

March 20, 1945.

R. E. FLANDERS

2,371,685

GRINDING MACHINE

Filed Aug. 17, 1940

6 Sheets-Sheet 1

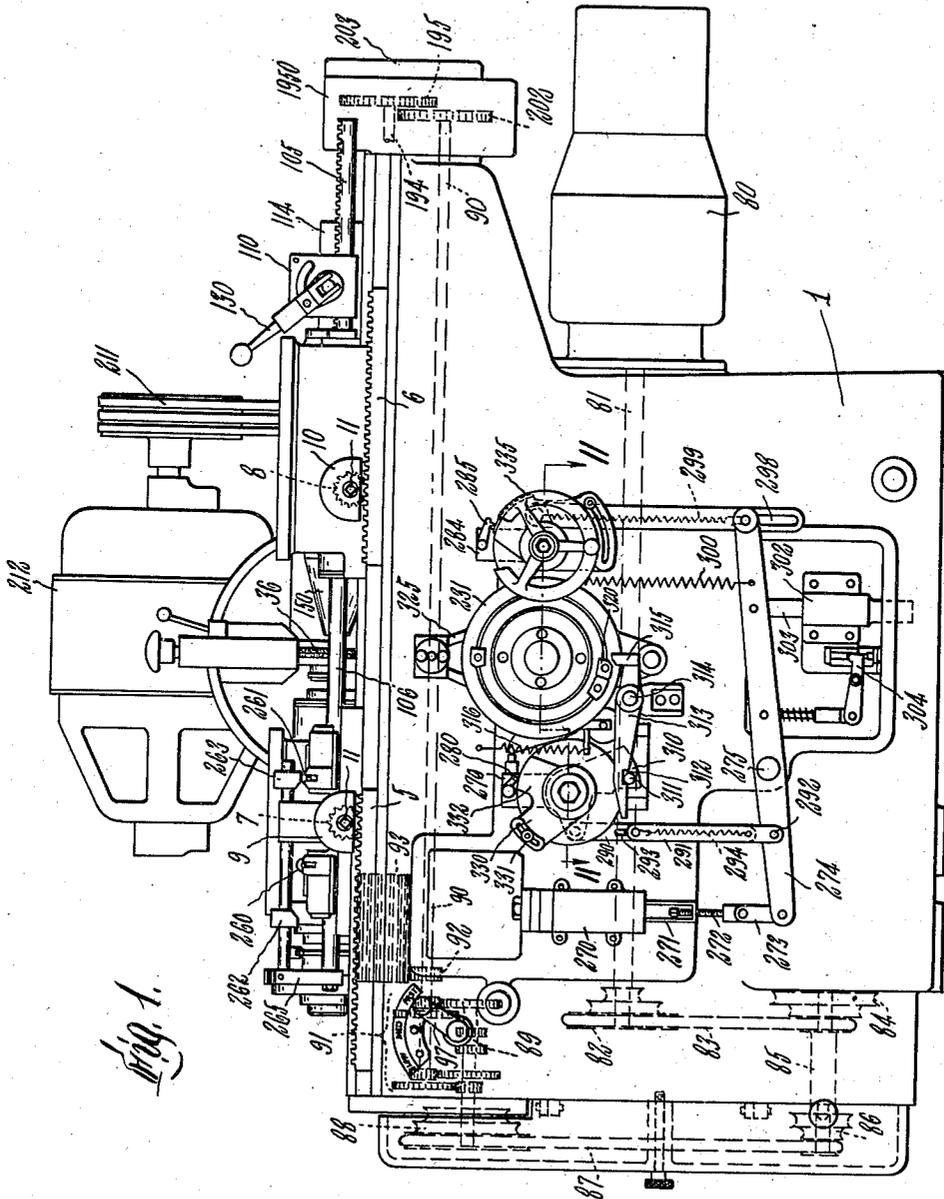


Fig. 1.

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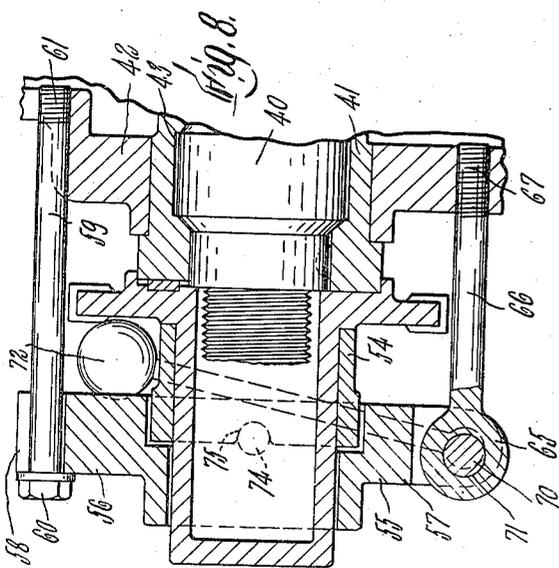
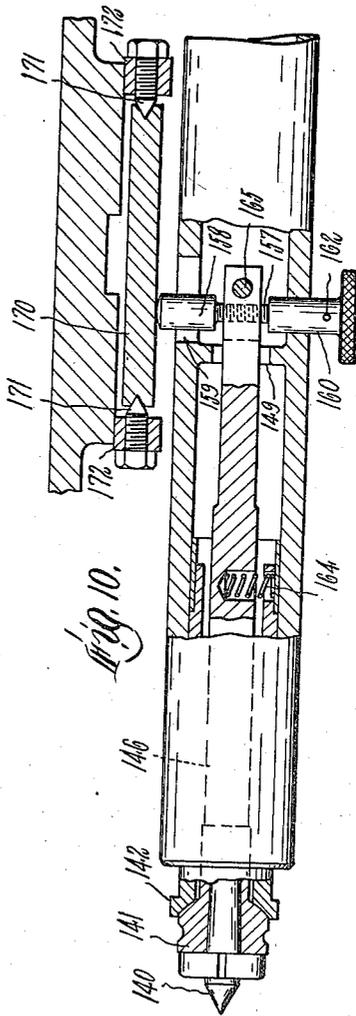
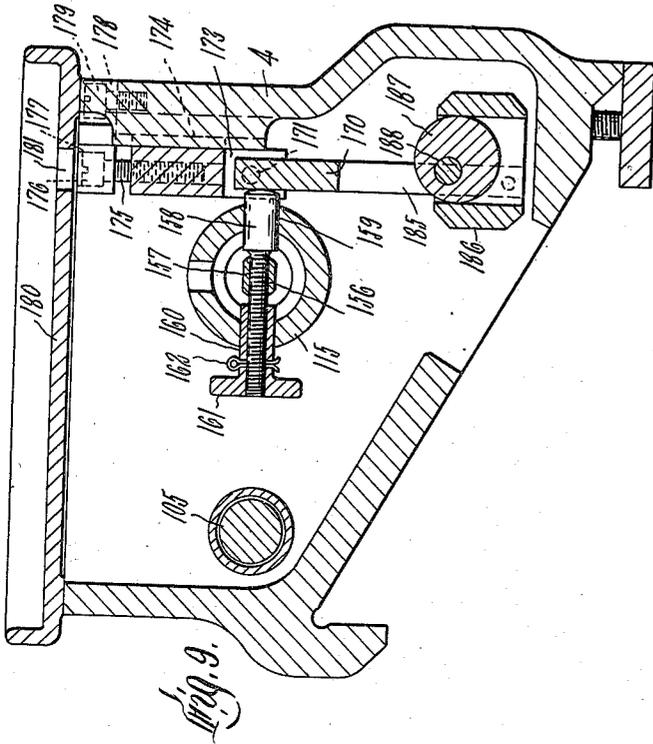
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6 Sheets-Sheet 4



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6 Sheets—Sheet 5

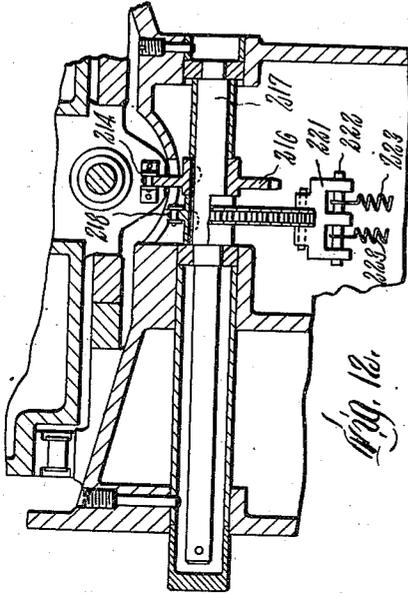


Fig. 12.

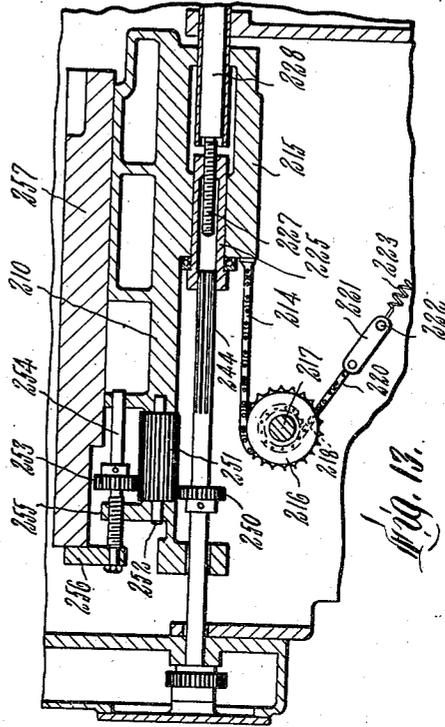


Fig. 13.

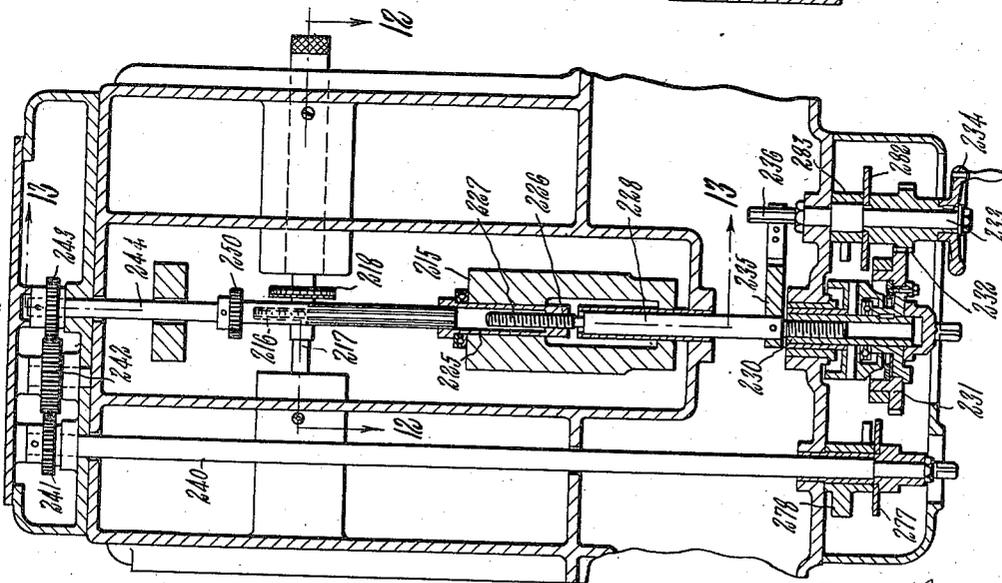


Fig. 14.

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6 Sheets-Sheet 6

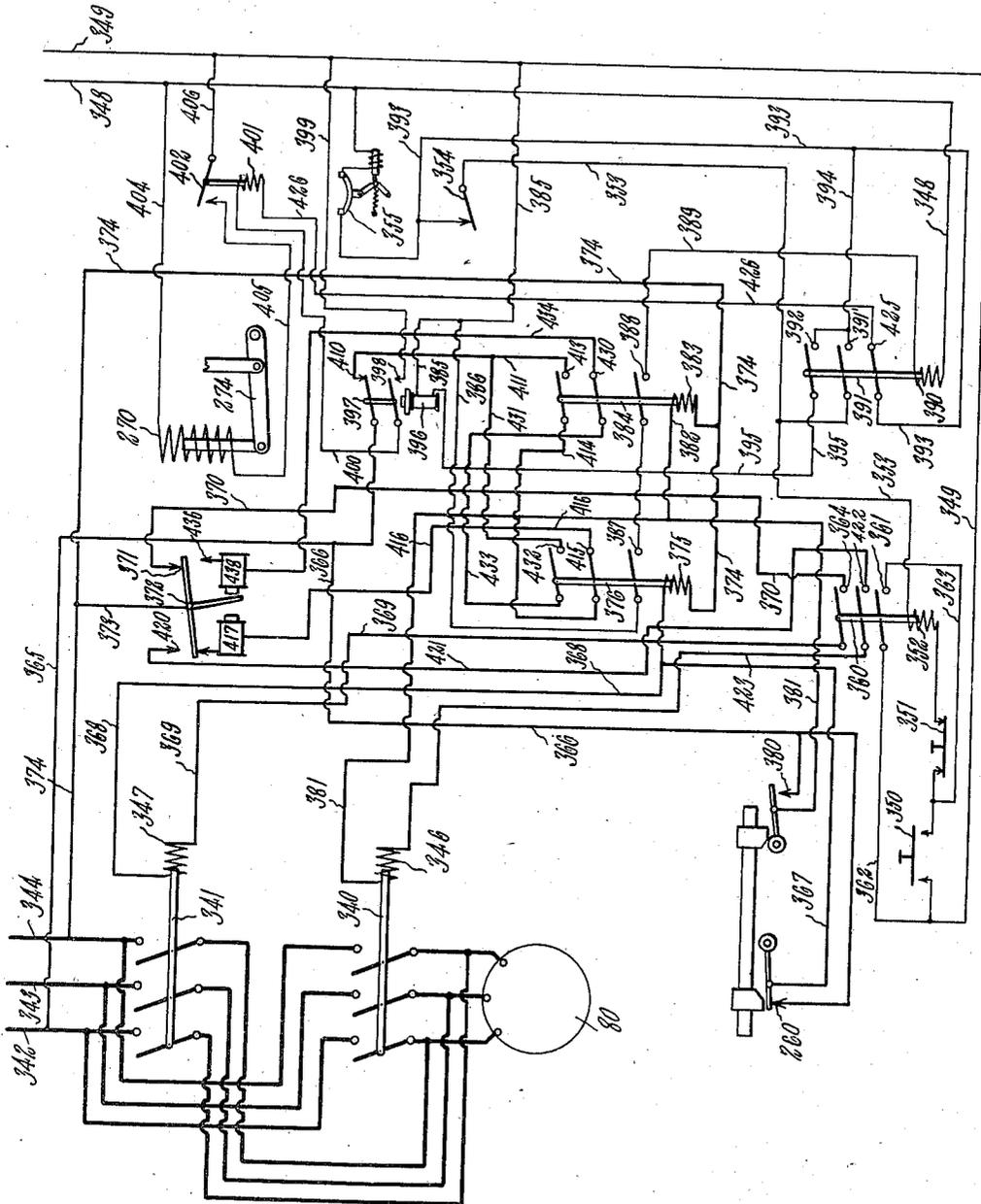


Fig. 14.

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UNITED STATES PATENT OFFICE

2,371,685

GRINDING MACHINE

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Application August 17, 1940, Serial No. 353,050

16 Claims. (Cl. 51—95)

This invention relates to grinding machines and is shown as embodied in such a machine of the general type illustrated in my Patent No. 2,187,227 granted January 16, 1940, for Grinding machines.

One object of the present invention is to avoid the necessity for machining and fitting a long slide on which the head and tailstocks are fastened as shown in my patent hereinbefore mentioned.

A further object is to reduce the load on the lead screw which results in more accurate lead control.

Both of these objects are obtained in accordance with this invention by securing the head and tailstocks to the bed and providing for motion of their spindles to produce the axial motion of the work.

Another object is to simplify the automatic control of traverse, wheel feed, and truing.

Further objects and advantages will appear from a description of an embodiment of the invention disclosed in the accompanying drawings in which

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

Figure 2 is a fragmentary top plan of the machine, parts of the head and tailstock casings being broken away.

Figures 3 and 4 are outer end elevations of the head and tailstocks, respectively, Figure 4 showing the tailstock casing broken away and certain of the parts in section.

Figures 5 and 6 are sectional views on the correspondingly numbered section lines of Figures 3 and 4, respectively.

Figure 7 is a detail section on line 7—7 of Figure 6.

Figure 8 is a detail section on line 8—8 of Figure 3.

Figures 9 and 10 are detail sections on the correspondingly numbered section lines of Figure 6.

Figure 11 is a detail section on line 11—11 of Figure 1.

Figures 12 and 13 are detail sections on lines 12—12 and 13—13, respectively, of Figure 11.

Figure 14 is a wiring diagram showing certain of the controls.

Referring to Figures 1 and 2, at 1 is indicated a machine base provided with longitudinally extending inclined ways, one of which is shown at 2 in Figure 3, upon which are mounted a headstock 3 and a tailstock 4. Both the head and tailstocks are arranged to be clamped to the bed and both are adjustable axially therealong. For

the purpose of this adjustment the bed is provided with a pair of rack bars 5 and 6 and the head and tailstocks are provided with pinions 7 and 8, respectively, meshing with these rack bars and supported in casings 9 and 10 secured to the respective stocks. A squared shaft 11, which carries the respective pinions 7 and 8, extends outwardly for the reception of a wrench or handle by which it may be turned, thus to adjust the head and tailstocks axially as may be desired. When adjusted as desired they are clamped rigidly in position by any suitable means (not shown), this, however, being well-known in the art.

The headstock 3 carries therein a rotary and axially movable work holding spindle 15 which at its forward end carries a work holding face plate 16. This face plate, as shown best in Figure 5, has a rearwardly extending skirt 17 which extends between the annular packing rings 18 and 19. The outer packing ring 18 is secured as by screws 20 to the end of the headstock, and the packing ring 19 is secured to the end of a bushing 21 within which the spindle 15 is journaled and which is clamped to the headstock through a shoulder 22 of the bushing and a nut 23 threaded on its inner end and bearing against the inner face of the headstock.

The face plate 16 may be secured to the end of the spindle 15 as by screws 24 and a cone center 25 may be suitably mounted axially within the face plate 16 and the end of the shaft 15. A work driving pin 25 may be secured in the face plate for driving engagement with the usual dog which is clamped to the work.

At its rear end the spindle 15 has a reduced diameter portion 26 over which may be placed a sleeve 27 having its outer face threaded, this sleeve forming a lead screw. It is secured for rotation with the spindle 15 as by a key 28 and it may have tapered ends 29 and 30 for engagement with the matingly tapered collars 31 and 32 between which it may be clamped, as by a nut 33 threaded on the reduced diameter threaded portion of the spindle, the collar 31 being backed up by an annular shoulder 34 on the spindle.

A separate sleeve 30 for each different lead of thread is provided, this corresponding to the type of work to be operated upon, herein shown as a tap 35 (see Figure 2).

In order that the rotation of the spindle 15 shall cause axial movement thereof, the lead screw 30 is provided with a lead nut 40. This lead nut is keyed to a quill 41 journaled in a bearing 42 of the head stock. This quill 41 has a portion of enlarged internal diameter as at 43 for

reception of a mating large diameter portion 44 of the lead nut. The ends of this enlarged diameter portion 43 and the corresponding portion 44 of the nut are matingly tapered and a sleeve 46 with a tapered inner face is retained within the quill 41 as by a sleeve 47 threaded into the inner end of the quill 41. This sleeve 47 may be provided with external ribs 48 to receive a tool such as a spanner wrench by which it may be turned. With this construction, lead nuts 44 corresponding to the various lead screws 30 may be removably clamped in position within the quill 41. While under normal operation the nut 40 is held stationary so that the spindle 15 in its rotation moves axially, it is desirable to provide for angular adjustment of the nut in order that the threads of the work may be properly lined up with the grinding wheel. To this end the quill 41 is mounted for turning movement in the portion 42, but it may be clamped after adjustment has been made.

In order to effect such clamping action and also to facilitate the turning of the quill 41 for adjustment, the following means has been provided. The outer end of the spindle is enclosed within a housing 50 provided at its inner end with a hand wheel portion 51 by which it may be turned. This hand wheel portion 51 is fixed angularly to the quill 41 as by the radial key 52, the hand wheel thus facilitating the angular adjustment of the quill when the quill is free to be adjusted. In order that the quill may be clamped there is provided on the housing 50 a sleeve 54 and a clamp ring 55. The ring 55 is provided with oppositely extending ears 56 and 57. The ear 56 is slotted as at 58 to receive a screw 59, the head 60 of which engages the outer end of the ear 56. The ear 57 is slotted and within the slot is positioned the eye 65 of an eye bolt 66 threaded at 67 into the headstock. Thus the ring 55 is held against rotation by its engagement with the members 59 and 66.

The ear 55 may be pressed against the outer end of the sleeve 54 or retracted therefrom to clamp or release the lead nut. For this purpose the rock shaft 70 (Fig. 8) which passes through the ear 57 has an eccentric portion 71 on which the eye 65 is journaled. This rock shaft 70 is provided with an actuating handle 72. By rocking this handle the rock shaft 70 is rocked, thus to move the ring 55 from and toward clamping engagement with the sleeve 54 and the hand wheel 51. The ring 55 is provided with a pair of spaced pins 74 which engage in recesses 75 in the end of the sleeve 54, thus to provide diametrical points to which pressure is applied to the sleeve 54 as by the tilting motion of the ring 55 as it is moved between clamping and released position. When the ring 55 is in clamped position, it will be evident that as the spindle 15 is rotated it is moved axially through the rotation of the lead screw engaging the stationary nut 40.

Means for so rotating the spindle comprises the motor 80 (see Figure 1) mounted on the machine bed and connected to drive a shaft 81. This shaft 81 is shown as provided with a cone pulley 82 having three steps thereon which is connected as by the belt 83 to a corresponding step of the cone pulley 84 mounted on a shaft 85. The shaft 85 is also provided with a second cone pulley 86 shown also as having three steps, which is connected as by the belt 87 to the corresponding step of a three step pulley 88 carried by a shaft 89. This shaft 89 is connected to drive a shaft 90 through a three-speed sliding gear mechanism in-

dicated as a whole at 91 and of any suitable description, this arrangement of sliding gear and cone pulleys permitting a selection from twenty-seven speeds for the rotation of the shaft 90.

At the headstock end the shaft 90 is connected through a gear 92 to drive a long gear 93. As shown best in Figure 5, this long gear 93 may drive either or both sets of gears of a compound gear 94 keyed to the intermediate portion of the spindle 15. This compound gear includes a gear portion 95 having a hub 96 and a gear portion 97 having a hub portion 98. These hub portions may be secured together as by screws 99 and they form between them an annular recess for the reception of a ballbearing 99 which engages in a groove 100 in a yoke member 101. The compound gear 94 is provided in order to increase the permissive travel axially of the shaft 15 while maintaining a geared connection between it and the long gear 93, since as long as either of its gear portions is in engagement with the long gear 93, it is in driven relation thereto.

When the spindle 15 has progressed axially in one direction to a given extent, the motor 80 is reversed to drive it in the other direction and for the reverse direction of traverse. Means for doing this will later be described.

Means are provided by which the axial motion of the spindle 15 produces like axial motion of the tailstock spindle. A portion of this mechanism comprises the yoke 101 hereinbefore mentioned, this yoke being secured to a bar 105 mounted for axial movement with the headstock 3 and to which the tailstock spindle may be clamped. In order to protect the headstock from the entry of coolant or foreign matter through the hole through which the bar 105 passes, this bar may extend through a pipe 106 secured at the headstock end by a threaded connection into the headstock casing and extending into the tailstock casing as through a suitable packing gland at 107. The rear end of the bar 105 is formed as a rack bar and slidable on this bar 105 at the rack portion is a casing 110 (see Figures 1, 2 and 4). This casing has a rearward extension 111 through which is passed a bolt 112 extending through a slot 113 in a cap 114 (see Figures 2 and 6) which houses the rear end of a tailstock spindle 115 slidably but non-rotatably mounted in the tailstock 4.

Means are provided for clamping the casing 110 to the rack bar 105 so that as the rack bar is moved axially with the headstock spindle, the tailstock spindle is moved correspondingly in the same direction. To this end the casing 110 is provided with a rock shaft 120 on which is journaled a pinion 121 which meshes with the teeth of the rack bar 105. This rock shaft 120 has keyed thereto a ring 122 and between the ring 122 and a friction cone 123 integral with or secured to the pinion 121 is a friction shoe 124 which may be pressed up against the cone 123 to an adjustable extent as by a nut 125 threaded on the inner end of the rock shaft 120. Thus the pinion 121 is frictionally held to the rock shaft. This rock shaft extends through the forward face of the casing 110 where it has secured thereto an arm 126, the outer end of which carries a spring latch pin 127 which may be engaged in a latch pin socket 128 in a face plate 129 carried by the casing 110. This latch may be released from its socket by pulling outwardly on a handle 130 fulcrumed at 131 on the rock shaft 120 and through which a shank 132 of the latch pin 127 projects, this shank having a head 134 on its forward end.

By pulling outwardly on the handle 130 the latch pin may be retracted from its socket 128 and then by rocking this handle to the right as viewed in Figure 1 about the axis of the shaft 120, the shaft 120 may be turned, thus turning the pinion 121 and producing a corresponding retraction of the tailstock spindle. This provides for retracting the tailstock spindle for the removal and insertion of work between the spindles. In the normal operative condition the handle is in the position shown in Figure 1 and is latched in this position, in which position also the head and tailstock spindles are connected to the rack bar 105 for simultaneous and equal axial motion, thus carrying the work 35 and effecting the lengthwise traverse of it with relation to the grinding wheel 36.

The tailstock spindle carries the cone center 140, which as shown in Figure 6, is carried by a tailstock center block 141. In grinding a tap it is desirable that the lands of the tap be relieved in order to provide clearance back of the cutting edges of the tap, and for this purpose a motion of the tap from and toward the grinding wheel in time with the rotation of the tap is provided. As shown this relief is produced by a motion of the tailstock center. To this end the center block 141 is rockably mounted in the forward end of a sleeve 142 slidable axially within the tailstock spindle 115. This sleeve 142 is keyed to the spindle 115, for this purpose a screw plug 143 being provided which is threaded into a side wall of the spindle 115 and has a reduced extremity 144 riding in a slot 145 in the sleeve 142. The shank 146 of the center block 141 extends rearwardly in the sleeve 142 and through a slot 147 in its rear end. To the rear of this sleeve 142 is positioned a coil spring 148 which reacts between the rear end of this sleeve and a transverse partition 149 of the spindle 115, this acting to press the sleeve 142 forwardly and carrying with it the center 140 so as to hold the work snugly between the head and tailstock centers. A second spring 1480, also surrounding the shank 146, bears at one end against the rear end of the sleeve 142 and against a collar 1481 engaging a transverse pin 1482 extending through the shank 146. This spring 1480 holds the center block 141 with its concave rear face into engagement with the forward end of the sleeve 142, while permitting rocking motion of the block 141. The tailstock center is arranged to be rocked about its bearing against the end of the sleeve 142 to produce the relieving action.

To prevent the entrance of coolant and foreign matter into the tailstock, a conical flexible shield 150 is secured at its forward end to the center block 141 and to its rear end to a boss 151 of the tailstock.

The rear end of the shank 146 is split as at 155 and has a threaded opening 156 to receive a screw 157 (Figures 9 and 10) provided with a head 158 which screw extends through a slot 159 through the spindle 115. On the forward end of the screw 157 is threaded a sleeve 160 having a knurled head 161 at its forward end. This sleeve 160, as shown in Figure 9, is secured to the screw 157 as by a cotter pin 162. The split ends 155 are clamped together as by the thumb screw 165 which extends through a slot 166 in the top of the spindle 115 so that it may be accessible for actuation to clamp or release the screw 157. By adjustment of the screw 157 the tailstock center may be adjusted laterally for parallel or tapered work as may be desired. In the case of taps it is

common practice to provide for taper with the end diameter larger so all the cutting is done by the first few teeth.

The head 158 is pressed by a spring 164 against the face of the lever 170 pivoted between a pair of centers 171 fixed in a pair of oppositely disposed ears 172 of a slide 173. This slide, as best shown in Figure 9, is mounted for vertical sliding movement in a guideway 174 in the rear wall of the tailstock 4 and it may be vertically adjusted by means of a screw 175 threaded thereinto and provided with a head 176 positioned in a recess 177 in a block 178. This block 178 is secured to the rear wall of the casing 4, as by means of a screw 179. The cover 180 of the tailstock casing is provided with an opening 181 in substantial alinement with the head 176 and through which this head is accessible to a screwdriver in order to adjust the slide 173 vertically. This adjustment determines the effective amplitude of motion of the head 158 and thus of the dead center 140 for the relieving action for a given amplitude of swinging motion of the lever 170. When the axis of the centers 171 is in axial alinement with the head 158, swinging motion of the lever 170 is ineffective to oscillate the center block 141 and the center 140, but as the slide 173 is moved upwardly, the amplitude of this relieving motion of the center 140 is increased. The lower end of the lever 170 is formed as a narrowed depending tail 185 (see Figures 6 and 9) to the lower end of which is secured a U shaped guide 186 between the sides of which is positioned an eccentric 187 for bearing on opposed walls thereof. This eccentric 187 is secured to the forward extremity of a stub shaft 188 which is pinned to and within a sleeve 189. This sleeve is journaled in bearings 190 and 191 and is held in axial position by a nut 192 on one side of the bearing 191 which holds this against an annular shoulder 193 of the sleeve 189.

Keyed for longitudinal but non-rotative motion relative to the sleeve 189 is a shaft 194. This shaft 194 extends into a change gear casing 1950 at the tailstock end of the machine (see Figures 1, 2 and 4). On the splined end of this shaft 194 is a gear 195, and clamped to a boss 196 through which the shaft 194 passes is a hanger 197 having a slotted arm 198 for the reception of a stub shaft 199. This stub shaft carries the change gears 200 and 201, the gear 201 meshing with the gear 195 and the gear 200 meshing with a gear 202 on the splined rear end of the shaft 90. A hinged cover 203 provides access to this train of gears so that the speed ratio between the shafts 194 and 90 may be adjusted as desired. Thus for each revolution of the drive shaft 90 and consequently rotation of the work spindle, the correct number of oscillations of the dead center 140 may be produced depending upon the number of flutes in the tap being ground and thus produce a relief on each of the lands between the flutes.

In order to properly relate the direction of relief for right and left hand taps, provision is made for indicating the correct angular position of the cam 187 when a cutting edge of the tap is in the plane of the work and wheel centers. To this end the sleeve 189 is provided with a pointer 1890 which may be turned into registry with the proper mark R or L, on a ring member 1891 secured as by screws to the tailstock of the machine. This adjustment for right or left hand taps may be done only when the change gears 200 and 201 are out of mesh with one or both of their mating gears, as it requires the turning of

the shaft 194 to which the sleeve 189 is keyed relative to the shaft 90.

In setting up for a right hand tap, for example, the slide 173 is adjusted so that the pivots 171 are opposite to the center of the screw 157, in which position the top of the slide 173 is opposite the zero indication on the scale 205 (Figure 6). Thus adjusted, the grinding will be concentric and with or without taper, depending on the setting of the screw 157. The machine can then be adjusted so that the tap is automatically sized to the proper diameter. Then the tap is adjusted angularly to bring a cutting face to a predetermined angular position (which may be determined by any suitable gaging means not shown) and dogged in that position. The sleeve 189 is then adjusted to bring the pointer at 1890 in line with the letter R and the change gears are then brought into mesh. The slide 173 is then moved to position to give the desired eccentricity for relief. The extent of eccentricity is determined by the setting of the slide 173, while the start of the oscillation producing the eccentricity is determined by the setting of the screw 157. Each succeeding tap is dogged when in the same angular position of a cutting edge. Screw 157 being in fixed position, the starting point of the relieving oscillation may remain fixed regardless of the amount of eccentricity, the direction of motion of the slide 173 being sufficiently eccentric to the axis of the shaft 198, so that adjustment for relief does not change the size adjustment. The setting for left hand taps is the same, except that the cutting edges of the tap are faced in the opposite direction and the sleeve 189 is adjusted so that the pointer 1890 is brought into line with the letter L.

The tailstock center construction and control per se are not claimed herein, but form subject matter of a divisional application Serial No. 408,368, filed August 26, 1941, for Tailstock.

The feed and truing mechanism may be of the general type shown in my Patent No. 2,187,227, though there are certain changes in arrangements of the parts which will now be described. This mechanism as shown herein is not herein claimed per se as it forms subject matter of a divisional application Serial No. 397,710 filed June 12, 1941, for Grinding wheel and truing mechanism feed.

The grinding wheel 36 is mounted on a carriage 210 and is driven through a belt connection 211 and suitable driving pulleys from a motor 212 also mounted on the carriage 210 substantially as shown in my Patent No. 2,187,227, this carriage being movable transverse to the axis of the headstock spindle. It is arranged to be fed toward the work by mechanism quite similar to that shown in said patent, the details of which, however, as shown are somewhat different. The carriage 210 is normally pulled rearwardly as far as permitted by the feed mechanism and for this purpose a chain 214 (see Figure 13) is secured to a portion 215 depending from the carriage, the rear end of this chain being secured to a sprocket wheel 216. This sprocket wheel 216 is keyed to a shaft 217 to which is also keyed a second sprocket wheel 218. Around this sprocket wheel 218 is partly wrapped a sprocket chain 220 to the forward end of which is secured a forked link 221. This forked link has a transverse pin 222 at its forward end over which are engaged the upper ends of two coil springs 223. The lower ends of these springs are secured to a suitable portion of the machine base similar to the ar-

angement shown in Figure 11 of my Patent No. 2,187,227.

This portion 215 of the wheel carriage has journaled therein the sleeve 225, the forward end of which is formed as at 226 as a nut for threaded engagement with the rear threaded portion 227 of a feed shaft 228. This feed shaft 228 corresponds to the shaft 645 shown in my Patent No. 2,187,227 and has threaded connection at its forward end with a nut member 230 which carries frictionally mounted thereon a gear 231, this mechanism being the same as that shown in my Patent No. 2,187,227. This gear is driven in relation to a gear 232 journaled on a shaft 233 and has connected thereto a hand wheel 234. This mechanism is the same as that shown in said Patent No. 2,187,227, with the exception that in the present machine the shaft 233 is located to the right of the gear 231 instead of to the left thereof as in my patent, and the bar 235 which is secured to the shaft 228 to hold it from rotation is guided by an extension 236 of the shaft 233 rather than by a separate member. At 240 is shown a truing feed shaft similar to the truing feed shaft 1089 of my patent and which is connected to rotate the sleeve 225 through the gear train comprising the gears 241 on the shaft 240, the idler gear 242, and a gear 243 carried by the shaft 244. The forward end of this shaft 244 has a splined connection with the sleeve 225. Intermediate its ends it also carries a gear 250 meshing with a long gear 251 journaled on a stub shaft 252 of the wheel carriage 210. This long gear 251 also meshes with a gear 253 carried by a shaft 254. This shaft 254 is threaded through a lug 255 forming a portion of the slide 210 and it is journaled in a lug 256 secured to a truing device slide 257. Thus as the shaft 244 is turned to advance the grinding wheel slide 210, it also turns the shaft 254 and advances the wheel truing slide 257 by the same amount, the gears 250 and 253 being of the same size. This action, therefore, is the same as that shown in my Patent No. 2,187,227, each increment of feed of the truing mechanism also being accompanied by an equal increment of feed of the grinding wheel.

The means for rotating the feed mechanism both for the wheel feed through the rotation of the sleeve 225 which is independent of the truing device feed and the rotation of the truing device feed which is associated with an equal wheel feed is accomplished by mechanism somewhat different from that shown in my Patent No. 2,187,227 being controlled in the present machine through electrical mechanism which takes the place of the lay shaft and its operating mechanism disclosed in my prior patent.

This electrical mechanism includes the two electric switches 260 and 261 carried by the headstock and actuated by dogs 262 and 263, respectively, carried by a bar 264 secured to a bracket 265, which in turn is secured to the bar 195. The bar 264 thus partakes of the traverse motion of the head and tailstock spindles thus to move the dogs 262 and 263 into and out of cooperative relation with the switches 261 and 262, respectively. These switches 261 and 262 are normally closed switches and are opened by engagement with their respective dogs, and as will later appear they control the direction of rotation of the motor 80 and also control the energization of a feed solenoid 270. The core of this solenoid is adjustably connected through a yoke 271 and adjusting screw 272 to a link 273 which

is in turn secured to the left hand end of a lever 274 (see Figure 1). This lever 274 is fulcrumed at 275 to the machine bed and is arranged to actuate ratchet mechanisms for turning the shaft 240 and the gear 232 step by step. The shaft 240 carries the ratchet wheel 277 (Figures 1 and 11) and also a rockable collar 278 provided with an arm 279 provided with a ratchet dog 280, which cooperates with the ratchet wheel 277. Similarly the gear 232 for the wheel feed carries the ratchet wheel 282 and a rockable collar 283 provided with the arm extension 284 provided with a ratchet dog 285 for cooperation with the ratchet wheel 282.

The rockable collar 278 is connected through a two-part link 290, 291 to the lever 274 at 292. The two parts 290 and 291 have a pin and slot lost motion connection with each other at 293 and there is also a connection through a coil spring 294 between the lower end of the portion 290 and the upper end of the portion 291 such that rocking of the lever 274 will rock the collar 278 when such motion is permitted, but this collar may be held against rocking, whereupon the spring 294 yields and permits lost motion between the link portions 290, 291.

The ratchet collar 283 is connected to the right hand end of the lever 274 through a pin and slot connection at 298, the lever 274 being also connected at its end through a spring 299 to the same rocking collar 283. Rocking of this lever 274 acting through the spring 299 will also serve to rock the collar 283 and ratchet the gear 232 around when such action is permitted, but if it is prevented the motion is taken up in the lost motion of the pin and slot connection at 298, the spring 299 being stretched. A coil spring 300 connected at one end to the lever 274 and the other to a suitable fixed portion of the machine frame tends to hold the right hand of the lever upwardly with the solenoid core of the solenoid 270 in depressed condition. At 302 is shown a dash pot connected to the lever 274 through the link 303, this having for its purpose to prevent a too sudden motion of the lever 274. At 304 is shown a lubricant pump which is connected for actuation by oscillation of the lever 274.

The truing feed actuated by rotation of the shaft 240 may be prevented, for this purpose the collar 278 having an extension 310 (see Figure 1) provided with a latch pin 311 which may engage in a notch 312 in a latch lever 313 fulcrumed at 314 to the machine frame and carrying at the opposite side of its fulcrum a dog 315. This prevents actuation of the truing device feed until such time as the oscillation of the lever 274 acting through the ratchet wheel slide feed has turned the gear 231 sufficiently to cause a dog 320 adjustably secured in a concentric groove thereof to contact the dog 315 and rock the lever 313 in a direction to release the latch pin 311, whereupon further oscillation of the lever 274 frees the ratchet collar 278 for rocking, thus to cause the oscillation of the lever 274 to actuate the truing device feed and with it, by an equal increment, the wheel feed, quite independently of and in addition to the wheel feed produced by turning of the gear 232. Should the feed wheel be turned far enough for the dog 320 to pass beyond the dog 315, the truing feed then becomes latched against actuation and wheel feed without truing is re-established until such time as another dog 320 on the wheel 231 reaches a position to release the latch. Thus truing may be effected at any point or points desired in the

grinding cycle at the time of a work feed, as, for example, prior to or after finish grinding, or at both times, depending upon the settings of the wheel dogs 320. The feed of the wheel slide through rotation of the gear 232 may be stopped at any desired point by a positive stop mechanism such as is disclosed in my Patent No. 2,187,227, and a portion of which, including a spring 316 and related parts, is shown in Figure 1. Likewise the grinding wheel slide may be moved independently of the ratchet feed mechanisms by the rocking of the lever 325 corresponding to the lever 649 shown in the same patent, and which may be controlled in the same manner as shown therein.

It will be noted that in the patented structure the amount of feed, whether through the wheel slide or the truing device, is adjustable by changing the effective lever arms of the actuating mechanism. In the present case the effective lever arms of the actuating mechanism remain fixed and the adjustment of the stroke of the ratchet dogs is accomplished by other means. As shown in Figure 1, the adjustment for the length of feed of the ratchet dog 280 is effected by the angular adjustment of a dog knock-off plate 330 having a pin and slot connection at 331 to a fixed portion of the machine bed and having a shield 332 which may cover more or less of the teeth of the ratchet wheel 277, thus to adjust the proportion of the stroke of the ratchet dog 280 which is effective in rotating the ratchet wheel 277. Similarly the effective length of stroke of the dog 285 is produced by the angular adjustment of a similar shield 335. This feed mechanism is not claimed herein, but forms subject matter of a copending application Serial Number 397,710, now Patent No. 2,284,954, granted June 2, 1942, for Grinding wheel and truing mechanism feed.

In Figure 14 is shown a wiring diagram of the controls of the motor 80 and the solenoid 270. As shown in this figure, the motor 80 is of the three-phase type wired to rotate in opposite directions in accordance with the closure of the two control switches 340 and 341, the power being derived from the three-phase leads 342, 343, 344. The switches 340 and 341 are normally open switches, but they may be closed by energization of their respective closing coils 346 and 347.

At 348 and 349 is shown a pair of direct current control lines. The line 349 leads to one side of the starting switch 350, which when depressed completes a circuit through the normally closed stop switch 351, switch coil 352, lead 353, the normally closed switch 354, and overload switch 355 to the opposite lines 348. Energization of the switch coil 352 closes the normally open three-pole switch 360. The closure of the contact at 361 of this three-pole switch short circuits the starting switch 350 through the leads 362 and 363, so that the starting switch 350 may be allowed to open without de-energizing the coil 352, though opening of the stop switch 351 will do so. Assuming that the work spindle is at the left hand limit of its traverse so that the switch at 260 is closed, and the switch at 380 is open, the alternating current line 342 is connected through the leads 365 and 366, the switch 260, leads 367, 368, the switch coil 347, lead 369, contact 364 of the switch 360, lead 370, contact 371 of the relay 372 and leads 373 and 374 to the alternating current line 344. At this time the relay 372 is in the position shown in its armature rocked toward the electromagnet 438. This en-

ergization of the coil 347 closes the motor switch 341 and energizes the work carriage motor 80 to cause traverse of the work carriage toward the right. At the same time current passes between the lead 368, coil 375 of the three-pole switch 376 and lead 374 to the lines 344, thus closing two of the poles and opening the intermediate third pole of the three-pole switch 376. As the carriage moves to the right, the removal of the right hand dog from the switch 380 permits this switch to close. This closes a circuit from the line 342 through leads 365, 366, a switch 380, leads 381 and 382, through the coil 383 of the three-pole switch 384 and lead 374 to the line 344, thus closing two contacts of the switch 384 while opening the central contact, so that both switches 376 and 384 are now in their two-pole closed position. This completes a direct control circuit from the line 349 through leads 385, 386, contact 387 of switch 376 and contact 388 of switch 384, lead 389, coil 390 of the three-pole switch 391, to the line 348, thus closing the upper two contacts of the switch 391 and opening the lower contact. The closing of the contact 392 of this switch 391 closes a circuit from the direct current control line 348 through the switch 355, leads 393 and 394, contact 392, lead 395, through the coil 396 of a two-pole time delay switch 397, through lead 385 to line 349. Closing of contact 391' closes a holding circuit for the coil 352 from the lead 394, lead 353 and lead 363.

The carriage movement finally opens the switch 260, de-energizing the three-pole switch 375, opening the two outside contacts and closing the central one. The opening of the contact at 387 breaks the circuit through the coil 390 of the three-pole switch 391 allowing the two upper poles of this switch to open and the lower one to close. This opens the contact 392 and de-energizes the time delay switch coil 396, but this time delay switch 397 remains closed for a predetermined time so that current continues to pass through its contact 398 from the direct current line 349, through lead 399, contact 398, lead 400, coil 401 of the relay 402, lead 426, closed contact 425, lead 393, switch 355 to the direct current line 348. Closing of the relay 402 energizes the wheel feed solenoid 270 from the direct current line 348, lead 404, coil 270, lead 405, relay 402, and lead 406 to line 349. The wheel feed lever 274 thus makes one stroke. The purpose of the time delay switch 397 is to give the solenoid 270 and the motor 80 time to complete their operation. When this time delay switch 397 finally opens, it de-energizes the coil 401 allowing the relay 402 to open and closes the contact at 410. This closes the circuit from the alternating current line 342 through the contact 410, the lead 411, closed contact 413, lead 414, closed contact 415, lead 416, through the left hand coil 417 of the relay 372, leads 373 and 374 to the alternating current line 344. The armature of the relay 372 is thus pulled to the left, breaking the circuit at 371, allowing the main switch 341 to open and stopping the work traversing motor 80 and making contact at 420. Closing of the contact at 420 closes a circuit from the alternating current line 344 through leads 374 and 373, contact 420, lead 421, contact 422 of the switch 360, lead 423, coil 346 of the switch 340, lead 381, dog switch 380, leads 366 and 365, to the alternating current line 342. This starts the work motor 80 rotating in the reverse direction with carriage traverse to the left. When the traverse dog permits closing of the contact 380, both of

the three-pole switches 376 and 384 are moved to two-pole closed position as heretofore described. This closes two poles of the switch 391 and the time delay switch 397. This continues until the stop dog opens the switch 260 which permits the switch 384 to move to two-contact open position. Opening the contact at 388 breaks the circuit with the coil 390 and allows the switch 391 to move to two-pole open position, but closes the contact at 425 so that with the delay switch 397 holding on, the solenoid 270 is energized to provide a single wheel feed action as before described. Opening of the switch 384 to two-pole open position closes the contact at 430, so that when the time delay switch lets go and closes the contact 410, a circuit is closed through from the alternating current line 342 through the lead 365, contact 410, leads 411 and 413, closed contact 432, lead 433, contact 430, lead 434, right hand relay coil 438, contact 436, relay 372, leads 373 and 374 to the alternating current line 344. This throws the relay 372 to the right into the position shown in Figure 14, whereupon the cycle is repeated with the work carriage traversing toward the right.

From the foregoing description of an embodiment of this invention, it should be evident to those skilled in the art that various changes and modifications might be made without departing from the spirit or scope of this invention as defined by the appended claims.

I claim:

1. In a machine of the class described, a bed, a headstock and a tailstock, means for clamping said stocks to said bed, said head and tailstocks having spindles movable axially relative thereto, means eccentric to and connecting said spindles for simultaneous motion in the same direction relatively to their stocks; and means for so moving said spindles.

2. In a machine of the class described, a bed, a headstock and a tailstock, means for clamping said stocks to said bed, said head and tailstocks having spindles movable axially relative thereto, means eccentric to and connecting said spindles for simultaneous motion in the same direction relatively to their stocks, means for so moving said spindles, and means for adjusting independent of the spacing of said stocks the spacing between said spindles.

3. In a machine of the class described, a bed, a headstock and a tailstock, means for clamping said stocks to said bed, said head and tailstocks having axially movable spindles, means eccentric to and connecting said spindles for simultaneous motion in the same direction, means for so moving said spindles, and means for adjusting the connection of said connecting means to one of said spindles lengthwise of said connecting means to adjust the spacing of said spindles.

4. In a machine of the class described, a bed, a headstock and a tailstock, means for clamping said stocks to said bed, said head and tailstocks each having a spindle movable axially relative thereto, means for moving one of said spindles axially relative to its stock, a member eccentric to and movable with said one spindle relative to its stock and extending in proximity to the other of said spindles, and means for releasably locking said other spindle to said member.

5. In a machine of the class described, a bed, a headstock and a tailstock, means for clamping said stocks to said bed, said head and tailstocks each having a spindle movable axially relative to its respective stock, a lead screw carried by one

of said spindles, means for rotating said one spindle, a fixed nut engaging said lead screw, a member held from rotation with said one spindle but connected for axial motion therewith, and means for releasably securing the other of said spindles to said member to be moved axially relative to its stock by the motion of said member.

6. In a machine of the class described, a bed, a headstock and a tailstock, means for clamping said stocks to said bed, said head and tailstocks each having a spindle movable axially relative to its respective stock, a lead screw carried by one of said spindles, means for rotating said one spindle, a nut engaging said lead screw, means for clamping said nut in adjustable angular relation and against axial motion, a member held from rotation with said one spindle but connected for axial motion therewith relative to its stock, and means for releasably securing the other of said spindles to said member to be moved axially relative to its stock by the motion of said member.

7. In combination, a headstock, a rotary and axially movable work-holding and driving spindle carried by said headstock, a drive shaft substantially parallel to said spindle, a long gear on said shaft, a lead screw secured to said spindle, a normally fixed nut engaging said lead screw, a pair of spaced gears carried by said spindle in driven engagement with said long gear, a member positioned between said spaced gears movable with the axial motion of said spindle but non-rotatable therewith, a tailstock having an axially movable spindle in operative alignment with said headstock spindle, and operative connections from said member causing axial motion of said tailstock spindle with said headstock spindle.

8. In combination, a headstock, a rotary and axially movable work-holding and driving spindle carried by said headstock, a drive shaft substantially parallel to said spindle, a long gear on said shaft, a lead screw secured to said spindle, an axially fixed nut engaging said lead screw, means for clamping said nut against rotation with said lead screw, means actuatable to adjust said nut angularly when said clamping means is released, a pair of spaced gears carried by said spindle in driven engagement with said long gear, a member positioned between said spaced gears movable with the axial motion of said spindle but non-rotatable therewith, a tailstock having an axially movable spindle in operative alignment with said headstock spindle, and operative connections from said member causing axial motion of said tailstock spindle with said headstock spindle.

9. In combination, alined head and tailstock spindles, means supporting said spindles for axial motion and said headstock spindle for rotation, a lead screw, operative connections from said lead screw to said headstock spindle for causing the rotation of said headstock spindle to produce axial motion thereof, connections between said spindles causing the axial motion of said headstock spindle to produce corresponding axial motion of said tailstock spindle, centers carried by said spindles, and means for oscillating one of said centers in time with the rotation of said headstock spindle.

10. In combination, alined head and tailstock spindles, means supporting said spindles for axial motion and said headstock spindle for rotation, a lead screw, operative connections from said lead screw to said headstock spindle for causing the rotation of said headstock spindle to produce axial motion thereof, connections between said spindles

causing the axial motion of said headstock spindle to produce corresponding axial motion of said tailstock spindle, centers carried by said spindles, means for oscillating one of said centers in time with the rotation of said headstock spindle, and means for indicating the proper relation of such oscillation with reference to the angular position of said headstock spindle.

11. In combination, alined head and tailstock spindles, means supporting said spindles for axial motion and said headstock spindle for rotation, a lead screw, operative connections from said lead screw to said headstock spindle for causing the rotation of said headstock spindle to produce axial motion thereof, connections between said spindles causing the axial motion of said headstock spindle to produce corresponding axial motion of said tailstock spindle, centers carried by said spindles, means for oscillating one of said centers in time with the rotation of said headstock spindle, a cutting tool across which work carried by said centers traverses by axial motion of said spindles, and means for adjusting one of said centers laterally of such axial motion to cause work to be cut parallel or tapered depending on such adjustment.

12. In combination, alined head and tailstock spindles, means supporting said spindles for axial motion and said headstock spindle for rotation, a lead screw, operative connections from said lead screw to said headstock spindle for causing the rotation of said headstock spindle to produce axial motion thereof, connections between said spindles causing the axial motion of said headstock spindle to produce corresponding axial motion of said tailstock spindle, centers carried by said spindles between which a tap to be ground may be placed, a grinding wheel positioned to grind the threads of the tap, means for oscillating one of said centers in time with the rotation of said headstock spindle, and means for indicating the proper relation of such oscillation to relieve the lands on the tap depending on whether the tap is right or left hand and with reference to a definite angular position for a cutting edge of said tap.

13. In a machine of the class described, a bed, a headstock and a tailstock, means for clamping said stocks to said bed, said head and tailstocks each having an axially movable spindle, a lead screw carried by one of said spindles, means for rotating said one spindle, a fixed nut engaging said lead screw, a member held from rotation with said one spindle but connected for axial motion therewith, means for releasably securing the other of said spindles to said member to be moved axially by the motion of said member, one of said spindles having a center, and means for adjusting said center laterally.

14. In a machine of the class described, a bed, a headstock and a tailstock, means for clamping said stocks to said bed, said head and tailstocks each having an axially movable spindle, a lead screw carried by one of said spindles, means for rotating said one spindle, a fixed nut engaging said lead screw, a member held from rotation with said one spindle but connected for axial motion therewith, means for releasably securing the other of said spindles to said member to be moved axially by the motion of said member, one of said spindles having a center, and means for oscillating said center laterally in time with the rotation of said one spindle.

15. In a machine of the class described, a bed, a headstock and tailstock, means for clamping

said stocks to said bed; said head and tailstocks each having an axially movable spindle; a lead screw carried by one of said spindles; means for rotating said one spindle; a fixed nut engaging said lead screw, a member held from rotation with said one spindle but connected for axial motion therewith, means for releasably securing the other of said spindles to said member to be moved axially by the motion of said member, one of said spindles having a center, means for adjusting said center laterally, and means for oscillating said center laterally from its laterally adjusted position in time with the rotation of said one spindle.

16) In combination, work supporting means, a reversible electric motor driven means for traversing said work supporting means; a tool carrier movable transverse to the line of traverse, a solenoid connected to said carrier and constituting a motor for producing such transverse motion, a pair of traverse limit switches operated by traverse of said work support, and means controlled by said switches for controlling said motor to produce traverses in opposite directions of the work supporting means and to actuate said solenoid to feed the tool relative to said work supporting means.

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