Feb. 13, 1940. J. I. GARSIDE ET AL 2,190,134

GRINDING MACHINE

Filed June 9, 1939 4 Sheets-Sheet 1

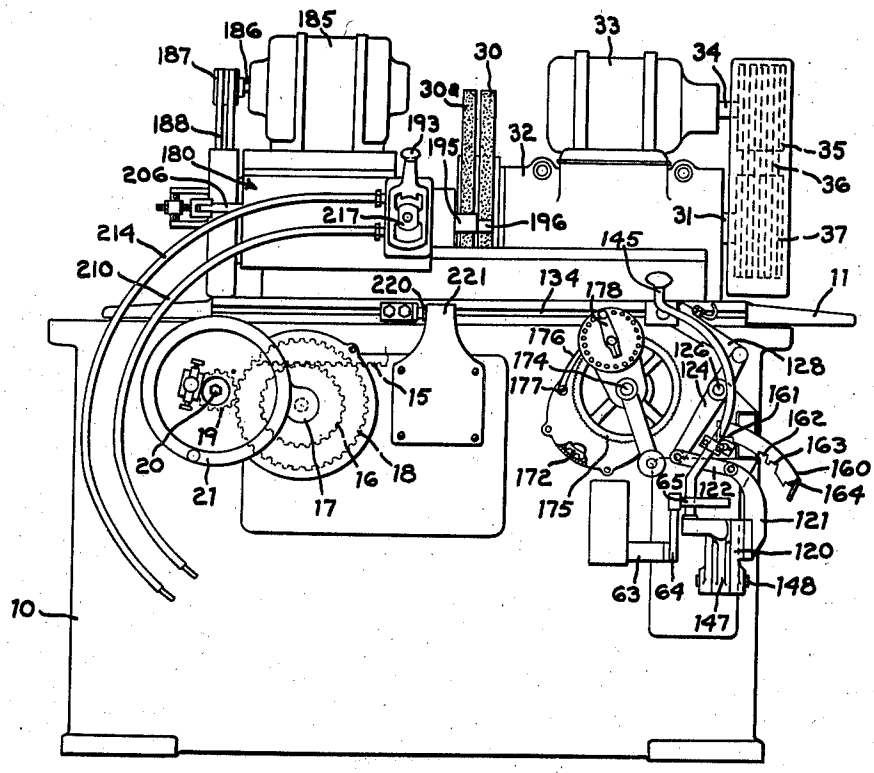

FIG. 1

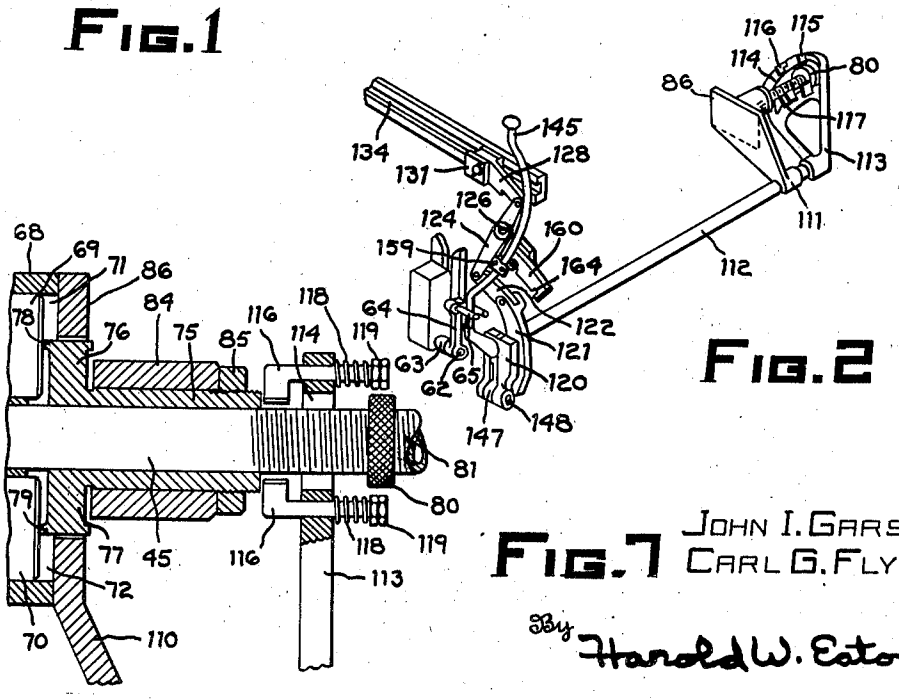

FIG. 2

FIG. 7

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GRINDING MACHINE

Filed June 9, 1939 4 Sheets-Sheet 2

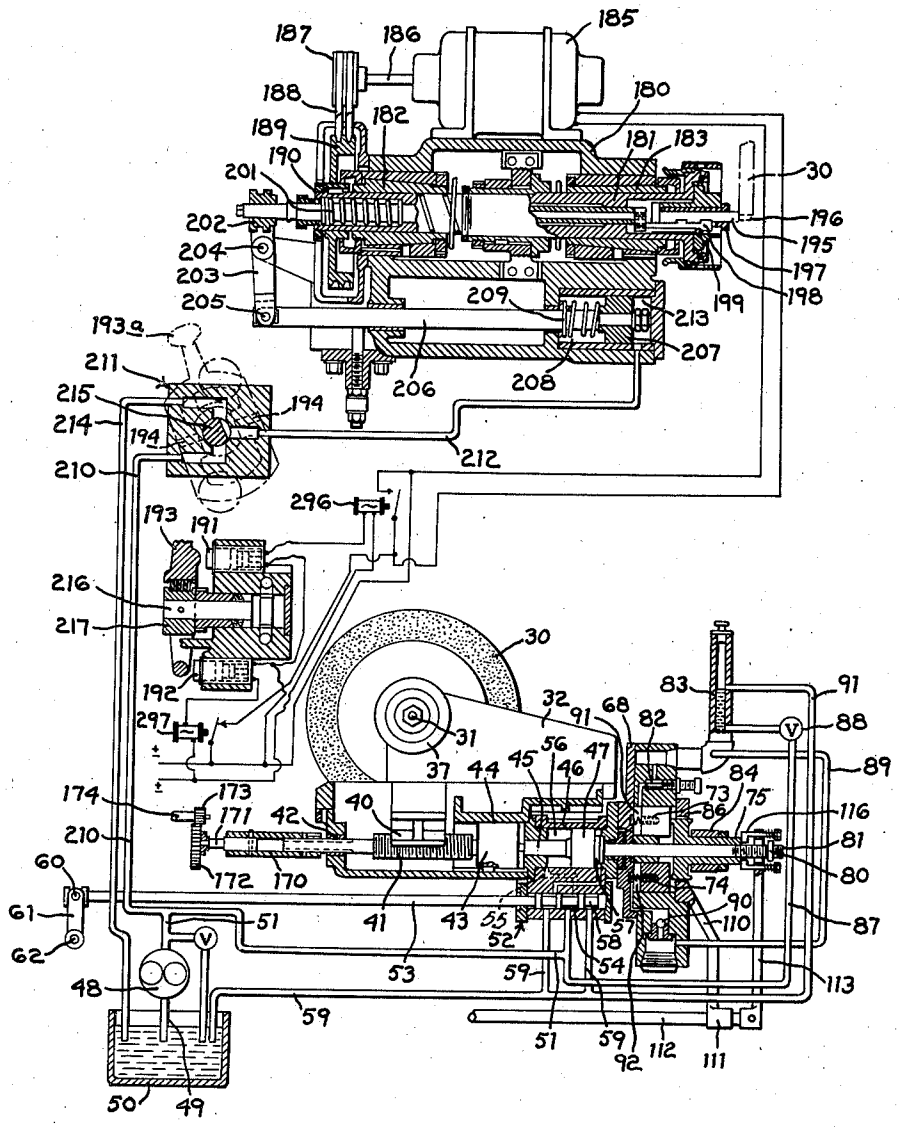

FIG. 3

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GRINDING MACHINE

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FIG. 5

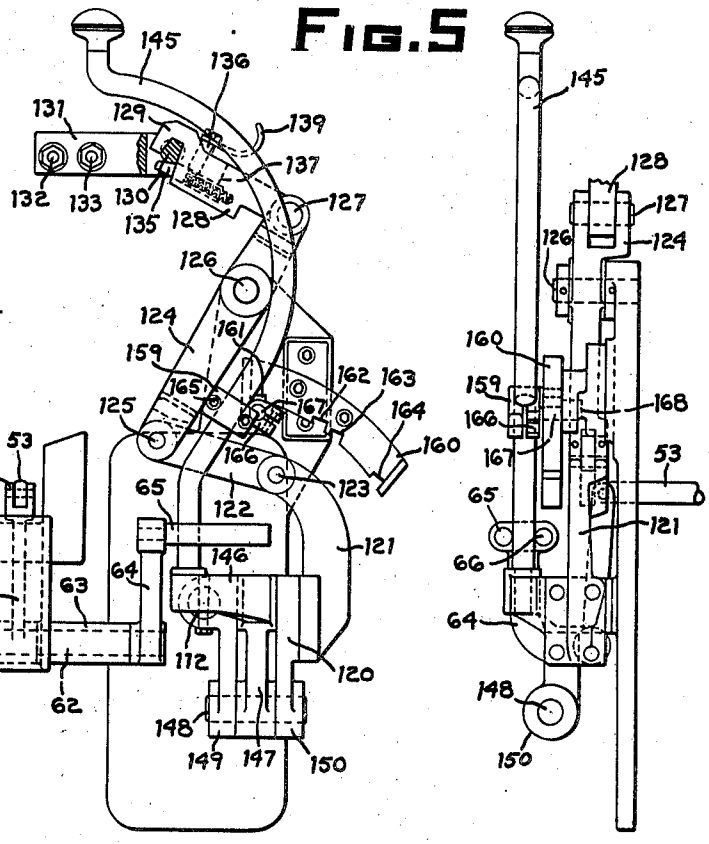

FIG. 4

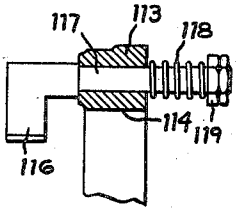

FIG. 8

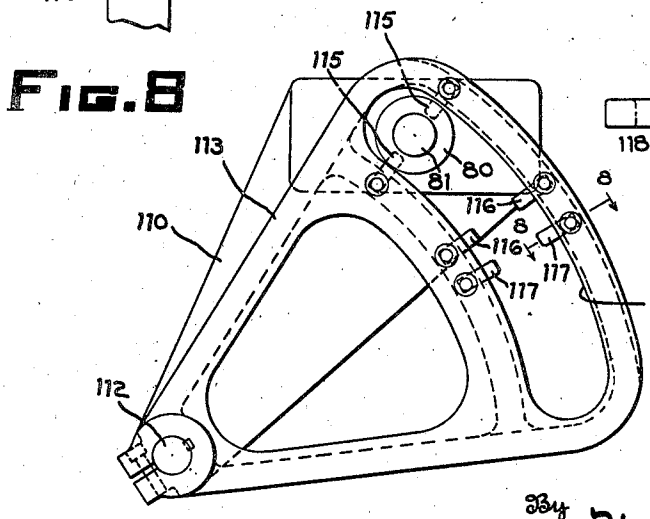

FIG. 6

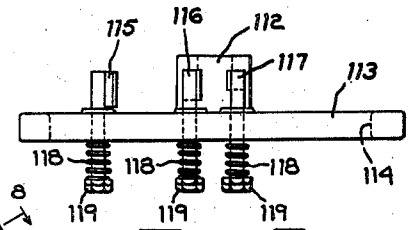

FIG. 9

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GRINDING MACHINE

Filed June 9, 1939 4 Sheets-Sheet 4

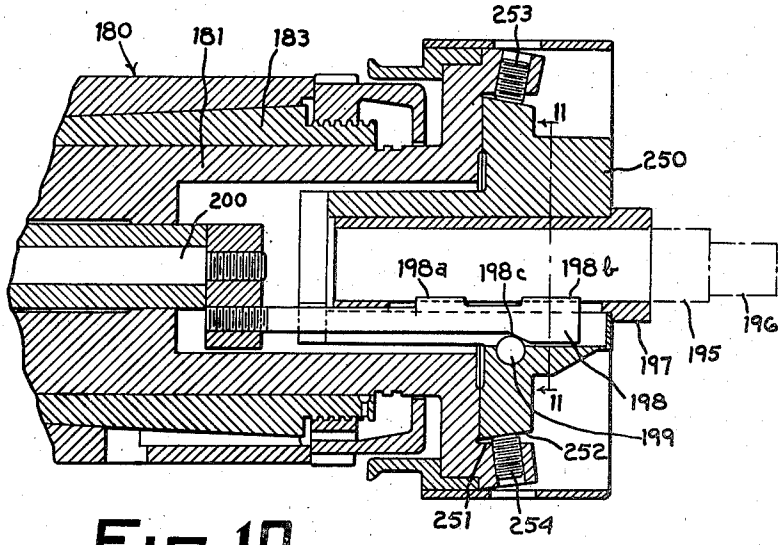

FIG. 10

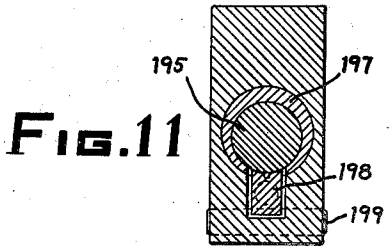

FIG. 11

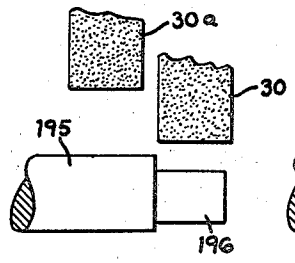

FIG. 12

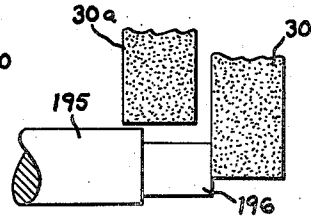

FIG. 14

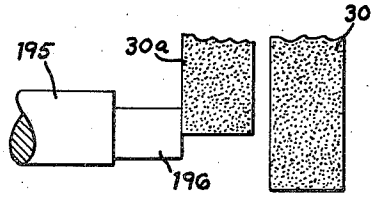

FIG. 16

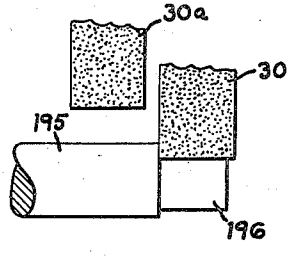

FIG. 13

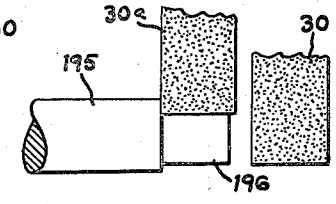

FIG. 15

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Patented Feb. 13, 1940 2,190,134

UNITED STATES PATENT OFFICE

2,190,134

GRINDING MACHINE

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Application June 9, 1939, Serial No. 278,330

9 Claims. (Cl. 51—105)

The invention relates to grinding machines, and more particularly to an interlock control mechanism therefor.

One object of the invention is to provide an improved hydraulically operated grinding machine with an interlocked control between the longitudinally movable work supporting table and the transversely movable wheel slide. A further object of the invention is to provide a chucking grinding machine with a control mechanism which prevents an infeeding movement of the grinding wheel unless the work table is positioned in proper predetermined relation with the operative face of the grinding wheel.

Another object of the invention is to provide a grinding machine in which a manually operable control lever which serves to control the transverse movement of the wheel slide is interlocked with the longitudinally movable work table so that the lever cannot be shifted to initiate a wheel feeding movement unless the work is positioned in a predetermined relationship with the grinding wheel. A further object of the invention is to provide an interlocked control mechanism between a wheel feed control lever and the longitudinally traversable table which serves to prevent a longitudinal traversing movement of the work table when the wheel is in a forward or grinding position. 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 an improved grinding machine embodying this invention;

Fig. 2 is a fragmentary perspective view of the interlock control between the wheel slide control lever and the work table together with the multi-stop mechanism for limiting the infeeding movement of the grinding wheel;

Fig. 3 is a fragmentary piping and wiring diagram, showing the hydraulically operated system for moving the grinding machine elements and the electrical control mechanism therefor;

Fig. 4 is a fragmentary front elevation, on an enlarged scale, of the control lever and interlock mechanism;

Fig. 5 is a right-hand elevation of the parts as shown in Fig. 4;

Fig. 6 is a fragmentary rear elevation, on an enlarged scale, showing the multi-stop mechanism for controlling the infeeding movement of the grinding wheel;

Fig. 7 is a fragmentary cross sectional view, on an enlarged scale, of the dash pot feed mechanism and feed stops;

Fig. 8 is a cross sectional view, on an enlarged scale, taken approximately on the line 8—8 of Fig. 6;

Fig. 9 is a plan view of the feed stops and the supporting member;

Fig. 10 is a fragmentary sectional view, on an enlarged scale, through the work chuck and spindle;

Fig. 11 is a fragmentary cross sectional view taken approximately on the line 11—11 of Fig. 10;

Fig. 12 is a fragmentary detail view showing the respective positions of the work and grinding wheels in a loading position;

Fig. 13 is a similar view showing the position of the work and grinding wheels in performing the first step in the grinding operation;

Fig. 14 is a similar view showing the position of the parts during the second step of the grinding operation;

Fig. 15 is a similar view showing the position of the parts during the third step of the grinding operation; and

Fig. 16 is a similar view showing the position of the parts during the fourth or final step.

A grinding machine has been illustrated in the drawings comprising a base 10 which supports a longitudinally traversable work table 11 on the usual V-way and flat way (not shown). The table 11 may be traversed longitudinally either manually or by power by any of the old and well known manual or power operated mechanisms. For simplicity of illustration, a manually operable traverse mechanism has been illustrated. A rack bar 15 depending from the under side of the table 11 meshes with a gear 16 which is supported on a rotatable shaft 17. The shaft 17 also supports a gear 18 which is either formed integral with the gear 16 or is rigidly connected thereto and arranged to rotate therewith. The gear 18 meshes with a gear 19 carried on the inner end of a rotatable shaft 20. The outer end of the shaft 20 supports a manually operable traverse wheel 21. By rotating the hand wheel 21 in either direction, the work supporting table 11 may be traversed longitudinally in either direction, as desired. This machine is particularly adapted for grinding a work piece by means of

the plunge-cut method, that is, by feeding the grinding wheel directly into the work.

A rotatable grinding wheel 30 is supported on one end of a rotatable grinding wheel spindle 31 which is journalled in bearings (not shown) in a transversely movable wheel slide 32. The wheel slide 32 is arranged to be moved transversely on the usual V-way and flat way (not shown) on the base 10. The grinding wheel spindle 31 may be rotated in any well known manner, such as by means of an overhead drive shaft or countershaft or by means of an electric motor 33 which is mounted on the upper surface of the wheel slide 32. The motor 33 is provided with a motor shaft 34 which carries on its outer end a driving pulley 35. The pulley 35 is connected by multiple V-belts 36 with a multi-grooved driven pulley 37 mounted on the outer end of the wheel spindle 31. The belt drive above described is commonly known as a multiple V-belt type in which a plurality of belts 36 of V-shaped cross sectional area are connected between multi-V-grooved pulleys 35 and 37. The wheel slide 32 is arranged for a transverse feeding movement toward and from the work supporting table 11 by means of a wheel feeding mechanism to be hereinafter described.

Wheel feeding mechanism

A wheel feeding mechanism is provided to control the feeding movement and adjustment of the grinding wheel 30 toward and from the work supporting table 11. The wheel slide 32 is provided with a depending half nut 40 which meshes with a rotatable cross feed screw 41. The feed screw 41 is rotatably supported at one end by a bearing 42 which is supported in fixed relation to the base 10. The other end of the feed screw 41 is rotatably journalled in a slidably mounted bearing member 43 which is slidably keyed within a cylindrical aperture 44 formed within the base 10 of the machine. The feed screw 41 may be rotated manually for adjusting the position of the wheel slide 32 in setting up the machine by means of a manually operable feeding mechanism to be hereinafter described.

In order that the wheel slide 32 may be rapidly moved toward the work supporting table to grind a work piece by the plunge-cut method, the feed screw is connected to a piston rod 45. A fluid pressure cylinder 46 is formed within the base 10 of the machine and contains a slidably mounted piston 47 which is connected with or formed integral with the piston rod 45. As illustrated in Fig. 3, the other end of the piston rod 45 is fixedly connected to the slidably mounted bearing member 43 so that when fluid pressure is admitted to either end chamber of the cylinder 46, the endwise movement of the piston rod 45 will be transmitted to produce an axial or endwise movement of the feed screw 41 which in turn transmits this motion to produce a transverse feeding movement of the wheel slide 32 and the rotatable grinding wheel 30. A motor driven fluid pressure pump 48 is arranged to pump fluid through a pipe 49 from a reservoir 50 which is preferably located within the base 10 of the machine. The pump 48 forces fluid under pressure through a pipe 51 to a feed control valve 52. The feed control valve 52 is preferably a piston type valve comprising a valve stem 53 having formed integrally therewith a plurality of valve pistons. In the position of the valve 52 (Fig. 3), fluid under pressure passing through the pipe 51 enters a valve chamber 56 and passes through a passage 55 into a cylinder chamber 56 to move the wheel slide to its rearmost or inoperative position. During the passage of fluid under pressure into the cylinder chamber 56, fluid is exhausted from a cylinder chamber 57, into a valve chamber 58, and out through an exhaust pipe 59 to the reservoir 50.

Similarly, when the valve stem is shifted toward the left (Fig. 3), the direction of flow of fluid within the feed cylinder 46 will be reversed. In this position of the valve, fluid under pressure passing through the pipe 51 will enter the valve chamber 54 and pass through a passage into the cylinder chamber 57 to initiate a movement of the piston 47 toward the left which in turn transmits a movement toward the left of the feed screw 41, the half nut 40, the wheel slide 32, and the rotatable grinding wheel 30 to cause the wheel 30 to move transversely so as to approach the work supporting table 11.

The valve stem 53 projects from the front of the machine base and is connected by means of a stud 60 with the upper end of a pivotally mounted lever 61 which is in turn fixedly mounted at one end of a rock shaft 62 which is journalled in a bearing 63 fixedly mounted relative to the base 10. The right-hand end (Fig. 4) of the rock shaft 62 is provided with a lever 64 which is fixedly mounted thereon. The lever 64 carries at its upper end a pair of spaced parallel pins or studs 65 and 66 which are engaged by a manually operable control lever to be hereinafter described.

Dash pot

The piston and cylinder mechanism, above described, serves to cause the grinding wheel 30 rapidly to approach or recede from the work piece. In order to reduce the rapid approaching movement to a predetermined grinding feed, it is desirable to provide a wheel feed controlling mechanism, such as a dash pot mechanism, which may be rendered effective when the grinding wheel 30 is about to contact with the surface of the work piece to be ground. As illustrated in Fig. 3, an outwardly extending casing 68 is fixed to the end of the cylinder 46 and contains a pair of diametrically arranged spaced dash pot pistons 69 and 70 which slide within dash pot cylinders 71 and 72. The dash pot pistons are normally held in a rearward position by springs 73 and 74, respectively. During the rapid approach of the grinding wheel 30, the dash pot pistons are inoperative.

The piston rod 45 extends toward the rear of the machine and is provided with a slidably mounted sleeve 75. The sleeve 75 is provided with diametrically projecting arms 76 and 77 which are provided with bosses 78 and 79, respectively. The bosses 78 and 79 are positioned and arranged to engage the dash pot pistons 69 and 70, respectively, at a point substantially coinciding with the axes of the dash pot pistons. When fluid is admitted under pressure to the cylinder chamber 57 to cause the grinding wheel 30 to move toward the work piece, the rapid approaching movement continues until an adjustable collar 80, carried by a threaded end portion 81, engages the end of the sleeve 75. The continued movement of the piston 47 is resisted by the dash pot pistons 69 and 70, which forces fluid under pressure from the dash pot cylinders 71 and 72 through an adjustable needle valve 82 into a reservoir 83. By adjustment of the needle valve 82, the exhaust of fluid from the dash pot cylinders 71 and 72 may be readily controlled to produce the desired grinding infeed,

so that the grinding wheel will be moved into the work piece to grind the same at the desired rate of feed. This dash pot mechanism is substantially the same as that shown in the United States Patent No. 2,101,970 dated December 7, 1937, to Raymond A. Cole and Charles H. Amidon, and since this feature is not considered to be a part of the present invention, the details of disclosure have not been completely described herein. For details of disclosure not contained herein, reference may be had to the prior patent above mentioned.

The fluid reservoir 83 and the dash pot cylinders 71 and 72 form a separate fluid system which is independent of the main feed cylinder 46 and its control valve 52. In order to fill the reservoir 83, a pipe 87 is connected with the pipe 51 which leads from the fluid pressure pump 48, and a valve 88 in the pipe 87 serves to admit fluid from the pump into the reservoir 83 to fill the dash pot system in setting up the machine and to maintain it full during use. An overflow pipe 91 is provided which is connected with the pipe 59 to convey excess fluid from the reservoir 83 to the reservoir 50. If desired, the valve 88 may be maintained slightly open during use of the machine so that the reservoir 83 is at all times filled and any overflow therefrom may readily return to the reservoir 50.

In order to allow the dash pot cylinder chambers 91 and 92 to fill quickly as the wheel slide 32 moves rearwardly, a ball check valve 90 is provided in the dash pot cylinder casing 68 which is connected by means of a pipe 89 with the reservoir 83. By providing this ball check by-pass, fluid is quickly admitted into the dash pot cylinders and does not have to be drawn in wholly through the needle valve 82.

Positive stop

In order to grind a work piece to a predetermined size, it is necessary to feed the grinding wheel 30 toward the work piece to grind the same and then to stop the infeed and allow the grinding wheel 30 to grind out or to allow the sparks to die out in order to round up the work so that it will be ground to a true cylindrical surface of a predetermined size. In the present disclosure, the machine as set up is provided with two grinding wheels, namely, the grinding wheel 30 which serves to rough grind a piece of work to the required rough size, and also a finish grinding wheel 30*a* which is of a smaller diameter and is mounted adjacent to the grinding wheel 30 so that after the work piece has been rough ground by means of the wheel 30, the work supporting table 11 may be traversed longitudinally toward the left (Fig. 1) to position the work piece in operative relation with the finish grinding wheel 30*a* to facilitate a finish grinding operation. In order that the work piece may be rough ground to a predetermined extent, after which it may be finish ground to a predetermined size, it is desirable to provide a positive stop mechanism comprising a plurality of stop elements which may be automatically moved into an operating position in timed relation with the longitudinal positioning movement of the work supporting table 11. As illustrated in Fig. 7, an adjustable stop sleeve 84 surrounds the sleeve 75 and is held in adjusted position thereon by means of a lock nut 85. The positive stop sleeve 84 is arranged to engage the end face of the dash pot cylinder head 86 positively to limit the infeeding movement of the slide 32 and the grinding wheels 30 and 30*a*.

A multi-stop mechanism is provided for limiting the infeeding movement of the wheel slide to limit the infeeding movement of the grinding wheels 30 and 30*a* so as to grind a work piece first to a predetermined rough size and then to a predetermined finish size. This multi-stop mechanism is preferably arranged to be automatically actuated by and in timed relation with the longitudinal positioning movement of the work supporting table 11.

As illustrated in the drawings, a bracket 110 is fixedly mounted on the dash pot cylinder head 86 and projects downwardly therefrom and is provided with a bearing portion 111 which serves rotatably to support a rock shaft 112. The rock shaft 112 supports a sector-shaped frame 113. The frame 113 is provided with an arcuate-shaped elongated slot 114 which surrounds the threaded portion 81 of the piston rod 45. The frame 113 serves as a support for a plurality of spaced pairs of stop blocks 115, 116 and 117 which are arranged so as to be engaged by the collar 80. The stop blocks 115, 116 and 117 are arranged to be moved into an operative engagement with the end of the sleeve 75 so that further movement of the collar 80 serves through stop blocks 115, 116 or 117 to move the sleeve 75 endwise so that the bosses 78 and 79 engage the dash pot pistons 69 and 70, respectively, after which the rapid approach of the grinding wheels 30 and 30*a* is reduced to a slower grinding feed. The slow grinding feed continues until the positive stop sleeve 84 carried by the sleeve 75 engages the dash pot cylinder head 86 to positively limit the forward feed of the grinding wheels 30 and 30*a*. The pairs of stop blocks 115, 116 and 117 are each provided with a supporting stud which is slidably keyed within an aperture or hole in the bracket 113, and are normally held in position with the stop blocks 115, 116 and 117 yieldably engaging the bracket 113 by means of springs 118 which surround the stud. The springs 118 are interposed between the bracket 113 and the nuts 119 on the end of the studs.

The shaft 112 projects through the base of the machine through a point in front of the machine base. A bracket 120 is mounted on the front end of the shaft 112 outside the base. By swinging the bracket 120, the shaft 112 may be rocked to shift the plate 113 successively to position the stop blocks 115, 116 and 117 in an operative position with relation to the collar 80 and the sleeve 75.

In order that the stop blocks 115, 116 and 117 may be moved in timed relation with the table movement, a linkage mechanism is provided connecting the bracket 120 with the table 11. A bracket 121 is fixedly mounted on the side of the bracket 120 and is pivotally connected to a link 122 by means of a stud 123. The link 122 is connected to a pivotally mounted rock arm 124 by means of a stud 125. The rock arm 124 is pivotally supported by means of a stud 126 which is fixedly mounted on the front of the machine base 10. The upper end of the rock arm 124 is pivotally connected by means of a stud 127 with a link 128. The upper end of the link 128 is provided with a hook-shaped portion 129 which is arranged to detachably engage a stud 130 which is either fixedly mounted on or formed integral with a slide block 131 which is adjustably mounted by means of bolts 132 and 133

carried by a T-slot 134 formed in the front edge of the table 11.

It is desirable to provide a readily detachable connection between the link 128 and the stud 130 so that during a grinding wheel truing operation the feed stop mechanism may be readily disconnected before the truing operation is started and may be readily connected again after the wheel truing operation has been completed. A spring-pressed detent 135 normally serves to hold the hook-shaped end 129 of the link 128 in engagement with the stud 130. A stud 136 is fixedly mounted to the detent 135 and is arranged to slide longitudinally in an elongated slot 137 formed in the link 128. A handle 139 is fixedly connected to the upper end of the stud 136 and serves to facilitate withdrawal of the detent 135 when it is desired to disconnect the stop mechanism from the table 11, so as to allow independent movement of the table without affecting the position of the stop mechanism and its operating parts.

In order to attain one of the main objects of the invention, a suitable interconnection or interlock is provided between the wheel feeding movement and the table traversing movement. A manually operable control lever 145 is connected by means of a bracket 146 with a pivotally mounted lever 147. The lever 147 is pivotally supported by means of a stud 148 supported in a pair of spaced bosses 149 and 150 which are formed integral with the bracket 120. The lever 145 is positioned between the studs 65 and 66 and is preferably of a size to fit the space therebetween. Movement of the control lever 145 about the supporting stud 148 serves, through the studs 65 and 66, the lever 64, the rock shaft 62, the lever 61, to shift the valve stem 53 so as to shift the control valve 52 to initiate either a forward or rearward movement of the grinding wheel 30 and its supporting slide 32.

In order to prevent longitudinal shifting of the work supporting table when the grinding wheel is in an operative grinding position, and to prevent an infeeding movement of the grinding wheel unless the work supporting table is positioned in one of a series of predetermined positions, a suitable interlock is provided to control the shifting movement of the lever 145. An arcuate-shaped member 160 is fixedly mounted on the base of the machine. The arcuate member 160 is provided with a plurality of notches 161, 162, 163 and 164 in its lower surface. The lever 145 is provided with an adjustably positioned member 159 which is arranged to be clamped thereon by means of clamping screws 165. The member 159 is provided with an integral clamping device 166 which serves as a support for a stud 167. The stud 167 is provided with an enlarged head 168 which is spaced from the member 166 by a distance slightly greater than the thickness of the arcuate member 160. The head 168 projects upwardly and is shaped to mate with the notches 161, 162, 163 and 164.

In the position of the parts (Fig. 4), the head 168 is aligned with the notch 161 and the lever 145 may be swung toward the operator so that the head 168 of the stud 167 slides within the notch 161, thus shifting the control valve 52 to initiate a forward feeding movement of the grinding wheels 30 and 30a. During the time interval in which the grinding wheel is moved toward and from the work to grind the same, the head 168 engaging the notch 161 prevents a longitudinal traversing movement of the table 11 and thereby prevents a shifting movement of the stop plate member 113. After the grinding operation has been completed, the lever 145 is then moved toward the rear of the machine to shift the control valve 52 into the position illustrated in Fig. 3, which movement slides the head 168 of the stud 167 into the position illustrated in Fig. 5. In this position of the lever 145, the lever together with the actuating mechanism for the feed stop may be moved longitudinally by the traversing movement of the work supporting table 11. During the longitudinal traversing movement of the table, the head 168 of the stud 167 rides along the rear face of the segment 160 and thus locks the lever 145 so as to prevent its movement in a counterclockwise direction (Fig. 5) to initiate another infeeding movement of the grinding wheel until the head 168 is aligned with one of the notches 161, 162, 163 or 164, thus providing an interlock to prevent an infeeding movement of the grinding wheel during the table traversing movement unless the work piece is located in a predetermined position for the next grinding operation.

Manual feed adjustment

The feed screw 41 is arranged so that it may be rotated manually to adjust the position of the wheel slide 32 in setting up the machine for a given grinding operation or for compensating for wheel wear during grinding. The feed screw 41 is slidably keyed at its forward end within a rotatable sleeve 170. The sleeve 170 is fixedly mounted on the inner end of a rotatable shaft 171 which supports a gear 172 meshing with a gear 173. The gear 173 is formed on the end of a rotatably supported shaft 174. The shaft 174 supports on its outer end a manually operable feed wheel 175. The feed screw may be rotated manually by rotation of the feed wheel 175 in either direction to adjust the position of the grinding wheels 30 and 30a together with their supporting slide 32. A stop pawl 176 is pivotally mounted on a stud 177 on the base 10. The pawl 176 is arranged to engage an abutment (not shown) carried by the manually operable feed wheel 175. The manually operable feed wheel 175 is provided with a micrometer adjusting mechanism 178 to facilitate adjustment of the stop abutment relative to the feed wheel 175. This mechanism has not been illustrated in detail, since it is not considered to be part of the present invention. Reference may be had to the prior U. S. patent to C. H. Norton No. 762,838 dated June 14, 1904, for details of disclosure not found herein.

Work support

A rotatable work support is provided on the work supporting table 11 rotatably to support a work piece in operative relation with the grinding wheels 30 and 30a for a grinding operation. In the preferred construction, a live spindle work rotating and supporting mechanism is provided which is substantially the same as that shown in the prior U. S. patent to Cole and Amidon No. 2,101,790 above referred to. This mechanism may comprise a headstock 180 which is arranged rotatably to support a spindle 181 in bearings 182 and 183, respectively. The headstock 180 is provided with a surface which mates with a correspondingly shaped surface on the work supporting table 11 whereby the headstock may be adjusted longitudinally therealong and clamped in adjusted position in a manner similar to that shown in the prior patent above referred to.

The work supporting spindle 181 may be rotated by means of an electric motor 185 which is mounted on top of the headstock 180. A motor shaft 186 is provided with a multi-V-grooved pulley 187 which is connected by multiple V-belts 188 with a multi-V-grooved pulley 189 which is keyed to the end of the work supporting spindle 181 and is held in adjusted position thereon by means of a collar 190.

In order that the electric motor 185 may be readily controlled from the operator's station in front of the machine base, a two-button snap switch 191—192 is provided which is preferably mounted on the front of the headstock 180. A lever 193 is pivotally mounted on a pair of opposed studs 194. When the lever 193 is rocked in a clockwise direction (Fig. 3), that is, when the knob moves toward the headstock 180, the push button 191 is actuated to close a circuit through a relay switch 296 to start rotation of the headstock motor 185. Similarly, if the lever 193 is rocked in a counterclockwise direction (Fig. 3), that is when the knob moves away from the headstock 180, the push button 192 is actuated to close a circuit through a relay switch 297 so as to break the circuit to the motor 185 and thus stop the motor 185 to stop the rotation of the work supporting spindle 181.

In grinding certain types of work, it is desirable to provide a live spindle work supporting member which is arranged so that the work piece may be inserted, ground and removed therefrom without stopping the rotation of the spindle.

The work holding mechanism illustrated in the drawings is particularly adapted for grinding a cylindrically shaped work piece having an eccentric portion 196 on its end. A work piece 195 having an eccentric portion 196 is supported in a collet 197 having a central aperture which is eccentric relative to the axis of rotation of the headstock spindle 181 by an amount equal to the offset of the eccentric 196 relative to the work piece 190. The work piece is clamped in position within the collet 197 by means of a clamping member 198, the upper surface of which is provided with two spaced V-shaped portions 198*a* and 198*b* which engage the cylindrical portion 195 of the work piece. The under surface of the clamping member 198 is provided with a cam face 198*c* which rides on a stud 199 fixed in the rotatable part of the headstock. The clamping member 198 is connected to a slide rod 200 which passes through a central aperture within the headstock spindle 181. A spring 201 serves normally to exert a pressure tending to move the clamping member 198 toward the left (Fig. 3) in a clamped position.

The outer end of the rod 200 is provided with a spool-shaped member 202 which is pivotally connected to the upper end of a rock arm 203. The rock arm 203 is pivotally mounted on a stud 204 which is fixed to the headstock frame 180. The lower end of the rock arm 203 is yoke-shaped and is connected by means of a stud 205 with a slidably mounted piston rod 206. A piston 207 is mounted on the right-hand end of the piston rod 206 (Fig. 3). The piston 207 is slidably mounted within a cylinder 208 which is formed as an integral part of the headstock 180. A spring 209 surrounds the piston rod 206 and is interposed between the piston 207 and the left-hand end of the cylinder 208 (Fig. 3). The spring 209 is a compression spring and normally serves to exert a pressure to move the rod 206 toward the right (Fig. 3) to cause the clamping member 198 to move toward the left to clamp the work piece 195 in operative position within the headstock 180, the spring 209 having sufficient compression to exert the required clamping pressure.

In order to release the work piece, a fluid pressure mechanism is provided. Fluid under pressure from the pump 48 passing through the pipe 51 passes through a pipe 210 to a valve 211 and through a pipe 212 into a cylinder chamber 213 to cause the piston 207 to move toward the left (Fig. 3), which transmits a motion against the compression of the spring 209 to move the clamping member 198 toward the right (Fig. 3) to unclamp the work piece 195. The position of the parts as illustrated in Fig. 3 shows the work piece 195 in a clamped operative position. In this position of the parts, the pipe 212 is connected by an exhaust pipe 214 to allow fluid within the cylinder chamber 213 to exhaust and return to the reservoir 50 within the base 10. The valve 211 is preferably a rotary type valve having a rotary valve member 215 which is provided with a valve stem 216 having a collar 217 fixedly mounted thereon. The collar 217 serves as a support for the opposed studs 194 and 195 which pivotally support the headstock control lever 193. When the headstock control lever 193 is rotated in a counter-clockwise direction into dotted line position 193*a* (Fig. 3), the rotary valve member 215 is connected to exhaust fluid from the chamber 213 and thereby releases the compression of the spring 209 to clamp the work piece 195 in operative position within the collar 197.

When it is desired to release the work piece 195 after a grinding operation has been completed, the lever 193 is rocked in a clockwise direction from the position 193*a* to turn the valve member 215 in a clockwise direction into a position whereby fluid under pressure passing through the pipe 210 passes through the pipe 212 into the cylinder chamber 213 to move the piston 207 toward the left to move the clamping member 198 toward the right (Fig. 3) to unclamp the work piece 195 so that it may be removed from the headstock and replaced with an unground work piece.

The work is preferably loaded into the collet 197 by means of a special loading fixture which has not been illustrated in this application, since it is not considered to be a part of the present invention. This locating fixture serves to locate the eccentric portion 196 so that its axis coincides with the axis of rotation of the headstock spindle 181.

The various steps in the grinding operation are diagrammatically illustrated in Figs. 12 to 16 inclusive. Fig. 12 shows the relative positions of the grinding wheels 30 and 30*a* when the work piece 195 is loaded into the machine. Fig. 13 shows the first step in the grinding operation with the grinding wheel 30 in engagement with the eccentric pin 196 to rough grind the same to a predetermined size. Fig. 14 shows the second step in the operation, in which the work piece has been traversed toward the left and the end face of the eccentric stud 196 is rough ground by the side face of the grinding wheel 30. Fig. 15 shows the third step in the grinding operation, in which the work piece 195 has been traversed toward the left to position the eccentric stud 196 opposite the grinding wheel 30*a* and the grinding wheel has advanced into operative position to finish grind the eccentric pin 196. Fig. 16 shows the fourth step in the grinding operation, in which the work piece 195 has been

traversed a further distance toward the left and the side face of the grinding wheel 30*a* fed into engagement with the end face of the eccentric pin 196 to finish grind the same.

The operation of this improved grinding machine will be readily apparent from the foregoing disclosure. Assuming the wheel slide 32 to be in its rearmost position, a work piece 195 is set in a loading fixture (not shown) and is inserted within the work supporting collet 197. The lever 193 is then moved in a counterclockwise direction into the dotted line position indicated in Fig. 3 to exhaust fluid within the cylinder chamber 113, thereby releasing the compression of the spring 209 which serves to move the clamping member 198 toward the left (Fig. 3). The cam surface formed on the under side of the clamping member 198 riding on the pin 199 serves to move the clamping member 198 upwardly, rigidly to clamp the work piece 195 in position within the work holding collet 197. In this position of the parts, the lever 193 is rocked toward the headstock to actuate the push button switch 191, thereby operating the relay switch 296 to start the electric motor 185 which in turn starts rotation of the headstock spindle 181 and the work piece 195.

The grinding wheels 30 and 30*a* are rotated by the closing of a circuit to start the motor 33. The lever 145 may then be moved toward the operator, that is, in a counterclockwise direction (Fig. 5) to shift the control valve 52 so as to admit fluid under pressure to start the forward movement of the wheel slide 32 and the grinding wheels 30 and 30*a*. During this movement the head 168 of the stud 167 slides within the notch 161 in the arcuate member 160. The grinding operation proceeds until the collar adjacent to the rear end of the piston rod engages the stop block 115 and moves the stop block into a stopped position against the end of the sleeve to positively limit the infeeding movement of the grinding wheel. This movement causes the grinding wheel 30 to move from the position illustrated in Fig. 12 into the position illustrated in Fig. 13. The grinding wheel 30 being set for a rough grinding operation, grinds the eccentric portion 196 of the work piece 195 to the required extent. The hand traverse wheel is then turned to cause a slight movement of the table 11 toward the right so that the shoulder of the work piece is brought up into engagement with the side face of the wheel 30 to clean up the shoulder thereon.

The control lever 145 is then moved toward the machine base or in a clockwise direction (Fig. 5) which shifts the wheel feed control valve to produce a rearward movement of the wheel slide 32 and the grinding wheels 30 and 30*a*. At the same time, the head 168 moves out of the notch 161 in the member 160 so that the table is traversed longitudinally by manual rotation of the hand wheel 21 to move the work piece so that the grinding wheel 30 may be fed into the position illustrated in Fig. 14 to grind the end face of the eccentric portion 196 of the work piece 195. During this traversing movement of the work table, the stop carrying sector 113 is rocked in a clockwise direction (Fig. 2) to position the next stop block in operative relation with the collars on the feeding mechanism. When the work piece has been positioned as indicated in Fig. 14, the lever 145 may be moved outwardly to start an infeeding movement of the grinding wheel.

In this position of the parts, the head 168 of the stud 167 is aligned with the notch 162. The wheel feeds into the work to a position illustrated in Fig. 14 to rough grind the end face of the eccentric 196 to the required extent, after which the lever 145 is moved toward the machine, that is, in a clockwise direction (Fig. 5) to cause a rearward movement of the wheel slide, after which the table may be traversed to a position to bring the eccentric 196 into operative relation with the finish grinding wheel 30*a*, as illustrated in Fig. 15. In this position of the parts, the lever 145 may be again moved away from the machine, that is, in a counterclockwise direction (Fig. 5), in which position the head 168 of the stud 167 is aligned with the notch 163 and produces a shifting movement of the control valve 52 to cause an infeeding movement of the wheel slide 32 which continues until the grinding wheel 30*a* grinds the periphery of the eccentric 196 to the required extent. When the eccentric has reached a predetermined size, the table 11 is jogged toward the right a sufficient distance so that the side face of the wheel contacts and grinds or cleans up the shoulder on the work piece. The lever 145 is then shifted rearwardly, that is, in a clockwise direction (Fig. 5), to cause a rearward movement of the wheel slide 32 and the grinding wheel 30*a*, after which the hand traverse wheel 21 may then be rotated to again traverse the table 11 toward the left, so that the work piece 195 bears the relation with the wheel 30*a* as shown in Fig. 16, in which position the head 168 of the stud 167 is aligned with the notch 164.

In this position of the parts, the lever 145 may be again shifted to start an advancing or infeeding movement of the grinding wheel slide 32 and the grinding wheel 30*a* so that the finish grinding wheel 30*a* grinds the end face of the eccentric portion 196 of the work piece. The lever 145 may then be moved toward the machine, that is, in a clockwise direction (Fig. 5) to cause a rearward movement of the grinding wheel slide 32 and the grinding wheels 30 and 30*a*. The work table 11 may then be traversed toward the right by rotation of the manually operable traverse wheel 21 into its initial position with an adjustable stop dog 220 carried by the T-slot 134 on the table 11 in engagement with a fixed stop abutment 221 mounted on the front of the machine base. The knob of the control lever 193 is then pulled away from the headstock so that the lever 193 actuates the push button switch 192 to operate the relay switch 297 to stop the rotation of the headstock motor 185. At the same time, the lever 193 is then rocked in a clockwise direction to shift the rotary valve member 215 into a position to admit fluid under pressure through the pipe 212 into the cylinder chamber 213 to unclamp the work piece by shifting the clamping member 198 toward the right (Fig. 3). The finish ground work piece may then be removed from the collet 197 and a new piece, in its locating adapter, inserted in position for the next grinding operation.

During the traversing movement of the table 11, the head 168 on the stud 167 slides along the rear face of the sector 160 and prevents a shifting movement of the control lever 145 to produce an infeeding movement. Similarly, when the head 168 of the stud 167 is in engagement with the notches 161, 162, 163, or 164, the table cannot be traversed due to the fact that such movement is prevented by the engagement of the head 168 with the notches in the arcuate

member 160, thus serving as an interlock to prevent an infeeding movement of the grinding wheel during a longitudinal positioning movement of the work piece, and similarly preventing a longitudinal movement of the work piece during an infeed grinding movement of the wheel slide 32.

While the machine disclosed in this application illustrates the grinding of a work piece having an eccentric pin projecting from its end, this machine is equally applicable to grinding other types of work pieces, such as multi-diameters and the like, it being merely necessary to change the eccentric quill or bushing 197 for a bushing of the required size and shape to accommodate the work piece to be ground. As illustrated in Fig. 10 of the drawings, the collet 197 is supported in a work holding plate 250 which is removably supported in a recessed portion 251 formed in the right-hand end of the headstock spindle. The member 250 is provided with a frusto-conical peripheral surface 252 which is engaged by a plurality of symmetrically positioned adjusting and clamping screws 253 and 254 (only two of which have been illustrated) by means of which the collet 197 and the member 250 may be held in position and may also be adjusted laterally as desired in setting up the machine for a given grinding operation.

It will thus be seen that there has been provided by this invention apparatus in which the various objects hereinabove 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. In a grinding machine having a longitudinally movable work supporting table, a transversely movable wheel slide, a rotatable grinding wheel thereon, means to traverse said table longitudinally, means including a control lever to move the wheel slide transversely in either direction, and means actuated by the longitudinal movement of said table to hold said lever so as to prevent an infeeding movement of the wheel slide except when the table is in a predetermined grinding position.

2. In a grinding machine having a longitudinally movable work supporting table, a transversely movable wheel slide, a rotatable grinding wheel on said slide, a manually operable mechanism to traverse said table longitudinally, a fluid pressure system including a piston and cylinder operatively connected to move the wheel slide transversely in either direction, a control valve therefor, a control lever for actuating said valve, and means actuated by longitudinal movement of said table to hold said lever so as to prevent an infeeding movement of the wheel slide except when the table is in a predetermined grinding position.

3. In a grinding machine having a longitudinally movable work table, a transversely movable wheel slide, a rotatable grinding wheel thereon, means to traverse said table longitudinally, means including a control lever to move the wheel slide transversely in either direction, a notched quadrant, a stud on said lever, a head on the stud which is shaped to mate with the notches in said quadrant, and means actuated by longitudinal movement of said table to cause a relative movement between the quadrant and head so as to prevent movement of the lever to cause an infeed of the grinding wheel except when the table is in a predetermined grinding position.

4. In a grinding machine having a longitudinally movable work supporting table, a transversely movable wheel slide, a rotatable grinding wheel on said slide, means to traverse said table longitudinally, means including a control lever to move the wheel slide transversely in either direction, a plurality of stops successively to limit the infeeding of the grinding wheel, means actuated by the longitudinal movement of the table to successively move said stops into an operative position, and means actuated by said table movement to hold said lever so as to prevent an infeeding movement of the wheel slide except when the table is in a predetermined grinding position.

5. In a grinding machine having a longitudinally movable work supporting table, a transversely movable wheel slide, a rotatable grinding wheel on said slide, a manually operable mechanism to traverse said table longitudinally, a fluid pressure system including a piston and cylinder operatively connected to move the wheel slide transversely in either direction, a control valve therefor, a control lever for actuating said valve, a plurality of stops successively to limit the infeeding movement of the grinding wheel, means actuated by the longitudinal movement of the table to successively move said stops into an operative position, and means actuated by longitudinal movement of said table to hold said lever so as to prevent an infeeding movement of the grinding wheel and slide except when the table is in a predetermined grinding position.

6. In a grinding machine having a longitudinally movable work supporting table, a transversely movable wheel slide, a rotatable grinding wheel, a traversing mechanism to traverse said table longitudinally, a fluid pressure system including a piston and cylinder operatively connected to move the wheel slide transversely in either direction, a control valve therefor, a plurality of stops successively to limit the infeeding movement of the grinding wheel, and a manually operable control lever which is operatively connected when moved in a longitudinal direction to successively move said stops onto an operative position and which is operatively connected when moved in a transverse direction to actuate said control valve to produce a movement of the wheel slide in either direction.

7. In a grinding machine having a longitudinally movable work supporting table, a transversely movable wheel slide, a rotatable grinding wheel thereon, a traversing machinism to traverse said table longitudinally, a fluid pressure system including a piston and cylinder operatively connected to move the wheel slide transversely in either direction, a control valve therefore, a plurality of stops successively to limit the infeeding movement of the grinding wheel, a manually operable control lever which is operatively connected when moved in a longitudinal direction to successively move said stops into an operative position and which is operatively connected when moved in a transverse direction to actuate said control valve to produce a transverse movement of the wheel slide in either direction, and an interlock for said lever which prevents shifting of the feed stops during movement of the wheel slide and prevents movement

of the wheel slide during shifting of the feed stops.

8. In a grinding machine having a longitudinally movable work supporting table, a transversely movable wheel slide, a rotatable grinding wheel thereon, a traversing mechanism to traverse said table longitudinally, a fluid pressure system including a piston and cylinder operatively connected to move the wheel slide transversely in either direction, a control valve therefor, a plurality of stops successively to limit the infeeding movement of the grinding wheel, a control lever operatively connected to actuate said valve and said stops, detachable connections between said table and said lever whereby the lever is moved longitudinally when the table is traversed automatically to position successive stops in operative position, and means to prevent longitudinal movement of the table during the transverse movement of the wheel slide.

9. In a grinding machine having a longitudinally movable work supporting table, a transversely movable wheel slide, a rotatable grinding wheel thereon, a traversing mechanism to traverse the table longitudinally, a fluid pressure system including a piston and cylinder operatively connected to move the wheel slide transversely in either direction, a control lever therefore, a plurality of stops successively to limit the infeeding movement of the grinding wheel, a control lever operatively connected to actuate said valve and said stops, said connections being arranged so that a transverse movement of the lever serves to shift the valve to produce a transverse movement of the grinding wheel slide, connections between said table and said lever whereby movement of the table moves the lever longitudinally, and means to prevent shifting the lever transversely and thereby prevent an infeeding movement of the slide during a longitudinal traversing movement of the work table.

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CERTIFICATE OF CORRECTION.

Patent No. 2,190,134. February 13, 1940.

JOHN I. GARSIDE, ET AL.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 8, second column, line 6, claim 9, for the word "lever" read --valve--; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 14th day of May, A. D. 1940.

Henry Van Arsdale,
Acting Commissioner of Patents.

(Seal)