Oct. 16, 1928. 1,687,725

B. M. W. HANSON

MACHINE FOR GRINDING FLUTED TOOLS

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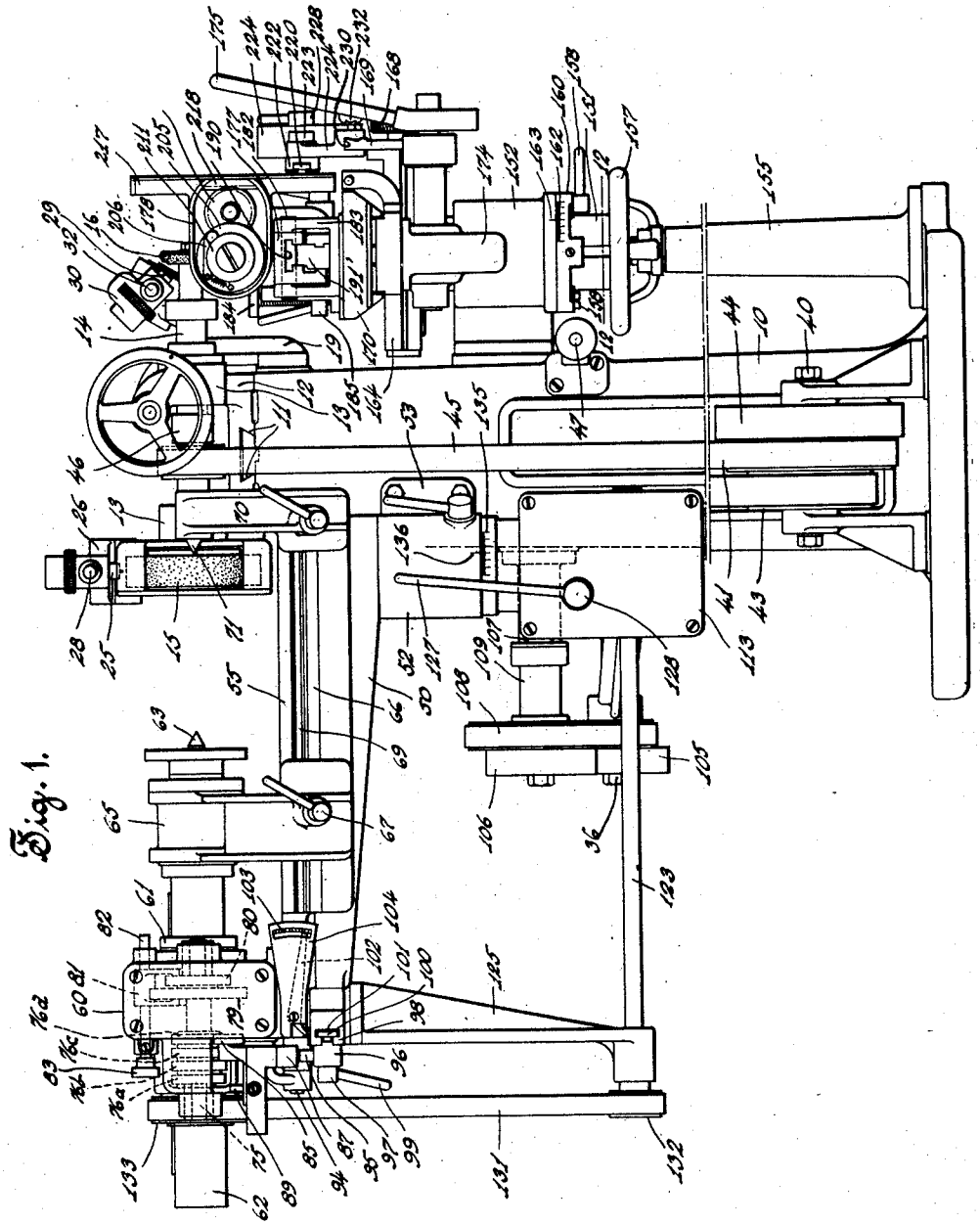


Fig. 1.

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Fig. 2.

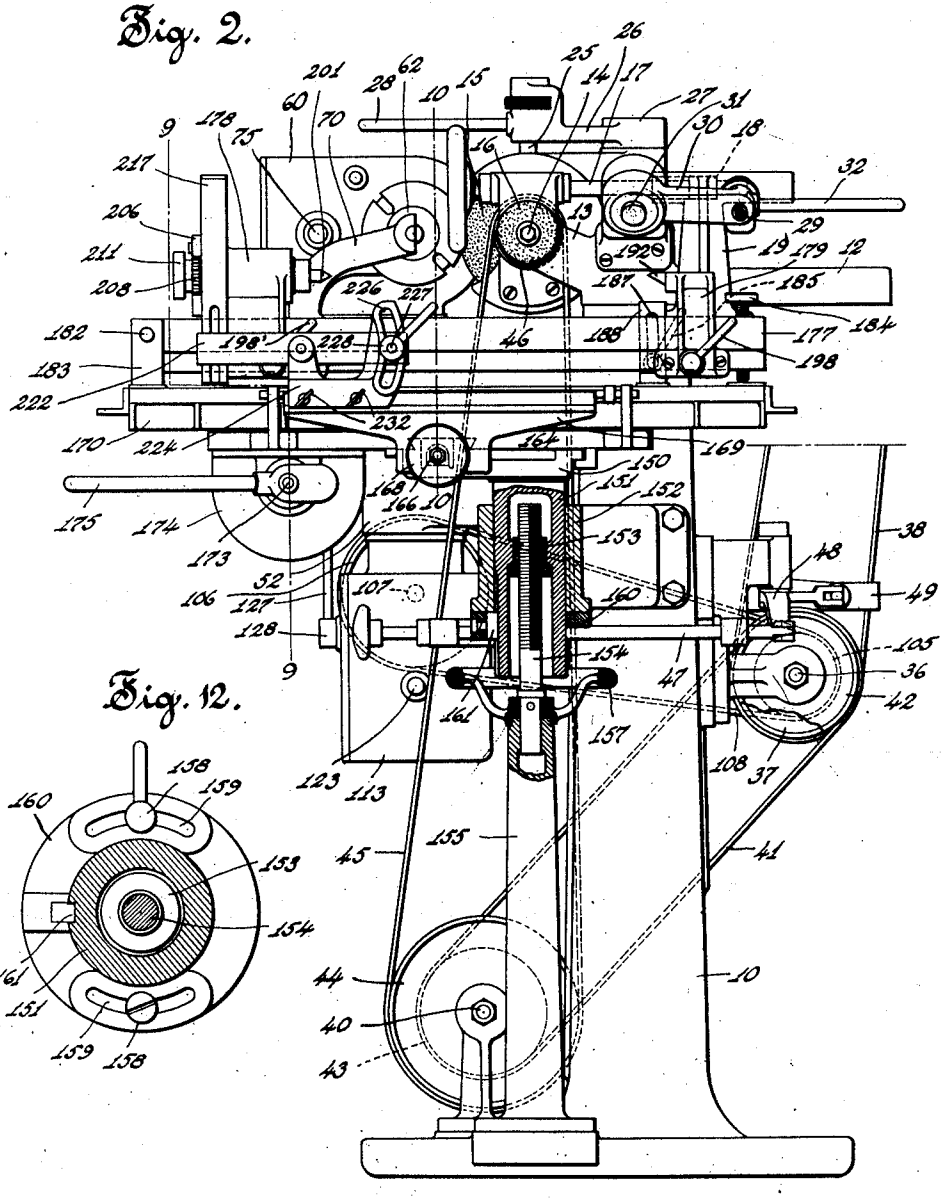


Fig. 12.

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MACHINE FOR GRINDING FLUTED TOOLS

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Fig. 3.

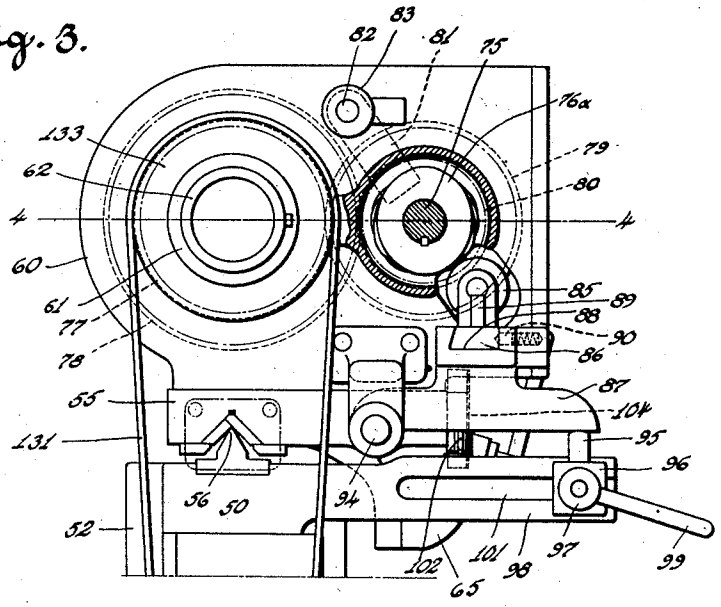
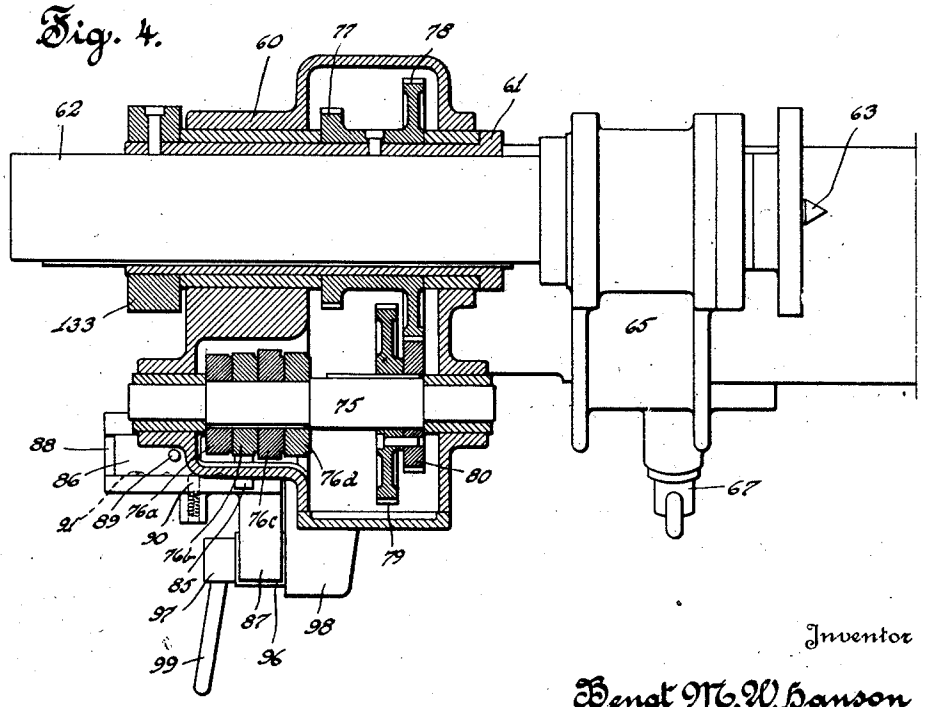


Fig. 4.



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MACHINE FOR GRINDING FLUTED TOOLS

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Fig. 9

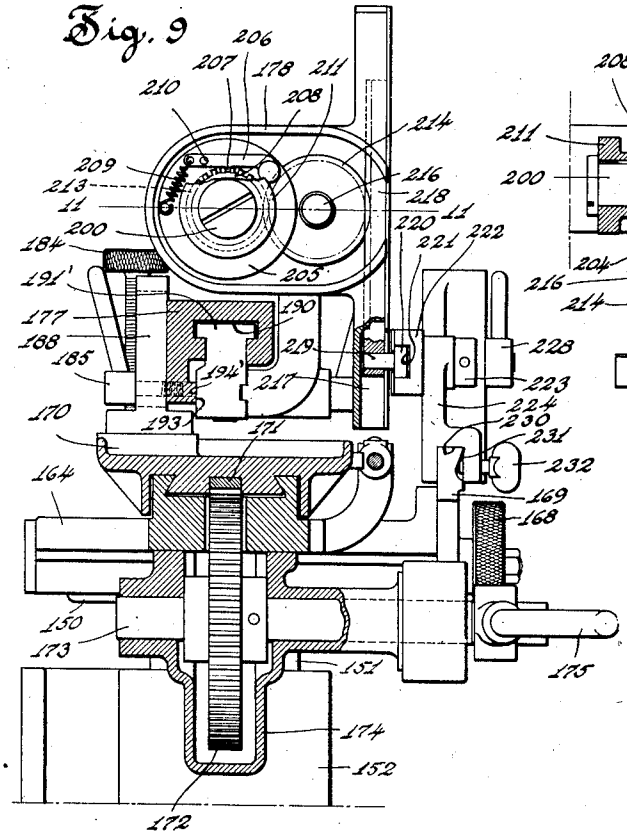


Fig. 11.

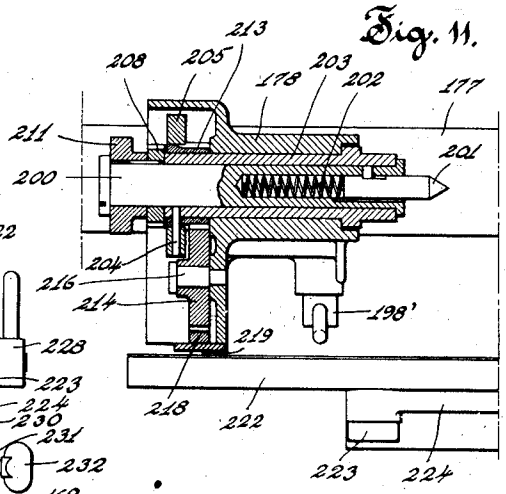


Fig. 5.

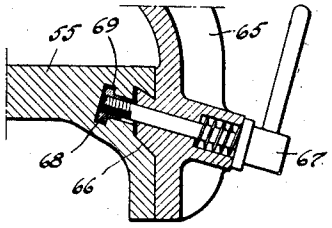


Fig. 10.

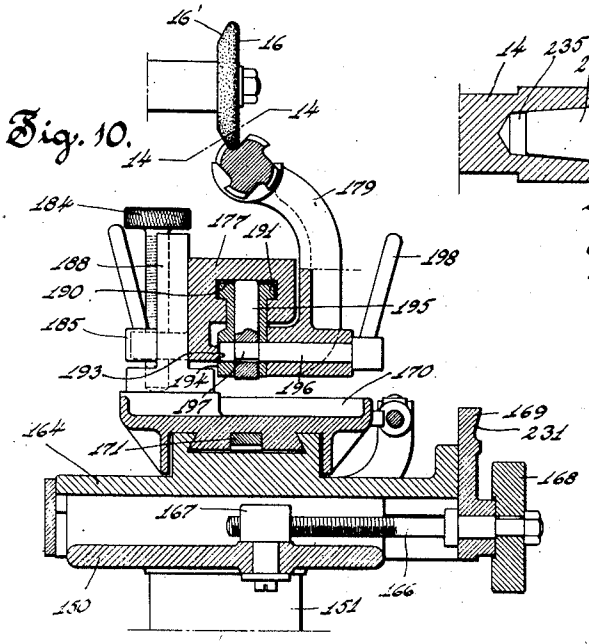


Fig. 13.

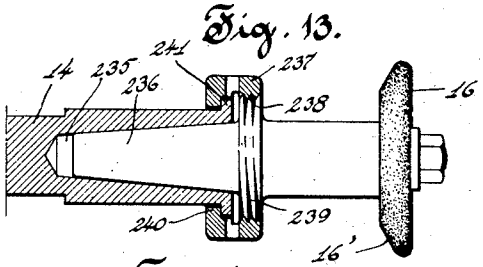
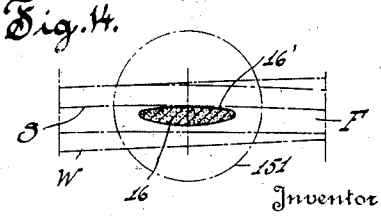


Fig. 14.



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MACHINE FOR GRINDING FLUTED TOOLS

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Fig. 6.

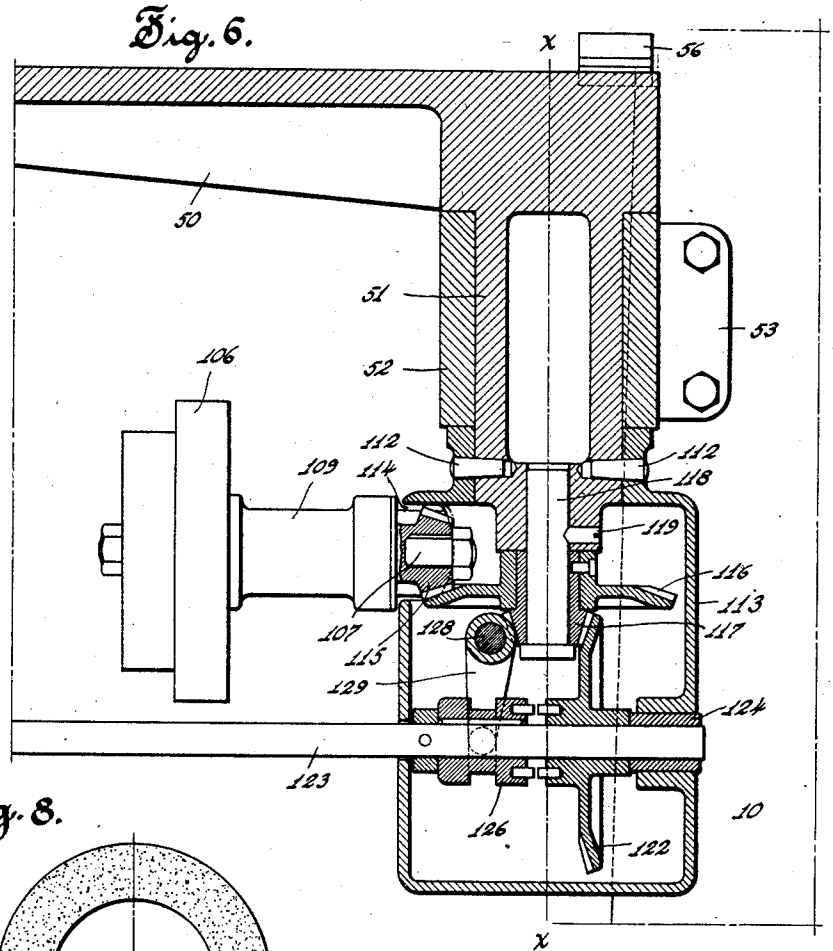


Fig. 8.

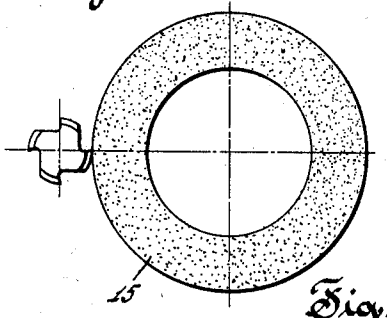


Fig. 7.

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1,687,725

UNITED STATES PATENT OFFICE.

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MACHINE FOR GRINDING FLUTED TOOLS.

Application filed December 18, 1925. Serial No. 76,301.

The present invention relates to machines for grinding fluted tools, such as taps, reamers, and the like.

The object of the invention is to provide a simple and compact machine by means of which taps and the like may be chamfered with the desired taper and relief, and the flutes of taps and reamers, etc., may be very conveniently, rapidly and accurately ground. By the use of the present machine, fluted tools may be economically ground in quantity, and the workmen in a shop may readily maintain the teeth or cutting edges of taps, reamers, and other tools, which they use in their work, in sharpened and first-class condition and at small expense. The machine is adapted for use in grinding tools of various sorts and shapes and may be employed to operate upon straight fluted, spirally fluted, tapered or non-tapered taps, reamers, etc.

A machine constructed in accordance with the present invention is characterized by various features of novelty and advantage, some of which may be employed in other connections than those herein shown. In the present illustrative embodiment, the machine has a pair of grinding wheels preferably mounted upon a single spindle, one of the grinding wheels being employed to grind the peripheral surfaces or faces of the teeth or lands of taps suitably supported between centers mounted on a holder or rocking bed which is angularly adjustable relative to the grinding wheel associated therewith and movable relative to the wheel in order to effect the desired relief. The other grinding wheel is constructed and arranged to grind the forward or generally radially extending faces of the teeth or lands on the work which is supported between suitable centers mounted for longitudinal movement. Very simple and effective means are provided for indexing the pieces of work so as to bring the successive lands into operative position to the last mentioned grinding wheel and for automatically turning or rotating the work during the grinding operation where the flutes on the work are spirally arranged. Also, the work holders are supported for adjustment in various respects in order that the proper relation between the pieces of work and the grinding wheels may be very quickly and accurately established.

Other objects will be in part obvious and in part pointed out more in detail hereinafter.

The invention accordingly consists in the features of construction, combination of elements and arrangement of parts which will be exemplified in the construction hereinafter set forth, and the scope of the application of which will be indicated in the appended claims.

In the accompanying drawings:

Figure 1 is a front view of the machine;

Fig. 2 is an end view of the machine;

Fig. 3 is an end view of the work support and holder which are associated with the wheel adapted to grind the peripheral surfaces of the work;

Fig. 4 is a horizontal sectional view taken substantially on line 4—4 of Fig. 3;

Fig. 5 is a detail view of the means for clamping the head stock, shown in Fig. 4, in place;

Fig. 6 is a vertical sectional view through the work support of the chamfer portion of the machine, the bearing for this support, and the gearing associated therewith;

Fig. 7 is a top plan view showing a tap supported in grinding relation to the cylindrical wheel;

Fig. 8 is a detail view showing, more or less diagrammatically and in end elevation, the cylindrical grinding wheel and tap;

Fig. 9 is a transverse sectional view taken through the portion of the machine in which the flutes are ground, this view being taken substantially on line 9—9 of Fig. 2;

Fig. 10 is a vertical sectional view taken, in part, on line 10—10 of Fig. 2 and showing the tail stock partly in section so as to illustrate the manner in which it is suspended and clamped in adjusted position;

Fig. 11 is a horizontal sectional view taken on line 11—11 of Fig. 9 through the head stock;

Fig. 12 is a detail view showing the manner in which the swivelled support 150 may be

clamped in place, this view being taken substantially on line 12—12 of Fig. 1;

Fig. 13 is a view showing the manner in which the arbor of one of the grinding wheels may be secured in place on a spindle; and

Fig. 14 is a view through the grinding wheel 16 and shows the work in dotted lines, this view being taken substantially on line 14—14 of Fig. 10.

Referring to the drawings in detail, 10 denotes, generally, a fixed bed or frame, preferably in the form of a standard, on the upper end of which is provided suitable ways 11 on which a grinding wheel slide 12 is adjustably mounted. This slide has spaced bearings 13, 13, in which is journalled a spindle 14 having, on its opposite ends, grinding wheels 15 and 16. The grinding wheel 15 is of cylindrical form and, in the present illustrative disclosure, is arranged to grind the peripheral faces of the teeth at the forward ends of taps so that the taps are brought to the desired chamfered or tapered shape. The other grinding wheel 16, which is adapted to be used for grinding the front faces of the lands or teeth on the work, has a conical grinding surface 16′. It will be noted that the slide 12 is mounted for adjustment on a line at right angles to the grinding wheel spindle. For the purpose of so adjusting this slide, there is journalled therein against longitudinal movement relative thereto a screw 17 having threaded engagement with a nut 18 carried by a bracket 19 fixed to the side of the standard 10 and overhanging the slide. Suitable means are associated with the respective grinding wheels for truing the same. In the present illustrative disclosure, the truing means associated with the grinding wheel 15 includes a diamond tool 25 supported in a horizontal swinging arm 26 pivoted to the grinding wheel slide as at 27. The swinging arm 26 may have a handle 28 for moving the diamond point back and forth across the peripheral face of the grinding wheel 15 in order to true the latter. The truing means associated with the grinding wheel 16 has a diamond tool 29 carried by an arm 30 pivoted on a stud or pin 31. The arm 30 has a handle 32. It will be noted that the arm 31 is so supported that the diamond point 29 may be oscillated across the operative grinding face of the wheel 16 in order to give that face the desired conical shape.

Journalled in suitable bearing brackets 35 extending from the rear of the standard 10 is a main or drive shaft 36 having the usual fixed and loose pulleys 37 which may be driven by a belt 38. The grinding wheel spindle 14 is driven from the main shaft 36 in the following manner: Located in front and at the base of the standard 10 is an intermediate shaft 40 driven by a belt 41 passing about pulleys 42 and 43, respectively, fixed to the drive shaft 36 and the intermediate shaft 40. Also fixed to the intermediate shaft 40 is a stepped pulley 44 about which passes a belt 45 which runs over a stepped pulley 46 fixed to the grinding wheel spindle 14 between the bearings 13. It will be noted, particularly from Figs. 1 and 2, that the belt 41 passes through the standard 10, the standard having suitable openings to this end. The belt 38 may be shifted to throw the power on and off of the machine by means of a rod 47 connected by a lever 48 to the usual fork 49.

Reference will now be had to that portion of the machine in which the operation of grinding the peripheral faces of the lands or teeth is carried out, and which portion, for convenience and brevity in description, will be referred to as the chamfer portion. This portion of the machine has a support adapted for angular adjustment in a horizontal plane about an axis x—x which lies in the central plane y—y of the grinding wheel 15 and to which axis the grinding wheel is adjustable at substantially right angles in that plane. In the present instance, this support includes a laterally extending arm 50 having a depending cylindrical post 51 journalled in the bearing 52 of a bracket 53 secured to, and extending laterally from, the standard 10. Mounted on the arm 50, for rocking movement, is a work holder which includes a rocking bed 55. By preference, in order to eliminate friction and wear and to provide for a smooth rocking movement of the bed 55, the latter is fulcrumed on knife edges 56. On the outer end of the rocking bed is a bearing box 60 in which is journalled a sleeve 61 supporting a work spindle 62 having on its forward end means for engaging the tap or other piece of work to be sharpened. In the present instance, the spindle is shown as having a work center 63 and a dog 64. The spindle is keyed to the sleeve as shown. The work spindle 62 is journalled in, but held against longitudinal movement relative to, a head stock 65 adjustably secured to the forward face of the rocking bed 55. In the present instance, the head stock, shown most clearly in Fig. 5, is slidably mounted in a guideway 66 on the rocking bed and is secured in place by a clamping bolt 67 cooperating at its inner end with a nut 68 slidably mounted in a T-groove 69. 70 designates a tail stock having a work center 71 alined with, and opposed to, the center 63. The tail stock is arranged to be adjusted and clamped in any adjustable position on the rocking bed in the same manner as the head stock. It will be noted, particularly from Figs. 3 and 7, that the head and tail centers are disposed (in any angular position of the support 50) in a line which is substantially normal to the axis x—x about which the support is adjustable. It may also be noted that the line on which the rocking bed is fulcrumed is substantially normal to the axis x—x. This means that the work

centers and the knife edges are located in a vertical plane which includes the axis x—x of the support.

The means for imparting a rocking movement to the rocking bed in accordance with the desired relief on the work will now be described with particular reference to Figs. 1, 3 and 4. Journalled in the bearing box 60 in parallelism with the work spindle 62 is a shaft 75 provided with a plurality of pattern cams 76^a, 76^b, 76^c and 76^d, the peripheral contours of which differ from one another. For instance, the first pattern cam 76^a may have two lobes; the next one 76^b, three lobes; the next one four lobes, and the last one five lobes so that the cams respectively correspond to two, three, four and five fluted tools. The shaft 75 is driven in timed relation with the spindle 62, as, for instance, through change speed gearing which may consist of a pair of gears 77 and 78 fixed to the work spindle sleeve 61 and gears 79 and 80 keyed to, and shiftable on, the shaft 75 and adapted to respectively mesh with the gears 77 and 78. The gears 78 and 80 may have a ratio of one to two, and the gears 77 and 79, a ratio of one to one. For the purpose of shifting the gears 79 and 80, there is provided a yoke or fork 81 fixed to a slidable rod 82 having a knob or handle 83. Adapted to be selectively engaged with the pattern cams is an abutting or rest member which is here shown as having the form of a roller 85 journalled in a slide 86 mounted on a link or lever 87. The slide 86, which is mounted in a groove 88 in the upper face of the link 87, may be moved longitudinally of the shaft 75 by means of a handle 89. In order to prevent accidental displacement of the slide, there is a spring pressed plunger 90 adapted to selectively engage recesses 91 provided in the slide.

The link or lever 87 is pivoted at its rear end on a pin or stud 94 on the rocking bed and is supported at its forward end on a fulcrum 95 which is adjustable laterally of the axis about which the rocking bed is adapted to be rocked. In the present instance, the fulcrum member is in the form of a pin carried by a block 96 which is adapted to be clamped by a bolt 97 in any desired position of adjustment on an extension 98 extending forwardly from the free or left hand end of the support 50. The clamping bolt 97 has, on its outer end, a handle 99 and, on its inner end, a nut 100 located in a T-groove 101 in the side face of the extension 98.

It will be noted, that with the arrangement described, a very flexible selectivity over a considerable range may be had so that any tap having a practical number of flutes may be operated upon; also, any desired extent of relief on the lands or teeth of the work may be had. In the case of a two fluted tap, the gears 77 and 79 will be engaged and the roller 85 will be engaged with the cam 76^a having two lobes. Similarly, in cases where three, four or five fluted tools are to be operated upon, the gears 77 and 79 will be engaged and the roller 85 will be respectively engaged with the cams 76^b, 76^c and 76^d. In the event that a six fluted tap is to be ground, the gears 78 and 80 are engaged and the roller 85 is engaged with the three lobe cam 76^b, as shown in Fig. 4. The roller will be engaged with the cam 76^c, and this cam will be driven through the gears 78 and 80, where an eight fluted tap is to be ground. In the event of a ten fluted tap, the roller will be engaged with the cam 76^d with the gears 78 and 80 engaged. Any desired extent of relief may be had by adjusting the abutment or pin 95. The greater amount of relief desired, the farther will the abutment or fulcrum 95 be adjusted away from the line of the knife edges 56. A lesser extent of relief may be had by adjusting the abutment 95 towards the knife edges 56.

The lands of the tap operated upon must, of course, bear the proper relation to the lobes of the pattern cam which is employed for rocking the work holder. To facilitate bringing about this relation, an indicator is provided for denoting the position of the rocking bed with respect to the grinding wheel. This indicator includes a pointer or lever 102 pivoted either on the rocking bed 55 or the support 50 and adapted to engage the other of these elements. In the present instance, the pointer is pivoted on the rocking bed and has one end engaging or resting upon the extension or arm 98 of the support. The other end of the pointer moves with respect to a scale 103 which may be provided on a casing 104 within which the pointer is housed.

In accordance with the present invention, a novel drive is provided for the work spindle 62, this drive being such as to permit of adjustment of the work support and to reduce to a minimum the number of parts required. This drive, in the present instance, includes a stepped pulley 105 on the main drive shaft 36; a stepped pulley 106 on a shaft 107; and a belt 108 passing about these pulleys. The shaft 107 is journalled in a bearing bracket 109 secured to, and extending laterally from, the standard 10. The axis of the shaft 107 is normal to the axis x—x about which the support 50 is adjustable. Secured to the lower end of the post 51, as by means of pins 112, is a gear box 113 which is adapted to be turned with the arm 50, this box having a horizontally extending slot 114 to accommodate the shaft 107. The shaft 107 carries a bevel pinion 115 which meshes with a bevel gear 116 housed within the casing 113 and fixed to the hub of a gear 117 journalled on a pin 118 located axially in the lower end of the post 51 and secured thereto by a set screw 119. The gear 117 meshes with a gear 122 loose on a shaft

123 one end of which is journalled in a bearing 124 provided on the gear box 113. The other end of the shaft is journalled in the lower end of a bracket 125 depending from the free end of the support or arm 50. The gear 122 is adapted to be fixed, at will, to the shaft 123 by a clutch sleeve 126 keyed to the shaft 123 for sliding movement. This sleeve may be engaged and disengaged with the gear 122 by moving in the proper direction a handle 127 fixed to a shaft 128 which carries within the gear box the usual shipper lever 129. The sleeve 61, together with the work spindle 62 keyed thereto, is driven from the shaft 123 in any suitable manner, as, for instance, by means of a belt 131 passing about pulleys 132 and 133, respectively fixed to the outer ends of the sleeve 61 and the shaft 123. It will be noted that this driving mechanism is very simple and economic in construction and arrangement and yet it is very effective in operation. The support 50, together with the parts thereon, may be angularly adjusted in order to bring the work into proper angular relation to the grinding wheel 15 without disturbing, in any way, the driving connections or other parts of the machine.

The operation of the portion of the machine in which the taps are chamfered will now be briefly explained. The tap to be ground is positioned between the centers 63 and 71, as shown most clearly in Fig. 7, the head and tail stocks first having been properly adjusted longitudinally of the rocking bed in order that the grinding wheel may properly engage the forward end of the tap which is to be brought into tapered form. When adjusting the tap on the centers 63 and 71, the rocking bed will be in its foremost lowest position and which position will be indicated by the pointer 102; that is to say, the low point of one of the lobes of the pattern cam to be employed, and which low point corresponds to the high point of a land of the tap, will be resting on the roller 85. The tap, with the parts in this position, will be angularly adjusted upon the centers so that the high point of a land of the tap will be directly opposed to the grinding wheel, as shown in Fig. 8. The support 50 is angularly adjusted so that the axis of the tap is brought to an angle relative to the axis of the grinding wheel in accordance with the taper to be given to the tap and, to facilitate this adjustment, there may be provided a scale 135 on the upper end of the gear box 113 and a cooperating scale mark 136 on the bearing 52. The mechanism having been properly set up, power is now thrown onto the work spindle, and the grinding wheel is advanced into engagement with the work by moving the slide 12 through the screw 17. During the grinding operation, the pattern cam, which rests upon the roller 85, will impart a rocking movement to the tap corresponding to the circumferential contour to be given thereto. It is important to note that the grinding wheel 15 is adjustable in a plane passing centrally through the grinding wheel and including the axis about which the support 50 is adjustable. The tail stock extends laterally very slightly beyond the axis of the tap. With this arrangement, the tap may be quickly and accurately adjusted with respect to the grinding wheel; the grinding wheel may be properly adjusted and fed with respect to the tap; and, as will be seen particularly from Fig. 7, in no position of adjustment of the support will the head or tail stocks interfere with the grinding wheel. The grinding wheel may extend beyond the forward or smaller end of the tap, as shown in this figure.

That portion of the machine which is employed for grinding the flutes of the work; that is, the forward faces of the lands or teeth, will now be described with particular reference to Figs. 1, 2, 9, 10, 11 and 12. This portion of the machine has a support or table 150 provided with a depending stem 151 mounted for turning or swivel movement in a bracket 152 secured to, and extending laterally from, the standard 10. This table is also mounted for vertical adjustment, it being rotatably supported on a nut 153 carried by a vertical screw 154 rotatably supported in the upper end of a fixed post 155. The screw is fixed to the hub 156 of a hand wheel 157, the hub resting upon the upper end of the post 155. It will be noted that the table 150, with the parts mounted thereon, is supported in a very simple and effective manner for vertical adjustment and for angular adjustment about a vertical axis. The support 150 is secured in any desired angular position by a pair of screws 158 threaded into the bracket 152 and extending through arcuate slots 159 in a ring 160, keyed, as at 161, to the stem. For the purpose of determining the angular position of the table or support, the ring 160, which turns with the stem 151, is provided with a scale 162 and the lower end of the bearing 152 has a cooperating mark 163.

Mounted upon the table 150 is a slide 164 which may be transversely adjusted by means of a screw 166 having threaded engagement with a nut 167 on the table 150 (see Fig. 10). The screw has a handle or knob 168 and is journalled in, and held against longitudinal movement relative to, a plate or rail 169 secured to the front face of the transverse slide. Mounted on the transverse slide for longitudinal movement is a slide or bed 170 having, on its under side, a rack 171 with which meshes a gear 172 fixed to a shaft 173 journalled in a bearing bracket or guard 174 on the under side of the transverse slide and adjacent one end thereof. The forward end of the shaft 173 has a handle 175 by means of which the gear 172 is turned when it is

desired to move the slide 170. Carried by the longitudinally movable slide 170 is a work holder which may include a bar 177 and head and tail stocks 178 and 179, respectively, carried thereby. The bar 177 is pivoted on a pin 182 in the upper end of a bracket 183 arising from the left hand end (referring to Fig. 2) of the longitudinally movable slide 170. The other end of the bar carries an adjustable screw 184 which rests upon the sliding bed. By turning the screw 184, the bar may be angularly adjusted in a vertical plane in accordance with the longitudinal taper to be imparted to the work. The bar may be secured in any position of adjustment by means of a clamp 185 screwed into the bar and projecting through an arcuate slot 187 in a lug 188 extending upwardly from the sliding bed. The slot 187 is struck about the pin 182 as a center.

The head and tail stocks are each carried by the bar 177 for adjustment thereon in a novel and advantageous manner. The under side of the bar is provided with a T-groove 190 in which engages a T-head 191 forming part of the tail stock, as will be seen most clearly from Fig. 10. The tail stock depends from this head, extends forwardly and then upwardly and rearwardly in overhanging relation to the bar. The upper end of the tail stock is provided with the usual center 192. The bar is further provided with a vertical thrust surface 193 against which bears a face 194 provided adjacent the lower end, and at the rear side, of the tail stock. For the purpose of locking or clamping the tail stock in any desired position of adjustment, a pin 195 is mounted for vertical movement in a bore which extends through the T-head 191. Extending horizontally through the body portion of the tail stock is a shaft 196 having an eccentric cam portion 197 engaging in a transverse opening in the pin 195. On the outer end of this shaft is a handle 198. When the handle is in the position shown in Figs. 2 and 10, the cam 197 holds the pin 195 against the upper surface of the T-groove 190 so that the tail stock is locked in place. When it is desired to re-adjust the tail stock, the handle 198 is thrown down, the tail stock is adjusted longitudinally of the bar, and then the handle 198 is thrown up to the position illustrated. The head stock is supported in the same manner as is the tail stock. The T-head on the head stock is designated by the numeral 191′, and the handle, which corresponds to the handle 198, is designated by the numeral 198′. The arrangement just described is of advantage in that the interengaging sliding surfaces between the bar and head and tail stocks are protected from injury, and these surfaces are protected against grit, emery or the like.

During the grinding operation on tools, such as reamers having straight flutes, it is merely necessary to index the work to bring the successive flutes into engagement with the grinding wheel 16 and to reciprocate the sliding bed longitudinally to thereby move the work longitudinally while in engagement with the wheel. In the case, however, of a reamer or tap having a spiral flute, it is necessary, as the work is moved lengthwise, to turn the work about its own axis to bring successive portions of the flute operated upon into the proper grinding plans. The rate at which a spirally fluted piece of work is turned during the grinding operation will, of course, depend upon the spirality of the flutes. In the present illustrative disclosure, the head stock 178 is provided with an indexible spindle 200 having a work center 201. This center is keyed for limited longitudinal movement in, but against rotation relative to, the spindle, and behind the center is a compression spring 202. This arrangement permits ready removal of the pieces of work from between the centers and prevents injury to the centers when positioning pieces of work on, and removing them from, the centers. The spindle 200 is journalled in a rotatable sleeve 203 to which is fixed, by means of a pin 204, a disk or collar 205 pivotally carrying a lever or pawl 206 having a tooth 207 adapted to engage in the notches of a toothed wheel 208 fixed to the spindle 200. The pawl is normally urged into engaging relation with the wheel by a spring 209 and the pawl may be disengaged from the wheel by a handle 210. Keyed to the outer end of the spindle is a knob 211 by means of which this spindle may be turned to manually index the work when the pawl is disengaged from the wheel 208. Fixed to the sleeve 203 is a gear 213 with which meshes a gear 214 journalled on a stud 216 carried by the head stock. The head stock has a vertical channel 217 in which is mounted for vertical reciprocating movement a rack bar 218, the teeth of which mesh with the teeth of the gear 214. Carried by the lower end of the rack is a part or pin 219 having a head 220 engaging in a groove 221 on an angularly adjustable guide element 222. This guide element 222 is pivoted, as at 223, to a normally stationary member or bracket 224 which is adjustable longitudinally of the plate or rail 169. The bracket 224 has an arcuate slot 226 through which extends a threaded stud 227 projecting forwardly from one end of the guide 222. On the outer end of this stud is screwed a clamp nut 228. The bracket may be adjustably secured to the rail 169 in any suitable manner. In the present instance, however, the bracket has, at its lower end, a groove 230 which receives the upper end of the rail. The rail has, in its forward face and adjacent its upper edge, a longitudinally extending groove which provides an inwardly and downwardly facing surface 231 against

which is adapted to engage the ends of thumb screws 232 threaded in the bracket.

As previously stated, the operative or grinding surface 16′ of the grinding wheel which is employed for grinding the flutes is of conical shape, the advantage of this arrangement being that the grinding wheel will engage the work along a line substantially lying in a plane of the axis of the wheel, and the grinding wheel to each side of that line will clear the work so that spiral flutes may be operated upon. This arrangement will be more clearly understood from Fig. 14, which is a view taken substantially on line 14—14 of Fig. 10. The lower portion of the wheel is shown in horizontal section, and the work, designated by the letter W, has a flute F with a generally radially extending surface S to be ground. Furthermore, in accordance with the present invention, the grinding wheel 16, during the setting up of that portion of the machine in which the flutes are ground and during the normal operation of that portion of the machine, is positioned above the axis about which the work holder is swivelled. That is to say, the plane of the wheel 16 includes the axis of the stem 151 of the support or table 150, and the axes of the grinding wheel and support intersect one another. In the present illustrative disclosure, since it is desirable to have the grinding wheel 15 adjustable in the plane of itself, and this wheel is on the same spindle as is the wheel 16, this latter wheel is also adjustable in its own plane, and which plane includes the axis of the support 150. With this arrangement, it is possible to angularly adjust the work support, together with the work thereon, in accordance with the spirality of the flutes to be ground without danger of injuring the wheel or the work by striking one against the other. From Fig. 14, it will be seen that, when the work support is turned, the surface S to be ground more or less follows the curved surface of the wheel.

The size and shape of the wheel 16 will, of course, depend upon the character of the work to be ground and, in practice, a number of wheels, each having its own shank, may be provided to meet various requirements. In order that the shanks of the wheels may be conveniently and quickly assembled on, and removed from, the spindle 14, the novel arrangement shown in Fig. 13 is provided. The spindle is provided with a conical or tapered recess 235, and each of the shanks is provided with a correspondingly tapered portion 236. The taper of the recess 235 is rather pronounced so that, while the shanks may properly seat and center themselves in this recess, they will not become so wedged therein as to stick and require considerable effort to withdraw the same. In order to hold the shanks securely in place on the spindle, there is provided a rotatable collar or nut 237 adapted to overhang the end of the spindle and having an internal thread 238 receiving a complimentary threaded portion 239 on the shanks. The nut has a flange 240 adapted to abut against a circumferential rib 241 on the end of the spindle. It will be seen that, with this arrangement, when it is desired to change the shanks, it is merely necessary to unscrew the nut 238 from the threaded portion 239, withdraw the tapered portion 236 longitudinally from the recess 235 without going to the trouble of loosening the shank in the recess or exerting a considerable pull on the shank, as has heretofore been necessary. The selected shank is then inserted in the recess, and the nut is screwed up on the threaded portion 239 whereupon the shank is drawn home and the parts are very securely held together. Since the nut is fixed against withdrawal from the spindle, it cannot become lost or misplaced.

When it is desired to grind a tool having straight flutes and a uniform diameter throughout its length, the support 150, together with the parts thereon, is adjusted so that the slide 170 will be moved in a line which is parallel to the plane of the grinding wheel. The bar 177 will be adjusted so that it is in a horizontal plane, and the guide member or element 222 will be disengaged from the lug or pin 220 of the rack 218. The grinding wheel 16 will first have been adjusted to the position shown in Figs. 2, 10 and 14. The work having been positioned between the centers 192 and 201, the pawl 203 is disengaged from the wheel 208, and the spindle 200 is manually turned by the knob 211 so as to bring one of the flutes into indexed relation to the grinding wheel. The grinding of that flute is then carried out by moving the slide 170 longitudinally through the gear 172 and the rack 171. After that flute has been ground, the tap is again indexed to bring the next flute into operative relation to the grinding wheel, and the slide 170 is then again reciprocated, and this sequence of steps is repeated until all the flutes have been ground.

In the event that a spirally fluted tool, such as a tap or reamer, is to be operated upon, the piece of work is positioned between the centers, and the support 150 is angularly adjusted in accordance with the angle of spiral of the flutes, this adjustment being facilitated by the scale 162. As previously stated, as the grinding wheel 16 is positioned so that its axis is intersected by the axis about which the support is adjustable, when this support is adjusted there is little danger of injuring the grinding wheel by striking the work thereagainst. The guide element 222 is also angularly adjusted in accordance with the spirality of the flutes so that, when the work is moved longitudinally, it will be automati-

cally turned so as to properly bring successive portions of each flute in engagement with the grinding wheel. The work is indexed so as to bring one of the flutes into engagement with the grinding wheel. It may be that the spirality of the flute is not known and, in this instance, the operator may proceed as follows in adjusting the guide element 222. The operator may estimate what the spirality of the flute is and adjust the guide element 222 accordingly. He may then slowly move the slide 170 and, if the grinding wheel bites into the work too greatly, the guide element may be adjusted slightly in one direction; and, if the grinding wheel leaves the surface of the flute, the guide element may be adjusted in the opposite direction until this guide element is brought into a position where the grinding wheel properly follows the flute. The operator now having determined the proper position of the guide element for one piece of work, he does not need to disturb the position of this guide element for other pieces of work of the same job where all of the pieces have the same spirality and other dimensions. If desired, a suitably calibrated scale may be provided on the bracket 224 for indicating the positions of the guide element for flutes having various angles of spiral. The machine having been properly set up, the slide 170 is now reciprocated longitudinally to move the work past the wheel and, during such movement, the work will be turned through the rack 218 and the gears associated therewith.

In the event that the flutes to be ground taper in the direction of their lengths, the bar 177 will be adjusted by turning the screw 184. It is, of course, obvious that the head and tail stocks 178 and 179 will be adjusted on the bar 177 in accordance with the length of the work, and the bracket 224 will be properly adjusted on the rail 169.

What is claimed is:

1. In a machine of the character described, a frame having a bearing, a support having a stem mounted for turning and vertical movements in said bearing, a work holder on said support, a fixed post below said bearing, a screw supported for turning movement on said fixed post, means for turning said screw, a nut on said screw rotatably supporting said stem, and an index scale between said stem and bearing for indicating the angular position of adjustment of said support.

2. In a machine of the character described, a support mounted for swivel movement in a horizontal plane and for vertical adjustment, a transverse slide on said support, a longitudinally movable slide on said transverse slide, a bar extending longitudinally of, and pivoted to, said longitudinally movable slide for angular adjustment in a vertical plane, and head and tail stocks adjustably carried by said bar.

3. In a machine of the character described, a support mounted for swivel movement in a horizontal plane, a grinding wheel above said support and mounted for adjustment in a plane including the plane of the wheel and the axis about which said support is mounted for swivel movement, a longitudinally movable slide on said support, a bar extending longitudinally of said slide and mounted thereon for angular adjustment in a vertical plane, a head and a tail stock on said bar, and means for longitudinally moving said slide.

4. In a machine of the character described, a support mounted for swivel movement in a horizontal plane and vertical adjustment, a grinding wheel above said support, a slide mounted on said support for longitudinal movement generally in a plane parallel to the plane of the grinding wheel, a bar pivoted on said slide beneath said grinding wheel for angular adjustment in a vertical plane, and a head and tail stock carried by said bar.

5. In a machine of the character described, a longitudinally movable slide having a rotatable work engaging member, a normally stationary member, an angularly adjustable guide element on said stationary member, a movable rack on said slide and having a part guided by said guide member when said slide is moved longitudinally, and a connection between said rack and work engaging member whereby the latter is turned when said rack is moved longitudinally.

6. In a machine of the character described, a longitudinally movable slide, a rotatable work engaging member thereon, a normally stationary member, an angularly adjustable guide element on said stationary member and having longitudinally extending groove, a longitudinally movable rack on said slide and having a part engaging in, and guided by, said groove when said slide is moved longitudinally, and gearing between said rack and work engaging member whereby the latter is turned when said rack is moved.

7. In a machine of the character described, a longitudinally movable slide having a rotatable work spindle, a normally stationary member, an angularly adjustable guide element on said stationary member and having a guide groove, a movable rack on said slide and having a part engaging in, and guided by, said groove, and a connection between said rack and work spindle whereby the latter is turned when said rack is moved, said connection including means for breaking said connection, at will, to permit said work spindle to be turned independently of said rack.

8. In a machine of the character described, a longitudinally movable slide having a rotatable work spindle, a normally stationary member, an adjustable guide element on said stationary member, a rack carried by said slide, a connection between said rack and slide whereby said rack is moved in the direc-

tion of its length when said slide is moved longitudinally, a collar about said work spindle and driven by said rack, a toothed wheel fixed to said work spindle, and a pawl on said collar and engaging said wheel.

9. In a machine of the character described, a longitudinally movable slide, a normally stationary rail parallel to the line of movement of said slide, a work spindle mounted on said slide, a bracket carried by, and adjustable longitudinally of, said rail, a guide element pivoted to said bracket for angular adjustment, means for securing said bracket on said rail in any desired position of adjustment, and a connection between said guide element and spindle whereby the latter is rotated when said slide is moved longitudinally.

10. In a machine of the character described, a longitudinally movable slide, a normally stationary rail at one side of, and parallel to, said slide, a bracket on, and adjustable longitudinally of, said rail, a guide element having a groove and pivoted to said bracket, means for securing said guide element in any desired position of angular adjustment, a spindle carried by said slide, a rack mounted on said slide and having a part engaging in said guide groove, and gearing between said rack and spindle whereby the latter is rotated when said rack is moved upon longitudinal movement of said slide.

11. In a machine of the character described, a longitudinally movable slide, a bar mounted thereon for angular adjustment in a vertical plane, an adjustable head stock on said bar and having a spindle, a normally stationary member, a guide element having a groove and pivoted for angular adjustment on said stationary member, a rack carried by said head stock and having a part engaging in said groove, and a connection between said rack and spindle whereby the latter is rotated when said rack is moved in the direction of its length.

12. In a machine of the character described, a horizontally extending member provided on its under side with an undercut groove, a supporting stock slidably supported in the under side of said member and having a part engaging in said groove, said stock extending laterally and then upwardly, and means for clamping said stock in any desired position of adjustment on said member and including a vertically movable pin carried by said stock and engaging the upper surface of said groove, and a shaft extending laterally through said stock and having an eccentric portion located in said pin.

13. In a machine of the character described, a support mounted for swivel movement in a horizontal plane and mounted for vertical movement, a longitudinally movable slide on said support, a bar extending longitudinally of and pivoted on a horizontal axis to said slide for angular adjustment in a vertical plane, means for supporting a piece of work and adjustably carried by said bar, and means for adjusting said bar in said vertical plane.

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