May 9, 1933. S. H. EARL 1,908,476

MACHINE FOR SHARPENING GEAR CUTTERS

Filed Dec. 18, 1930 5 Sheets-Sheet 1

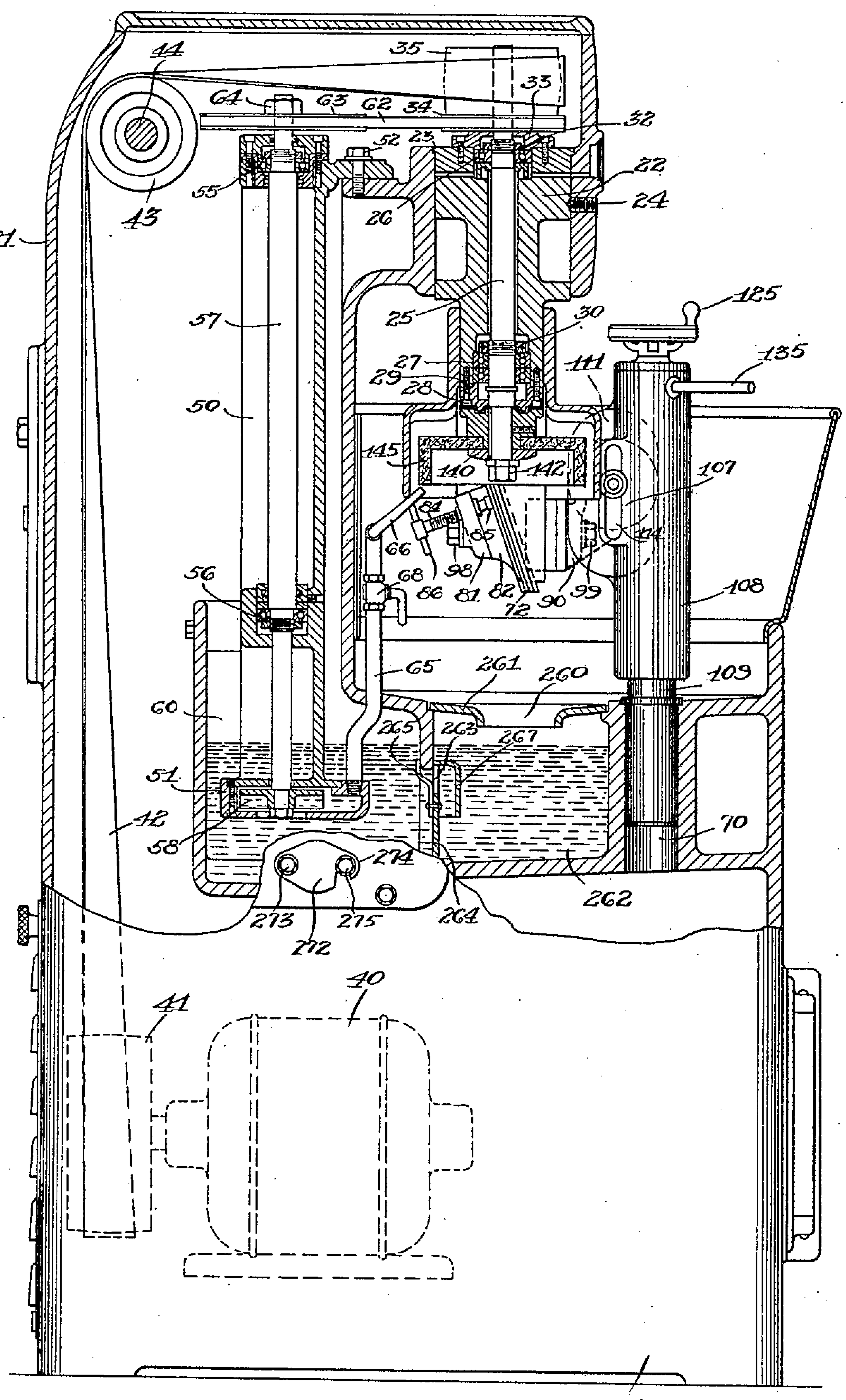

Fig. 1

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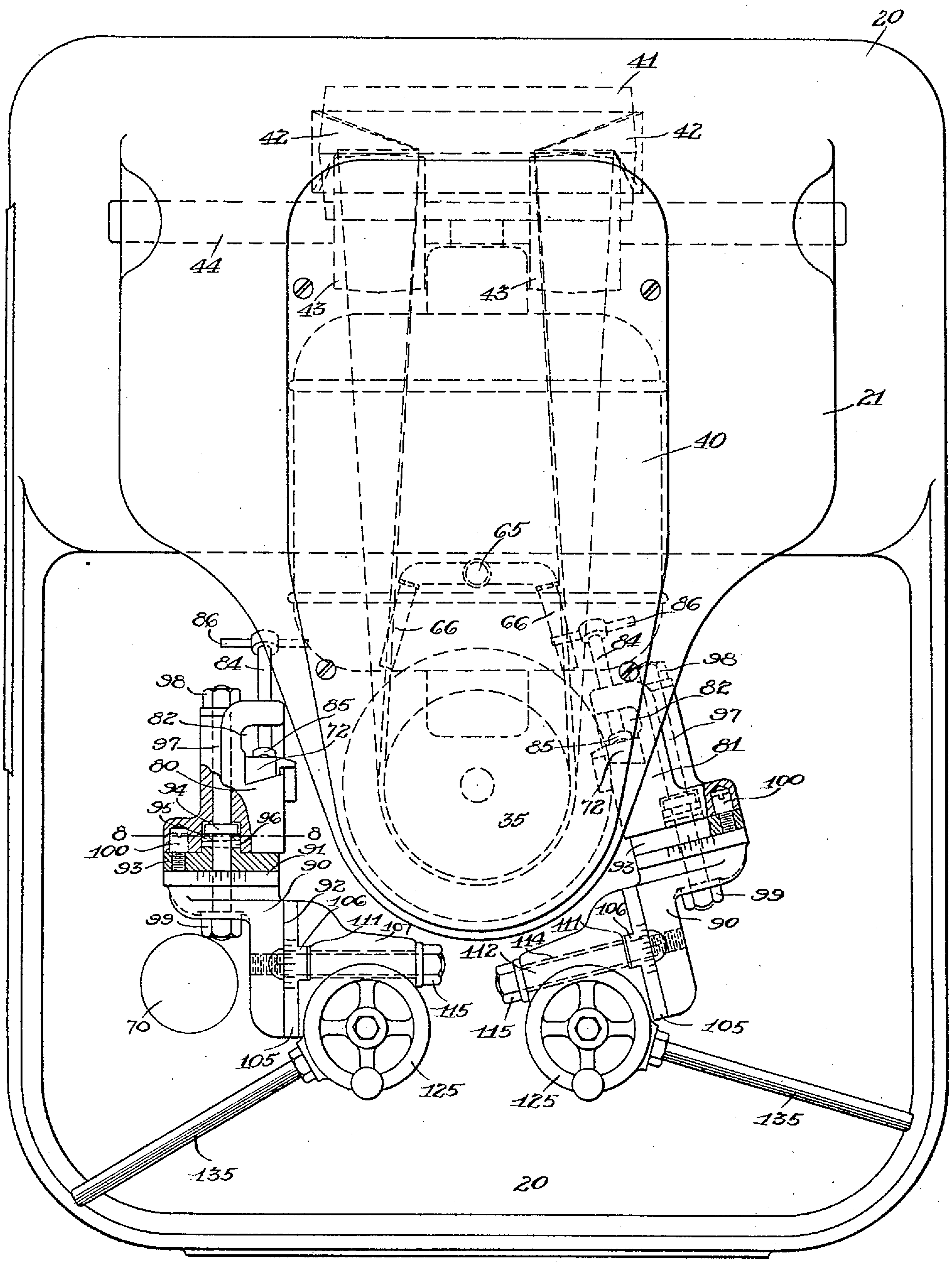

Fig. 2

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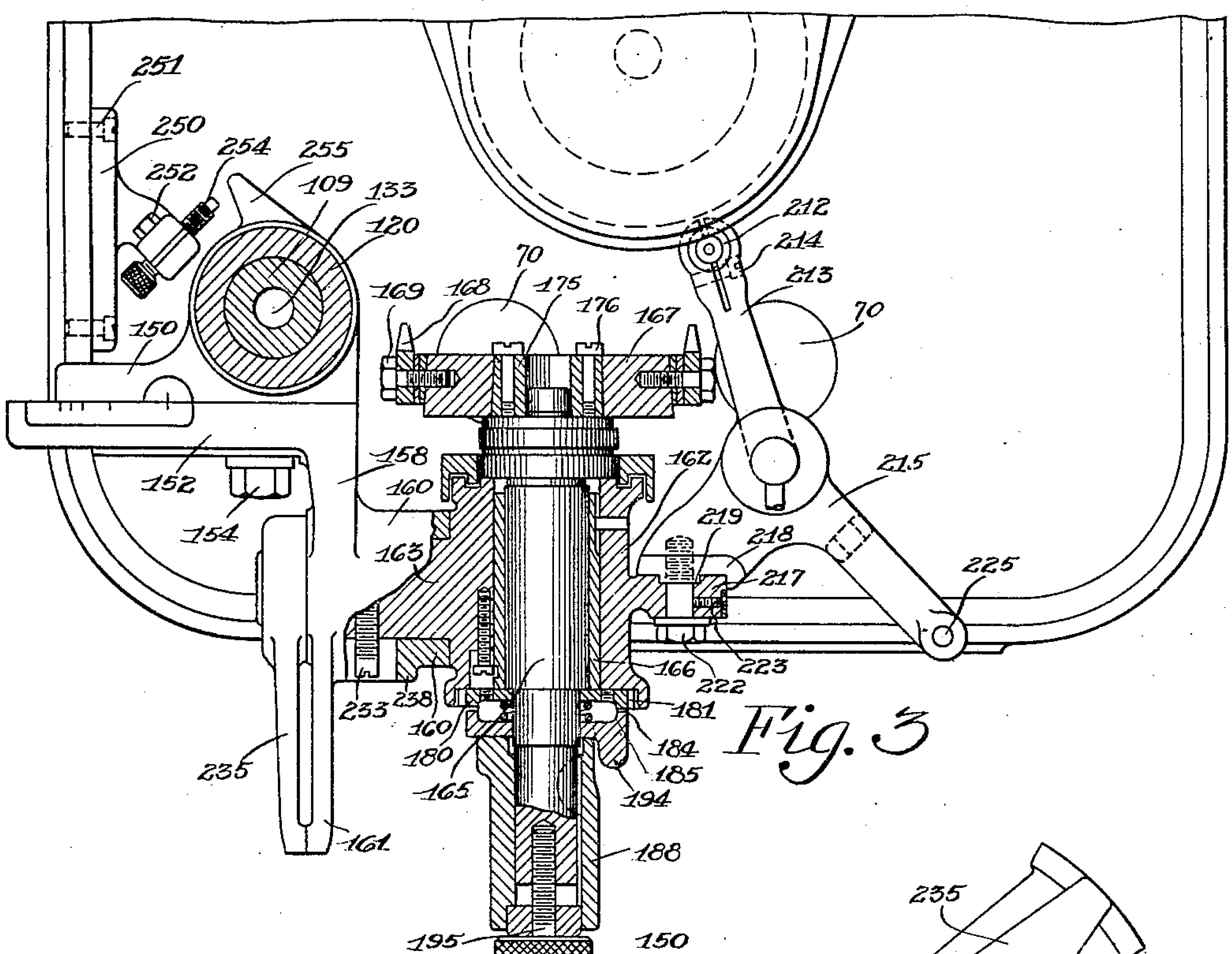


Fig. 3

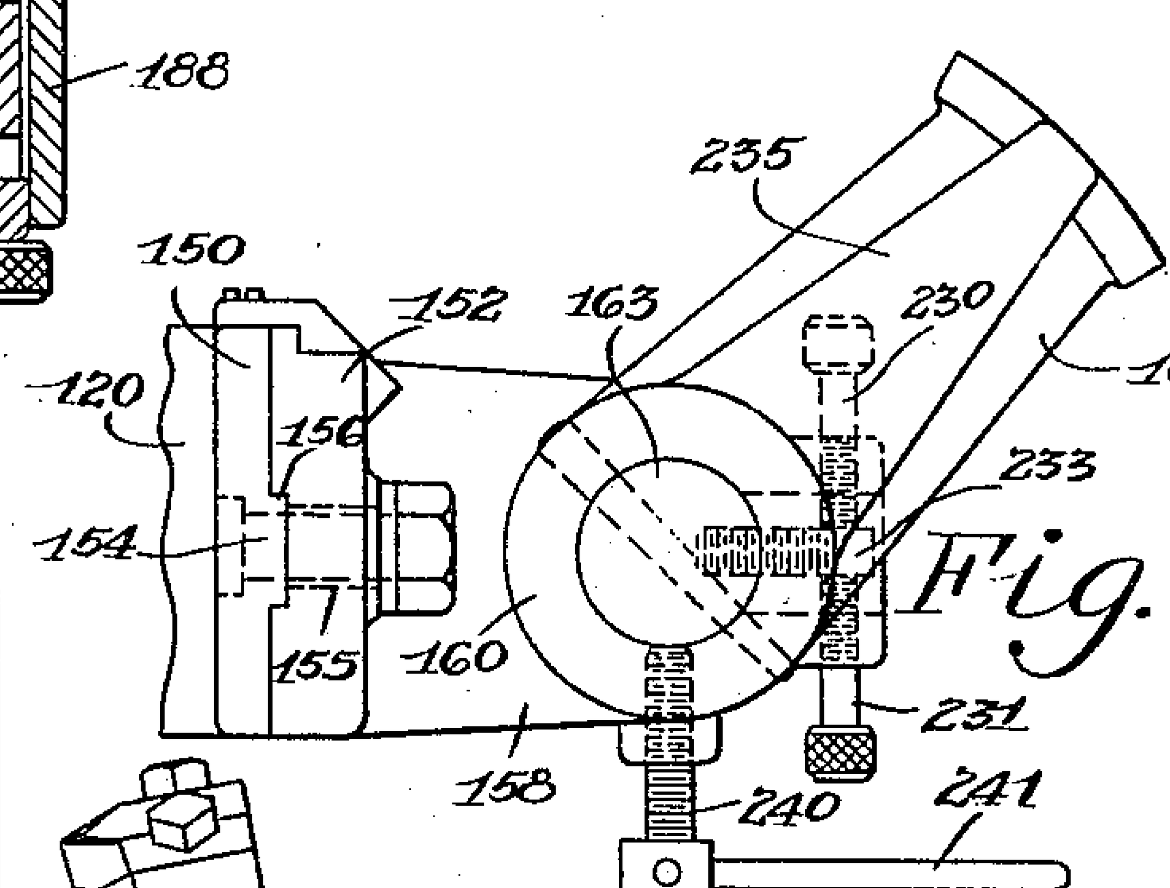


Fig. 6

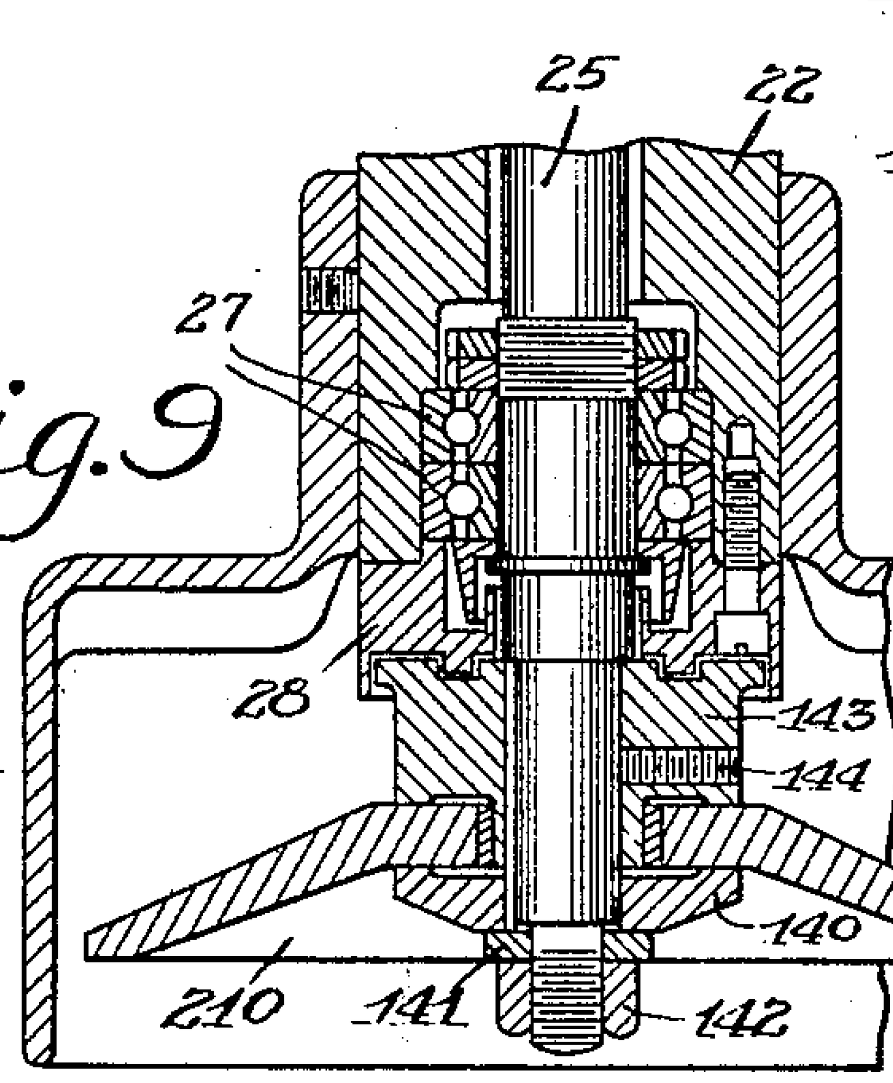
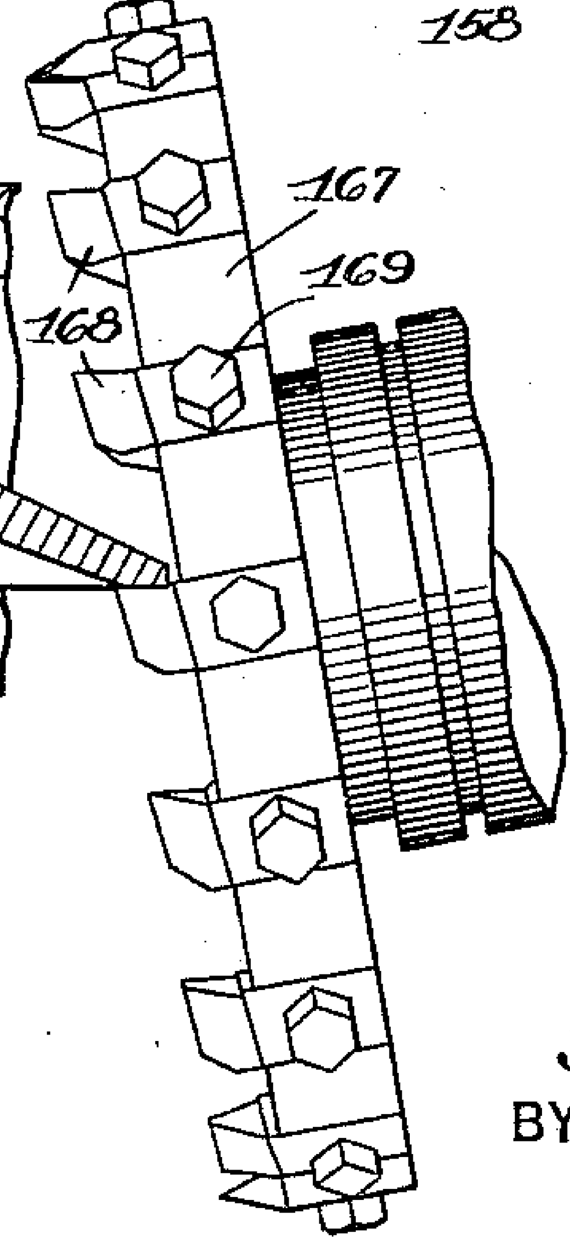


Fig. 9



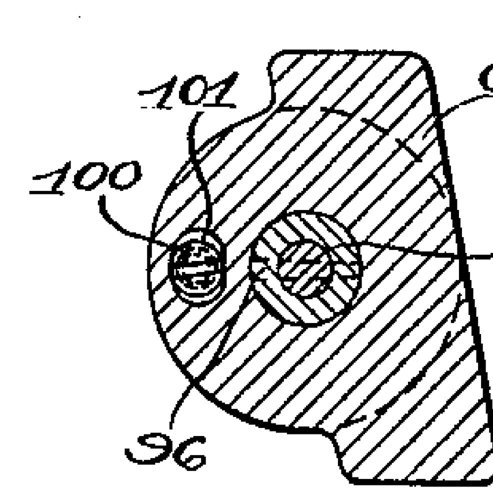


Fig. 8

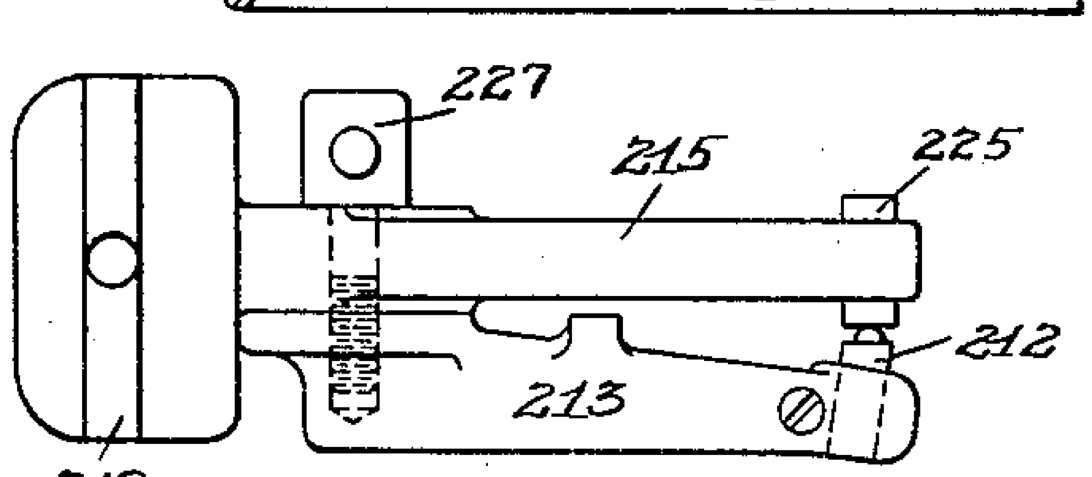


Fig. 7

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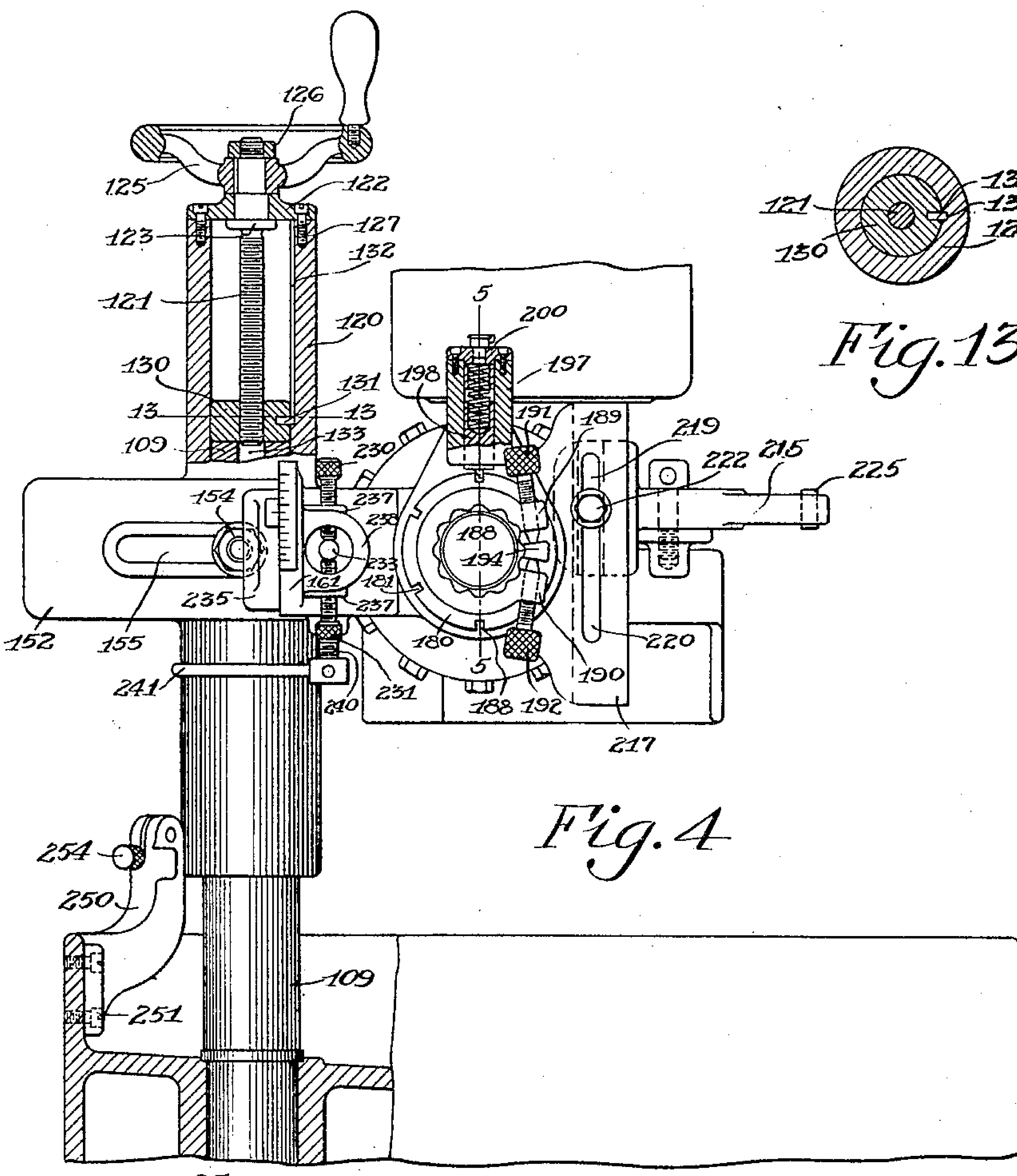

Fig. 4

Fig. 13

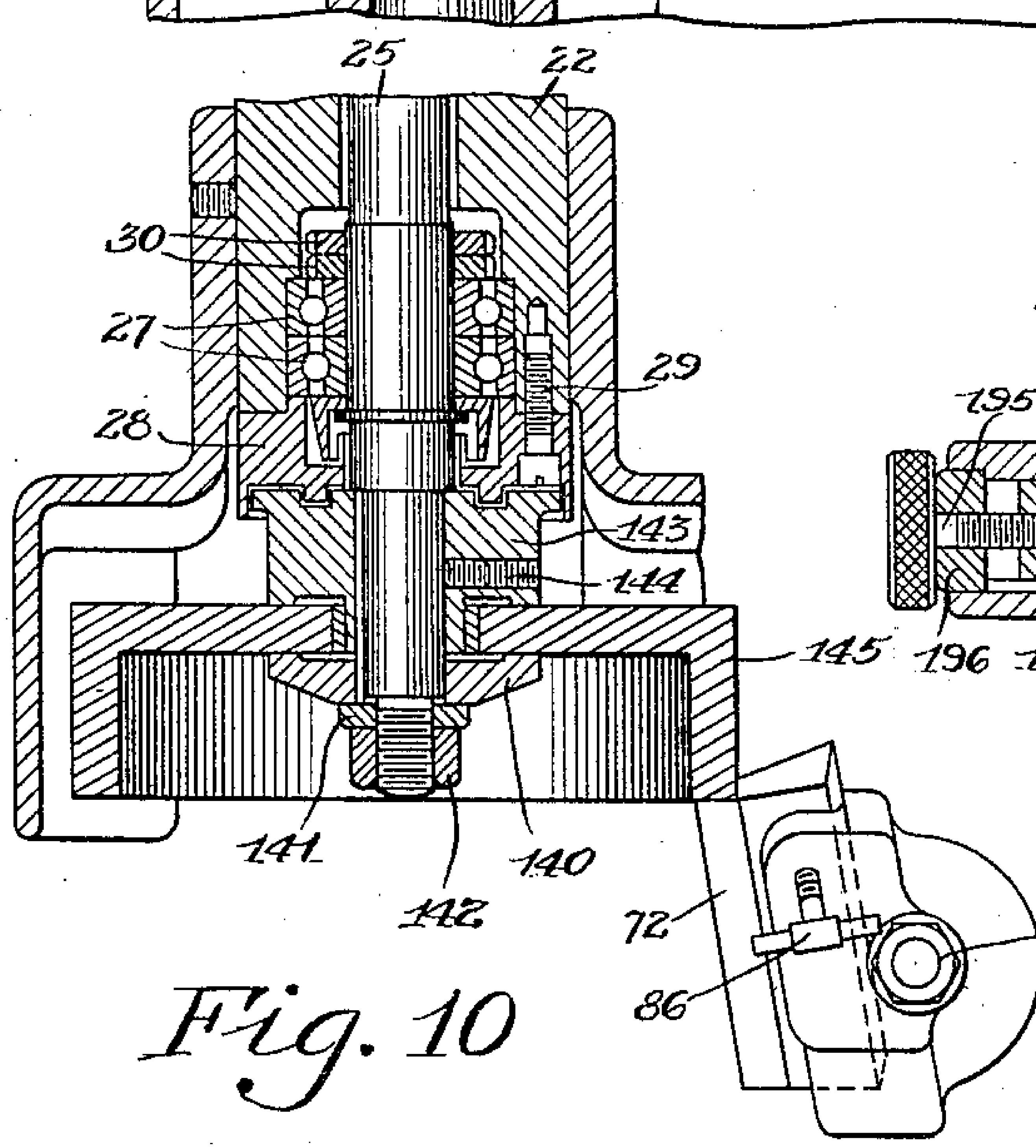

Fig. 10

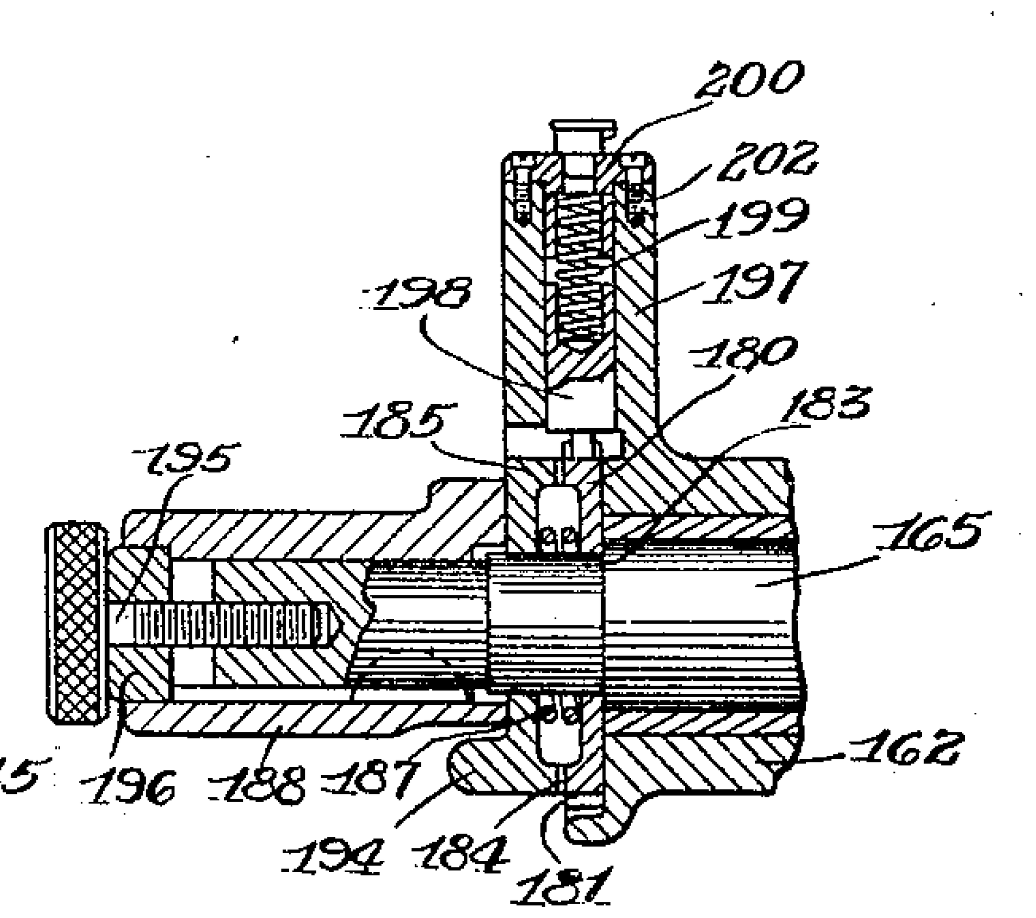

Fig. 5

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MACHINE FOR SHARPENING GEAR CUTTERS

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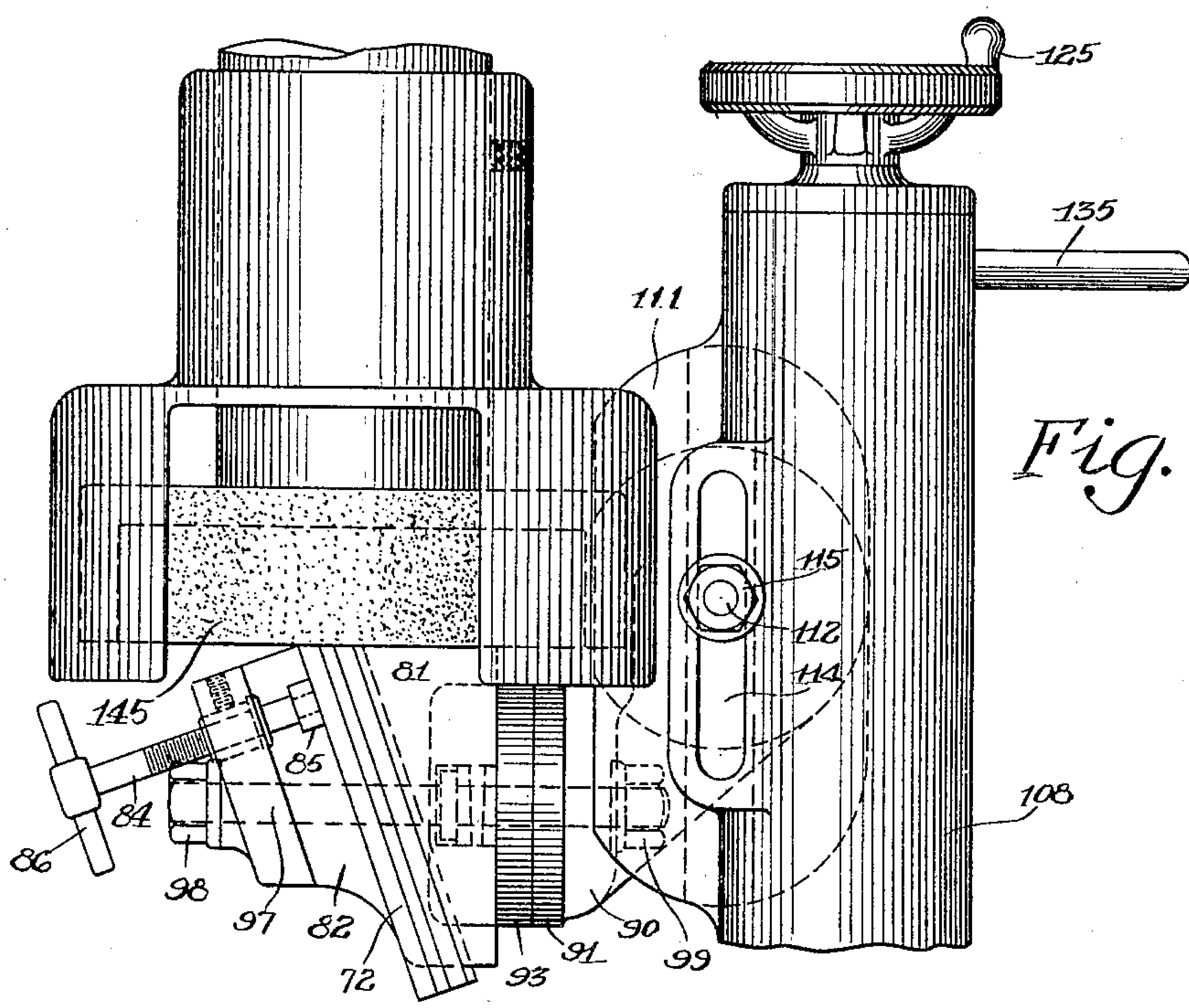

Fig. 11

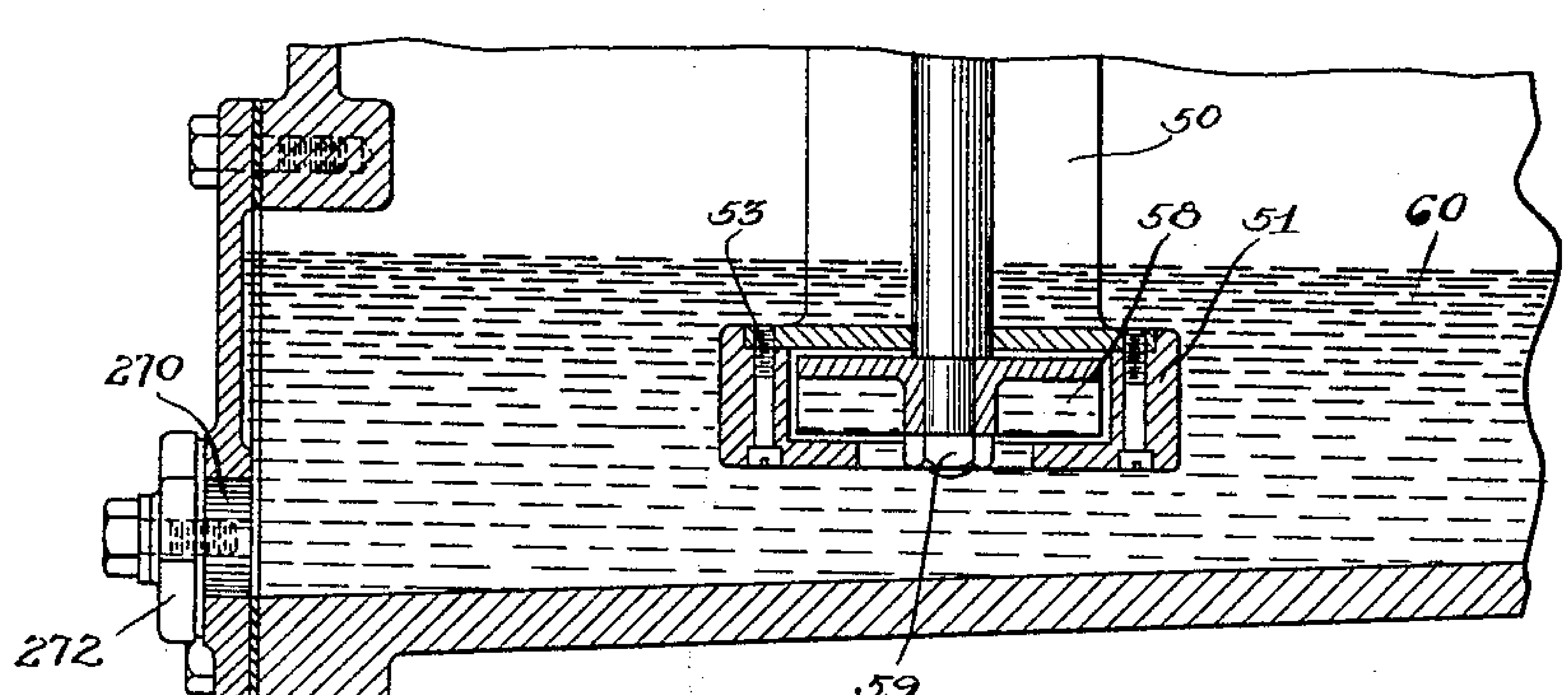

Fig. 12

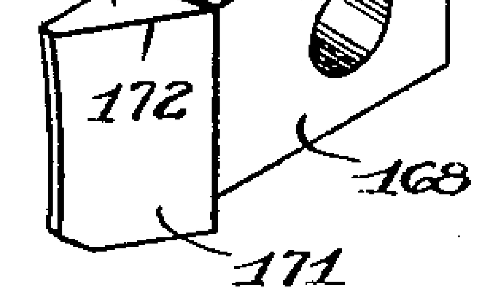

Fig. 14

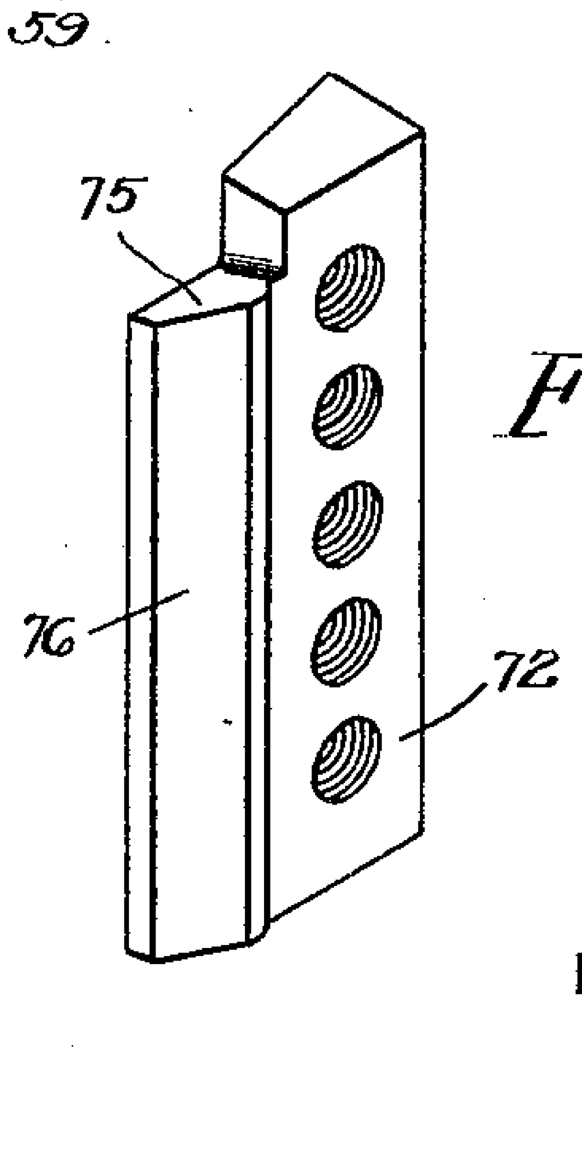

Fig. 15

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UNITED STATES PATENT OFFICE

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MACHINE FOR SHARPENING GEAR CUTTERS

Application filed December 18, 1930. Serial No. 503,212.

The present invention relates to machines for sharpening cutting tools and particularly to grinders for sharpening gear cutting tools.

The primary purpose of the present invention is to provide a practical, compact and relatively inexpensive machine for "wet" grinding gear cutters. This object of the invention is accomplished by providing a machine in which the movement of the cutting tool across the face of the grinding wheel for sharpening the tool is a hand operation and in which water or another suitable coolant is continuously and copiously supplied to the grinding wheel during the grinding operation. The present machine avoids all the objections to the old type of dry grinders as being unsanitary, dangerous and unhealthful while at the same time providing a machine which is essentially very simple and comparatively cheap.

The present invention has two different applications, one is the sharpening of reciprocatory tools such as are employed on straight and skew bevel generators and other straight tooth gear cutting machines and the other is the sharpening of face-mill gear cutters such as are used on machines for cutting longitudinally curved tooth gears like spiral bevel and hypoid gears. Heretofore separate machines have been required for sharpening these two separate types of tools. The present invention provides not only an improved form of machine for both jobs, as pointed out above, but it is within the contemplation of the present invention, also, to use one machine for sharpening both reciprocatory tools and face mill cutters. Thus a further feature of the present invention is the possible material saving which may be effected in the amount of equipment required in a gear cutting shop for sharpening the cutting tools.

In bevel gear generators and other gear cutting machines employing reciprocating cutting tools, there are ordinarily two tools used, one tool cutting one side tooth face of the gear blank and the other tool cutting the opposite side tooth face. Grinders built prior to this invention for grinding these tools were so constructed that separate grinding wheels were required to sharpen the two tools simultaneously. In the present machine both tools can be sharpened simultaneously with one wheel. Thus an added feature of the invention applicable to the sharpening of reciprocatory tools is the elimination of one grinding wheel and of the expensive mounting therefor.

The principal objects of the invention have already been referred to. Other objects of the invention will be apparent hereinafter from the specification and from the recital of the appended claims.

In the drawings:

Figure 1 is a part sectional and part side elevational view of a tool sharpener constructed according to the preferred embodiment of this invention and arranged for sharpening reciprocatory gear cutting tools;

Figure 2 is a plan view of this machine on a somewhat enlarged scale;

Figure 3 is a fragmentary plan view showing the machine arranged for sharpening a face mill gear cutter, parts of the cutter support being shown in section;

Figure 4 is a front elevational view of the cutter support shown in Figure 3, parts being shown in section;

Figure 5 is a section on the line 5—5 of Figure 4;

Figure 6 is a side elevational view showing details of the construction of the face mill cutter support shown in Figures 3 and 4;

Figure 7 is a detail view showing the method of gaging the height of the diamond dresser used in dressing the grinding wheel employed for sharpening the face mill cutters;

Figure 8 is a section on the line 8—8 of Figure 2;

Figure 9 is a fragmentary view on an enlarged scale illustrating the sharpening of a face mill cutter;

Figure 10 is a corresponding view illustrating the sharpening of a reciprocatory cutting tool;

Figure 11 is a view taken at right angles to Figure 10 and showing further details of the holder for the reciprocatory cutting tool;

Figure 12 is a fragmentary sectional view showing details of the reservoir for the coolant;

Figure 13 is a section on the line 13—13 of Figure 4; and

Figures 14 and 15 are perspective views of one blade of a face mill gear cutter and of a reciprocatory cutting tool, respectively, these being typical of the forms of tools to be ground on the sharpening machine of the present invention.

In a machine built according to the preferred embodiment of this invention, the grinding wheel is mounted upon a vertical spindle which is motor driven and continuously rotated during the operation of the machine. The cutting tools to be ground are secured to swingable supports which are mounted in the base of the machine and are operated by hand to move the cutting tools across the face of the grinding wheel for sharpening. Adjustments are provided to permit positioning the tools so as to grind their front faces correctly to various angles as is required. Three tool supports may be furnished with the machine, one for mounting a face mill gear cutter and two for mounting the upper and lower tools of a pair of reciprocatory gear cutting tools. The two reciprocatory tools may be ground simultaneously with the same wheel by swinging them simultaneously across the face of the wheel. A cup-shaped wheel is preferably employed when grinding the reciprocatory tools while a dished wheel is preferably used when sharpening face mill cutters. The support for the face mill cutters includes an indexing mechanism which permits indexing the cutter head around to allow of sharpening of all the blades of the cutter. A pump is provided with the machine and this pump is driven from the grinding wheel shaft to pump water or any other suitable coolant continuously from a reservoir in the base of the machine onto the grinding wheel during the operation of the machine.

Referring to the drawings by numerals of reference, 20 indicates the base or frame of the machine. The base is formed with an integral column or upright 21. The upright and base are hollow but are provided with reinforcing ribs at suitable points to give the requisite strength. A sleeve or bearing member 22 is secured in a vertical opening in the front portion of the column 21. This sleeve or bearing member 22 has a pressed fit in the opening in the column and is secured therein, also, by the shoulder 23. It is held against rotation in the opening by the set-screw 24.

The grinding wheel spindle 25 is journaled in anti-friction bearings 26 and 27 in the sleeve or bearing member 22. A labyrinth seal indicated at 28 is secured to the lower end of the sleeve 22 to protect the bearings 27 against entrance of grit or dirt therein. The seal 28 is secured to the bearing member 22 by screws 29 while the anti-friction bearings 27 are held in position against the seal by nuts 30. A nut 32 (Fig. 1) threaded on the upper end of the spindle 25 serves to hold the bearing 26 in position against a shoulder formed on the spindle.

There is a cap-member 33 (Fig. 1) secured to the upper end of the bearing member 22 and surrounding the spindle 25. Keyed to the spindle 25 above this cap-member is a pulley 34 and keyed to the spindle 25 above the pulley 34 is a second pulley 35.

The grinding wheel spindle 25 is driven continuously during the operation of the machine from a motor 40 which is housed in the base 20 of the machine. There is a pulley 41 connected to the armature shaft of the motor and this pulley 41 drives the pulley 35 through the belt 42. The drive from the pulley 41 to the pulley 35 is a right-angular drive, the belt 42 passing over idler pulleys 43. These idlers 43 are secured to a shaft 44 that is suitably journaled in the upright or column 21.

Secured within the column 21 is a bracket 50, to the lower end of which is secured a centrifugal pump 51 (Figs. 1 and 12). The upper end of the bracket 50 is secured to the upright 21 by bolts 52. The pump 51 is itself secured to the lower end of the bracket by screws 53. Journaled in anti-friction bearings 55 and 56 in the bracket 50 is the pump-shaft 57. The impeller or paddle 58 of the pump 51 is secured to the lower end of the shaft 57 by the nut 59. The pump is immersed in a reservoir 60 which is kept filled with water or any other suitable coolant above the level of the pump. The reservoir 60 is cast integral with the frame of the machine.

The pump-shaft 57 is driven continuously during the operation of the machine from the grinder spindle 25 through the pulley 32, the belt 62 and the pulley 63 which is keyed to the upper end of the pump shaft 67 and which is held thereon by the nut 65. The coolant is pumped from the reservoir 60 through the pipe 65 and branch pipes 66 to the grinding wheel to continuously force coolant on the wheel at opposite sides thereof. A valve 68 may be employed to control the rate of flow of the coolant.

There are three post openings 70 formed in the base of the machine. One of these openings is adapted to receive the post on which a spiral cutter is mounted when such a cutter is to be sharpened. The other two openings are adapted to receive the posts which carry the supports for the two reciprocatory tools when a pair of such tools are to be sharpened. When sharpening a pair of reciprocatory tools, the post which is adapted to carry the face mill cutter is removed from the machine and when a face mill cutter is to be sharpened, the posts which are adapted to carry the reciprocatory tools are removed from the machine. Suitable covers are provided to cover the several openings when not in use.

I shall first describe the sharpening of a pair of reciprocatory gear cutting tools and reference will be had, then, first of all to Figures 1, 2, 8, 10, 11 and 15. The pair of reciprocatory tools are ordinarily made alike except that one tool of the pair is sharpened on one end and the other tool of the pair on the other end. The sharpened end of each tool constitutes its front face. The cutting edge of the tool is formed by the acute angular junction of the front face of the tool with one of its side faces. This results from sharpening the tool with a front rake or shear angle.

One of a pair of reciprocatory gear cutting tools 72 is shown in Figure 15. The front face 75 of the tool intersects the side face 76 at an acute angle, the angle depending upon the front rake or shear angle of the tool. The sides of the tool are inclined to each other in accordance with the pressure angle of the tool. The tool is of uniform section throughout its length, the cutting clearance being obtained by inclining the tool to the line of cut. Depending upon the material in the gears to be cut, the tool may be ground with a hook or without a hook. A tool ground with a hook is a tool whose front face is inclined rearwardly from the tip of the tool to the base of the cutting portion thereof.

The two tool holders 80 and 81 provided with the present machine for holding a pair of reciprocatory cutting tools are similar in construction. Each tool holder is formed with a tool receiving socket 82. For cutting any usual material, there is a standard front rake angle indicated for reciprocatory gear cutting tools. As a matter of convenience, the tool holders provided with the present machine are made so that when the tools are in position they are held at an angle to the grinding wheel corresponding to the standard front rake or shear angle. Thus, the tool receiving sockets 82 formed in the holders 80 and 81 extend diagonally from top to bottom of the holders and the angle which the center line of each socket makes with a vertical line in the zero position of adjustment of the holder is determined by the standard shear angle.

Each of the cutting tools 72 of a pair is rigidly clamped in the sockets 82 of its respective tool holders 80 and 81 by the clamping screws 84 which thread in the holders 80 and 81 and which are provided at their inner ends with enlarged heads 85 that engage the body portions of the tools.

The clamping screws are manipulated by the handles 86.

Each of the tool holders 80 and 81 is mounted for angular adjustment upon an angle bracket 90 which is formed with two faces 91 and 92 that extend at right angles to one another. There is an angularly adjustable disc 93 mounted on each of the brackets 90 and interposed between the face 91 of the bracket and the opposed face of the associated tool holder 80 or 81, as the case may be.

Each of the tool holders 80 and 81 is mounted for angular adjustment relative to the associated disc 93. Thus, each disc 93 is formed with a cylindrical collar portion 95 that is pinned by a pin 96 against a shoulder 94 formed on a rod 97 which extends through aligned openings in the tool holder 80 or 81, the associated disc 93 and the associated bracket 90. The collar portion 95 of each disc 93 and the shoulder 94 of each rod 97 fit into a suitable socket formed in the associated tool holder 80 or 81. The rods 97 are threaded at both ends to receive the nuts 98 and 99.

When a nut 98 is loosened, the tool holder 80 or 81, as the case may be, can be adjusted angularly on the disc 93. When a nut 99 is loosened, a disc 93 can be adjusted angularly with reference to the associated bracket 90.

Both the adjustment of a tool holder on its associated disc 93 and of the disc 93 on its associated bracket 90 tilt the tool holder so as to change the inclination of the cutting face of the tool from its tip to its base with reference to the plane of grinding. The adjustment of the tool holder 80 or 81, as the case may be, on the associated disc 93, is a very limited adjustment. There is a pin 100 (Figs. 2 and 8) threaded into each disc 93 and the head of this pin engages in an arcuate slot 101 formed in the associated tool holder limiting the movement of the tool holder on the associated disc 93. When a tool of 14½° pressure angle is to be sharpened, the tool holder is adjusted to the limit of its adjustment in one direction on the disc 93. This serves to bring the tool into position such that the cutting edge ground upon it will be perpendicular to its line of cut when mounted on the gear cutting machine. When a 20° pressure angle tool is to be sharpened, the tool holder is adjusted in the opposite direction to the limit of its adjustment on the disc 93. The cutting edge of the 20° pressure angle tool will then be ground so that it will be perpendicular to the line of cut of the tool when cutting a gear blank. 14½° and 20° are the two most common pressure angles employed on bevel gear generating tools. Where tools of other pressure angles are to be sharpened, the tools can be adjusted into the correct position by adjusting tool holders and discs 93 together on the associated brackets 90. The adjoining peripheral surfaces of the discs and of the brackets are graduated to permit of accurately making the required adjustments. The separate adjustments of the tool holders with reference to the associated discs 93 and of the respective discs 93 with reference to the corresponding brackets 90 are provided simply as a matter of convenience for the complete adjustment might be made by simply adjusting each tool holder with its disc on the bracket 90.

The adjustment of the tool holders and discs 93 together on the associated brackets 90 is of sufficient latitude to allow positioning a tool of any pressure angle, also, so as to grind the tool with a hook.

Each of the brackets 90 is adjustable angularly on an associated disc 105. The discs 105 are in turn adjustable vertically on guide surfaces 107 which are cast integral with the sleeves 108 that fit on the respective posts 109. There is a tongue 106 formed on each disc 105 which engages in a groove 111 of the associated guide surface 107 to guide the disc 105 in its adjustment on that plate. Each bracket 90 is secured in any position of its angular adjustment on the associated disc 105 and each disc 105 is secured in any position of its vertical adjustment on the associated guide plate 107 by a screw member 112 which threads into the angle bracket 90 and passes through an opening in the associated disc 105 and through an elongated slot 114 in the associated sleeve 108, and which has a nut 115 threaded on its outer end.

The purpose of the angular adjustment of the bracket 90 on the disc 105 is to enable positioning the tool to be ground so as to grind other than a standard shear or rake angle on the tool as may be required to meet exceptional cutting conditions. The contiguous peripheral surfaces of the disc and bracket are graduated to allow this adjustment to be accurately made. The adjustment of a disc 105 on the associated guide surface 107 is to permit bringing the face of the cutting tool into the grinding plane after the other adjustments have been made.

To increase the range of vertical adjustment of the tool holders, the sleeves 108 are constructed, also, so that they are vertically adjustable on associated posts 109 which carry the complete tool supports. Each sleeve 108 is adjusted on its associated post 109 in exactly the same way as the sleeve 120 which carries the face mill cutter support is adjustable on its post 109 and reference may be had to Figures 4 and 13, in which the latter adjustment is shown, for an understanding of the manner in which each sleeve 108 is adjusted on its post 109.

There is a screw shaft 121 secured in a cap 122 that is secured to each of the sleeves 108 and 120 by screws 127. Each of the screw shafts 121 is provided with a shoulder 123 that fits against the lower face of the cap 122 and a handwheel 125 is keyed to the screw shaft 121 above the associated cap 122. The handwheel is secured on the screw shaft by a nut 126. The caps 122 are secured to their respective sleeves 108 and 120 by screws 127. Each of the screws 121 threads into a nut 130 that rests upon the upper face of the associated post 109 but is not secured to that post. Each of the nuts 130 carries a pin 131 that is adapted to travel in a groove 132 cut vertically in the inside wall of the sleeve 108 or 120 as the case may be. The pins 131 serve to hold the associated nuts 130 against rotation relative to the associated sleeves 108 or 120 so that when the associated handwheels 125 are rotated, the sleeves will be adjusted vertically on the associated posts 109. At the same time, inasmuch as the nuts 130 are not connected to the post 109, the sleeves 108 and 130 can be oscillated on their associated posts 109 without changing the position of vertical adjustment of the sleeves on the posts. Each of the posts 109 is bored as indicated at 133 so as to allow passage of the screw shaft 121 down into the post in the process of vertical adjustment of the sleeve on the post.

The posts 109 which carry the supports for the reciprocatory tools are mounted with a driven fit in the post openings 70 at either side of the central plane of the machine. There is a hand-grip or bar 135 secured in each of the sleeves 108 and the operator of the machine grasps these to swing the sleeves 108, and, with the sleeves, the associated tool holders about the axes of the post 109 to move the front faces of the cutting tools across the surface of the grinding wheel.

The grinding wheel is secured to the grinding wheel spindle 25 by a disc 140, a washer 141 and a nut 142. The nut 142 threads on to the lower end of the spindle 25 and the grinding wheel is clamped against a collar 143 which is formed at its rear face to constitute part of the labyrinth seal for the anti-friction bearings 27 and which is held against rotation with reference to the spindle 25 by a set-screw 144. In grinding reciprocatory tools, a cup-shaped grinding wheel is preferably employed. Such a wheel is shown at 145 in the drawings.

To grind a pair of reciprocatory tools, the two tools of the pair are secured in the sockets 82 of the respective tool holders 80 and 81, being clamped in place by the clamping screws 84. The tool holders are adjusted angularly on the associated discs 93 to one limit or the other of adjustment of the tool holders on the discs if 14½° or 20° pressure angle tools are to be sharpened. If the tools are of some other pressure angle or if it is desired to grind the tools with a hook, the discs 93 together with the tool holders will be adjusted angularly directly on the associated brackets 90. If the rake or shear angle of the tools is standard, no angular adjustment of the brackets 90 on the discs 105 is necessary. The inclination of the sockets 82 of the tool holders takes care of this adjustment. If any other than a standard rake angle is desired, then the brackets 90 will be adjusted on the discs 105. When the required setting adjustments have been made, the discs 105 are adjusted on the guide plates 107 and the sleeves 108 on the posts 109, to bring the front faces of the tools into the grinding plane, that is, into the plane of the tip surface of the cup-shaped wheels 145.

When the various adjustments have been made and the wheel 145 has been secured to the grinding spindle 25, the operator starts the machine. This causes the grinding wheel spindle to be rotated from the motor 40 through the pulleys 41, 43 and 35 and the belt 42. Coolant is pumped onto the wheel from the pump 51 which is driven from the grinding wheel spindle through the pulleys 34 and 63 and the belt 62. The operator stands in front of the machine and grasps the two handles 135 and he rocks these handles toward and away from each other, thus moving the front faces of the tools across the tip surface of the rotating grinding wheel, thus grinding back these surfaces to sharpen the tools. The tools are advanced into the wheels to grind off the desired amount of stock by rotating the handwheels 125 to adjust the sleeves 108 vertically on the post 109. Mention is again made of the fact that the rocking of the tools across the face of the grinding wheel does not affect the adjustment of the sleeves 108 on the post 109 for the nuts 130 simply fit on top of the post and are not secured thereto.

I shall now describe the support which is provided for mounting face-mill gear cutters so as to sharpen such cutters on a machine constructed according to this invention. The hole 70 in which the post 109 that carries the face mill support is inserted is considerably to one side of the central plane of the machine. The sleeve 120 which carries the face mill cutter support is adjustable on the associated post 109 through rotation of the handwheel 125 as already described. This sleeve 120 is formed at one side with a flat guide surface 150 (Figs. 3 and 6). An angular bracket 152 is mounted on the sleeve 120 for linear adjustment on the guide surface 150. The angular bracket 152 is secured in any position of its adjustment on the plate 150 by a bolt 154 which engages in the plate 150 and passes through an elongated slot 155 formed in the bracket 152. The plate 150 is formed with a tongue 156 which engages in a correspondingly shaped groove in the bracket 152 to guide the bracket in its adjustment on the plate.

The bracket 152 is formed with an arm 158 (Figs. 3, 4 and 6) that is formed to provide a sleeve or bearing portion 160. The arm portion 158 of the bracket is formed, also, with a plate 161 which projects beyond the sleeve or bearing portion 160 of the bracket.

The cutter carrier 162 is mounted for rotatable adjustment in the bearing portion 160 of the bracket 152, the carrier 162 being provided for this purpose with a stem portion 163 which is journaled in the sleeve or bearing portion 160. The cutter spindle 165 is rotatably mounted in a bushing 166 in the cutter carrier 162. The face mill cutter to be ground is secured to the spindle 165 by any suitable means.

The smaller sizes of face mill cutters have the cutting blades formed integral with the cutter heads but the larger sizes of cutters are of the inserted blade type, the blades being removable and being secured in slots in the periphery of the cutter heads. One of the larger sizes of face mill gear cutters is shown in the drawings. This cutter comprises the cutter head 167 and the removable cutting blades 168 which are secured to the cutter head by screws 169. The blades 168 of the cutter are relieved both on their sides and tips from front to rear to provide the cutting clearance. Each of the cutting blades may be made so that it cuts on two sides but the present standard practise is to make the cutters so that alternate blades cut opposite sides of the gear teeth. This means that the thickness of each blade is slightly less than the thickness of the tooth slots to be cut and that alternate blades are provided with a front rake or shear angle extending in opposite directions, one blade being given a front rake to provide a cutting edge at one side and the next blade having a front rake which provides a cutting edge at the opposite side. One of the blades is shown in Figure 14. Here the front face 170 of the blade is inclined to the side face 171 at an acute angle to provide a side cutting edge indicated at 172. The blades may or may not be provided with a hook depending upon the material in the gears to be cut.

In the drawings, the cutter to be ground is shown secured to the spindle 165 by a ring member 175 which has its periphery tapered to correspond to the taper of the bore of the cutter head 167. This ring member 175 fits over the nose of the spindle 165 and is secured to the spindle by adjusting screws 176.

180 designates a notched index plate, the number of notches 181 (Figs. 3, 4 and 5) in this plate is equal to the number of the blades in the cutter head if all of the blades have two cutting edges or if all of the blades have cutting edges on the same side. The number of notches 181 in the index plate is equal to half the number of blades in the cutter head if alternate blades of the cutter head have opposite side cutting edges. Several index plates are furnished with the machine to permit grinding of the different cutters which are within the capacity of the machine.

The index plate being used is pressed on to the spindle 165 against the shoulder 183 thereof. The index plate 180 has clutch teeth 184 on its rear face. There is a sleeve 185 mounted on the spindle 165 behind the index plate 180. This sleeve is formed with clutch teeth on its front face which are adapted to engage the clutch teeth 184 of the index plate 180. The sleeve 185 is slidable on the spindle 165 to engage or disengage the clutch teeth of the sleeve and the index plate. There is a spring 187 which surrounds the spindle 165 and which is interposed between the sleeve 185 and the index plate 180 and which tends to move the sleeve away from the index plate to disengage the clutch teeth.

Keyed to the spindle 165 behind the sleeve 185 is an adjusting collar 188. The collar 188 is formed with ears 189 and 190 (Fig. 4) into which thread the adjusting screws 191 and 192. These screws engage opposite side faces of the lug 194 formed on the sleeve 185. The adjusting collar 188 is adjustable axially on the spindle 165 by means of a screw 195 which is mounted in the guide 196 that is pressed into the collar 188 and which threads into the end of the spindle 165.

The carrier 162 is formed with a projection 197 that is bored to house the index locking plunger 198. The tip of this plunger is formed so as to engage in the notches 181 of the index plate 180 to lock the index plate against movement relative to the carrier 162 in one direction but to allow the index plate to be ratcheted around in the opposite direction. The locking plunger 198 is constantly urged into locking position by the coil spring 199 which is interposed between the plunger 198 and the cap 200 which closes the outside end of the bore of the projection 197. This cap is secured in position by screws 202.

When the screw 195 is threaded up, the collar 188 will force the sleeve 185 forward against the resistance of the spring 187 to engage the clutch teeth of the sleeve 185 with the clutch teeth 184 of the index plate 180. Thus the index plate 180 will be secured to the sleeve 185. The sleeve 185 is secured against rotation relative to the collar 188 by the screws 191 and 192 when these screws are adjusted into engagement with the ear or lug 194 of the sleeve 185. When the locking plunger 198 is engaged with one of the notches 181 of the index plate 180, the index plate will be secured to the cutter carrier 162 and since the index plate is secured by the clutch to the sleeve 185 and by the collar 188 to the spindle 165, the spindle 165 will be locked in one direction against rotation relative to the carrier 162. Thus the face mill cutter which is secured to the spindle 165 will be held against rotation in one direction with one of its blades in position to be sharpened.

When one of the blades of the cutter has been sharpened the cutter spindle is indexed to bring another blade into grinding position. This is done simply by rotating the collar 188 in one direction to cause the locking plunger 198 to ratchet out of the notch 181 of the index plate with which it has previously been engaged and drop into the next notch of the plate.

The grinding wheel which is used for grinding face mill cutters is of dished shape. This type of wheel is used in order to clear the cutter head. The same type of wheel might be used for grinding the reciprocatory tools but it is preferred to use a cupped wheel for this latter purpose because such a wheel does not change in diameter as it is dressed. The dished wheel 210 is secured to the grinding wheel spindle 25 in the same manner as the cup shaped wheel, namely, by the nut 142, washer 141 and clamping disc 140.

The cup shaped wheel can be dressed with a hand dresser of any suitable type. For dressing the dished wheel, there is a dressing device secured to the face-mill cutter carrier 162. This latter dressing device functions not only to keep the wheel 210 in shape but also as a gauge to enable the cutter to be adjusted accurately into the two positions which it occupies, respectively, when the outside cutting blades and the inside cutting blades are being sharpened.

The dressing device for the dished wheel comprises a diamond that is mounted in a suitable holder 212 (Figs. 3 and 7). The holder 212 is clamped in an arm 213 by a screw 214, the arm being formed at its outer end as a split-clamp. The arm 213 is mounted for swinging adjustment on a bracket 215. The bracket 215 is double-armed. One arm is adjustably secured to a plate 217 that is formed integral with the carrier 162 at one side thereof. This arm of the bracket 215 is formed with a foot portion 218 that is provided with a tongue 219 that engages in a correspondingly shaped elongated groove in the plate portion 217 of the carrier. The plate portion 217 of the carrier is formed with an elongated slot 220 that communicates with the groove in which the tongue 219 fits. The bracket 215 is secured to the plate 217 by a bolt 222 which passes through the slot 220 of the plate member and threads into the bracket. A set-screw 223 is provided to lock the bolt 222 against rotation once the adjustment of the bracket 215 on the plate portion 217 has been made. The adjoining surfaces of the bracket and the plate portion 217 are graduated to permit this adjustment to be accurately made.

There is a plug-gauge 225 secured in the outer end of the other arm of the bracket 215. This serves for setting the diamond holder 212 in the arm 213 for height.

The arm 213 is secured to the bracket 215 by the clamping screw 227. When the wheel is to be dressed, the arm 213 is swung into the position shown in Figure 3 and clamped there by the screw 227. When the diamond is to be gauged, the arm 213 is swung inwardly to bring the diamond into contact with the plug-gauge 225. During actual grinding, the arm 213 is clamped in inoperative position shown in Figure 7 by the screw 227.

In setting up the machine to grind a face mill cutter, the posts 109 which carry the reciprocatory tool holders are removed from their holes 70 and the post 109 which carries the face mill cutter holder is inserted in its hole 70. The angle bracket 152 is then adjusted on the plate 150 in accordance with the diameter of the cutter to be sharpened. The bracket 152 is suitably graduated as shown in Figure 3 to enable this adjustment to be accurately made. When the adjustment has been made, the angle bracket is secured in adjusted position by tightening up the bolt 154. The cutter carrier 162 is then adjusted angularly in the bearing portion 160 of the angle bracket 152 to tilt the cutter so that the blades will be ground with their cutting edges perpendicular to the plane of cut or with a hook as may be desired. This adjustment is made by adjusting the set-screws 230 and 231 (Figs. 4 and 6) which engage with the stud 233 (Figs. 3, 4 and 6) that is threaded into the stem portion 163 of the cutter carrier. To enable this adjustment to be made accurately, there is an arm 235 pinned to the stem portion 163 of the cutter carrier and this arm is provided on its periphery with an index mark which reads against peripheral graduations on the arm 161 which extends from the angle bracket 152. The screws 230 and 231 thread into lugs or ears 237 formed in opposite sides of a circular projection 238 formed on the bearing portion 160 of the bracket 152. The stud 233 extends centrally into the opening in the bearing portion 160 formed by the circular projection 238. The carrier 162 is clamped in any position of its angular adjustment by the clamping screw 240 (Figs. 4 and 6) which is manipulated by the lever 241. The head of the screw engages against the periphery of the stem portion 160 of the carrier 162.

The diamond carrying bracket 215 is now adjusted on the plate portion 217 of the carrier 162 depending upon whether the outside or inside cutting blades of the cutter are to be sharpened first. The contiguous surfaces of the plate portion 217 and of the foot portion 218 of the bracket 216 are graduated to enable the adjustment to be made accurately. The arm 213 is then swung to carry a diamond holder over the gauge-block 225 and the diamond holder 212 is adjusted in the arm 213 until the diamond engages this block. The diamond holder is then swung into dressing position, corresponding to that shown in Figure 3, and the arm 213 clamped in this position by the screw 227.

The grinding wheel 210 is now started up and the handwheel 125 rotated to adjust the sleeve 120 on the post 109 until when the cutter carrier is swung about the axis of the post, the diamond will dress the grinding wheel. The diamond is fed into the wheel by continuing to rotate the handwheel 125 until the wheel has been dressed satisfactorily. The arm 213 is now swung out of the way and clamped in inoperative position shown in Figure 7 by the screw 237. The knurled screw 195 is now loosened up to allow disengagement of the clutch carried by the sleeve 185 from the clutch carried by the index plate 180 and the spindle 165 is rotated by turning the collar 188 until one of the outside or one of the inside blades of the cutter, depending upon the previous setting of the diamond, is as close as possible to the working surface of the grinding wheel. The clutches are then retightened. If the cutting edge of the blank is slightly away from the grinding wheel after the clutches have been retightened it can be brought against the wheel by adjusting the feed screws 191 and 192.

There is a bracket 250 (Figs. 3 and 4) secured to the base or frame of the machine by screws 251. This bracket is formed with an arm, the outer end of which is split to provide a split clamp that is closed by a screw 252. There is a stop screw 254 threaded into the arm of the bracket and it is clamped in any adjusted position by tightening up on the screw 252. The stop screw 254 is adapted to engage a lug 255 formed on the sleeve 120 when the cutter carrier is swung in one direction about the axis of the post 109 to limit the inward movement of the cutter.

The screw 254 is adjusted to allow the cutter carrier to swing in just far enough for the grinding wheel to grind to the bottom of the cutting portion of the blades of the cutter but not to grind into the cutter head. The head of the screw 254 will allow the cutter to be swung far enough away to clear the wheel.

Now with the grinding wheel rotating and the coolant being pumped on to the wheel, the cutter carrier is swung about the axis of the post 109 to grind the face of one of the blades of the cutter. The correct amount of stock can be taken off of the blades by adjustment of the feed screws 191 and 192. After one of the blades has been ground, the cutter spindle is indexed by grasping the collar 188 and turning the collar in such direction as to cause the locking plunger 197 to ratchet out of one of the notches of the index plate 180 and drop into the next notch. The next similar blade of the cutter is then ground by swinging the cutter carrier into the grinding wheel as before. This swinging movement is a manual operation and the operator may grasp any convenient part of the cutter carrier in order to swing it as, for instance, the collar 188.

When all of the outside blades of the cutter have been ground, for instance, the carrier 162 is adjusted in the bearing portion 160 of the angle bracket 152 to adjust the cutter angularly to grind the opposite angle of rake on the front faces of the inside cutting blades. This adjustment is effected by loosening up on the screw 240 (Figs. 4 and 6) and adjusting the screws 230 and 231, the amount of adjustment being determined by reading the graduations on the periphery of the arm 161. The bracket 215 which carries the diamond is then adjusted on the plate portion 217 of the cutter carrier 162 to set the diamond for the inside blade. The diamond is checked against the gauge 225, as before and then swung into dressing position and locked there by the screw 227. The handwheel 125 is rotated to bring the diamond into dressing engagement with the grinding wheel and the grinding wheel is dressed. The diamond carrying arm 213 is then swung out of the way and locked in inoperative position by the screw 227. The clutch is opened and the cutter spindle 165 rotated to bring one of the inside blades of the cutter as close as possible to the grinding wheel. The clutch is then locked up again and the blades brought into engagement with the grinding wheel by adjusting the screws 191 and 192. The inside blades are ground, indexing between blades, as before.

The drawings illustrate the grinding of one hand of cutter. To grind a cutter of the opposite hand, the grinding wheel is inverted on the grinding wheel spindle 25, the diamond carrying arm 213 is inverted on the bracket 215 so that the diamond is gauged against the opposite end of their plug-gauge 225 and the index locking plunger 198 is turned around in the bore of the extension 197 so that when the cutter spindle is turned in the correct direction, the locking dog will ratchet out of the notches 181 of the index plate 180. The locking pawl 198 can be turned around in the housing 197 when the cap 200 has been removed.

During the grinding operation on either reciprocatory or face mill cutters, the coolant is constantly supplied to the grinding wheel. It drops off the wheel into a trough formed in the base of the machine (see Fig. 1) and flows into a well 262 formed into the base of the machine through an opening 260 in the removable cover plate 261 of the well. The well 262 is connected with the reservoir 60 through an opening 263 in a sheet-metal partition 264 that is held in position between the well and the reservoir by a spring-clip 265. To keep the scum on the coolant in the well from getting into the coolant in the reservoir, there is a guard 267 secured to the partition 264 in such spaced relation to the partition as to provide a duct leading from below the normal level of water or other coolant in the well into the opening 263 in the partition. Thus the water that flows from the well 262 back into the reservoir is taken from below the level of the scum on the water in the well.

The reservoir 60 is provided with an inclined bottom shown in Figures 1 and 12 and can be drained through the duct 270 which leads to one side of the base 20 of the machine. The duct 270 is closed by a swinging gate member 272 that pivots on a bolt 273 which is threaded into the base of the machine and is provided with a hooked portion 274 that is engaged by the head of the bolt 275 which also threads into the side of the machine. To drain the reservoir 60, the gate is swung upwardly about its pivot bolt 273. To clean the well out, the gate is entirely removed by removing the bolt 273.

From the preceding description it will be seen that a compact machine has been provided which enables either reciprocatory tools or face mill gear cutters to be wet-ground. While particular embodiments of the invention have been described, it will be understood that various modifications of the invention are possible and that this application is intended to cover any adaptations, uses, or embodiments of the present invention following, in general, the principles of the invention and including such departures from the present disclosure as come within known or customary practise in the gear art and as may be applied to the essential features hereinbefore set forth and as fall within the scope of the invention or the limits of the appended claims.

Having thus described my invention, what I claim is:

1. In combination, a frame provided with a plurality of sockets, a grinding wheel spindle journaled in the frame, a plurality of tool holders constructed to hold, respectively, different types of tools, each of said tool holders comprising a post adapted to be mounted removably in one of the sockets in the frame to extend in parallelism with the grinding wheel spindle, a sleeve mounted on the post for manual oscillation about an axis parallel to the axis of the wheel spindle and adjustable thereon in the direction of its axis of oscillation, and a tool support adjustable angularly on the sleeve.

2. In a machine for sharpening gear cutting tools, a frame, a rotatable grinding wheel spindle journaled in the frame, a grinding wheel removably secured thereto, a post mounted in the frame and extending in parallelism with the grinding wheel spindle, a sleeve mounted on the post, a nut mounted on the post, and having a splined connection with said sleeve to rotate with said sleeve and to be movable axially independently of said sleeve, a screw carried by the sleeve adapted

to thread into said nut for adjusting the sleeve axially on the post, and a tool holder carried by the sleeve and adjustable thereon to permit adjusting the tool carried thereby in accordance with the shear angle and inclination of the cutting edge of the tool to be ground, means for rotating the grinding wheel spindle, and means for continuously supplying a coolant to the grinding wheel during rotation thereof.

3. In a machine for sharpening gear cutting tools comprising a frame, a rotatable grinding wheel spindle journaled in the frame with its axis vertical, a grinding wheel removably secured to said spindle, a post secured in the frame and extending in parallelism to the grinding wheel spindle, a sleeve oscillatably mounted on the post, means for adjusting the sleeve vertically on the post, a bracket angularly adjustable on the sleeve, a tool holder adjustable angularly on the bracket about an axis extending at right angles to the axis about which the bracket is adjustable, said sleeve being oscillatable on the post to move the tool across the face of the wheel to sharpen the same, means for rotating the grinding wheel spindle and means driven thereby for continuously supplying a coolant to the grinding wheel during rotation thereof.

4. A machine for sharpening gear cutting tools comprising a frame, a grinding wheel spindle journaled in the frame with its axis vertical, a vertical post secured to the frame, a sleeve mounted on the post for adjustment in a direction parallel to the axis of the wheel spindle, said sleeve being also oscillatable on said post about a vertical axis independently of its adjustment, and a tool support mounted on said sleeve for angular adjustment thereon in two directions at right angles to one another.

5. A machine for sharpening gear cutting tools comprising a frame, a grinding wheel spindle journaled in said frame with its axis vertical, a vertical post secured to the frame, a sleeve mounted on the post for adjustment in a direction parallel to the axis of the wheel spindle, said sleeve being also oscillatable on said post about a vertical axis independently of its adjustment, a tool support mounted on said sleeve for angular adjustment thereon in two directions at right angles to one another, a cutter spindle rotatably mounted in said tool support, and means for indexing said cutter spindle.

6. In a machine for sharpening gear cutting tools, a frame, a rotatable grinding wheel spindle journaled in the frame with its axis vertical, a grinding wheel removably secured thereto, a vertical post mounted in the frame, a sleeve mounted on the post, a nut resting on the top of said post and having a splined connection with said sleeve to rotate with said sleeve and to be movable axially independently of the sleeve, a screw carried by the sleeve adapted to thread into said nut for adjusting the sleeve axially on the post and a tool holder carried by the sleeve, said sleeve being oscillatable to move a tool carried by said tool-holder across the grinding wheel.

7. A machine for sharpening gear cutting tools comprising a frame, a rotatable grinding wheel spindle journaled in the frame with its axis vertical, a grinding wheel removably secured to this spindle, means for rotating the grinding wheel spindle, a post secured in the frame and extending in parallelism to the grinding wheel spindle, a sleeve mounted on the frame for manual oscillation about an axis parallel to the axis of the cutter spindle, means for adjusting the sleeve vertically on the post, a bracket mounted on the sleeve for angular adjustment thereon about an axis at right angles to the axis of oscillation of the sleeve, and a tool holder adjustable angularly on the bracket about an axis extending at right angles to the axis about which the bracket is adjustable.

8. A machine for sharpening gear cutting tools comprising a frame, a rotatable grinding wheel spindle journaled in the frame with its axis vertical, a grinding wheel removably secured thereto, a vertical post mounted in the frame, a sleeve mounted on the post, a nut resting on the top of said post and having a splined connection with said sleeve to rotate with said sleeve and to be movable axially independently of the sleeve, a screw carried by the sleeve adapted to thread into said nut for adjusting the sleeve axially on the post and a tool holder carried by the sleeve and adjustable thereon about an axis at right angles to the axis of the sleeve, said sleeve being oscillatable to move a tool carried by said tool holder across the grinding wheel.

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