Sept. 16, 1958 J. A. ANANIA 2,851,832

GRINDING MACHINES FOR CUTTER TOOLS

Filed Feb. 7, 1955 7 Sheets-Sheet 1

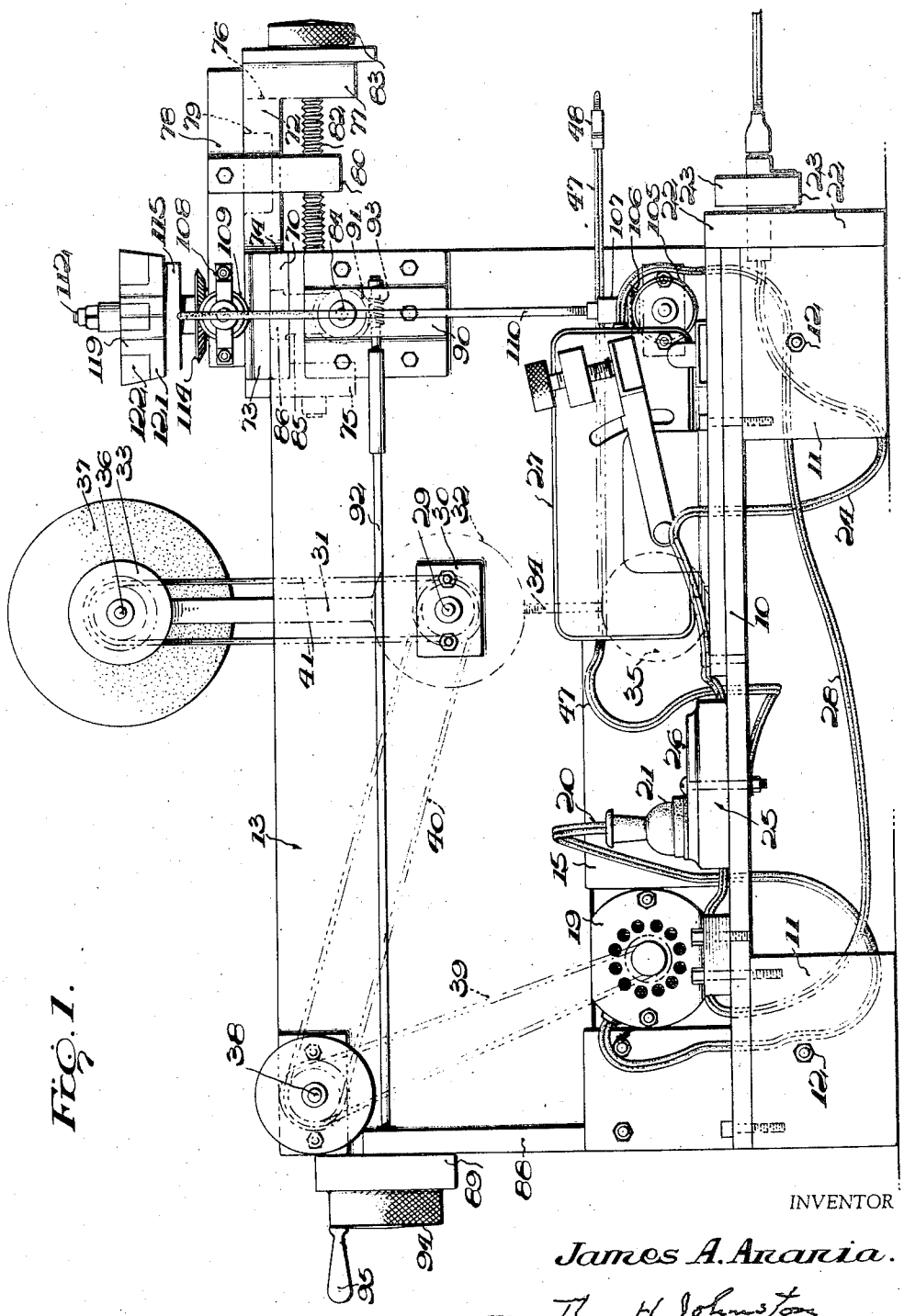


FIG. 1.

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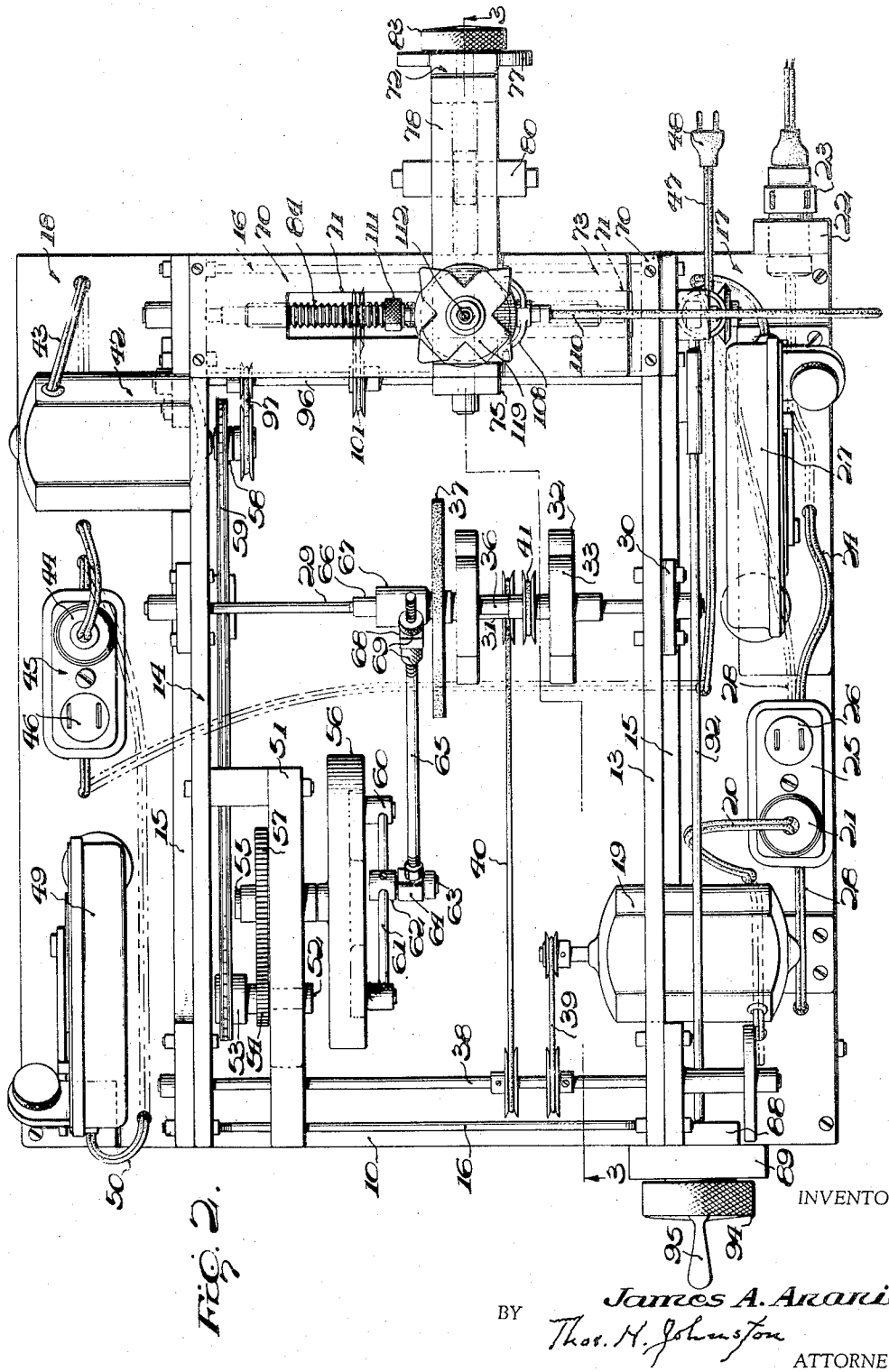


Fig. 2.

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GRINDING MACHINES FOR CUTTER TOOLS

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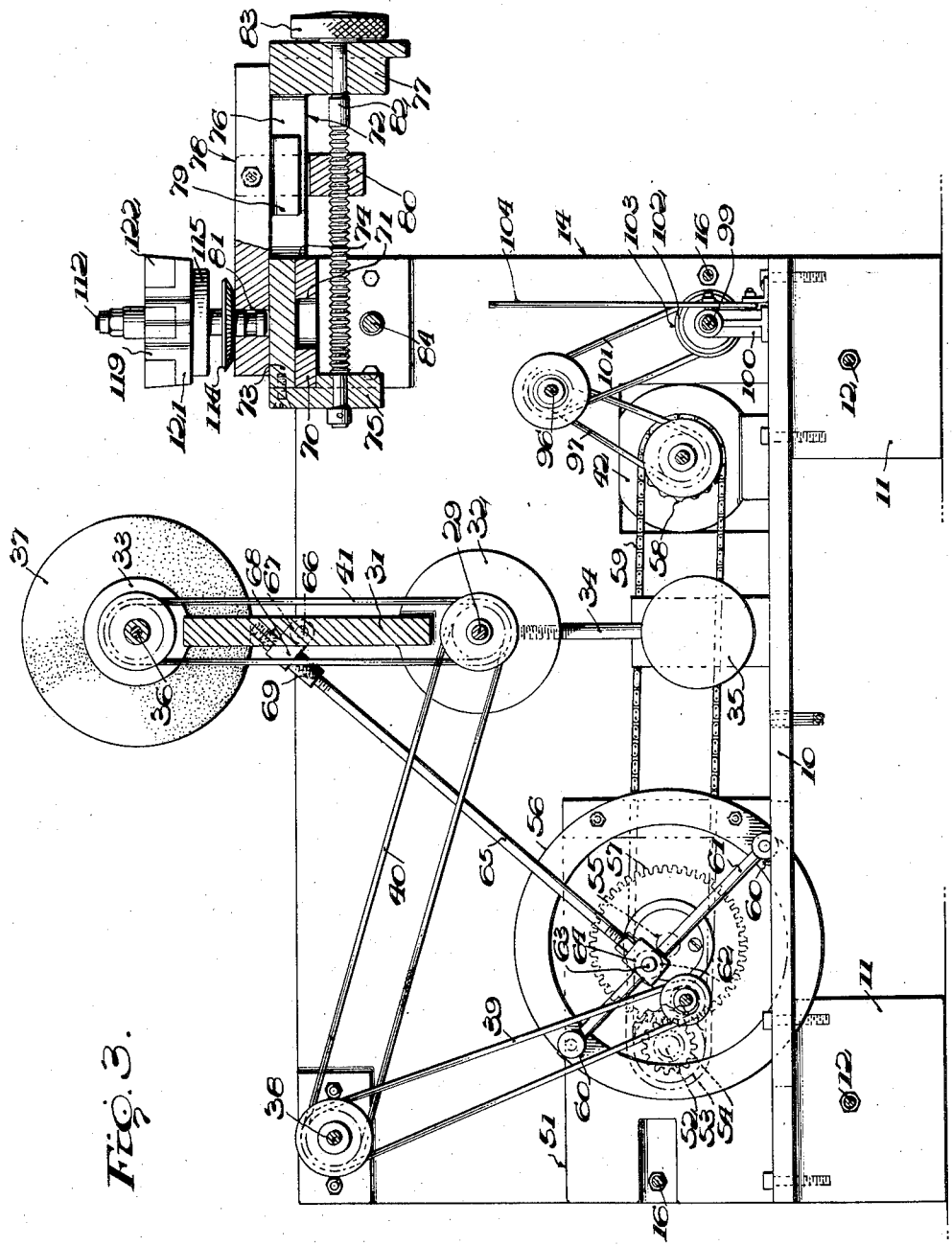


Fig. 3.

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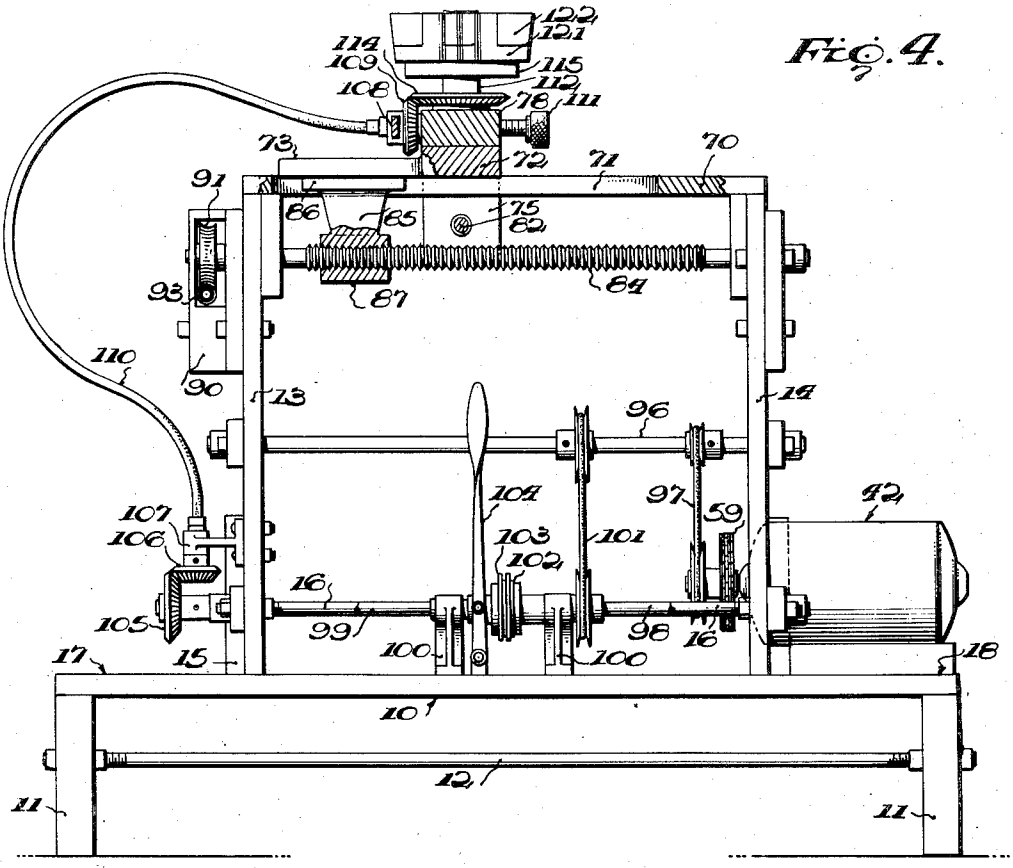
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GRINDING MACHINES FOR CUTTER TOOLS

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Fig. 4.



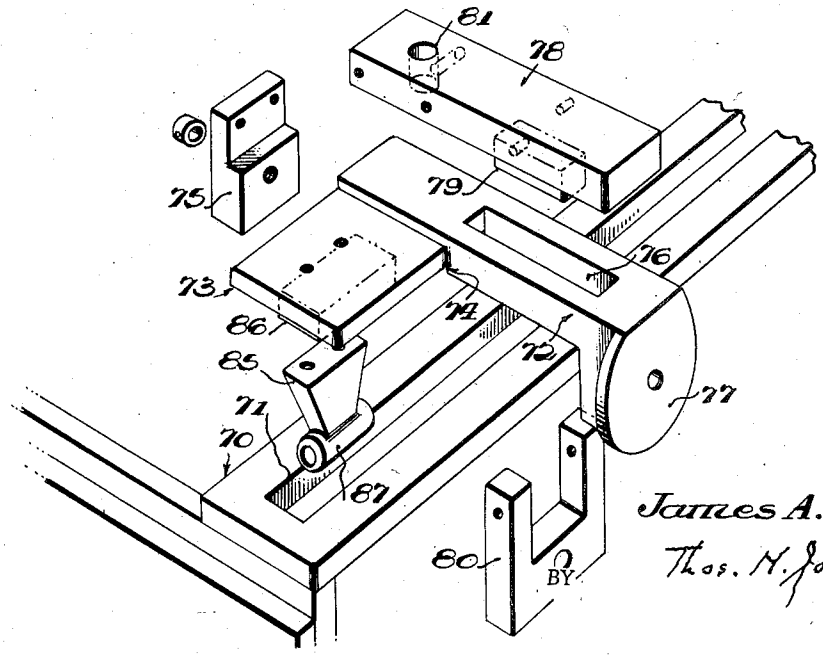


Fig. 5.

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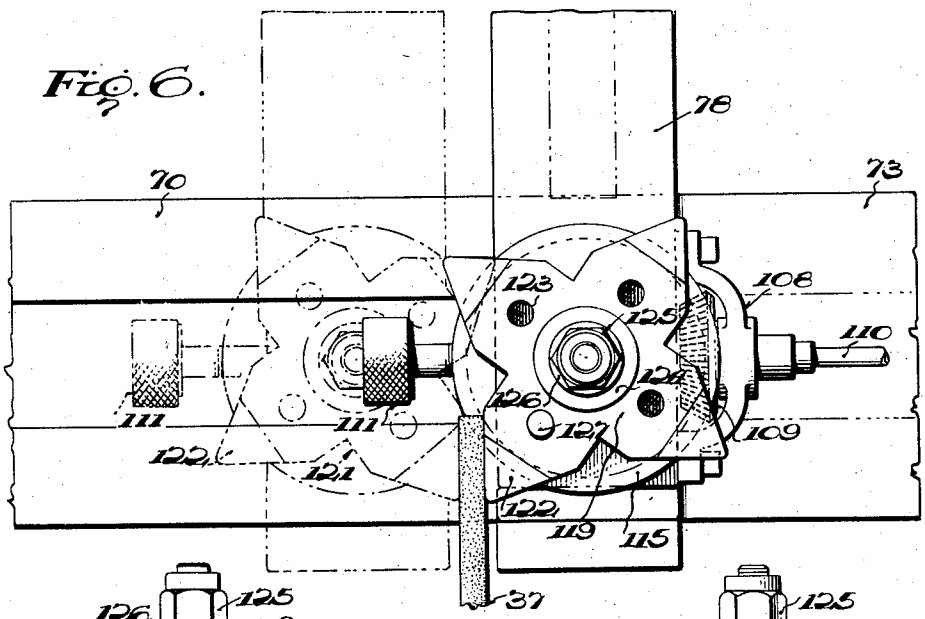
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Fig. 6.



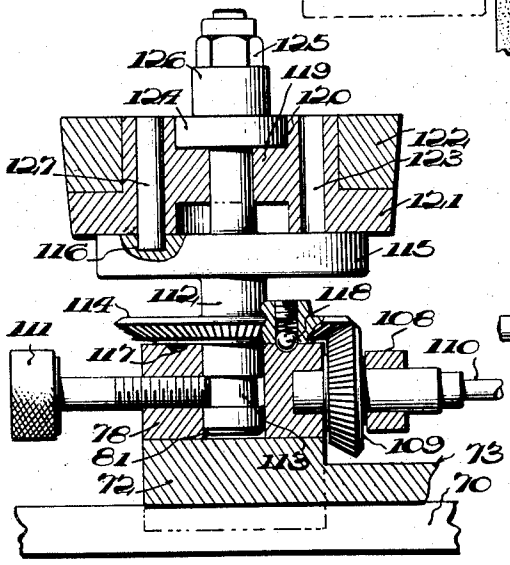


Fig. 7.

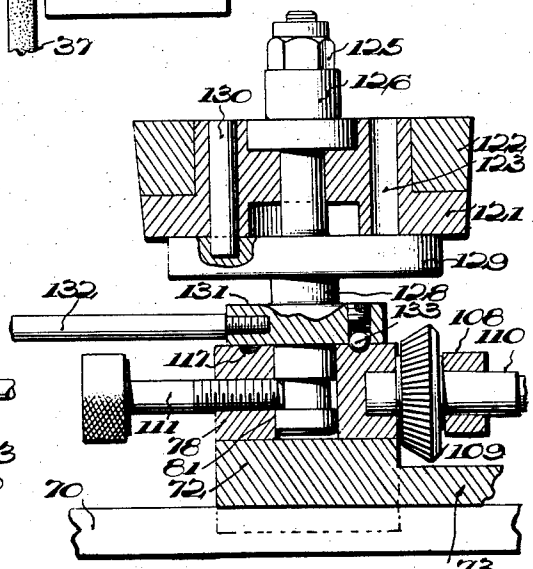


Fig. 8.

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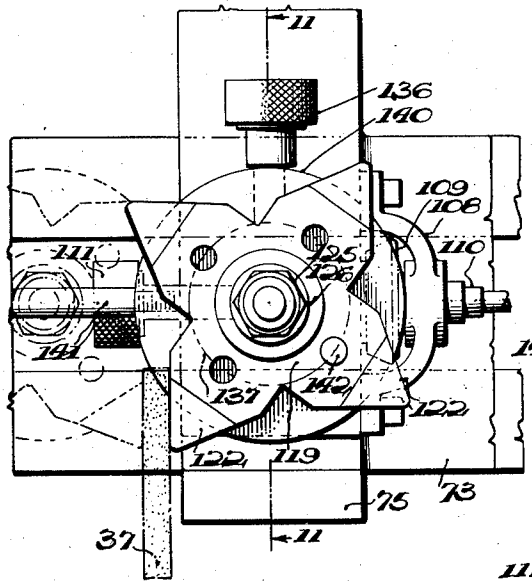
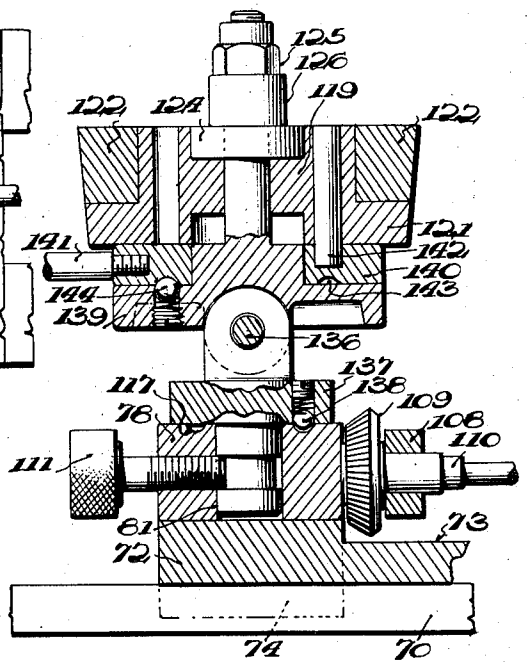


FIG. 9.

FIG. 10.



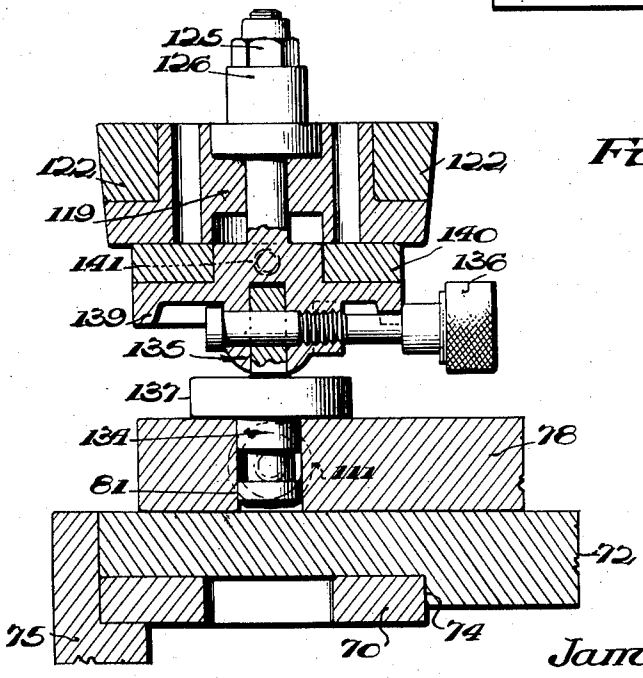


FIG. 11.

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GRINDING MACHINES FOR CUTTER TOOLS

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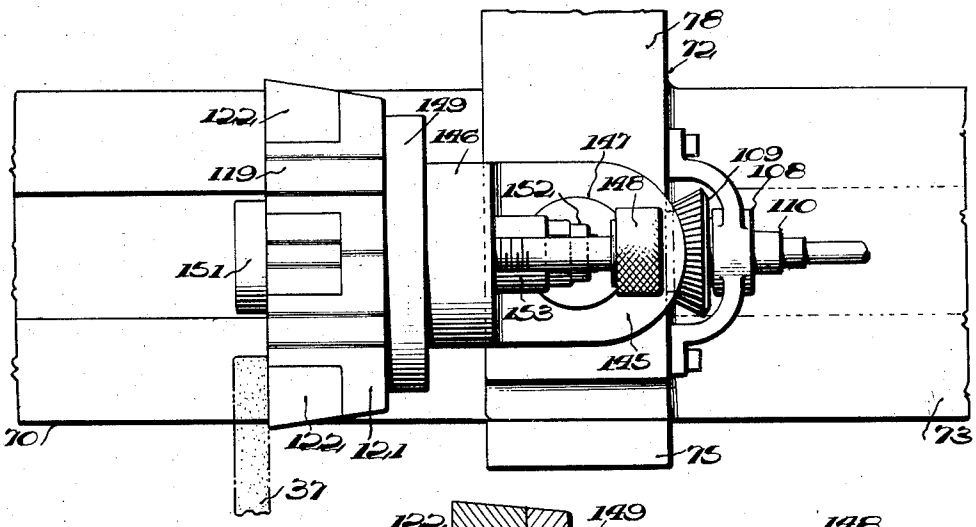


Fig. 12.

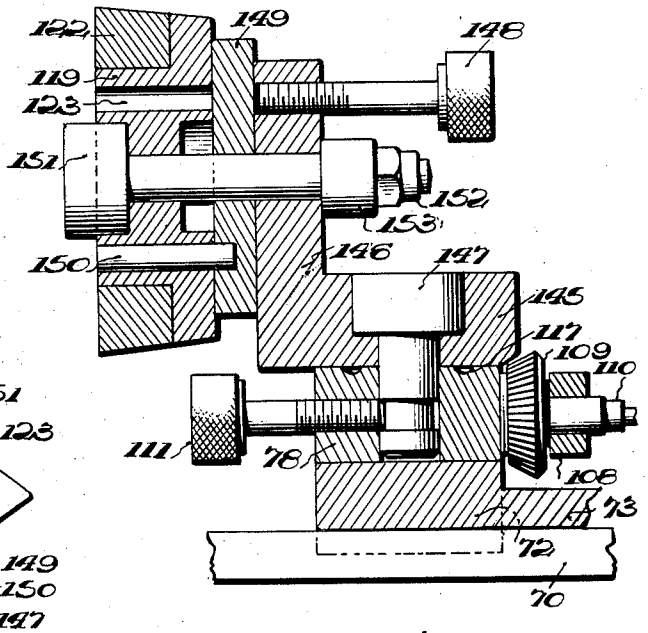
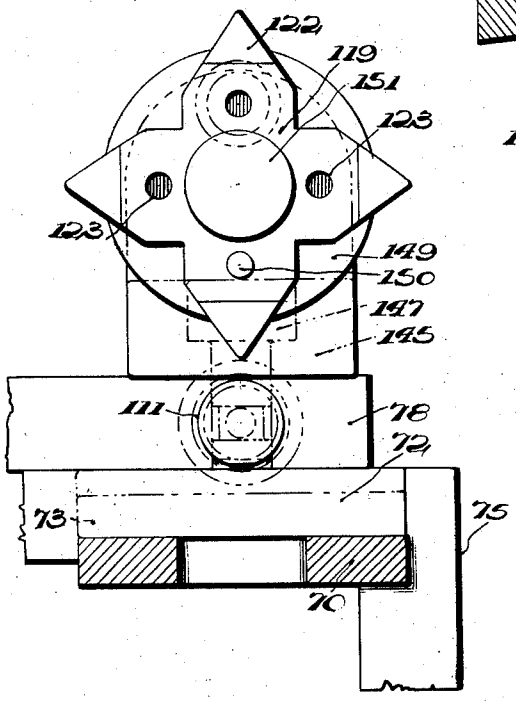


Fig. 14.

Fig. 13.



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United States Patent Office 2,851,832 Patented Sept. 16, 1958

2,851,832

GRINDING MACHINES FOR CUTTER TOOLS

James A. Anania, Newark, N. J., assignor of twenty-five percent to Frederick L. Knecht, Glen Rock, and fifty percent to William J. Matt, Jr., Westfield, N. J.

Application February 7, 1955, Serial No. 486,605

2 Claims. (Cl. 51—218)

This invention relates to an improved grinding machine for machine tools.

One of the objects of the invention is to provide a machine especially adapted to grind the cutters of the cutter tool assembly shown in my co-pending application filed June 28, 1954, Serial Number 439,613, now Patent No. 2,799,917.

A further object of the invention is to provide a machine wherein the several cutters of the cutter head employed may be selectively ground without the necessity for removing the cutters from the cutter head.

Another object of the invention is to provide a machine embodying a source of power for rotating the grinding wheel employed, and another source of power for rocking said wheel into and out of engagement with the work, so that the wheel may not be caused to tarry in engagement with the work should the rotation of the wheel be retarded by contact of the wheel with the work.

A further object of the invention is to provide a machine wherein the grinding wheel will be rotated at a relatively high rate of speed, while, in relation to the rotary speed of said wheel, the wheel will be rocked back and forth more or less slowly, and wherein the rotary speed of said wheel as well as the rocking motion thereof may each be separately regulated and varied.

Another object of the invention is to provide a machine embodying a tool post especially adapted to support the cutter head for grinding the side faces of the cutters at a right angle to the upper end faces of said cutters, wherein manually controlled power driven means will be provided for rotatably setting said post, wherein another post will be provided to support the head for grinding the side faces of the cutters when it is desired to rotatably set the post by hand exclusively, wherein another post will be provided to support the head for grinding the full side faces of the cutters, and wherein still another post will be provided to support the head for grinding the upper end faces of the cutters.

And a still further object of the invention is to provide a machine wherein the tool post may be adjusted forwardly or backwardly to either increase or decrease the width of grind, and may also be adjusted laterally to either increase or decrease the depth of grind.

Other and incidental objects will appear as the description of the invention proceeds, and in the drawings:

Figure 1 is a side elevation of my improved grinding machine.

Figure 2 is a top plan view of the machine.

Figure 3 is a vertical, longitudinal section on the line 3—3 of Figure 2.

Figure 4 is a front end elevation of the machine, parts being shown in section.

Figure 5 is a detail perspective view of the tool post carriage, the parts being shown separated but in proper relative position.

Figure 6 is a detail plan view of the tool post carriage, and showing a cutter head thereon.

Figure 7 is a detail, transverse, vertical section through the post and head of Figure 6.

Figure 8 is a detail, transverse, vertical section showing a tool post adapted to be rotatably set manually.

Figure 9 is a detail plan view of a tool post adapted to set the cutter head in inclined position.

Figure 10 is a detail, transverse, vertical section through the post of Figure 9.

Figure 11 is a detail, transverse, vertical section on the line 11—11 of Figure 9.

Figure 12 is a detail plan view of a tool post adapted to support the cutter head for grinding the upper end faces of the cutters thereof.

Figure 13 is a detail front elevation of the tool post of Figure 12.

Figure 14 is a detail, transverse, vertical section through the post of Figure 12.

In carrying the invention into effect, I employ a frame embodying a flat, oblong base plate **10**, and secured to said plate at the corners thereof are suitable legs **11** between the front and rear pairs of which extends transverse tie rods **12**. Appropriately fixed to the base plate in parallel relation are vertical side plates **13** and **14** reinforced at their lower margins by side strips **15**, and extending between the lower portions of the plates near their front and rear ends are tie rods **16**. As will be observed, the side plates **13** and **14** are set inwardly from the side edges of the base plate **10** to provide a shelf **17** at one side of the frame, and a like shelf **18** at the opposite side of the frame.

Mounted upon the shelf **17** to project through a suitable opening in the side plate **13** near the rear end thereof is an electric motor **19** which, in comparison with another motor employed, as will be later explained, is designated a high speed motor, and connected to the lead **20** of the motor is a plug **21**. Fixed to the adjacent leg **11** of the frame at the forward end of the shelf **17** is a block **22** upon which is mounted an appropriate multiple socket fixture **23**, and plugged into said fixture is the lead **24** of a suitable double outlet **25** mounted upon the shelf adjacent the motor **19**. The plug **21** is normally engaged in one of the sockets of the outlet **25**, and the other socket **26** of said outlet is provided so that the extension cord of a conventional hand lamp may be plugged into the socket to provide a convenient light for the person operating the machine. Mounted upon the shelf **17** forwardly of the outlet **25** is a suitable rheostat **27** connected in the circuit of the motor **19** by wires **28** and adjustable for varying the speed of the motor. The motor **19**, fixture **23**, outlet **25**, and rheostat **27** are all conventionally shown, and the particular circuits employed are not especially important except that suitable means be provided for varying or regulating the speed of the motor **19**.

Extending between the side plates **13** and **14** medially thereof is a transverse shaft **29**, the ends of which are journaled in bearings **30**, and mounted to rock on said shaft is a flat arm **31** rectangular in cross section. Formed on the lower end of said arm at its side edges is a lower yoke embodying circular cheek plates **32**, and formed on the arm at its upper end is a similar upper yoke comprising circular cheek plates **33** somewhat smaller in diameter, however, than the cheek plates **32**. The plates **32** of the lower yoke are journaled upon the shaft **29** so that the arm **31** may freely rock thereon, and lineally adjustable upon said plates are depending rods **34** which extend in a plane with the arm and carry counterweights **35**. Thus, by adjusting the rods **34** on the cheek plates **32**, the arm **31** may be balanced on the shaft **29**. Journaled through the cheek plates **33** of the upper yoke of the arm **31** is a shaft **36**, and removably

fixed to the inner end of said shaft is a flat grinding wheel 37 of approved character.

Journaled upon the side plates 13 and 14 rearwardly of the motor 19 is a transverse shaft 38, and extending between the armature shaft of the motor and the shaft 38 is a drive belt 39. Extending between the shaft 38 and the shaft 29 is a drive belt 40, and extending between the shaft 29 and the grinding wheel shaft 36 is a drive belt 41 which straddles the arm 31, suitable pulleys being provided on the several shafts for said belts. As will be perceived, when the motor 19 is energized, the grinding wheel 37 will be rotated at high speed, while by adjusting the rheostat 27 and thus varying the speed of the motor, the rotation of the grinding wheel may in turn be set at the speed desired.

Mounted upon the forward end portion of the shelf 18 of the frame to project through a suitable opening in the side plate 14 is an electric motor 42, which, in comparison with the motor 19, is designated a low speed motor, and extending from the motor 42 is a lead 43 having a plug 44. Fixed to the shelf 18 rearwardly of the motor 42 is a double outlet 45, like the outlet 25. The plug 44 of the motor is normally engaged in one of the sockets of said outlet, the other socket 46 of said outlet being for the same purpose as explained in connection with the socket 26 of the outlet 25, and connected to the outlet 45 is a lead 47, the terminal plug 48 of which is normally engaged with the fixture 23. Mounted upon the rear end portion of the shelf 18 is a suitable rheostat 49, like the rheostat 27. The rheostat 49 is connected in the circuit of the motor 42 by wires 50 and is adjustable for varying the speed of the motor. The motor 42, outlet 45, and rheostat 49, as in the instance of like elements previously described, are conventionally shown, and, as formerly stated, the particular circuits employed are not especially important, except that suitable means be provided for varying or regulating the speed of the motor 42. A conventional current supply lead is shown as plugged into the fixture 23 for furnishing current to both of the motors 19 and 42.

Fixed to the rear end portion of the side plate 14 of the frame and spaced inwardly from said plate in parallel relation thereto is a panel 51, and fixed to said panel is a stub shaft 52. Journaled upon the shaft is a sleeve which carries a sprocket 53 at one end and a gear 54 at its other end, and journaled through the panel forwardly of the shaft 52 is a shaft 55 provided at one end, at the inner side of the panel, with a circular head 56 and at its opposite end, at the outer side of the panel, with a gear 57 meshing with the gear 54. The armature shaft of the motor 42 carries a sprocket 58, and extending between the sprockets 53 and 58 is a sprocket chain 59. Thus, when the motor is energized, the head 56 will be rotated.

Projecting inwardly from the head 56 of the shaft 55 at diametric points are lateral posts 60, and fixed to said posts is a cross rod 61 extending diametrically of the head. Slidably adjustable upon the rod is a crank sleeve 62 from which extends a lateral crank pin 63, and journaled upon said pin is a pitman sleeve 64 fixed to the lower end of a pitman 65. Extending laterally from the grinding wheel arm 31 medially thereof is a crank pin 66 upon which is journaled a pitman sleeve 67, and extending radially from said sleeve medially thereof is a head 68 which slidably receives the upper end portion of the pitman 65 therethrough. Screwed on the pitman to abut opposite sides of the head 68 are nuts 69 adjustable for varying the effective length of the pitman.

The sleeve 62 is positioned upon the rod 61 away from the axis of the head 56, so that when the head is rotated, as previously described, the arm 31 will, as will now be understood, be rocked back and forth to swing the grinding wheel 31 forwardly and backwardly in an arcuate path. As will be seen, the travel of the arm 31 will be determined by the radius of the pin 63 with respect to

the axis of the head 56. Consequently, the length of the arcuate throw of the grinding wheel 37 may be increased or decreased by adjusting the sleeve 62 along the rod 61. Furthermore, it is also to be noted that the effective length of the pitman 65 will determine the setting of the arm 31 around a circle concentric to the shaft 29. Accordingly, as will now be clear, the segment of arcuate travel of the grinding wheel may be lowered by increasing the effective length of the pitman 65, or raised by decreasing the effective length of the pitman. The particular objectives of the adjustments just described will be later explained.

Fixed to the forward ends of the side plates 13 and 14 flush with the upper edges thereof is a cross plate 70 in which is formed a longitudinal slot 71, and slidable upon the plate is the tool post carriage employed. This carriage includes an L-shaped bottom section comprising a relatively thick bottom bar 72 of rectangular cross section, and an integral, rectangular side plate 73 which projects laterally from the inner end portion of said bar. The plate 73, which is of a width corresponding to the width of the cross plate 70, overlies the cross plate, and formed on the lower side of the bar in alignment with the forward edge of the side plate is a shoulder 74 which abuts the forward longitudinal edge of the cross plate. Detachably secured to the inner end of the bar 72 is a keeper plate 75 which engages beneath the cross plate 70 to slidably connect the bottom section of the carriage with said cross plate and sustain the bar 72 to extend forwardly from the cross plate at a right angle thereto. Formed in the bar 72 medially thereof is a longitudinal slot 76, and detachably or otherwise fixed to the outer end of said bar is a head 77.

The tool post carriage further includes a top section which comprises an oblong top bar 78 which slidably rests upon the bottom bar 72 mating therewith, the top bar being, however, somewhat thicker than the bottom bar. Formed on the top bar 78 is a tongue 79 which slidably fits in the slot 76 of the bottom bar 72, and snugly straddling both bars is a yoke 80, the sides of which are detachably fixed to the top bar 78. The yoke thus slidably connects the top bar with the bottom bar for forward and rearward movement on said bottom bar. Formed in the top bar 78 near its inner end is a socket 81.

Journaled through the keeper plate 75 and through the head 77 of the bottom bar 72 is a screw shaft 82 which is screwed through the yoke 80 and is provided at its forward end with a knob 83. Thus, as will be understood, the knob 83 may be manually turned for adjusting the top bar 78 either forwardly or rearwardly upon the bottom bar 72. If so desired, the head 77 may be provided with suitable graduations, so that the knob 83 may be turned to obtain an accurate adjustment of said top bar.

Journaled upon the side plates 13 and 14 of the frame beneath the cross plate 70 is a screw shaft 84, and depending from the side plate 73 of the bottom section of the tool post carriage is an arm 85 detachably connected at its upper end to a head 86. The head 86 may be integrally formed on the plate 73 or otherwise fixed thereto and provides a tongue on the plate slidably fitting in the slot 71 of the cross plate 70 for guiding the bottom section of the carriage when the carriage is shifted laterally in a direction along the cross plate. Formed on the lower end of the arm 85 is a sleeve 87 screwed on the shaft 84.

Fixed to the rear end of the side plate 13 is a lateral bracket plate 88 which is provided with a head 89, and fixed to the plate 13 at its forward end is a block 90 which receives the adjacent end of the shaft 84 therethrough and is recessed to accommodate a worm wheel 91 fixed to said shaft. Journaled at its forward end upon the block 90 and at its rear end portion through the plate 88 and head 89 is a hand shaft 92 to the forward end of which is fixed a worm 93 engaging the worm wheel 91, and fixed to the rear end of said shaft is a hand wheel 94

which carries a crank handle **95**. As will be perceived, the shaft **92** may thus be manually rotated for turning the shaft **84** and adjusting the tool post carriage laterally with respect to the path of arcuate travel of the grinding wheel **37**. If so desired, the head **89** may be provided with suitable graduations, so that the tool post carriage may be laterally adjusted accurately.

Journaled upon the side plates **13** and **14** of the frame near the forward ends of said plates above and forwardly of the low speed motor **42** is a transverse shaft **96**, and extending between the armature shaft of said motor and the shaft **96** is a drive belt **97** trained about suitable pulleys on said shafts. Journaled at their outer ends upon the side plates **13** and **14** forwardly of the motor **42** and near the base plate **10** are aligned shafts **98** and **99**, the inner end portions of which are carried by bearings **100** rising from the base plate, and extending about suitable pulleys on the shafts **96** and **98** is a drive belt **101**. Fixed to the inner end of the shaft **98** is a clutch disk **102**, and splined upon the inner end of the shaft **99** is a coacting clutch disk **103** shiftable to engage the disk **102** by a hand lever **104** pivoted at its lower end upon the base plate **10**.

At its outer end, the shaft **99** carries a bevel gear **105**, and meshing with said gear is a bevel gear **106** journaled by a bearing bracket **107** fixed to the side plate **13**. Fixed to the adjacent edge of the top bar **78** of the tool post carriage is a bearing bracket **108** which journals a bevel gear **109**, the axis of which is disposed in a plane with the vertical axis of the socket **81**, and extending between the gears **106** and **109** is a flexible cable **110**. Thus, when the hand lever **104** is thrown to engage the clutch disk **103** with the clutch disk **102**, the gear **109** will, as will be seen, be rotated by the motor **42**.

Mounted upon the top bar **78** of the tool post carriage is a stop screw **111** disposed opposite the gear **109**, and removably fitting at its lower end in the socket **81** of said bar is a tool post **112**, the lower end of which is provided with an annular groove **113** in which the inner end of the screw **111** is engaged for limiting the post against upward displacement while also permitting free rotation of the post. Formed on the tool post **112** at a point near above the groove **113** is a bevel gear **114** which meshes with the gear **109** and rests against the upper face of the bar **78** to provide a bearing plate rotatably supporting the post upon said bar, and formed on the post near above the gear **114** is a circular rest plate **115** in which is provided a socket **116**. As will be appreciated in view of the previous description, when the hand lever **104** is thrown to couple the shafts **98** and **99**, the tool post **112** will be mechanically rotated. Formed in the upper face of the top bar **78** of the carriage about the axis of the socket **81** is a series of quadrantly spaced sockets **117**, and mounted upon the gear **114** is a spring-pressed ball detent **118** engageable in said sockets selectively for locating the rotated position of the post and normally holding the post stationary.

As previously indicated, the machine of the present invention is especially designed for grinding the cutters of the cutter head shown in my prior application heretofore identified, and in order to better bring out the operation of the present machine, I have shown a like cutter head **119** disposed upon the post **112** and seated upon the rest plate **115**. Briefly, it may be noted that the head **119** is formed at its upper and lower sides with like sockets **120**, and projecting from the head are quadrantly spaced cutter rests **121** upon which are seated suitable cutters **122**. Each cutter and rest therefor, considered as a unit, is V-shaped in cross section as well as V-shaped in vertical section so that the sides of each unit converge radially outward and also converge downwardly toward the lower side of the head. The upper end faces of the cutters are flat. Formed through the head near the base of each cutter is a vertical opening **123**.

For the purposes of the present invention, I employ a filler ring **124** which is removably seated in the upper socket **120** of the head **119**, and screwed upon the upper end of the post **112** is a nut **125** coacting with a collar **126** for removably securing the head in position. Disposed in one of the openings **123** of the head is a pin **127** engaged at its lower end in the socket **116** of the rest plate **115** for locking the head against rotation independently of the tool post.

Assuming now that the tool post carriage is disposed in a lateral position with respect to the plane of rocking movement of the grinding wheel **37** to support the cutter head **119** in the position shown in full lines in Figure 6 of the drawings, it will be seen that one side face of one of the cutters **122** will be presented parallel at its upper edge to said plane. Thus, further assuming that the machine is in operation, it will also be seen that as the grinding wheel **37** approaches the end of its forward throw, the adjacent side of the wheel will, due to the fact that the downward slope of said side face of the cutter will incline away from the wheel, grind said side face of the cutter along the line of its junction with the flat upper end face of said cutter to form a sharp edge, it being noted, in this connection, that the grinding wheel is mounted to rock in a fixed vertical plane.

As the back and forth motion of the grinding wheel **37** is continuous, said wheel will, after brushing the cutter being ground, be rocked backwardly away from said cutter, when the hand lever **104** may be thrown to cause rotation of the tool post **112** and head **119** ninety degrees and dispose a side face of the next cutter **122** in a position to be ground. Thus, as will be understood, corresponding side faces of all of the cutters may be ground successively, and in order that the opposite corresponding side faces of the cutters may be successively ground, the tool post carriage is shifted laterally to the position shown in dotted lines in Figure 6 of the drawings, when, as will be understood, the cutter head may again be intermittently rotated to successively present each of said opposite corresponding side faces of the cutters in position to be ground. As will be perceived, grinding of the cutters may be easily and quickly accomplished.

The tool post **112** is proportioned to support the cutter head **119**, and consequently the cutters **122**, at a mean height above the tool post carriage such that, as regards the cutter being ground, the grinding wheel **37** will first engage said cutter at a mean point near the end of the arc of the forward throw of said wheel, and consequently, for given diameter of the grinding wheel and given setting of the sleeve **62** and grinding wheel arm, as previously described, the length of grind, as will be determined by the movement of the grinding wheel along the edge of the cutter being ground, will remain constant for given setting of the block **78** of the tool post carriage, as will also the vertical width of grind, determined by the width of the peripheral portion of the diameter of the grinding wheel caused to engage the cutter. As will be perceived, the length of grind as well as the vertical width of grind may be initially set, roughly, by adjusting the sleeve **62** to either lengthen or shorten the arcuate travel of the grinding wheel **37**, as previously described, and then subsequently set to a nicety by adjusting the effective length of the pitman **65**, as also previously described.

As heretofore noted, the knob **83** of the shaft **82** is operable for shifting the top block **78** of the tool post carriage either forwardly or backwardly, and when a cutter **122** of the head **119** is being ground, is employed to feed the cutter toward or away from the arcuate path of the grinding wheel **37** for either increasing or decreasing the length of grind as well as the width of grind. Also, as heretofore noted, the hand wheel **94** is operable for shifting the tool post carriage laterally and accordingly is employed to move the cutter head **119** from the full line position shown in Figure 6 of the drawings to the dotted line position shown. In either position of the cutter head, the hand wheel **94** is further employed

to adjust the tool post carriage laterally and, in respect to the cutter being ground, feed said cutter into the path of the grinding wheel 37 for depth of grind.

In connection with the grinding operation, the desirability of rotating the grinding wheel 37 at high speed is to be noted. At the same time, it is also equally desirable to rock said wheel back and forth more or less slowly. Accordingly, I employ the high speed motor 19 for driving the grinding wheel, and the low speed motor 42 for rocking the grinding wheel back and forth. As will be perceived, the speed of the wheel and the frequency of rocking motion of the wheel may be independently varied by separately regulating the speed of the motors. An equally important reason for employing separate motors, as compared with a single motor, lies in the fact that should the cutter being ground be fed to the grinding wheel too fast, the wheel might stick and momentarily cause the speed of the motor 19 to slow down. Such slowing down of the speed of the motor 19 will, however, in no way affect the speed of the motor 42, so that sticking of the wheel will not cause the wheel to tarry in its rocking motion in engagement with said cutter.

In Fig. 8 of the drawings, I have shown a tool post 128 adapted to be manually rotated for selectively disposing the several cutters of the cutter head 119 in a position to be ground. The post 128 is provided with a rest plate 129 which seats the cutter head, and securing the cutter head in position is the nut 125 and collar 126, the rest plate being recessed to receive the lower end of a locking pin 130, like the pin 127. The lower end of the post 128 is formed to fit in the socket 81 of the top bar 78 of the tool post carriage, and is grooved to receive the inner end of the stop screw 111. Formed on the post to seat against the upper face of the bar 78 is a circular bearing plate 131 which carries a radial hand lever 132, and mounted upon the plate to selectively engage in the sockets 117 of said bar is a spring-pressed detent 133, like the detent 118. As will be observed, the bearing plate 131 does not coact with the gear 109, so that the tool post may be freely rotated manually by means of the lever 132. Otherwise, the post 128 conforms to the construction of the post 112.

In Figures 9, 10, and 11 of the drawings, I have shown a tool post adapted to be manually rotated as well as adapted for the same grinding operation performed when the axis of the cutter head 119 is disposed vertically, while, also, a full side face of any one of the cutters of the cutter head may be presented flat to the grinding wheel. The tool post comprises a lower section 134, and an upper section 135 pivotally connected to the lower section by a clamp screw 136 which may be tightened for securing the upper section in adjusted position with respect to the lower section. The lower section is formed at its lower end to fit in the socket 81 of the top bar 78 of the tool post carriage, being grooved to receive the inner end of the stop screw 111, and formed on the section to seat against the upper face of the bar 78 is a bearing plate 137 which carries a spring-pressed detent 138 to engage in a chosen one of the sockets 117 of said bar. The stop screw 111 is set up tight against the lower end of the post, in this instance, for locking the lower section of the tool post against rotation.

The upper section 135 of the tool post is provided with a rest plate 139, and fitting said section of the post to overlie the rest plate is a shoe plate 140 having a radial hand lever 141. The cutter head 119 is seated upon the shoe plate 140, being retained by the nut 125 and collar 126, and said plate is recessed to receive the lower end of a locking pin 142, like the pin 127. Formed in the lower face of the shoe plate 140 is a series of quadrantly spaced sockets 143, and mounted upon the plate 139 to selectively engage in said sockets is a spring-pressed detent 144. Thus, the shoe plate 140 may be manually rotated to selectively dispose either side face of any one of the cutters 122 in position for grinding, when the detent 144 will serve to hold the head in adjusted position.

Assuming now that it is desired to grind corresponding side faces of the cutters 122, the upper section 135 of the tool post is tilted in one direction to a position corresponding to the downwardly sloping angle of said side faces of the cutters, so that the entire area of each of said faces will be successively presented flat to the grinding wheel, while, when it is desired to successively grind the opposite corresponding side faces of the cutters, the upper section of the tool post is tilted in the opposite direction, as will be understood. When grinding the full side faces of the cutters, the side faces of the cutter rests 121 will be worn away somewhat, but practical use of the cutter head has shown that this factor is immaterial. It is also to be noted that by positioning the upper section 135 of the tool post vertically, said post may be employed in the same manner as the tool post 128 previously described.

In Figures 12, 13 and 14 of the drawings, I have shown an angle-shaped tool post adapted for use in grinding the upper end faces of the cutters of the cutter head. This tool post includes a flat bottom plate 145 from which rises a vertical side plate 146, and extending through the bottom plate is a stud bolt 147 which fits in the socket 81 of the top bar 78 of the tool post carriage and is grooved to receive the inner end of the stop screw 111. The stop screw is set up tight against the bolt, so that the tool post will be clamped against rotation.

The plate 146 carries a set screw 148, and resting against the front face of said plate is a circular shoe plate 149 which seats the cutter head 119 and is recessed to receive the inner end of a locking pin 150, like the pin 127. The cutter head is thus locked to the shoe plate, and extending through the head, the shoe plate, and the side plate 146 of the tool post is a bolt 151 rotatably mounting the head and shoe plate and which receives a nut 152 and collar 153, like the nut 125 and collar 126.

As will be seen, the cutter head 119 is mounted on the plate 146 of the tool post in a vertical plane, so that the flat upper end faces of the cutters 122 may be presented flat against the grinding wheel 37. Accordingly, by rotatably adjusting the head, each of said faces may be disposed in a position to be ground, when the screw 148 is tightened against the shoe plate 149 for locking the head in adjusted position.

Having thus described my invention, I claim:

1. In a grinding machine, a frame, a tool post carriage mounted thereon and including a bottom section and a mating top section slidable forwardly and rearwardly upon the bottom section and formed to mount a tool post, means carried by the frame slidably mounting the bottom section and supporting the carriage for lateral movement, adjusting means carried by the frame and operatively connected to said bottom section for shifting the carriage laterally, adjusting means mounted upon the bottom section and operatively connected to the top section for shifting the top section forwardly and rearwardly, a gear journaled upon the top section and disposed to rotate a tool post mounted upon said top section, power-driven means carried by the frame and operatively connected to said gear for rotating the same, and means interposed in the connection between said power-driven means and said gear and manually operable to control the rotation of said gear step by step.

2. In a grinding machine, a frame including a base plate, spaced side plates rising therefrom, a cross plate extending between the upper portions of the side plates, a tool post carriage including a bottom section slidable laterally along said cross plate and a top section slidable forwardly and rearwardly upon the bottom section and formed to mount a tool post, adjusting means carried by the frame and operatively connected to said bottom section of the carriage for shifting the carriage laterally, adjusting means mounted upon the bottom section of

the carriage and operatively connected to the top section for shifting the top section forwardly and rearwardly, a drive shaft journaled at its outer end upon one of said side plates, an aligned driven shaft journaled at its outer end upon the other of said side plates, bearings rising from the base plate and journaling said shafts near their inner ends, said shafts being disposed near said base plate beneath said cross plate, a manually operable clutch operatively connected with the inner ends of said shafts for coupling the shafts to turn in unison, a gear fixed to the outer end of said driven shaft, a driven gear journaled upon the adjacent side plate of the frame near the outer end of said driven shaft and meshing with the former gear, a gear journaled upon the top section of the carriage and disposed to rotate a tool post mounted on said top section, and a flexible drive cable extending between said driven gear and the gear of said top section of the carriage and of a length to accommodate lateral movement of the carriage as well as forward and rearward movement of said top section.

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