speed. The shaft 27 is journalled in the bearing 35 in the lower removable plate 36. The plate 36 tapers inwardly and downwardly to provide a lubricating oil reservoir 37. The arrangement is such that the end of the shaft 29 opposite the differential gearing, may be connected to the lower gear 38 of a standard gear pump 39. The latter has the usual inlet and outlet, in this instance the inlet being shown as 40, positioned in the body of lubricating oil in the reservoir, which inlet 40 is connected to the suction side of the gear pump 39. The outlet 41 from the discharge side of the pump may communicate with the bearing surface between the downwardly tapering rotating plate 25 and the non-rotating supporting structure below it. The shafts 29 and 32 are held in position by means of the connecting yoke or bracket 42. That portion of the shaft 27 above the worm, may bear in the tapered bearings 43.

When it is desired to vary the speed of rotation of the table, the differential gearing is operated by the lever 44 communicating with the shafts and gearing in a usual manner. It is to be noted that the table 24 and supporting structure 34 may be moved forward or backward on the tracks 45 of the stationary supporting structure 46, the lower portion of the upper transversely movable supporting structure 34 being grooved as shown at 47 to register with the tracks 45. It is to be noted that I provide an oil and water guard 48 adjacent the bearing surface between the plate 25 and supporting structure.

Referring now to the mechanism for tilting the table 24 with its connected supporting structure 34, I may provide a hand wheel 48 mounted on stub-shaft 49, which shaft terminates in bevel gear 50. The bevel gear 50 meshes with an angularly disposed bevel gear 51 mounted on horizontal shaft 52. The end of this shaft adjacent the bevel gear 51 is journaled in the bracket 53, which bracket 53 is more or less fixedly connected with the supporting structure 34. The opposite end of the shaft 52 is screw-threaded, as shown at 54, registering with screw-threaded bracket 55 which latter is fixedly connected to the lower non-movable supporting structure 46. When it is desired to move the supporting structure and table backward or forward the hand wheel 48 may be either manually or mechanically rotated to move the supporting structure and satisfy requirements.

Referring now to the particular mechanism for tilting the table, the trunnion 56, journalled in the casting 34, is fixedly connected to the table body so that upon rotation of the trunnion the entire table body and its movable supporting structure will be tilted to the desired angle. The trunnion 56 is connected to the link, designated as a whole 57, the latter being provided at its outer end with the segmental teeth 58 adapted to mesh with the pinion 59 mounted on shaft 60, which shaft communicates with handle 61 for rotating same. Adjacent the segmental teeth 58 is the elongated narrow slot 62 conforming with the arc of the teeth; this slot being adapted to register with the clamp bolt 63 fixedly mounted on the structure 34. The object of this clamp bolt, of course, is to lock the link 57 rigidly in position and therefore hold the table at any desired angle.

Referring now to the particular connection between the link 57 and trunnion 56, the exterior of the link is split as shown at 64, the two parts being locked by means of the lock nut 65, the trunnion 56 in effect, acting as the hub. The key 66 prevents the link 57 from turning on its axis. Above the trunnion and integrally connected with the link 57 is the graduated scale arrangement 67 registering with the graduated scale 68 on the bearing cover 69, the latter being held in position by the lock bolt 70.

The operation of bracket 57 should be apparent from the foregoing mechanical description of parts. When it is desirable to tilt the table and table body from the horizontal either forward or backward the lock nut 63 is loosened and through the action of the handle 61 and registration of the pinion 60 with the segmental teeth 59 the table and table body are tilted to the desired angle, the graduations on the scale 67 determining the amount of tilting required, this, of course, being predetermined. When the table and table body have been tilted to the desired angle the lock nut 63 is again tightened and the table and table body held rigidly in position. It is to be noted that the trunnions, graduated scale arrangement and link 57 are uniform on both sides of the table. This is possible due to the fact that the shaft 60 extends horizontally across the front of the table connecting a pinion 59′ meshing with segmental teeth 58′ on the bracket 57′, the tilting arrangement on both sides of the table are duplicated, causing them to be actuated together.

My apparatus is designed to do either wet or dry grinding. When it is desired to use the machine in wet grinding operation, a pump and nozzle can be provided. In other words, it is within the purview of this invention to do either wet or dry grinding.

Referring now to Fig. 2, the hollow casting 70 is clamped to the table 24 by means of the clamp bolts 71. It is to be noted that this casting 70 has vertical side walls 72 and outwardly tapering upper walls 73. In this particular instance the interior of the vertical walls 72 have been ground to the required diameter; this was done by allowing the table and table body to lie in a horizontal plane. When it was desired to vertically grind the tapered surface 73 the table and table body were tilted from the horizontal, as heretofore described, until the desired angle was reached, namely: the position as now shown in Fig. 2. The water, in the case of wet grinding, drains in this instance from the lefthand edge of the table through the water drains 74, and is collected in the base 46 of the apparatus.

The sprocket chain 75 connects the driving shaft from the motor to transmit the power to the shaft 32. Oil collecting on the bearing surface between the table support 25 and the supporting structure therebelow will drain 76 between the bearings 43 and shaft 27 into the oil body. In addition, oil will flow by gravity into the duct 77 adjacent the shaft 27 and bearing 35 to lubricate the lower portion and base of said shaft.

Referring now to Fig. 5, I provide a flexible apron 77, preferably of canvas or tough fabric, to cover the exposed portion of the V-shaped slide ways 4, to protect them from accumulation of grit and dirt, principally from the grinding operation. I wish to point out that the apron 77 has been cut away in Fig. 5 in order to clearly illustrate the hydraulic mechanism for reciprocation.

Referring now to Figs. 7 and 8, in which I have disclosed a particular construction of bearing which I have found desirable for use with the grinding spindle, within the stationary arbor itself is mounted the grinding spindle 78 having screw-threaded lower portion 79 on which the grinding stone 13 is adapted to be mounted. The interior of the arbor 6 is cut away, as shown at 80, for the additional purpose of providing an oil receiver or well 81, to be introduced to the well through the conduit or duct 82 and closed by the screw 83. Surrounding the lower portion of the spindle 78 is a tapered bearing 84 having its largest point extending downward, the lower portion of the bearing is screw-threaded as shown at 85 to register with the screw-threaded adjusting nut 86. This screw-threaded adjusting nut being held in place by means of screw-threaded retaining plate 87 registering with the screw-thread 88 of the arbor 6. A washer of felt or other material 89 is placed between the closure cap 87 and tapered bearing 84 and lock nut 86 for the purpose of retaining the oil in the bearing. A set screw 90 is provided to assist in maintaining a more or less permanent adjustment.

The tapered bearing 84 is split as shown at 91 and the wedge screw 92 is adapted to be forced between the split portion 91 for the purpose of preventing rotation of the bearing, and maintaining a tight adjustment between the bearing and grinding spindle. Oil is fed to the spindle through the oil duct 93 adjacent the interior of the arbor and exterior of the tapered bearing, the excess being caused to flow by centrifugal force to the curved return duct 94 to the oil reservoir 81. A felt packing 75 is also inserted in slot 91.

I am aware that heretofore attempts have been made to provide vertical grinding machines for grinding vertical surfaces, but I believe I am the first to perfect and put into commercial operation a grinding machine which by a simple adjustment will first grind vertical surfaces and without removing the work to be ground from the table

can be manipulated to grind a tapered surface vertically. I also believe I am the first to perfect what may be called a universal table which is adapted to be rotated and which can be tilted to any desired angle from the horizontal without interfering with the rotation of said table. By my invention, it is possible to meet all the requirements of production and miscellaneous grinding. The tilting feature of the universal table allows the grinding of any degree of taper within range of the table, such as inside straights, outside straights, inside and outside tapers, shoulder or flanged surfaces, with one chucking or setting of the work. The motor 33 for transmitting the power to rotate the table is mounted on the same structure with the trunnion 56, said motor, of course, tilting with the table.

It is to be noted that the tapered bearing 84 tapers in an outward direction downward, changing the present method which consisted in tapering inwardly, leaving the arbor bearing surface straight through the bearing. This construction allows the spindle shaft 78 to expand or contract, i. e., lengthen or shorten with different temperatures without the danger of jambing and without the necessity of changing the adjustment. The felt washer or packing 89 and gland nut 87 provides an oil-tight lower bearing end and prevents the lubricating oil from leaking and running over the grinding stone 13. The importance of this, of course, will be realized by those skilled in this art, as one of the disadvantages of former methods of vertical grinding has been that the oil leaks into the grinding stone or the work being ground.

I have shown and described my improved form of universal rotating and tilting table in combination with a vertical grinding machine. I wish to make it clear that the table itself with its supporting structure may be used in combination with drill presses, boring mills, or any other type of machine adapted for handling different kinds of boring, grinding or finishing.

I claim as my invention:

1. In a vertical grinding machine, the combination with spaced supporting columns having a central opening, of a head mounted on one side of the opening, a connection passing through the opening communicating between said head and a source of driving power, a grinding spindle mounted on the head and adapted to be rotated by the source of power, a rotating table on which the work is mounted, a support for said table, a motor mounted on the table support for rotating said table, and means for tilting the table and table support to a desired angle from the horizontal.

2. In a vertical grinding machine, the combination with spaced upright supporting columns, of a head mounted on one side of the upright columns and adapted to be reciprocated on the ways of the columns, a source of driving power on the opposite side of the columns, a connection passing through the space between the supporting columns connecting the head and source of power so that they move as a unit, a grinding spindle mounted on the head and adapted to be rotated by the source of power transmitting rotary movement thereto, a rotating table on which the work is mounted, a support for said table, a motor mounted on the table support for rotating said table, and means for vertically grinding straight or tapered surfaces, consisting in means for tilting said table and support to a desirable angle from the horizontal, and means for rigidly locking said table and table support in tilted position.

3. In a vertical grinding machine, the combination with spaced supporting columns, of a head mounted on one side of the columns and adapted to be reciprocated on the columns, a grinding spindle carried by the head, means on the opposite side of the columns connected to move as part of a unit with the head for rotating the grinding spindle, means passing between the spaced columns for connecting said head, and means for rotating the grinding spindle, a table below the grinding spindle on which the work is mounted, means for tilting said table to an angle from the horizontal, and means for securely locking same in tilted position.

4. In a vertical grinding machine, the combination with spaced supporting columns, of a head mounted on one side thereof, a grinding spindle carried by the head, a motor having connection through the spaced supporting columns with the head for rotating said spindle, said head and motor adapted to reciprocate as a unit, hydraulic mechanism connected with the head and functioning to automatically reciprocate said head, a table on which the work is mounted, rotating means mounted on the table support for rotating the table and means for tilting said table to a predetermined angle from the horizontal.

5. In a vertical grinding machine, the combination with spaced supporting columns, of a head mounted on one side thereof, a grinding spindle carried by the head, a motor having connection through the spaced columns with the head for rotating said spindle, hydraulic mechanism connected with the head and functioning to automatically reciprocate said head, a table on which the work is mounted, rotating means mounted on the table support for rotating the table and means for tilting said table to a predetermined angle from the horizontal, comprising trunnions positioned on the opposite

sides of the support, a link having segmental teeth connected with the trunnion, said teeth meshing to tilt the table, and means for locking same in tilted position.

6. In a vertical grinding machine, a grinding spindle, a work supporting table, means for raising and lowering the grinding spindle relative to the work supporting table, means for rotating the table, means for tilting the table angularly for differential work to be operated upon by the grinding spindle, and means for holding the table in its adjusted tilted position.

7. In a vertical grinding machine, a grinding spindle, a rotatable table, a non-rotatable support for the table, a motor supported by said non-rotatable support, said motor rotating the table at the desired speed, and means for angularly tilting the table relative to the grinding spindle for different kinds of work to be operated upon, substantially as described.

8. In a vertical grinding machine, a grinding spindle, a rotating table, a vertical spindle rigidly secured to said rotating table, a non-rotative supporting structure upon which the rotating table is mounted, an electric motor mounted on said non-rotative support, and gearing means driven by said motor for engaging the vertical spindle for rotating the table, substantially as described.

9. In a vertical grinding machine, a grinding spindle, a rotating table having a tapered seat, a non-rotating support having a complemental seat for the reception of the work supporting table, a motor mounted on said non-rotative supporting structure for variably rotating the table, substantially as described.

10. In a vertical grinding machine, the combination with a grinding spindle and a work supporting table, a non-rotating structure upon which the table is supported, opposed trunnions integral with said non-rotatable supporting structure, means for supporting said structure by said trunnions, a motor for rotating the table, means for rocking said rotatable supporting structure on said trunnions to adjustably tilt the same, and means for securely holding the table in its adjusted position relative to the grinding spindle.

11. In a vertical grinding machine, a grinding spindle, a work supporting table, a non-rotatable structure for supporting said table, said non-rotatable structure being provided with opposed trunnions secured in a supporting base for rockably supporting said table, means for tilting said table, comprising arms secured to each of said trunnions, and means for engaging said arms simultaneously for rocking the supporting structure by its trunnions, substantially as described.

12. In a vertical grinding machine, a grinding spindle, a work supporting table, a non-rotatable structure for supporting said table, said non-rotatable structure being provided with opposed trunnions secured in a supporting base for rockably supporting said table, means for tilting said table, comprising arms secured to each of said trunnions, means for engaging said arms simultaneously for rocking the supporting structure by its trunnions, said arms having arched slots therein, and locating devices engaging said slots for securely holding the arms in their adjusted position.

13. In a vertical grinding machine, a grinding spindle, a work supporting table, means for variably rotating said table relative to the spindle, means for tilting said table angularly with respect to the spindle, and means for longitudinally moving the table, substantially as described.

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