March 2, 1937. F. S. HAAS 2,072,814

GRINDING MACHINERY

Filed Jan. 3, 1934 4 Sheets-Sheet 1

Fig. 1

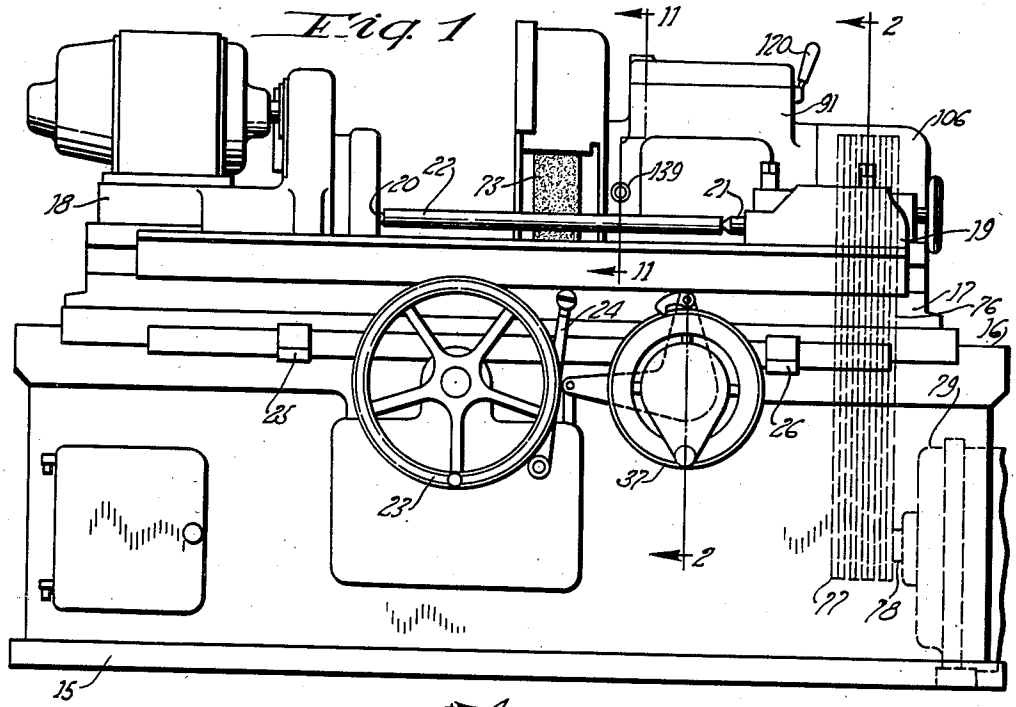
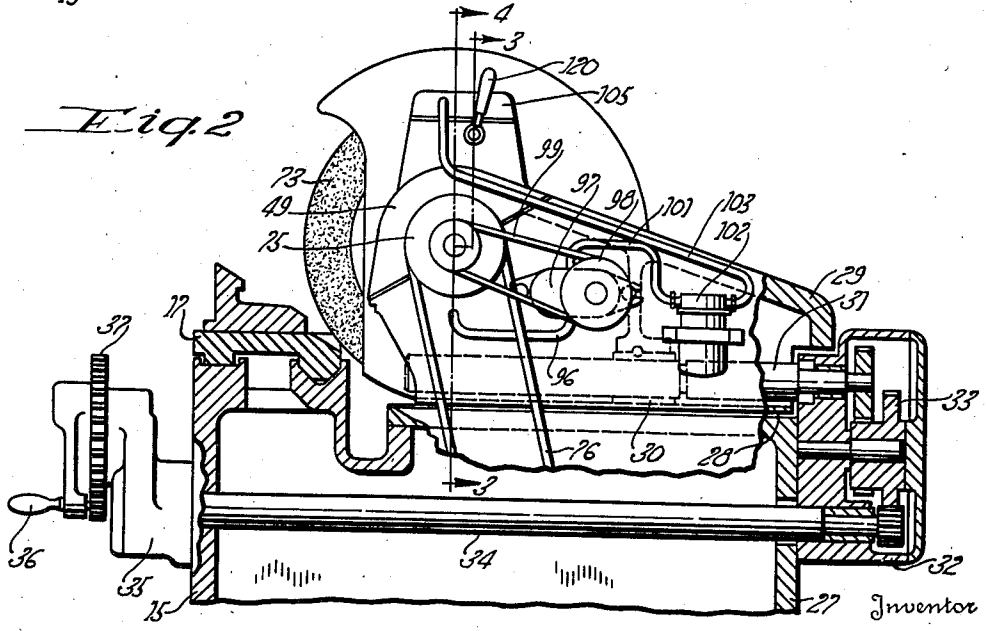



Fig. 2




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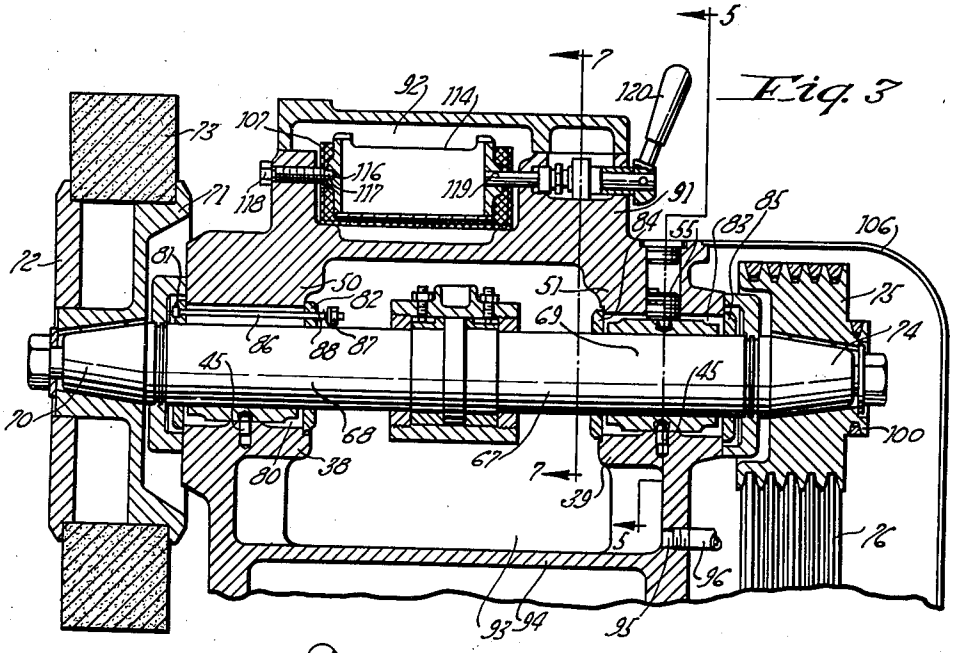


Fig. 3

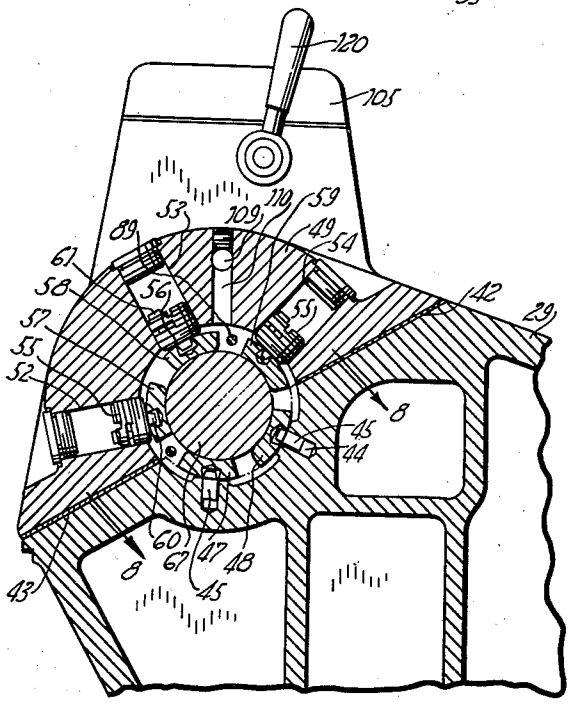


Fig. 5

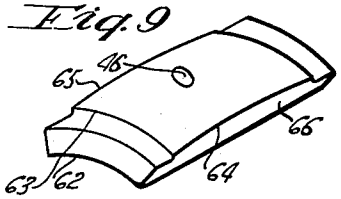


Fig. 9

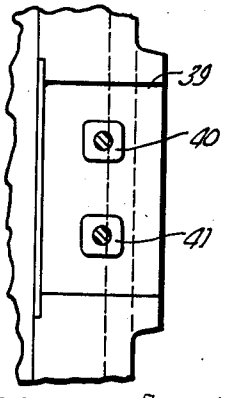


Fig. 8

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GRINDING MACHINERY

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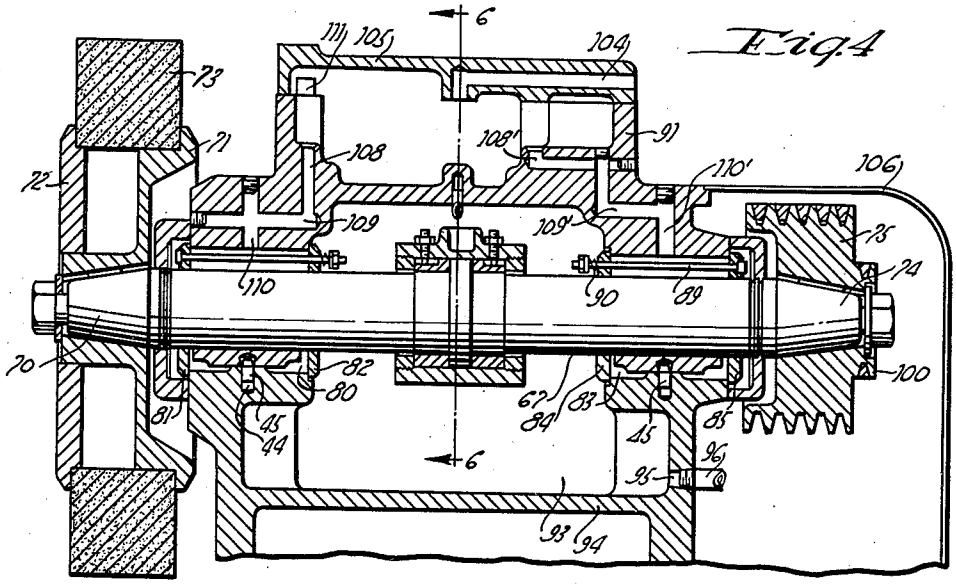



Fig. 4

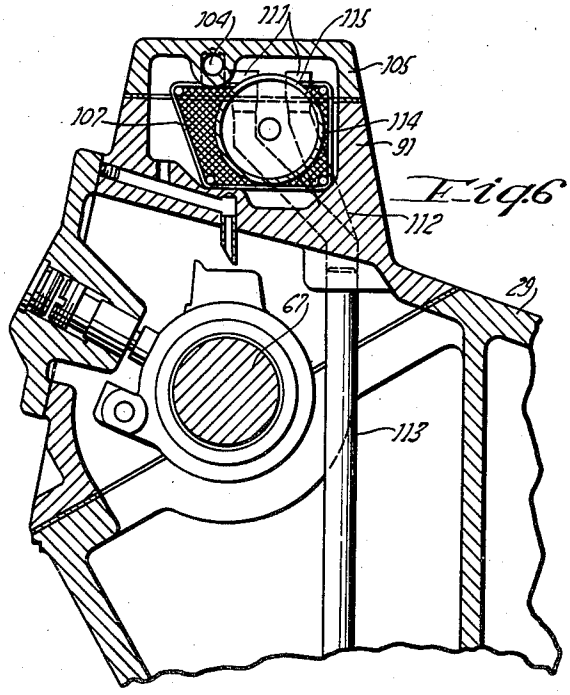



Fig. 6

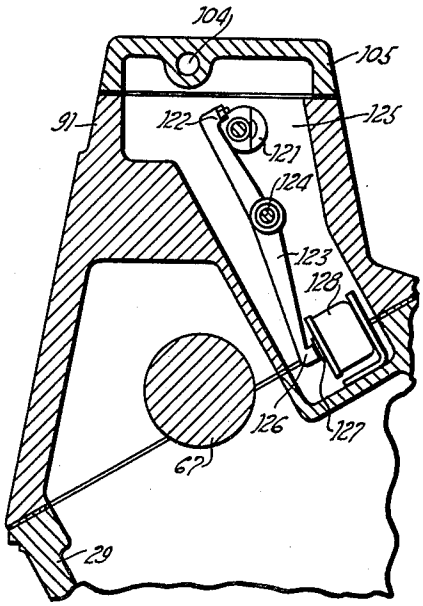



Fig. 7

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GRINDING MACHINERY

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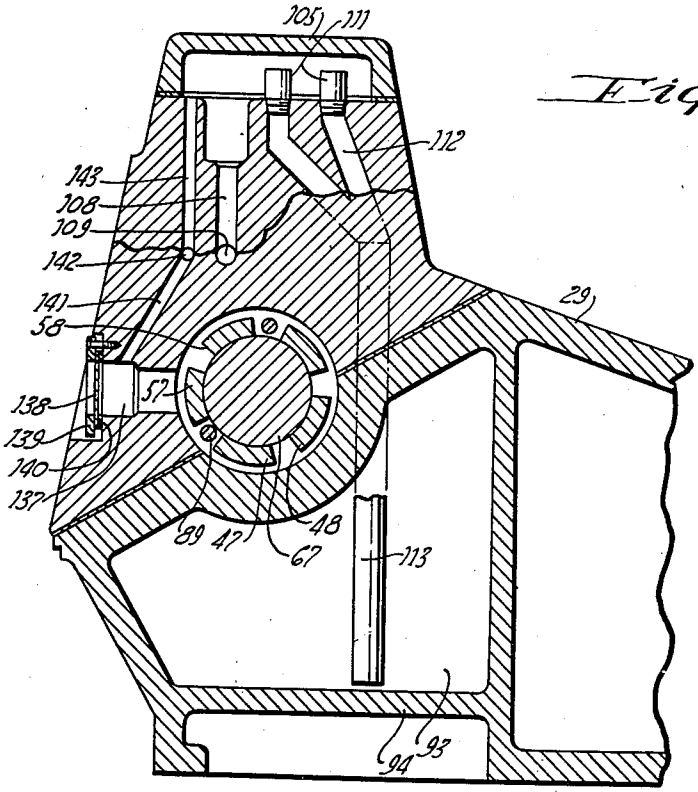



Fig. 11

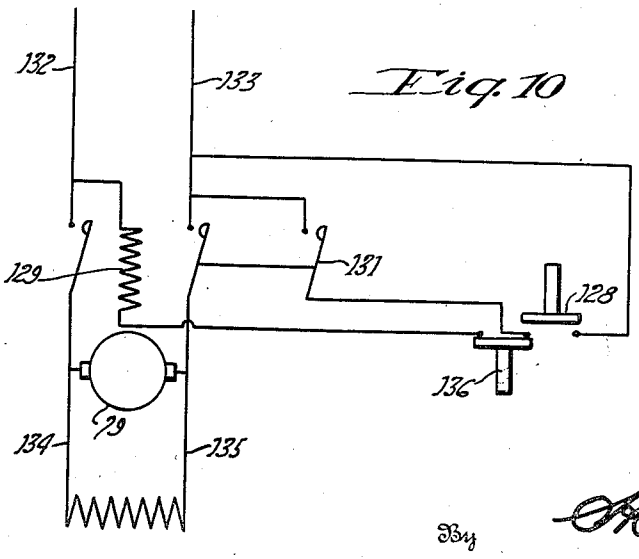



Fig. 10

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Patented Mar. 2, 1937 2,072,814

# UNITED STATES PATENT OFFICE

2,072,814

## GRINDING MACHINERY

Frederick S. Haas, Cincinnati, Ohio, assignor to Cincinnati Grinders Incorporated, Cincinnati, Ohio, a corporation of Ohio

Application January 3, 1934, Serial No. 705,106

6 Claims. (Cl. 308—73)

This invention relates to improvements in machine tools such as grinding machines and the like and particularly to improvements in means for supporting and rotating the spindles thereof.

One of the principal objects of the present invention is the provision of an improved rocker shoe bearing construction for machine tools, spindles or other rotating shafts.

Another object of the invention is the provision of means for supporting the rocker shoes which, due to its construction, reduces the manufacturing costs thereof to an absolute minimum.

A further object of the invention is the simple construction of the bearing members and the cooperating housing, whereby an efficient and sturdy product results without excessive production costs and by the use of ordinary processing tools.

Another object of the invention is the provision of improved means for mounting the said bearings so that slight eccentricities are readily compensated for and avoidance of any binding is obtained.

A further object of the invention is the provision of improved means for supplying lubricant to the bearings prior to the rotation of the spindle relative thereto.

It is also an object of the present invention to automatically effect the rotation of the spindle after the bearings have been properly lubricated and not before.

Other objects and advantages of the present invention should be readily apparent by reference to the following specification, considered in conjunction with the accompanying drawings forming a part thereof and it is to be understood that any modifications may be made in the exact structural details there shown and described, within the scope of the appended claims, without departing from or exceeding the spirit of the invention.

In the drawings:

Figure 1 is a front elevation of a grinding machine embodying the improvements of this invention.

Figure 2 is a view, partly in section and partly in elevation, as seen substantially from line 2—2 on Figure 1.

Figure 3 is a sectional view taken substantially on line 3—3 of Figure 2.

Figure 4 is a sectional view, similar to Figure 3, taken in a plane slightly ahead of the plane of Figure 3 and as seen, for example, on line 4—3 on Figure 2.

Figure 5 is a transverse sectional view taken on line 5—5 on Figure 3.

Figure 6 is a sectional view taken substantially on line 6—6 of Figure 4.

Figure 7 is a sectional view taken on line 7—7 of Figure 3.

Figure 8 is a fragmentary developed view of one of the supporting surfaces as seen on line 8—8 on Figure 5.

Figure 9 is a perspective view of one of the individual bearing shoes.

Figure 10 is a diagram of the electrical circuit involved in the invention.

Figure 11 is a sectional view taken on line 11—11 of Figure 1.

Throughout the several views of the drawings similar reference characters are employed to denote the same or similar parts.

As was noted above, this invention pertains primarily to improved means for supporting, lubricating and rotating spindles of machine tools, such as lathes, grinders and the like. For purposes of illustration, the invention has been shown in the drawings in connection with a grinding machine but it is to be understood that the invention is not limited to that type of machine.

The grinding machine illustrated in the drawings comprises a bed 15, on the upper surface of which is formed ways 16 for guiding a work supporting table 17 during its movements relative thereto. The table 17 supports at opposite ends a headstock 18 and tailstock 19 from which respectively project centers 20 and 21 for supporting a work piece 22. Any suitable means may be employed for effecting the reciprocation of the table 17, such as the hand wheel 23 and reversing lever 24. The lever 24 operates power reversing mechanism as is usual practice and is under the control of dogs 25 and 26 carried by the table 17.

Projecting rearwardly from the bed 15 is a supplemental bed 27 having formed on the upper surface thereof guide ways 28 for guiding a tool carriage 29 during its movements toward and from the work 22. In order to effect the said movements of the carriage 29 it carries interiorly thereof a nut 30 in threaded engagement with an adjusting screw 31. The said screw 31 is suitably journaled in a bracket 32 secured to the rear of the bed extension 27 and the bracket 32 encloses a gear train 33 which connects the screw 31 with a transverse shaft 34. The shaft 34 extends transversely of the machine and is journaled at opposite ends in the bracket 32 and, as mentioned above, in a second bracket 35 secured to the forward face of the bed 15. In addi-

tion, the bracket 35 encloses suitable actuating mechanism for shaft 34 and adjusting screw 31, as is well known, which is under the control of handle 36 and ratchet wheel 37.

The tool carriage 29 is provided at opposite ends thereof with supporting bearing portions 38 and 39, one of which, bearing portion 39 for example, is shown in plan in Figure 8. Since the said bearing portions 38 and 39 are identical in construction it is deemed sufficient for illustrative purposes and an understanding of the invention if but one of them be illustrated and described. The bearing portion 39 has formed thereon a pair of pads 40 and 41 which are each provided with a flat or plane surface. The carriage 29 at the ends of the bearing portion 39 is provided with plane surfaces 42 and 43, which as shown in Figure 5, are disposed at an angle to the horizontal. During the machining or processing of the said carriage the surfaces 42 and 43 are planed or milled in the usual manner, and during said planing or milling it is only necessary to employ a small face mill or planing tool to face off the lugs 40 and 41. From this it will be seen that the bearing supports may be machined with a minimum of expense instead of, as was past practice, resetting the carriage after the faces 42 and 43 were planed in order to bore the carriage and fit therein the bearings utilized in the past.

After the bearing pads 40 and 41 have been milled or otherwise suitably faced, small holes or pockets 44 are drilled therein in which are set pins 45. The pins 45 enter a co-operating socket 46 formed in bearing shoes 47 and 48. The shoes 47 and 48 are similar in all respects and are particularly illustrated in Figure 9 and will be described in detail later.

Mounted on the carriage 29 is a cap 49 having formed therein bearing portions 50 and 51 which are opposite to the carriage bearing portions 38 and 39. Each of the bearing portions 38 and 39 is provided with a plurality of radial bores 52, 53 and 54 into each of which is threaded a screw 55. The inner end of said screws is provided with a flat or plane surface 56 which functions as do the pads 40 and 41 for positioning the upper bearing shoes 57, 58 and 59. The bearing shoes 57, 58 and 59, similar to the shoes 47 and 48, are each provided with a socket 46 receiving the tit or pin 60 projecting from each of the screws 55 which prevents the shoes from shifting out of place. The screws 55 are individually adjustable to determine and effect the proper amount of pressure of their shoes, and after being adjusted are locked in position by suitable clamp or pinch bolts 61.

Each of the shoes is identical in construction, and as shown in Figure 9, has an arcuate bearing surface 62 which lies adjacent the spindle. As seen in Figure 3, the shoes are of a length substantially equal to the bearing portions 38 and 39 of the carriage and bearing portions 50 and 51 of the cap. The back of the shoes is arcuately shaped as at 63, which arc is substantially concentric with the bearing face 62. At the same time the said back of the shoes is curved lengthwise as illustrated at 64, wherefore the said shoes will contact with the flat surface of the beds 40 and 41 or the flat face of the screws 52 in such a manner as to rock in both directions. It will further be noted that the sockets 46 therein are offset with respect to the longitudinal axis of the shoes, being closer to the trailing edge 65 than the leading edge 66. The purpose for this construction will be described in detail later.

Disposed substantiallly centrally of the carriage bearing portions 38 and 39 and cap bearing portions 50 and 51 is a spindle 67 which has journal portions 68 and 69 thereon which are encircled by the said carriage and cap bearing portions and the bearing shoes associated therewith. The spindle 67 extends beyond the carriage and cap bearing portions 38 and 50 and is formed into a tapered nose 70 to which is secured a grinding wheel flange 71. The said flange 71 has secured thereto, as by a ring 72, a grinding wheel 73. Likewise the spindle 67 projects beyond the carriage and cap bearing portions 39 and 51 where it is formed into a tapered nose 74 receiving a pulley or sheave 75. The sheave 75 is shown in the drawings as of the multiple groove type for the multiple V belts 76. The said belts 76 are in turn trained about a sheave or pulley 77 secured to a motor shaft 78 of the main drive motor 79.

As will be seen in Figure 5, the bearing shoes are substantially equally radially spaced about the spindle with two bearing shoes 47 and 48 carried by the carriage and below the parting between the carriage and cap and with three bearing shoes 57, 58 and 59 associated with the cap and above the said parting. These shoes are in effect enclosed within chambers formed by the bearing portions 38 and 50 respectively associated with the carriage and cap and by the bearing portions 39 and 51 also respectively associated with the carriage and cap. The chamber 80 formed by the former bearing portions is closed at opposite ends by chamber end plates 81 and 82, while the chamber 83 formed by the latter bearing portions is closed at opposite ends by similar chamber end plates 84 and 85. The said chamber plates are each provided therethrough with a bore which very closely engages with the spindle bearing portions 68 and 69 without, however, forming an absolute seal, but instead providing a small orifice through which lubricant will flow from their respective chambers. The plates 81 and 82 are provided on their inner surfaces with a plane surface which engages similar surfaces formed at each end of the lubricant chambers 80 and 83. Passing through the chamber 80 and through the end plates 81 and 82 thereof are bolts 86 which have a head on one end for engagement with one plate and a nut 87 on the other. Between the nuts 87 and the adjacent plate, and encircling the bolts 86, are springs 88 which yieldably hold the plates to their co-operating surfaces on the carriage and cap bearing portions. The plates 84 and 85 are similarly held against the end surfaces of carriage and cap bearing portions 39 and 51 by bolts 89 which carry springs 90, similar to the springs 88.

From the foregoing it will be noted that the journal portions 68 and 69 of the spindle 67 are disposed in lubricant chambers through which the lubricant may flow. Due to the smallness of the orifice formed between the chamber end plates and the spindle journals a certain amount of pressure is necessary to force the lubricant therethrough. At the same time a semi-floating bearing has been provided, since the said chamber end plates are merely yieldably held in position so that they may shift with the spindle in the event the bearing shoes are positioned slightly inaccurately with respect to the axis of the spindle.

In order to supply the lubricant to the chambers 80 and 83 under a suitable head or pressure the cap 49 is formed with an upwardly projecting

housing 91, in the interior of which is formed a lubricant well 92. The lubricant is received and stored in the reservoir chamber 93 formed in the carriage 29 by a transversely extending base or wall 94. The reservoir has formed through the side wall thereof a port 95 with which is connected one end of a pipe or conduit 96. The pipe or conduit 96 terminates at the intake of a pump 97 that is fastened to the side wall of the carriage 29 and the said pump has associated therewith a pulley or sheave 98 about which is trained a belt or the like 99. The belt 99 is in turn trained about a pulley 100 formed integral with or secured to the pulley 75 of the spindle 67. From the other side of the pump 97 is the discharge pipe or conduit 101 which terminates at the intake of a lubricant purifier 102. The other discharge side of the purifier 102 is connected by a pipe or conduit 103 with a supply port 104 formed in the top cover plate 105 of the carriage cap 49. From the foregoing it will be noted that the tool carriage 29 is self-contained as far as the lubricating system therefor is concerned. The spindle pulley 75, pump 98, purifier 102 and the conduits are all suitably enclosed by a guard 106 secured to the side of the carriage 29 and bed extension 27.

Within the lubricant well 92 is a bucket 107 shown in Figures 3 and 6 as formed of a wire mesh through which the lubricant flows into the well proper. This wire mesh bucket 107 is utilized for breaking up any minute air bubbles that may be in the lubricant so that the lubricant actually delivered to the bearings is substantially homogeneous. At one end of the well 92 the cap 49 is provided with a series of connecting ports 108, 109 and 110, and at the other end with a series of connecting ports 108', 109', and 110', the former series terminating in the lubricant chamber 80, while the latter terminates in the lubricant chamber 83. Due to the height of these parts or the entrance thereto above the said chambers a pressure or head is developed on the lubricant which is sufficient to force the lubricant through the orifices formed between the chamber end plates and the spindle itself. From this it follows that there will be a continuous flow of lubricant from the well 92 through the series of ports and lubricant chambers from which the lubricant is discharged into the reservoir 93. It should be noted, however, that the flow of lubricant as effected by the pump 98 through the port 104 into the well 92 is materially greater than the outward flow thereof through the series of ports and chambers so that the said well is at all times filled during the operation of the machine.

In order to apprise the operator of the machine of the lubricant in the lubricant chambers they are each provided with a sight gauge. One of these sight gauges is shown in Figure 11 and comprises a bore 137 communicating at its inner end with the lubricant chamber 80. The outer end of this bore is closed by a glass window 138 held in place by a frame 139 and a gasket 140 between the glass window 138 and carriage wall.

The maximum level of the lubricant in the well 92 is determined by the stand pipes 111 which, as seen in Figure 6, rise to a height above the wire mesh bucket 107. The stand pipes 111 discharge into ports 112, which in turn empty into a discharge pipe 113 which terminates near the bottom of the lubricant reservoir 93. In practice, the pipe 113 terminates very closely to the base 94 of the well 93 whereby a drop or fall of the lubricant is prohibited and the agitation of the lubricant held to a minimum for holding to a minimum any air bubbles or the like in the lubricant.

The operation of rocking shoe bearings is well understood but it is believed that a short description of this operation would not be amiss at this time. Accordingly, and referring to Figure 5 wherein the spindle is rotating in a counterclockwise direction and assuming that the space between the lead-in edge of the bearing shoe and spindle is provided with operating fluid or lubricant, the operation is as follows:

When the spindle begins to rotate, the lubricating medium is drawn into the lead-in, or is already present at the lead-in, to the bearing by reason of the adhesiveness of the oil to the shaft or spindle. The surface layer of molecules of the oil adjacent thereto is drawn in between the surfaces of the shaft or spindle and bearing shoes. Since the oil or lubricating medium has inter-molecular friction, or what is commonly called viscosity, other molecules of oil are drawn into the bearing space. This causes the spindle journals to lift away from the bearing, and in so doing provides more room for lubricant to enter. After the lubricating medium has entered between the surfaces, the surface layer of molecules adjacent to the spindle is moving with the spindle, while the surface layer adjacent to the bearing is stationary with it. It is obvious, therefore, that all the lubricating medium between these surface layers is in a continual state of slip or what is known as shear. When the surfaces are relatively close to each other the shear forces in the oil are very great and since the stress in a liquid must be the same in all directions a pressure is built up normal to surfaces.

The hydro-dynamic theory is that fluid films show that in order to support a load the pressure change in the volume must be gradual. The theory also proves that to obtain a gradual change the volume must be wedge shaped with its thickness diminishing in the direction of motion. Equilibrium is reached when the integration of all the pressure elements in the volume is equal to the external load on the spindle. This condition of equilibrium will obtain as long as a copius supply of the lubricating medium is present at the lead-in edge of the shoe. This theory also shows that for optimum conditions the center of pressure occurs nearer to the trailing edge than to the leading edge of the bearing shoe. Therefore, in this invention the rocking shoes are shown with the supporting edge nearer to the trailing edge.

In the past in order to obtain this condition the rocking shoes were formed with a central rib having an arcuate contact surface which makes it relatively difficult and quite expensive to manufacture or produce. Alternately, the said shoes were formed of irregular shape, that is, with the outer surface of the shoe eccentric to the inner or bearing surface thereof. This type of construction again rendered the shoe difficult to manufacture and required relatively expensive processing operations. By the present construction the inner and outer surfaces of the shoes are substantially concentric with only a slight crown on the said outer surface from end to end. The shoes, however, may be made up in the form of a cylinder and the cylinder then crowned, whereupon the cylinder is divided into segments to provide the individual shoes. From this it will be seen that the construction of the present invention obtains the same beneficial results as the

prior constructions but at a cost considerably under the former manufacturing costs.

Since the lubricant is supplied to the bearing chambers 80 and 83 by gravity the well 92 and the said chambers will be drained if the machine is shut down for any appreciable period of time, such as during the noon hour or over night. It has been found that the greatest damage occurs to the spindle journals and supporting bearings during the interval between the starting of the rotation of the spindle and the supplying of lubricant thereto. In order to overcome this difficulty there is incorporated in the present invention means for supplying a suitable quantity of lubricant to the bearings prior to the starting thereof.

This mechanism comprises a container 114 disposed within the wire mesh bucket 107. The container 114 has an open top 115 which is below the upper level of the stand pipes 111 and will, therefore, receive lubricant by overflowing from the well 92 as the level thereof rises to and above the said open top 115. The container 114 is mounted for oscillation in order to dump the lubricant therefrom and for this reason has one end formed with a pocket 116 which is journaled on the nose 117 of a screw 118 let through the left hand side wall of the cap 49. The other end of the container 114 is secured to a shaft 119 journaled in the right hand wall of the cap 49. The shaft 119 extends through and beyond this wall to receive a handle 120 whereby the said shaft and container may be oscillated through 180° for dumping the container. The container is of such cubical content as to contain sufficient lubricant to fill the chambers 80 and 83 and thereby supply a sufficient amount of lubricant to the bearings to last the interval between the starting of rotation of the spindle and the supply of lubricant thereto by the pump 98.

As will be evident, after the lubricant has drained from the system during a shut-down, the chambers, supply ports and sight gauge bore will fill with air which will interfere with the operation of the bearing shoes if not disposed of. This air will be forced ahead of the lubricant into the sight gauge bore and will naturally collect at the top thereof. In order to dispose of this air the cap 49 is provided with a substantially vertically extending port 141 which empties into a connecting port 142 and said connecting port in turn empties into vertical port 143. The port 143 has its upper end substantially at the top of the lubricant in the well and the air will therefore be dissipated above the lubricant.

In order to insure the dumping of the lubricant from the reservoir container 114 prior to the rotation of the spindle, the spindle motor 79 is rotated or its rotation initiated by the handle 120. The mechanism for accomplishing this comprises a cam or projection 121 integral with or secured to the shaft 119 which operates on one end 122 of a lever 123. The lever 123 is pivoted intermediate its ends at 124 in a chamber 125 formed in the cap 49. The other end 126 of the lever 123 lies adjacent the push button 127 of a starting switch 128. The switch 128 is of the manual type for closing the circuit to effect the operation of the motor switch 129 which includes the magnetic locking switch plate 131, all as is usual practice. The motor starting magnetic switch 129 and the manual starting switch 128 are connected with the initial power source wires 132 and 133, while the magnetic starting switch is connected by wires 134 and 135 with the motor 75. In order to break the circuit and stop the said motor a stopping switch 136 is also provided.

From the foregoing it will now be evident that the operator with the lever 120 first discharges the oil or lubricant in the reservoir container 114 to the bearings and then initiates the rotation of the spindle motor for initiating operation of the lubricant circulating pump. From this it is also clear that the spindle bearings are adequately lubricated prior to the rotation of the spindle.

What is claimed is:

1. In a spindle supporting mechanism the combination of a housing, a spindle associated with the housing and having journal portions thereon, bearing portions formed in the housing to receive the spindle journals, segmental bearing shoes between the housing bearing portions and spindle journals, said shoes having an arcuate bearing portion and an arcuate back, plane surfaced pads associated with the housing for contact with the arcuate back of the shoes and having line contact with said shoes whereby they may rock, a cap on the housing and having bearing portions formed therein complementary to the housing bearing portions, screws carried by the cap and projecting into the bearing portions thereof and having a plane inner surface, and segmental shoes each having an arcuate back between the screws and spindle journals and which arcuate backs contact the plane face of the screws whereby said shoes may rock on the plane surface of the screws.

2. In a spindle supporting mechanism the combination of a housing, a spindle associated with the housing and having journal portions thereon, bearing portions formed in the housing to receive the spindle journals, segmental bearing shoes between the housing bearing portions and spindle journals, said shoes having an arcuate bearing portion and an arcuate back, plane surfaced pads associated with the housing for contact with the arcuate back of the shoes and having line contact with said shoes whereby they may rock, a cap on the housing and having bearing portions formed therein complementary to the housing bearing portions, screws carried by the cap and projecting into the bearing portions thereof and having a plane inner surface, segmental shoes each having an arcuate back between the screws and spindle journals and which arcuate backs contact the plane face of the screws whereby said shoes may rock on the plane surface of the screws, and means for holding the shoes against radial displacement with respect to the spindle journals.

3. In a spindle supporting mechanism the combination of a housing and closing cap, a spindle extending through the housing and cap and having formed thereon journal portions, the housing and cap having bearing portions encircling the spindle journals, segmental bearing shoes circumferentially spaced around the spindle journals and disposed between the said spindle journals and housing and cap, plane surfaced supporting members associated with the housing and cap bearing portions on which the arcuate bearing shoes rest and have line contact therewith for rocking purposes relative thereto, plates at each end of the housing and cap bearing portions for forming a chamber within said housing and cap bearing portions for enclosing the spindle journals and shoes, and yielding means for holding the plates in operative posi-

tion whereby they may shift with the spindle due to the rocking of the shoes.

4. A bearing structure for a precision grinding machine spindle including a base unit having spaced arcuate bearing receiving recesses formed therein, each of said recesses being provided with inwardly projecting lugs, centering studs carried by said lugs, individual arcuately shaped cap members overlying the respective bearing recesses, a plurality of adjustable abutment screws carried by the cap member, each of said screws having an inwardly extending centering stud, a grinding spindle projecting axially through said bearing recesses and a plurality of segmental bearings disposed in each of said recesses in circumscribing relation to the contained portion of the spindle, each of said segmental bearings having an arcuate inner face shaped to substantially the contour of the periphery of the shaft and having an outer face arcuately curved to fit within the bearing recess, said outer face being provided with a socket for reception of a lug or adjusting screw stud and being longitudinally crowned, whereby the studs interengage with the sockets for retaining the bearing members in position for limited oscillation on ther curved outer faces.

5. A bearing structure for a precision grinding machine spindle including a base unit having spaced arcuate bearing receiving recesses formed therein, each of said recesses being provided with inwardly projecting lugs, centering studs carried by said lugs, individual arcuately shaped cap members overlying the respective bearing recesses, a plurality of adjustable abutment screws carried by the cap member, each of said screws having an inwardly extending centering stud, a grinding spindle projecting axially through said bearing recesses, a plurality of segmental bearings disposed in each of said recesses in circumscribing relation to the contained portion of the spindle, each of said segmental bearings having an arcuate inner face shaped to substantially the contour of the periphery of the shaft and having an outer face arcuately curved to fit within the bearing recess, said outer face being provided with a socket for reception of a lug or adjusting screw stud and being longitudinally crowned, whereby the studs interengage with the sockets for retaining the bearing members in position for limited oscillation on their curved outer faces, said lugs on the base unit definitely determining the position of the segmental bearings carried thereby, and means for securing the adjustable screws in variable relation to the cap whereby the cap segmental bearings are variably urged into positioning engagement with the spindle.

6. A bearing structure for a precision grinding machine spindle including a base unit having spaced arcuate bearing receiving recesses formed therein, each of said recesses being provided with inwardly projecting lugs, centering studs carried by said lugs, individual arcuately shaped cap members overlying the respective bearing recesses, a plurality of adjustable abutment screws carried by the cap member, each of said screws having an inwardly extending centering stud, a grinding spindle projecting axially through said bearing recesses, a plurality of segmental bearings disposed in each of said recesses in circumscribing relation to the contained portion of the spindle, each of said segmental bearings having an arcuate inner face shaped to substantially the contour of the periphery of the shaft and having an outer face arcuately curved to fit within the bearing recess, said outer face being provided with a socket for reception of a lug or adjusting screw stud and being longitudinally crowned, whereby the studs interengage with the sockets for retaining the bearing members in position for limited oscillation on their curved outer faces, washer-like plates mounted on the spindle at opposite sides of the bearing areas and overlying the faces of the unit and cap at the bearings, and means for yieldingly urging these plates, one toward another into interfitting engagement with respective faces of said parts, whereby said plates are free to float with the shaft and form an oil seal against escape of lubricant axially of the bearings.

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