The invention relates to grinding machines, and more particularly to a machine for grinding cylindrical surfaces, such as crankshafts.

One object of the invention is to provide a simple, thoroughly practical grinding machine construction. Another object of the invention is to provide an improved electrical control mechanism for a grinding machine. Another object of the invention is to provide a grinding machine having an electrically actuated grinding wheel traversing mechanism. Another object of the invention is to provide a grinding machine having an electrically actuated grinding wheel traversing mechanism. Another object of the invention is to provide an improved grinding machine and control mechanism therefor in which the work table traversing mechanism, the wheel head traversing mechanism, the work rotating mechanism and the grinding wheel driving mechanism are all electrically controlled.

A further object of the invention is to provide a single control lever for controlling the longitudinal traversing movement of the table when moved in one direction and to control the traverse movement of the grinding wheel head when moved in another direction. A further object of the invention is to provide an improved interlock control mechanism for an electrically actuated table traverse mechanism and an electrically actuated wheel head traversing mechanism. Another object of the invention is to provide an interlocked electrical control mechanism whereby the rotation of the work, longitudinal traverse of the work table, traverse traverse of the grinding wheel slide and the movement of the work steady rest are all interlocked. Other objects will be in part obvious or in part pointed out hereinafter.

The invention accordingly consists in the features of construction, combinations of elements, and arrangements of parts, as will be exemplified in the structure to be hereinafter described, and the scope of the application of which will be indicated in the following claims.

In the accompanying drawings, in which is shown one of various possible embodiments of the mechanical features of this invention,

Fig. 1 is a front elevation of the improved grinding machine, having parts broken away and shown in section more clearly to show the operating construction;

Fig. 2 is a right-hand end elevation, on an enlarged scale, of the improved crankpin grinding machine;

Fig. 3 is an electrical wiring diagram of the electrical control units of the machine;

Fig. 4 is a fragmentary rear elevation, on an enlarged scale, showing the wheel slide construction and the operating mechanism therefor;

Fig. 5 is a fragmentary plan view of the limit switch assembly and operating dogs for the wheel slide;

Fig. 6 is a side elevation of the limit switches and dogs for controlling the same, as shown in Fig. 5;

Fig. 7 is a fragmentary vertical sectional view, taken approximately on the line 7—7 of Fig. 4, showing the two-speed traversing mechanism for traversing the wheel slide;

Fig. 8 is a fragmentary vertical sectional view, on an enlarged scale, taken approximately on the line 8—8 of Fig. 2, through the control lever mechanism for the table and wheel units;

Fig. 9 is a fragmentary cross sectional view, taken approximately on the line 9—9 of Fig. 8;

Fig. 10 is a fragmentary cross sectional view, taken approximately on the line 10—10 of Fig. 8;

Fig. 11 is a vertical sectional view through the control lever mechanism, taken approximately on the line 11—11 of Fig. 8;

Fig. 12 is a fragmentary sectional view, taken approximately on the line 12—12 of Fig. 11;

Fig. 13 is a horizontal sectional view, taken approximately on the line 13—13 of Fig. 12;

Fig. 14 is a fragmentary perspective phantom view of the electrically driven table traversing mechanism;

Fig. 15 is a fragmentary sectional view, on an enlarged scale, through the work steady rest, taken approximately on the line 15—15 of Fig. 11;

Fig. 16 is a fragmentary vertical section through a portion of the steadyrest, taken approximately on the line 16—16 of Fig. 15; and

Fig. 17 is a fragmentary detail view of the cam and limit switch on the left-hand side of the steadyrest.

An improved grinding machine embodying this invention has been illustrated in the drawings, comprising a base 28 which supports a longitudinally movable work supporting table 21 which is arranged to slide longitudinally on a V-way 22 and a flat way 23 on the base 28. The work supporting table 21 supports a pair of opposed work supporting and rotating heads 24 and 25, each of which supports a rotatable work supporting spindle 26 and 27 carrying work holders 28 and 29, respectively. The work holders 28 and 29 are provided with work clamps 30 and 31 by which a work piece such as a crankshaft to be ground...
may be clamped in an operating position on the machine. The details of the work clamping mechanism have not been illustrated, since this feature is not considered to be part of the present invention. These clamping members 30 and 51, as illustrated, are manually operable clamping members, such as for example shown in the prior United States Patent to Norton No. 1,563,310 dated November 24, 1925, to which reference may be had for a more complete disclosure of the work clamping mechanism.

The work spindles 26 and 27 are arranged so that they may be rotated in synchronism to rotate the opposite ends of the work piece, such as a crankshaft 205. An electric motor 36 is adjustable mounted on the table 21 and is provided with a driving pulley 38 which is connected by a driving belt, such as multiple V-belts 37, with a pulley 38 which is mounted on the end of a shaft 39 which is journaled in a bearing 40 which is supported on the work head 24. The other end of the shaft 39 is provided with a splined portion 41 which meshes with an internally splined portion 42 in a rotatable hollow shaft 43. The shaft 43 is journaled in bearings 44 and 45 carried by the work supporting heads 24 and 25, respectively. The hollow shaft 43 is provided with pulleys 46 and 47 which are slidably keyed to the hollow shaft 43 so as to facilitate longitudinal adjustment of the work heads 24 and 25, respectively. The pulleys 46 and 47 are connected by driving belts 48 and 49 with pulleys 50 and 51, respectively, which are mounted on work rotating spindles 26 and 27.

The driving belts 48 and 49 are preferably of the multiple V-belt type comprising a plurality of driving belts of V-shaped cross-sectional area which ride upon multiple grooves in the pulleys 46-50 and 47-51, respectively. By providing a drive as above described, a uniform driving torque is synchronously applied to each end of the work piece or crankshaft to be ground.

To facilitate grinding of crankshfts of different lengths, the work heads 24 and 25 are arranged to slide longitudinally on guiding and supporting surfaces 52 on the top of the work supporting table 21. The head 24 is provided with clamping members 53 and 54 and the head 25 is provided with clamping members 55 and 56. By means of which the heads may be locked in adjusted position on the table 21.

A rotatable grinding wheel 60 is mounted on the outer end of the wheel spindle 61 which is rotatably journaled in a transversely movable wheel slide 62. The other end of the wheel spindle 61 is provided with a driving pulley 63 which is connected by multiple V-belts 64 with a pulley 65 mounted on the outer end of a motor armature shaft 66 carried by an electric driving motor 67 which is mounted on the upper surface of the wheel slide 62. The wheel slide 62 is preferably supported on a transversely movable intermediate slide 68. The wheel slide 62 is supported on a transversely extending V-way 69 and flat way 70 on the intermediate slide 68. The intermediate slide 68 is in turn supported on a V-way 71 and a flat way 72 on the base 28 (Fig. 4).

The wheel slide 62 is arranged to be moved transversely on the intermediate slide 68 by a power operated mechanism, to be hereinafter described, to move the wheel rapidly toward or from an operating position with relation to the work piece. The wheel 66 is arranged so that it may be manually fed into the work piece to grind the same to the required and predetermined size. This mechanism may comprise a manually operable wheel feeding mechanism of the type shown in the aforementioned United States patent to C. H. Norton No. 762,838 dated June 14, 1904, to which reference may be had for a detailed disclosure thereof. The intermediate slide 68 is provided with a depending half nut 75 which meshes with or engages a rotatable cross feed screw 76 which is rotatably supported 77 in suitable bearings (not shown) in the base 28. The feed screw 76 is connected to or formed integral with a shaft 77 which projects from the front of the machine base and is operatively connected to be rotated by a manually operable feeding wheel 78.

The wheel slide 62 is provided with a power operated traversing mechanism which is arranged to move the slide first at a rapid rate to cause the grinding wheel 60 to approach the work piece and then to reduce the approaching speed to a proper speed for grinding the cheeks or end faces adjacent to a crankpin, if desired. In the preferred form, an electric motor driven driving mechanism is provided for moving the wheel slide 62 transversely relative to the intermediate slide 68 and the base 28. This mechanism comprises an electric motor 80 supported on a bracket 81 on the intermediate slide 68. The motor 80 is provided with a driving pulley 82 which is connected by a driving belt 83 with a pulley 84 mounted on the outer end of a rotatable shaft 85. The shaft 85 is journaled in a boss 86 projecting outwardly from a gear casing 87 which is fixed to the intermediate slide 68.

The inner end of the shaft 85 is provided with a gear 88 which meshes with a gear 89 supported on a shaft 90 which is rotatably journaled in bearings (not shown) in the casing 87. The shaft 90 supports a spiral gear 91 which is keyed thereto and rotate therewith. The spiral gear 91 meshes with a spiral gear 92 rotatably supported on a shaft 93 which is supported in bearings 97 and 98, respectively, in the casing 87. The gear 93 is free to rotate on the shaft 96 when driven by the spiral gear 94. The shaft 92 is provided with a worm 95 meshing with a worm gear 100 which is rotatably supported on the shaft 96. In order to transmit a rotary motion to the shaft 96, a movable clutch member 101 is slidably keyed thereto and is provided with clutch teeth at its opposite ends which are arranged to engage clutch teeth formed on the inner surface of the gear 95 or to engage a set of clutch teeth on the inner face of the worm gear 100 so that either the spiral gear 95 or the worm gear 100 may be locked by the clutch member 101 to rotate the shaft 96, either at a fast or a slow speed, as desired.

In order to shift the clutch member 101, a yoked member 102 is pivotally mounted on a stud 103 carried by the casing 87. An upwardly extending arm 104 is also supported on the stud 103 and is connected to move the yoked member 102. A spring 105 is connected between connected 106 carried by the casing 87 and a stud 107 carried by the arm 104 and serves normally to hold the clutch member 101 in engagement with the clutch teeth on the worm gear 100 to rotate the shaft 96 at a comparatively slow rate. In order to shift the clutch member 101 into engagement with the gear 95 to rotate the shaft 96 at a
comparatively rapid rate, an electric solenoid is provided and supported on a bracket which is fixed to or integral with the casing. The armature of the solenoid is connected by a screw and a stud with the upper end of the arm and is arranged so that when the solenoid is energized, the arm is rocked in a clockwise direction (Fig. 7) to shift the clutch member into engagement with the clutch teeth on the gear at a comparatively rapid rate.

The outer end of the shaft is provided with a sprocket which is connected by a link chain to the sprocket mounted on the outer end of a rotatable feed screw which is journalned in suitable bearings (not shown) in the intermediate slide. A half nut depends from the wheel slide and engages or meshes with the feed screw so that when the feed screw is rotated by the gear mechanism above described, the wheel slide will be moved transversely to cause the wheel to approach or recede from the work piece being ground either at a fast or at a slow speed. In order to maintain the desired driving tension on the link chain, the sprocket is rotatably mounted on a stud which is carried by an idler bracket which is pivotally supported on a stud fixed to the rear of the intermediate slide. A clamping screw passes through an elongated slot in the idler bracket and is screwed through the end of the intermediate slide. By manipulation of the screw, the idler bracket may be swung to take up the slack in the driving chain and then locked in adjusted position.

To facilitate an interlocking of the various mechanisms of the machine and controlling the electrical circuits therefor, a series of electrical switches, such as limit switches and switches which are mounted on the upper surface of the casing which is carried by the intermediate slide. A plate fixed to the wheel slide carries a plurality of adjustable dog bars which are arranged to engage and actuate the normally closed limit switches which are mounted on the plate. A dog bar or plate is adjustable to the plate by means of a screw which passes through an elongated slot in the plate. The dog bar is arranged so as to engage and actuate the limit switch when the wheel slide is moved. A similar dog is held in adjusted position on the plate by means of a screw which passes through an elongated slot. The dog bar is arranged to engage and actuate the switch when the wheel slide is moved. The operation of the limit switches above described, together with their inter-connection with the various mechanisms of the machine, will be described hereinafter.

The work table is arranged so that it may be traversed either manually or by power. A manually operable traverse mechanism is provided including a manually operable hand wheel which is connected through a worm gear mechanism (not shown) with a rack bar depending from the table. The manually operable traverse mechanism is not considered to be part of the present invention and consequently has not been illustrated in detail. This mechanism may be arranged substantially as shown in the prior expired patent to Norton No. 762,838 dated June 14, 1904, to which reference may be had for a more detailed disclosure of the manual traverse mechanism.

**Power traverse—work table**

It is desirable to provide a power operated traverse mechanism which is preferably arranged so that the work supporting table may be traversed rapidly to position various portions of the crankshaft in the operative relation with the grinding wheel, or moved at a relatively slow rate in either direction for truing the grinding wheel. An electrically driven mechanism is provided comprising a reversible electric motor which is supported on the rear of the base of the machine. An armature shaft is provided with a pulley which is connected by a driving belt to the pulley mounted on the end of a rotatable shaft. A gear is either fixed to or formed integral with the shaft. A movable clutch member is slidably keyed to a rotatable shaft. The clutch member is arranged so that it may be moved by means of a yoked member which is mounted on one end of a shaft. A lever and a link serve to rock the yoked member to shift the movable clutch member when desired. When the clutch member is thrown into engagement with a set of clutch teeth, which are formed integral with the shaft and gear, a rotary motion is transmitted to the shaft.

**Rapid table traverse**

The other end of the shaft carries a gear which meshes with a gear supported on the end of a rotatable shaft. The shaft carries a worm meshing with a worm wheel which is rotatably mounted on a shaft. The shaft carries a gear meshing with a gear which is rotatably supported on a shaft. The shaft supports a gear which meshes with a large gear mounted on the end of a shaft. The shaft is provided with a driving pinion which meshes with the rack bar depending from the table, so that when the clutch member is thrown into engagement with the clutch teeth, the rotary motion transmitted from the reversible electric motor is transmitted through the gear mechanism, above described, to the rack bar to traverse the table longitudinally at a relatively rapid rate.

**Slow table traverse**

In order to obtain a slow movement of the table for a truing operation, a reduction gear mechanism is provided comprising a gear which meshes with the gear and is supported on a rotatable shaft. The shaft supports a worm meshing with a worm gear mounted on a rotatable shaft. The shaft carries a gear which meshes with the rack bar.
plies a worm 200 which meshes with a worm gear 201 rotatably supported on the shaft 168. The gear 201 is provided with clutch teeth 202 which may be engaged by the movable clutch member 164. When a slow traverse of the table 21 is desired, the yoked member 166 is rocked in a clockwise direction to move the clutch member 164 toward the left (Fig. 14) so that it engages the clutch teeth 202 carried by the gear 201. Power from the reversible motor 181 is then transmitted through the gear 163, the gear 185, the shaft 196, the worm 197, the worm gear 188, the shaft 189, the worm 200, the worm gear 201, the clutch teeth 202, to rotate the clutch member 164 and the shaft 166 to transmit a rotary motion to the gear mechanism 115 to 107 inclusive to transmit a slow traversing movement to the rack bar 165 and the table 21.

Steadyrest

The work piece, such as the crankpin 205 being ground, is preferably steadied by a steadyrest 206 having a downwardly extending frame 207 which is fixedly mounted on the front of the machine base 26. The steadyrest frame 206 is arranged to support a movable steadyrest shoe 210 which may be moved into and out of an operative position by means of a handle 208. The slide 206 carries a pivotally mounted steadyrest shoe 210 which is arranged to engage the under side of the work piece 209 at a point adjacent to the line of contact between the work piece 209 and the operative face of the grinding wheel 60. The frame 206 also supports a horizontally movable steadyrest shoe 211 which is arranged to engage the work piece at a point diametrically opposite the line of contact between the grinding wheel 60 and the work piece 209.

The lower steadyrest shoe 210 is pivotally mounted on a stud 212 carried by the slide 208. The steadyrest shoe 210 is held in an upward position by means of a link 213 which is connected by a stud 214 with the shoe carrying member and is connected by a stud 215 with a slide block 216 which is actuated by a rod 217. The rod 217 may be precisely adjusted to maintain the steadyrest shoe 210 in supporting engagement with the work piece 209 by means of a knob 218 which is threaded onto a screw threaded portion 219 of the rod 217. To facilitate rapid removal of the lower shoe 210 from engagement with the work, a quick acting sleeve 220 supports the outer end of the rod 217 and is arranged so that when rotated by a handle 221 through a quarter turn, it may be rapidly withdrawn toward the left (Fig. 15) rapidly to slide the rod 217 and drop the work steadying shoe from operative engagement with the work piece 209. The work steadying shoe 211 is carried by a transversely movable slide 225 which is supported in the slide 206 and is adjusted relative thereto by means of a nut 226 and a screw 227.

The steadyrest slide 208 is arranged so that it may be rapidly moved to and from an operating position. As illustrated in Fig. 15, a spring presssed locating plunger 230 engages a locating aperture in the under side of the slide 208 and serves to hold the slide in an operating position during a grinding operation. When it is desired to traverse the table 21 or to remove a work piece 209, the slide 208 is spring disengaged from the machine, the locating plunger 230 may be rapidly withdrawn from the notch in the slide 208 by raising the lever 231 and then pulling the handle 209 to withdraw the steadyrest to an inoperative position.

In the present machine, the work rest is of a massive construction and requires considerable effort on the part of the operator manually to withdraw the same by means of the handle 208. To facilitate the withdrawal of the steadyrest to an inoperative position, a rack and gear mechanism is provided. A rack bar 235 is mounted on the slide 208. A gear 236 is mounted on a rotatable shaft 237 and meshes with the rack bar 235. The shaft 237 is journaled in suitable bearings in the steadyrest frame 207. A crank handle or lever 238 (Figs. 2 and 16) is mounted on the outer end of the shaft 237 and is arranged so that by manipulation of the lever 238, the steadyrest slide 208 may be readily moved to and from an operative position without undue exertion on the part of the operator.

Interlock—steadyrest and table traverse

It is desirable in a machine of this type to provide suitable interlocks between the various mechanisms of the machine to insure safe operation thereof. It is desirable to provide an interlock between the steadyrest and the table traverse mechanism which is so arranged that the table is prevented from a forward or operating position. To accomplish this result, a normally open limit switch 240 is mounted on a bracket 241 on the left-hand side of the steadyrest casing (Fig. 16). When the steadyrest is in a forward position, as indicated in Fig. 16, the limit switch 240 remains open, thereby causing a break in a circuit which controls the table traverse mechanism, so that the table movement cannot be started. A cam 242 is mounted on the end of the shaft 237 and is arranged so that when the lever 238 controlling the movement of the steadyrest is turned to withdraw the steadyrest to an inoperative position, the cam 240 swings into the position illustrated in Fig. 17 to close the limit switch 240 so that the table may then be traversed by manipulation of the table traverse control lever. This mechanism serves to prevent accidental starting of the table traverse when the work steadyrest and shoes are in an operating position between the crank arms of a crankshaft 205.

Interlock—work rotation and steadyrest

It is also desirable to provide an interlock between the work rotation and the steadyrest, so that the work piece or crankshaft cannot be rotated unless the steadyrest is in a forward or operating position. A limit switch 245 is mounted within the steadyrest casing 207. The roller 246 of the limit switch 245 is arranged in the path of a head 247 on the lower end of the locating plunger 235, so that when the lever 231 is lifted to withdraw the locating plunger 230 so that the rest may be withdrawn to an inoperative position, the head 247 of the plunger 230 engages the limit switch roller 245 and opens the limit switch 246, thereby breaking a circuit to the headstock or work driving motor 35 to prevent rotation thereof during the time the rest is in a rearward or inoperative position.

Main control lever

It is desirable to provide a single main control lever which is operatively connected and arranged so that when the lever is moved into various control positions, the movement of the table may be controlled to traverse the table in either direction at a comparatively slow rate to position the work piece in operative relation with the grinding wheel or may be moved at a slow rate.
rate for truing the grinding wheel. The control lever is also arranged so that when moved into a different position, the lever will control the forward and reverse feeding movements of the grinding wheel. A main control lever 250 is slidably and rotatably mounted within a sleeve 251 (Figs. 8 and 11) which is pivotally supported on a yoked member 252 by means of a stud 253 which passes through the two arms of the yoke 254 (Fig. 11) and through an enlarged portion of the sleeve 251. This pivotal connection serves to permit the control lever 250 to be rocked toward and from the machine. The yoked member 252 is provided with a horizontally extending stud or trunnion 254 (Fig. 11) which is journaled in a bearing 255 so that the lever 250 may be rocked sideways in either direction. The bearing 255 is formed as an integral part of a control apron 256 which is fastened to the front of the machine base 20. A cover plate 257 on the apron 256 is provided with an H-shaped opening 256 (Fig. 10) which serves to control the in and out and sidewise movement of the control lever 250.

The control lever 250 comprises a central rod 260, the lower end of which is supported in a bearing 261 in the sleeve 251. A sleeve 262 surrounds the upper portion of the rod 260 and is supported in a bearing 263 carried by the sleeve 264 and surrounds the rod 260 and is contained within an enlarged aperture within the sleeve 251 and is interposed between a shoulder at the bottom of the enlarged hole within the sleeve 251 and the end of the sleeve 262 and serves normally to hold the sleeve 262 and rod 260 in a neutral position. The lever 250 has been shown in its central or neutral position (Figs. 8, 10 and 11).

The sleeve 251 is provided with two rearwardly extending lugs 266 and 267 which support a rod 268. The yoked member 252 is supported by a pair of slidably mounted rods 271 and 272 (Figs. 11 and 12) which are slidably supported in bearings 273 and 274 in the apron 256. The slide rods 271 and 272 serve to support a member 275 having a cam track 276 formed in its lower surface. The member 275 is mounted and supported on the base slide rods 271 and 272 and has its opposite ends slotted and provided with clamping screws 280 and 281 by means of which the member 275 may be clamped in adjusted position on the rods 271 and 272. A follower 282 (Figs. 11 and 12) engages the cam track 276 and is formed on the upper end of a lever 283 supported on one end of a rotatable shaft 284 which is journaled in a bearing member 285 in the apron 256. The other end of the shaft 284 is provided with a downwardly extending lever 286 which is connected by a stud 287 with a yoked end 288 of the connecting link 168 which is connected to actuate the clutch member 164.

When the control lever 250 is moved in a clockwise direction (Fig. 11) about the pivot 253 into position 290a (Fig. 10), the rod 268, yoke member 275, slide rods 271 and 272 serve to move the cam member 275 toward the right (Fig. 11) which in turn serves to rock the follower 282 and the lever 283 in a clockwise direction (Fig. 12) which serves through the link 169 to shift the clutch member 164 toward the right (Fig. 14) into engagement with the clutch teeth 170 so as to transmit power from the table traverse motor 157 through the gear mechanism above described to traverse the table 21 at a comparatively rapid rate.

The electric motor 157 is a reversible type mo-
switch 301 to control the wheel slide motor 80 to cause either a forward or rearward movement of the wheel slide 62. The reversing switch 300 is provided with a control shaft 302. A gear segment 303 is mounted on the upper end of the shaft 302 and meshes with a gear segment 304 which is formed integral with a rotatable stud 305 which is journaled in a bearing 306 in the apron 250. The stud 305 is provided with a central aperture 307 and its upper surface is provided with a transversely extending slot 308 (Figs. 6, 9 and 11).

The lower end of the sleeve 251 supports a bushing 310 which is keyed thereto and clamped in place therein by means of a clamping screw 311 which passes through a pair of opposed lugs 312 in a split portion formed at the lower end of the sleeve 251. The bushing 310 is provided with a pair of downwardly extending portions 313 and 314 (Fig. 8) which serve as a guide normal to prevent rotation of an elongated key member 315 formed integral with the lower end of the rod 280. A stud 316 is also formed integral with the key member 315 and the rod 280.

When the control lever 250 is in a central position 250 within the H-shaped slot 250 (Fig. 10), a feeding movement of the wheel slide may be obtained by pushing downwardly on the control lever 250 against the tension of the spring 264. This movement serves to move the stud 316 downwardly into engagement with the hole 307 in the rotatable stud 305 and also serves to move the key member 315 downwardly into engagement with the transversely extending slot 308 in the gear segment member 304. In this position of the parts, the control lever 250 and rod 260 may be rotated by means of a crank arm 317. Movement of the crank arm 317 serves through the key 316 to move the gear segment 304, which transmits a corresponding movement of the gear segment 303 to shift the reversing switch 300, which operates through the magnetic starter reversing switch 305 to control the motor 80 to cause either a forward or rearward movement of the wheel slide 62.

The reversing switch 300 is preferably arranged so that the wheel slide 62 will be moved in the direction in which the crank arm 317 is moved, that is, when the crank arm 317 is moved toward the rear of the machine, the wheel slide 62 will be moved rearwardly, or when the crank arm 317 is moved forwardly toward the operator, the wheel slide 62 and motor 80 will be rotated to cause a forward approaching movement of the grinding wheel 60 and the wheel slide 62. The stud 316 engaging the hole 307 during the movement of the wheel slide 62 prevents the lever 250 from being shifted from its central position, thereby locking the control lever 250 so as to prevent a traversing movement of the table during the forward or rearward movement of the wheel slide 62.

During the normal operation of the machine, the limit switch 132 which is supported on the intermediate wheel slide 68 serves to prevent table traverse when the wheel slide 62 is in a forward position. In order that the grinding wheel 60 may be traversed when desired, it is desirable to provide a means for allowing a slow traversing movement of the work table when the wheel slide is in its forward position. To accomplish this result, a normally open limit switch 320 is mounted within the apron 256 and is connected in parallel with the limit switch 132. The switch 320 has a roller 321 which is arranged in the path of a cam surface 325 formed on the upper surface of the slide block 275 so that when the block 275 is moved toward the left (Fig. 11) as the control lever 250 is moved forward into a low speed position, the normally open limit switch 320 is closed, thereby closing the contact of the limit switch 320 and opening the limit switch 132 (Fig. 11) so that the wheel slide 62 will remain in the forward position during a slow traversing speed of the table 21 while truing the grinding wheel.

When the wheel slide 62 is moved forward into a grinding position, the movement starts at a rapid rate, which continues until the dog 142 engages and opens the limit switch 131, thereby deenergizing the solenoid 108 to release the tension of the spring 105, which shifts the clutch member 101 into a slow speed position to cause a slow forward advancing movement of the grinding wheel. The slow power infeed of the grinding wheel is preferably of a suitable rate for the grinding of the cheeks adjacent to the ends of a crankpin.

The slow power infeed of the wheel slide 62 continues until the dog 136 actuates the limit switch 133, thereby breaking the circuit which serves through the magnetic switch 301 to stop the rotation of the wheel feed motor 80. The dog 136 is preferably so adjusted that slow power infeed is started just periphery of the grinding wheel 60 engages the cylindrical body of the crankpin to be ground. The body or cylindrical pin may then be ground by manually advancing the grinding wheel 60 by rotation of the manually operable feed wheel 18. The crankpin may be accurately ground to a predetermined size by manipulation of the manually operable feed wheel.

After a grinding operation has been completed, it is desirable to provide a suitable control so that the grinding wheel slide 62 may be moved rapidly to its rearward position. This is preferably accomplished by means of a normally open limit switch 325 mounted within the control apron 256 and connected in parallel with the limit switch 131 to actuate the solenoid 108. The limit switch 325 is preferably arranged in the path of a cam surface 327 formed integral with the gear segment 304. The limit switch 325, which is normally open, is shunted across the circuit so that when the lever 317 is moved rearwardly to shift the reversing switch 300 to reverse the direction of rotation of the motor 80 to cause a rearward movement of the wheel slide 62, the solenoid 108 is energized instantaneously to shift the clutch member 101 into a high speed position rapidly to withdraw the wheel slide 62 and grinding wheel 60 to an inoperative position.

It is desirable to provide a control mechanism to prevent the table 21 from traversing beyond the desired extent to prevent the work from being too highly polished on the face of the wheel slide 275 so that when the block 275 is moved toward the left (Fig. 11) as the control lever 250 is moved forward into a low speed position, the normally open limit switch 320 is closed, thereby closing the contact of the limit switch 320 (Fig. 11) so that the wheel slide 62 will remain in the forward position during a slow traversing speed of the table 21 while truing the grinding wheel.

When the wheel slide 62 is moved forward into a grinding position, the movement starts at a rapid rate, which continues until the dog 142 engages and opens the limit switch 131, thereby deenergizing the solenoid 108 to release the tension of the spring 105, which shifts the clutch member 101 into a slow speed position to cause a slow forward advancing movement of the grinding wheel. The slow power infeed of the grinding wheel is preferably of a suitable rate for the grinding of the cheeks adjacent to the ends of a crankpin.

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It is desirable to provide a control mechanism to prevent the table 21 from traversing beyond the desired extent to prevent the work from being too highly polished on the face of the wheel slide 275 so that when the block 275 is moved toward the left (Fig. 11) as the control lever 250 is moved forward into a low speed position, the normally open limit switch 320 is closed, thereby closing the contact of the limit switch 320 (Fig. 11) so that the wheel slide 62 will remain in the forward position during a slow traversing speed of the table 21 while truing the grinding wheel.

When the wheel slide 62 is moved forward into a grinding position, the movement starts at a rapid rate, which continues until the dog 142 engages and opens the limit switch 131, thereby deenergizing the solenoid 108 to release the tension of the spring 105, which shifts the clutch member 101 into a slow speed position to cause a slow forward advancing movement of the grinding wheel. The slow power infeed of the grinding wheel is preferably of a suitable rate for the grinding of the cheeks adjacent to the ends of a crankpin.

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erse motor 151 before the wheel 60 engages either of the work supporting heads 28 or 29.

**Electrical control station**

The electrical wiring diagram has been illustrated in Fig. 3, showing the electrical diagram for controlling the various operating units on the machine. It is desirable to provide a central control station whereby the various operating units on the machine may be readily controlled within easy reach of the operator. A series of control push buttons are preferably mounted on the side of the steadyrest casing within easy reach of the operator. Referring now to Figs. 2 and 3, a push button control 335 is arranged to control the stopping and starting of the wheel rotating motor 67. When the push button 337 is pushed in, a circuit is made to operate a magnetic starter switch 338 to start the rotation of the motor 67. Similarly, pushing in on the button 339 serves to break the circuit, thereby operating the magnetic switch 336 to stop the rotation of the wheel driving motor 67. A push button switch 340 serves to control a magnetic switch 341 to stop and start a motor 342 for rotating a coolant fluid pump (not shown).

Pushing in on a button 343 serves to operate the magnetic switch 344 to stop the rotation of the motor 342. Similarly, pushing in on the button 344 serves through the magnetic starter switch 345 to start the rotation of the coolant fluid motor 342.

A push button switch 345 having a push button 346 serves as a jogging switch to operate through the magnetic switch 296 to inch or jog the motor 167 to cause the table 21 to move longitudinally by short increments. This switch serves instantaneously to close the magnetic switch 296, which serves to traverse the table through a very small extent to position the work piece in an operative relation with the grinding wheel 60. A push button switch 347 having a stop push button 348, an inch or jog button 349, and a run button 350 serves to control the rotation of the motor 35 for rotating the work head and crankshaft being ground. Pushing in on the stop button 351 serves to open a circuit, deenergizing a motor stop solenoid 351, which opens through a tripped switch 352 and a magnetic switch 353 to stop the rotation of the motor 35. The work stop control switch 354 is stopped by the rotation of the motor 35 so that the work heads are always in an upright or vertical position is not considered part of the present invention, consequently the details of construction and the controls have not been illustrated.

The work rotation motor 35 may be jogged or inched, if desired, by pushing the button 349 which operates through a solenoid relay 354 instantaneously to operate the magnetic switch 353 to inch or jog the rotation of the motor 35 and the work supporting heads 30 and 31, respectively. Pushing in on the button 351 closes a circuit and operates through the solenoid switch 354 to operate the magnetic switch 353 and continuously operate the motor 35 and the work supporting heads 30 and 31 during the grinding operation. It will be readily apparent from the foregoing description of the controls that the operator may, from a single position in front of the machine, operate not only the main control lever but also control the starting and stopping of jogging of the various motors on the machine.

The operation of this machine will be readily apparent from the foregoing disclosure. A work piece, such as a crankshaft 205, is placed in position on the work heads 28 and 29 and clamped in position thereon by the clamping members 30 and 31, respectively. The steadyrest lever 238 is then pushed forward to position the steadyrest slide 208 in an operating position with the locating plunger 230 in the position as illustrated in Fig. 15. The control lever 250 is then moved in a clockwise direction (Fig. 11) into position 250a (Fig. 10) and then shifted either into position 250b or 250c to move the table 21 longitudinally to position a crankpin in operative position opposite the operative face of the grinding wheel 60. When the crankpin is in a predetermined position, the control lever 250 is shifted from position 250b or 250c through the position 250a into position 250, as shown in Figs. 8, 10 and 11. The operator then pushes the button 337 to start the rotation of the motor 67 and the grinding wheel 60 and then pushes the button 350 to start rotation of the work drive motor 35 synchronously to rotate the work supporting heads 28 and 29 and the crankshaft 205. The lever 250 is then pushed downwardly so that the stud 316 engages the hole 307 in the rotatable stud 305 and the key 315 is inserted through the slot 317, after which the lever 237 is pulled toward the operator to start a rapid forward movement of the grinding wheel 60 and the wheel slide 62.

The rapid approaching movement of the wheel slide 62 continues until the dog 304 engages and actuates the limit switch 311 to brake the circuit and deenergize the solenoid 108 to release the tension of the spring 108 and shift the clutch member 101 toward the right (Fig. 7) into a slow speed position. During the rapid approaching movement of the grinding wheel, a manually operable hand wheel 360 may be rotated to operate a spark splitting device, that is to shift the grinding wheel spindle 61 axially in either direction precisely to locate the grinding wheel 60 relative to the crankpin to be ground, so that when the rapid approach is reduced to a slow approaching feed of the grinding wheel, the side grinding of the wheel on the cheeks of a crankpin will be equalized. The power approaching feed of the wheel at a slow rate continues until the dog 136 actuates the limit switch 133 to open a circuit, thereby releasing one side of the magnetic switch 330, 310 to stop the rotation of the wheel feed motor 80. The body of the crankpin may then be ground to the desired extent by manual rotation of the feed wheel 76. During the initial grinding of a crankpin 205, the work steady rest shoes 210 and 211 remain out of contact with the pin to allow the grinding wheel 60 to rough grind and round up the pin. After a preliminary grinding on the pin, the operator moves the steady rest shoes 210 and 211 into an operating position (Fig. 15) and thereafter manually adjusts the shoes 210 and 211 by actuating the knobs 218 and 226, respectively, during the grinding operation as the pin is ground to size.

After the pin has reached the desired size, the lever 250 being in a downward position, the lever 237 moves away from the operator, which serves to start the rotation of the motor 80 in the reverse direction and, through the electrical switches and circuits above described, serves to cause a rapid rearward movement of the wheel slide 62 to remove the grinding wheel 60 to its rearward or inoperative position. The lever 237 of the steadyrest is then raised by the locating plunger 230, and the steadyrest slide 208 is withdrawn by actuating the lever 238, after which the control lever 250 is allowed to move 75
upwardly to withdraw the pin 316 from the hole 307 so that the lever 250 may be again shifted through position 250a into position 250b or 250c to traverse the work supporting table 21 longitudinally to position the next crankpin in operative position opposite the operative face of the grinding wheel 68. The infed and sizing of the pin are then controlled in the manner above described. After all of the pins which are in axial alignment have been found, the push button 348 may then be pushed to operate through the control switches above described, a stop to the rotation of the work drive motor 35 with the work holders 28 and 29 in an upright or vertical position, after which the clamping members 30 and 31 may be released and the crankshaft 205 indexed to bring the next set of crankpins into axial alignment with the work rotating and supporting spindles 26 and 27, after which the clamps 30 and 31 secure the crankshaft 205 in position and the cycle of operation is continued by traversing the table 21 and feeding the wheel 60 until all of the crankpins on the shaft have been ground to the required and predetermined size.

To facilitate accurate positioning of the table 21, a jogging button 346 is provided which serves to jog or inch the motor 167 precisely to locate the table 21 relative to the grinding wheel 60. Similarly a jogging button 346 is provided to permit jogging or indexing the work rotating and supporting long 35 in setting up the machine for grinding a particular crankpin, so that the operator may be sure that the table 21 is in a position so that the crank arms clear the side face of the grinding wheel 68 before the work 205 is set in continuous rotation for a grinding operation.

It will thus be seen that there has been provided by this invention apparatus in which the various objects hereinafore set forth together with many thoroughly practical advantages are successfully achieved. As many possible embodiments may be made of the above invention and as many changes might be made in the embodiment above set forth, it is to be understood that all matter hereinbefore set forth or shown in the accompanying drawings is to be interpreted as illustrative and not in a limiting sense.

We claim:
1. A crankpin grinding machine having a transversely movable wheel slide, a longitudinally traversable work table, each of which is operated by a separate reversible electric motor, a separate reversing switch operatively connected to control each of said motors, a single manually operable main control lever, and connections between said reversing switches and the main control lever whereby either the work table or the wheel slide motor is rendered inoperative during the operation of the other member.

2. In a grinding machine, a rotatable grinding wheel, a transversely movable slide thereof, means including a reversible motor to move said slide in either direction, a multi-speed gear mechanism including a clutch interposed between the motor and said slide and arranged to move the slide at any one of said speeds, a solenoid to actuate said clutch, a manually operable reversing switch to control said motor, and means including an element actuated by movement of said slide to control said soleno'd and clutch to change the rate of movement of the slide.

3. In a grinding machine, a rotatable grinding wheel, a transversely movable slide thereof, means including a nut and screw mechanism to move said slide, means including a reversible electric motor to rotate said feed screw in either direction, a two-speed gear mechanism including a clutch interposed between the motor and said feed screw and arranged to rotate the feed screw at either of said speeds, a solenoid to actuate said clutch, a manually operable reversing switch to control said motor, means including a limit switch to control said soleno'd and clutch to change the rate of movement of the slide, and an adjustable cam on said slide to actuate said switch.

4. In a grinding machine, a rotatable grinding wheel, a transversely movable slide thereof, means including a rotatable screw and a nut to move said slide in either direction, a two-speed gear mechanism including a clutch to rotate said feed screw at either of two speeds, means including a reversible electric motor to transmit power to said gear mechanism, a manually operable reversing switch to control said motor, means normally to hold said clutch in a low speed position, a solenoid to shift said clutch into a high speed position, and means including a limit switch and a dog to control said soleno'd so that the grinding wheel is rotated at the required predetermined speed.

5. In a grinding machine, a rotatable grinding wheel, a transversely movable slide thereof, a manually operable control lever, and a two-speed gear mechanism including a clutch to rotate said slide and a rotatable grinding wheel, a transversely movable slide thereof, a manually operable control lever, and a two-speed gear mechanism including a clutch to rotate said slide and a rotatable grinding wheel, a transversely movable slide thereof, a manually operable control lever, and a two-speed gear mechanism including a clutch to rotate said slide and a rotatable grinding wheel, a transversely movable slide thereof, a manually operable control lever, and a two-speed gear mechanism including a clutch to rotate said slide and a rotatable grinding wheel, a transversely movable slide thereof, a manually operable control lever, and a two-speed gear mechanism including a clutch to rotate said slide and a rotatable grinding wheel, a transversely movable slide thereof, a manually operable control lever, and a two-speed gear mechanism including a clutch to rotate said slide and a rotatable grinding wheel, a transversely movable slide thereof, a manually operable control lever, and a two-speed gear mechanism including a clutch to rotate said slide and a rotatable grinding wheel, a transversely movable slide thereof, a manually operable control lever, and a two-speed gear mechanism including a clutch to rotate said slide and a rotatable grinding wheel.
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ing a reversible electric motor to actuate said gear mechanism, means normally to hold said clutch in a low speed position, a solenoid to shift the clutch into a high speed position, a manually operable reversing switch to start said motor in either direction, a limit switch and an adjustable cam for actuating said limit switch which are interposed between the base and slide, said limit switch being arranged to operate a circuit after the wheel has moved rapidly toward a work piece to actuate said solenoid and shift the clutch into a slow speed position to cause a slow movement of said wheel and slide.

2. In a grinding machine having a base, a rotatable grinding wheel, a transversely movable slide to support said wheel, means including a reversible electric motor which is operatively connected to move said slide in either direction to position the grinding wheel adjacent to the work piece or to move the same to an inoperative or rearward position, an intermediate slide supporting said reversible motor, a manually operable nut and screw mechanism interposed between the intermediate slide and base whereby the grinding wheel may be manually fed into the work, a reversing switch to control said motor, a longitudinally movable work supporting table, means including a manually operable lever to control the direction of movement of the table, and connections between said lever and said reversing switch whereby movement of the control lever in one direction serves to actuate the reversing switch and thereby control the transverse movement of said grinding wheel slide.

3. In a grinding machine having a rotatable grinding wheel, a transversely movable slide therefor, means including a reversible electric motor to drive said gear mechanism, a magnetic reverse starter switch therefor, a reversing switch for controlling the reversing of said motor, a limiter and switch means to actuate said limit switch and by and in timed relation with the forward movement of said wheel slide normally to render said table traversing motor inoperative during the infeeding movement of the work, and connections between said switch and clutch connected in parallel with the first limit switch which is actuated by and in timed relation with the movement of said clutch to a slow speed position to close a circuit to permit the wheel slide to remain in a forward position during a slow traversing speed of the work table.

4. In a grinding machine having a longitudinally movable work supporting table, means including a reversible electric motor to traverse said table in either direction, a reversing switch therefor, a rotatable grinding wheel, a transversely movable slide therefor, a manually operable reversing switch thereto, and a limit switch actuated by the forward movement of said slide to break a circuit and render the control lever therefor inoperative during the infeeding movement of the wheel slide.

5. In a grinding machine having a longitudinally movable work supporting table, a reversible motor to traverse said table in either direction, a reversing switch therefor, a rotatable work supporting table, an electric motor to rotate said work supporting table, a manually operable reversing switch therefor, a rotatable work supporting table, means including a gear mechanism and a clutch to move said table at either of two speeds, means including a reversible electric motor to rotate said clutch and gear mechanism, a reversing switch operatively connected to reverse said motor and gearing, a manually operable control lever, connections between said control lever and said clutch whereby movement of said lever in a second direction serves to shift the clutch to change the table speed, and connections between said lever and reversing switch whereby movement of said lever in a second direction serves to actuate the reversing switch and thereby to control the direction of movement of said table.

6. In a grinding machine having a longitudinally traversable work table, means including a reversible electric motor to traverse said table longitudinally in either direction, a reversing switch therefor, a two-speed gear mechanism including a clutch which is interposed between the table and said motor, a single control lever which is arranged for movement in two directions, two speed reversing switches, and a clutch whereby movement of the lever in one direction serves to actuate said clutch, and connections between said lever and the reversing switch to control the direction of movement of said table.

7. In a grinding machine having a transversely movable rotatable grinding wheel and a slide therefor, means including a reversible electric motor to traverse said slide in either direction, a reversing switch therefor, a steadiest which is movable to and from an operating position, and a limit switch actuated when the steadiest is moved to an inoperative position to break a circuit and prevent rotation of the work drive motor.

8. In a grinding machine having a longitudinally movable work supporting table, a reversible motor to traverse said table in either direction, a reversing switch therefor, a rotatable work supporting table, means including a reversible electric motor to traverse said slide in either direction, a reversing switch therefor, a steadiest which is movable to and from an operating position, and a limit switch which is actuated by the steadiest when the steadiest is moved to an inoperative position to open a circuit so as to prevent rotation of the table drive motor when the steadiest is in an operative position.

9. In a grinding machine, a rotatable grinding wheel, a transversely movable wheel slide to support said wheel, means including a reversible electric motor to move said slide in either direction, a longitudinally movable work supporting table, means including a gear mechanism and a clutch to move said table at either of two speeds, means including a reversible electric motor to rotate said clutch and gear mechanism, a reversing switch operatively connected to reverse said motor and gearing, a manually operable control lever, connections between said control lever and said clutch whereby movement of said lever in one direction serves to shift the clutch to change the table speed, and connections between said lever and reversing switch whereby movement of said lever in a second direction serves to actuate the reversing switch and thereby to control the direction of movement of said table.
tric motor to traverse said slide transversely in either direction, a reversing switch therefor, a longitudinally traversable work supporting table, means including a reversible electric motor to traverse the table longitudinally in either direction, a reversing switch therefor, a two-speed gear mechanism including a clutch which is interposed between the work supporting table and said second motor, a single control lever which is slidable vertically, rotatable and pivotally mounted so as to swing in two directions, connections between said lever and clutch whereby pivotal movement of said lever in one direction serves to actuate said clutch, connections between said lever and the second reversing switch whereby pivotal movement of said control lever in a second direction serves to control the direction of movement of said table, and connections between said lever and the first reversing switch which are rendered effective when said control lever is moved vertically to control the forward and rearward movement of said wheel slide.

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