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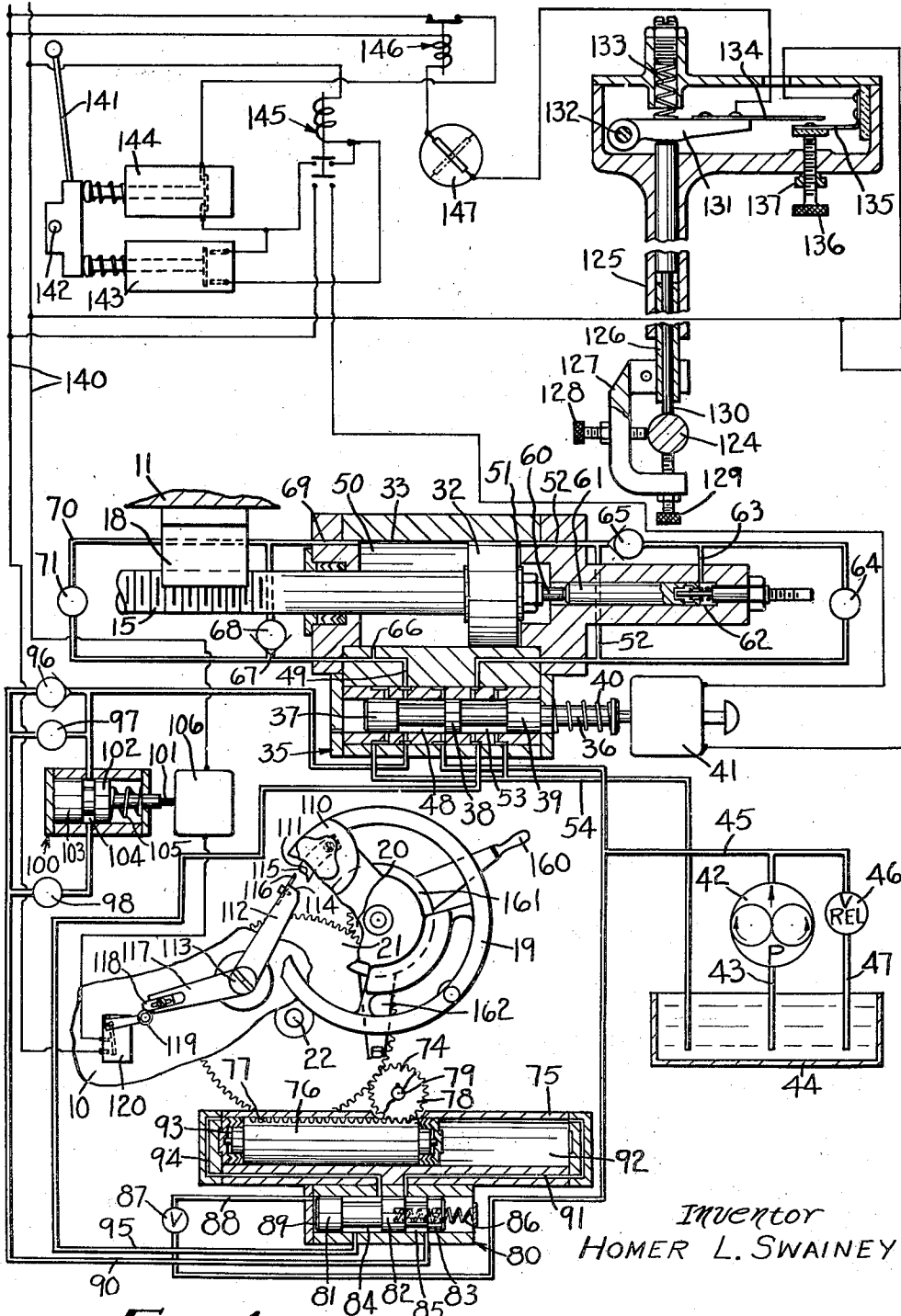
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2,582,610

GRINDING WHEEL FEEDING MECHANISM

Filed Dec. 9, 1950

2 SHEETS—SHEET 1



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2 SHEETS—SHEET 2

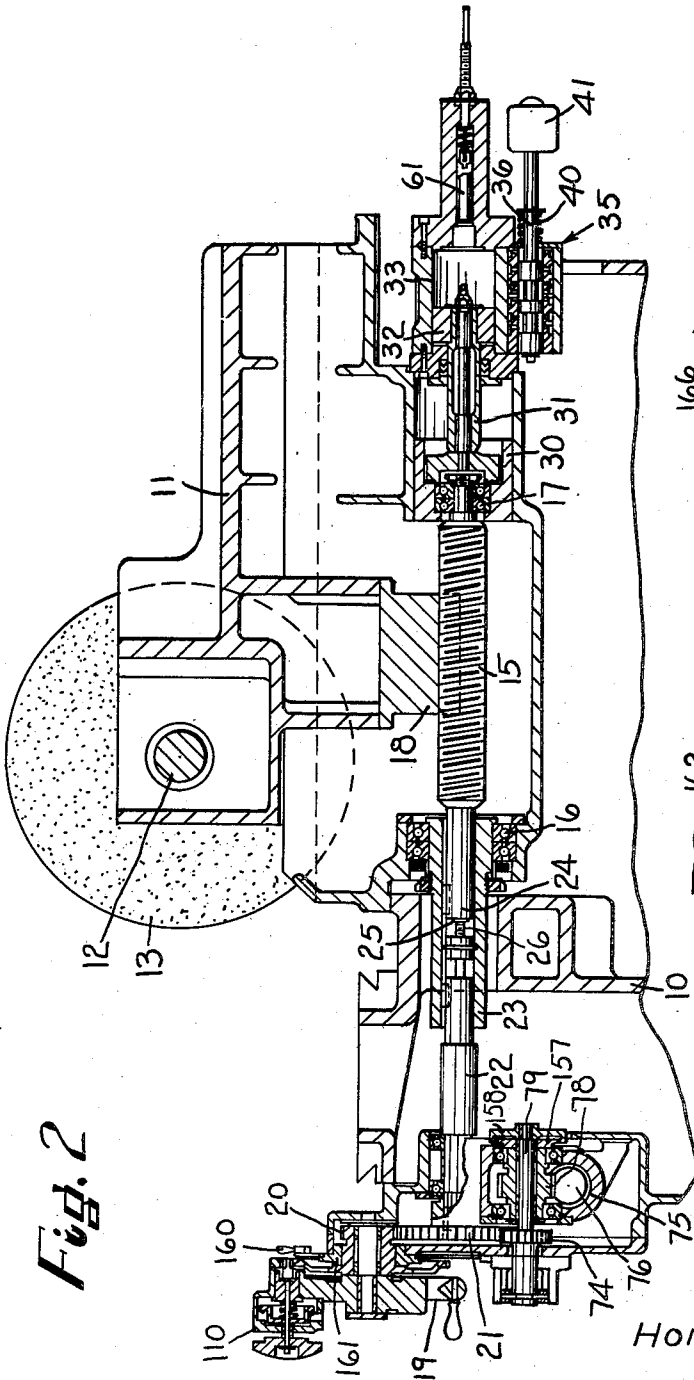


Fig. 2

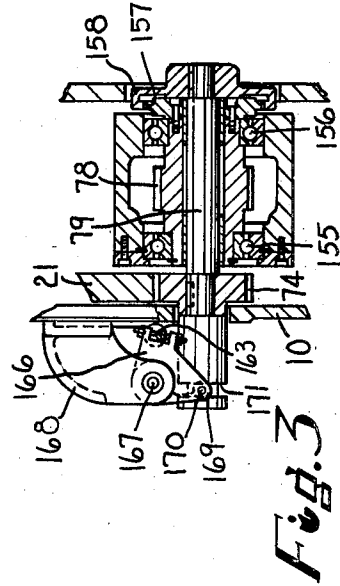


Fig. 3

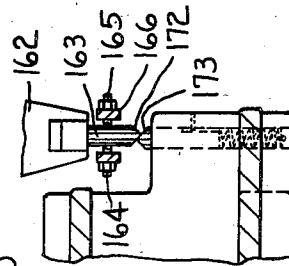


Fig. 4

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GRINDING WHEEL FEEDING MECHANISM

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7 Claims. (Cl. 51-165)

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The invention relates to grinding machines, and more particularly to a grinding wheel feeding mechanism for precisely and automatically controlling work size.

One object of the invention is to provide a simple and thoroughly practical feeding mechanism for precisely feeding a grinding wheel so as to control work size. Another object of the invention is to provide a feeding mechanism to feed the grinding wheel first at a grinding rate, and automatically to reduce the rate of infeed to a finishing feed prior to positively stopping the infeed. Another object is to provide a feeding mechanism with a work sizing head having a movable work engaging contact member to cause a withdrawal of the grinding wheel to an inoperative position when a work piece has been ground to a predetermined size.

Another object is to provide a nut and screw feeding mechanism with an adjustable stop abutment and stop pawl to limit the infeeding movement of the grinding wheel in which the pawl is arranged to actuate a limit switch to change the grinding feed to a finishing feed before the infeeding movement is stopped, and a work sizing head arranged to cause a withdrawal of the grinding wheel when a work piece has been ground to a predetermined size.

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 combined hydraulic and electrical diagram of the feeding mechanism and the controls therefor;

Fig. 2 is a cross-sectional view through the grinding wheel feeding mechanism;

Fig. 3 is a fragmentary horizontal sectional view, on an enlarged scale, through the feeding mechanism clutch and the actuating mechanism therefor; and

Fig. 4 is a fragmentary vertical section, on an enlarged scale, of the detent mechanism for holding the clutch either engaged or disengaged.

A grinding machine has been illustrated in the drawings of the type disclosed in my copending application Serial No. 191,386 filed October 21, 1950, comprising a base 10 which serves as a support for a transversely movable wheel slide 11. The wheel slide 11 is supported on the usual

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V-way and flatway (not shown). The wheel slide 11 serves as a support for a rotatable wheel spindle 12 having a grinding wheel 13 mounted adjacent to one end thereof. The grinding wheel spindle 12 may be driven by any suitable source of power such as for example an electric motor (not shown) mounted on the wheel slide 11.

The wheel slide 11 is arranged to be fed transversely by means of a suitable feeding mechanism such as a rotatable feed screw 15 which is journaled in anti-friction bearings 16 and 17. A half-nut 18 depends from the under side of the wheel slide 11 and meshes with or engages the feed screw 15. A manually operable feed wheel 19 is mounted on the front of the machine base 10. The feed wheel 19 is operatively connected to rotate a gear 20 which meshes with a gear 21. The gear 21 is keyed on the forward end of a rotatable shaft 22. The rear end of the shaft 22 is slidably keyed within the forward end of a rotatable sleeve 23. The forward cylindrical end portion 24 of the feed screw 15 is slidably keyed within the hollow sleeve 23. The forward end of the portion 24 of the feed screw 15 is provided with a stop abutment 25 which is arranged to move into engagement with a rounded end of an adjustable stop screw 26 which is carried by the shaft 22.

In order to facilitate a rapid positioning movement of the grinding wheel, that is, rapidly moving the grinding wheel and its supporting slide to and from an operative position, a hydraulically operated mechanism is provided. The bearing 17 for the right-hand end of the feed screw 15 (Fig. 2) is supported by a slidably mounted sleeve 30 which is connected to the forward end of a piston rod 31. A piston 32 is mounted on the other end of the piston rod 31 and is slidably mounted within a cylinder 33. The piston rod 31, the piston 32 and the cylinder 33 are arranged in axial alignment with the feed screw 15.

A suitable feed control valve 35 is provided for controlling the admission and exhaust of fluid from the cylinder 33. The valve 35 is preferably a piston-type valve comprising a valve stem 36 having a plurality of valve pistons 37, 38 and 39 formed integrally therewith. A compression spring 40 serves normally to maintain the valve stem 36 in its right-hand end position as illustrated in Fig. 1. A solenoid 41 is operatively connected to the right-hand end of the valve stem 36 and is arranged so that when energized, it serves to shift the valve stem 36 toward the left into a reverse position.

A suitable fluid pressure supply system is pro-

vided comprising a motor driven fluid pump 42 which draws fluid through a pipe 43 from a reservoir 44 and forces fluid under pressure through a pipe 45 to the feed control valve 35. A pressure relief valve 46 is connected to the pipe 45 by means of which excess fluid under pressure may be bypassed directly through a pipe 47 into the reservoir 44 so as to maintain a substantially uniform operating pressure in the hydraulic system.

In the position of the valve 35, as shown in Fig. 1, fluid under pressure passing through the pipe 45 enters a valve chamber 48 located between the valve pistons 37 and 38 and passes through a passage 49 into a cylinder chamber 50 to cause the piston 32 to move toward the right into the position illustrated in Fig. 1. Movement of the piston 32 toward the right also imparts a corresponding movement to the feed screw 15, the half-nut 18, the wheel slide 11 so as to move the grinding wheel 13 to a rearward or inoperative position. During this movement of the piston 32 fluid within a cylinder chamber 51 may exhaust through a passage 52, through a valve chamber 53 located between the valve pistons 38 and 39 and pass out through an exhaust pipe 54 into the reservoir 44.

In order to slow down the rapid rearward movement of the piston 32, a dash pot mechanism is provided. The piston rod 31 is provided with a rearwardly extending stud 60 which is arranged when moved toward the right to engage a dash pot piston 61. The dash pot piston 61 is slidably mounted within a dash pot cylinder 62. When the dash pot 61 moves rearwardly, fluid is exhausted from the dash pot cylinder 62 through a pipe 63 and through a throttle valve 64 and into the passage 52. A ball check valve 65 is provided so that fluid exhausting from the dash pot cylinder 62 must pass through the throttle valve 64. It will be readily apparent from the foregoing disclosure that until the stud 60 engages the dash pot piston 61, the piston 32 will move at a rapid rate. After the stud 60 engages the dash pot piston 61 the speed of movement of the piston is reduced to a predetermined slower rate as governed by fluid exhausting from the dash pot cylinder 62 through the pipe 63 and the throttle valve 64. It will be readily apparent from the foregoing disclosure that by adjustment of the throttle valve 64, the rapid rearward movement of the piston 32 may be reduced to a slower speed before the piston 32 engages the rear of the cylinder 33.

It is similarly desirable to provide a cushioning or slowing down movement of the piston 32 as it moves rapidly toward the left as the grinding wheel 13 approaches the workpiece to be ground. When the solenoid 41 is energized to shift the valve stem 36 toward the left fluid under pressure from the pipe 45 is passed through the valve chamber 53 and through the passage 52 into the cylinder chamber 51 to cause the piston 32 to move rapidly toward the left (Fig. 1). Fluid under pressure passing through the passage 52 may also pass through the throttle valve 64 and the ball check valve 65, through the pipe 63 into the dash pot cylinder 62 to return the dash pot piston 61 to its initial position. The initial rapid movement of the piston 32 causes fluid within the cylinder chamber 50 to exhaust through a port 66, through the passage 49, through the valve chamber 48 and out through the exhaust pipe 54. When the valve piston 32 closes the port 66 just before the piston reaches the end of its stroke toward the left, that is when the stop

abutment 25 engages the stop screw 26, fluid may then be exhausted through a passage 70, and through a throttle valve 71 into the passage 49 thereby facilitating a reduction in speed of the forward movement of the piston 32 before the forward approaching movement ceases. A ball check valve 68 is connected between the port 69 and the passage 67 which serves to facilitate a substantially unrestricted flow of fluid from the passage 49, through the port 69 into the cylinder chamber 50 so as to start the rapid rearward movement of the piston 32 when the solenoid 41 is deenergized.

A suitable cam operated feeding mechanism is provided for producing a slow precise feeding movement of the grinding wheel during the grinding operation. In the preferred form, a hydraulically operated mechanism is provided in which a fluid motor serves to produce a controlled rotary movement of the feed screw 15. As illustrated in the drawings a fluid pressure cylinder 75 is provided having a slidably mounted piston 76. The upper central portion of the piston 76 is provided with rack teeth 77 meshing with a gear 78 which is keyed on a rotatable shaft 79. The shaft 79 is also provided with a gear 74 which meshes with the gear 21. It will be readily apparent from the foregoing disclosure that when the piston 76 is moved endwise within the cylinder 75, a rotary motion will be imparted to the feed screw 15 through the rack and gear mechanism above described.

A shuttle-type control valve 80 is provided for controlling the admission to and exhaust of fluid from the cylinder 75. The valve 80 comprises a slidably mounted valve member having a plurality of spaced valve pistons 81, 82 and 83 forming a pair of valve chambers 84 and 85. A compression spring 86 is provided normally to hold the valve in a left-hand end position such as shown in Fig. 1. In order to shift the valve 80 into a right-hand end position, the pipe 45 is connected by a valve 87 with a pipe 88 which is in turn connected to a left-hand end chamber 89 within the valve 80. When it is desired to shift the valve 80 into a right-hand end position, the valve 87 may be opened to admit fluid under pressure from the pump 42 through the pipe 88 into the valve chamber 89.

In the position of valves 35 and 80 (Fig. 1) fluid under pressure entering the valve chamber 48 may pass through the pipe 90, through the valve chamber 85 in the valve 80, through a passage 91 into a cylinder chamber 92 to move the piston 76 toward the left into the position illustrated in Fig. 1. The left-hand movement of the piston 76 serves to impart a rotary motion to the feed screw 15 to cause a rearward movement of the nut 18, the wheel slide 11 and the grinding wheel 13. During this movement of the piston 76 fluid within a cylinder chamber 93 may exhaust through a passage 94, through the valve chamber 84, through a pipe 95 into the valve chamber 53 in the valve 35 and exhaust through the pipe 54 into the reservoir 44. It will be readily apparent from the foregoing disclosure that the feed control valve 35 is arranged to control the admission to and exhaust of fluid from the rapid feed cylinder 33 and the grinding feed cylinder 75.

It is desirable to control the grinding feed of the wheel so that a grinding feed may be obtained during the initial grinding after which the feed may be slowed down to a finishing feed before the infeeding movement of the grinding

wheel 13 is positively stopped. This is preferably accomplished by means of a finish feed control valve 97 and a grinding feed control valve 98 which are arranged to control the exhaust of fluid from the cylinder chamber 92. A ball check valve 96 is provided in the pipe 90 so as to allow pressure to flow substantially unrestricted from the valve 35 through the pipe 90 to the cylinder 75. When fluid is exhausted from the cylinder chamber 92 when the piston 76 starts its movement to the right to cause a feeding movement of the grinding wheel 13, the ball check valve 96 is arranged to prevent exhaust fluid passing therethrough so that the entire exhaust fluid from the cylinder chamber 92 must pass through either the grinding feed valve 98 or the finishing feed valve 97 or through both of the feed valves. During the initial infeeding movement of the grinding wheels as caused by the piston 76 fluid exhausted from the cylinder chamber 92 may pass through both of the valves 96 and 97. This exhaust of fluid serves to control the rate of the grinding feed.

In order to change the infeed from a grinding feed to a finishing feed, a solenoid valve 100 is provided comprising a valve stem 101 having valve pistons 102 and 103 formed integrally therewith, the valve pistons 102 and 103 being arranged to form a valve chamber 104. A compression spring 105 serves normally to hold the valve stem 101 in a righthand end position (Fig. 1) so that fluid may exhaust through both of the valves 96 and 97. A solenoid 106 is provided which when energized serves to shift the valve stem 101 toward the left against the compression of the spring 105 so as to render the grinding feed control valve 98 inoperative. After the valve 100 has been shifted into a left-hand end position all fluid exhausting from the cylinder chamber 92 must exhaust through the finish feed control valve 97 which is adjusted to produce a slow finishing feed of the grinding wheel before the infeeding movement is finally stopped.

A stop abutment mechanism is provided for positively stopping the rotary motion of the feed screw 15 thereby limiting the infeeding movement of the grinding wheel 13. This mechanism may comprise a micrometer adjusting mechanism 110 carried by the feed wheel 19 which is arranged to adjustably support a stop abutment 111. A stop pawl 112 is pivotally supported by a stud 113 fixedly mounted on the front of the machine base. It will be readily apparent that when the stop abutment rotates in a counter-clockwise direction with the feed wheel 19, the rotary motion of the feed screw 15 will continue until the stop abutment 111 engages a stop surface 114 on the upper end of the pawl 112.

It is desirable to feed the grinding wheel 13 first at a normal grinding rate and then to automatically reduce the feed to a very slow finishing feed before the rotation of the feed screw 15 is stopped by the mechanism above described. An arm 117 is supported on the stud 113 and is fixedly connected to move with the stop pawl 112. The stop pawl 112 is provided with an adjustable detent 116 which is arranged to be engaged by a cam 115 located adjacent to the stop abutment 111. The detent 116 is preferably adjusted so that the cam 115 will engage the detent 116 and rock the stop pawl 112 in a counter-clockwise direction before the stop surface 114 is engaged by the stop abutment 111. The rocking movement of the stop pawl 112 serves to im-

part a corresponding motion to the arm 117. The arm 117 supports an adjustable detent 118 which is arranged to engage an actuated roller 119 of a limit switch 120. The limit switch 120 is preferably a normally open limit switch which is connected so that when it is closed, the solenoid 106 is energized to shift the valve stem 101 toward the right thereby rendering the grinding feed control valve 98 inoperative during the finish grinding operation. It will be readily apparent from the foregoing disclosure that when the feed wheel 19 is rotated either manually or by movement of the piston 76, the rotary motion of the feed screw 15 and feed wheel 19 will move at a grinding feed rate until the cam 115 engages the detent 116 and rocks the stop pawl 112, the arm 117, the detent 118 in a counter-clockwise direction to actuate and close the limit switch 120 thereby energizing the solenoid 106, close the valve 100 thus rendering the grinding feed control valve inoperative so that thereafter fluid exhausting from the cylinder chamber 92 must pass through the finishing feed control valve 97. The slow finish feed continues until the stop abutment 111 engages the stop surface 114 on the stop pawl 112. In the preferred operation the grinding wheel remains in grinding contact with the work after the infeeding movement is stopped to permit the grinding wheel 13 to spark-out or finish grind the work piece.

An automatic control mechanism is provided for automatically controlling the duration of the grinding cycle comprising a work gaging head 125 having a movable work contact member. The gage head 125 is provided with a slidably movable work contact member 130 which is arranged to engage the periphery of the work piece 124 being ground. The gaging head 125 is provided with a C-shaped caliper head 127 having a pair of adjustably mounted work engaging screws 128 and 129 to facilitate maintaining the gage head 125 in a predetermined relationship with the work piece 124 during a grinding operation. The gaging head 125 is preferably supported by a bracket (not shown) on the wheel slide 11. This type of mounting is old and well known in the art and therefor has not been illustrated in the present application.

The upper end of the work contact member 130 engages a rock arm 131 which is pivotally supported by a stud 132. A compression spring 133 is arranged to exert a downward pressure on rock arm 131 to maintain the contact member 130 in operative engagement with the periphery of work piece 124 during a grinding operation. The rock arm 131 is provided with an electrical contact member 134 which is arranged to move into engagement with a contact member 135 mounted within the gage head 125. An adjustment screw 136 is provided for adjusting the contact element 135 to facilitate setting up gage head for sizing to grind a work piece to a predetermined size.

A pair of power lines 140 serve to supply electrical power to operate mechanism of the machine. A manually operable control lever 141 is pivotally supported by a stud 142 which is in turn supported on the front of machine base. The control lever 141 is arranged to close a normally open start switch 143 when the lever 141 is rocked in a counter-clockwise direction and to open a normally closed stop switch 144 when rocked in a clockwise direction. A relay switch 145 and a relay switch 146 together with a selector switch 147 are provided for controlling

the feeding mechanism in a manner to be hereinafter described.

When it is desired to start a grinding cycle, the lever 141 is rocked in a counter-clockwise direction to close the start switch 143 which serves to energize the relay switch 145 to close a circuit and thereby to energize the solenoid 41 so as to shift the feed control valve 35 to start a forward approaching and feeding movement of the wheel slide 11 and grinding wheel 13. The relay switch 145 is provided with a holding circuit so that only a momentary closing of the start switch 143 is required to start the grinding cycle. The piston 32 causes rapid approaching movement of the wheel slide 11 and the grinding wheel 13. The rapid approaching movement continues until the piston 32 engages the left-hand end of the cylinder 33 after which the approaching movement of the slide 11 is reduced to a grinding feed as governed by the throttle valve 97 and 98. The grinding feed continues until the cam 115 engages the detent 116 and rocks the feed pawl 112 and the arm 117 in a counter-clockwise direction to close the normally open limit switch 120. Closing the limit switch 120 serves to energize the solenoid 106 to close the valve 100 so as to render the throttle valve 98 inoperative thereby reducing the grinding feed to finishing feed as governed by the throttle valve 97. The finishing feed continues until the stop surface 111 on the feed wheel 19 engages the stop surface 114 on the feed pawl 112 thereby positively limiting the infeed movement of the wheel slide 11 and the grinding wheel 13. The grinding wheel 13 remains in engagement with the work piece 124 for a sparking-out or dwell. Until the work contact member 130 moves downward a sufficient distance to close the contacts 134—135 thereby closing a circuit to open the normally closed relay switch 146. The opening of the relay switch 146 serves to break the holding circuit on relay switch 145 thereby deenergizing the solenoid 41 so that the feed control valve 35 returns to the position illustrated in Figure 1. The shifting of the feed control valve 35 into this position causes a rearward movement of the wheel slide 13, that is, a movement of the piston 32 toward the right, and a simultaneous movement of the piston 76 toward the left to re-set both of the pistons for the next grinding cycle.

The selector switch 147 is provided to facilitate rendering gaging head 125 inoperative when desired to facilitate manually controlling grinding cycle.

It is desirable to provide a suitable clutch mechanism whereby the feed wheel may, if desired, be operated independent of the cylinder 75 for setting up the machine, or for manual operation thereof when desired. The gear 78 is supported by anti-fraction bearings 155 and 156 (Fig. 3). The shaft 79 is provided with an internal gear 157 which is arranged to mesh with an external gear 158 which is fixedly mounted to rotate with the gear 78. As shown in Fig. 3, the gears 157 and 158 are in mesh so that rotation of the gear 78 caused by the piston 76 will impart a rotary motion to the feed screw 15. When it is desired to declutch the power mechanism from the manual control, the shaft 79 is moved axially toward the right (Fig. 3) to slide the internal gear 157 out of mesh with the external gear 158, after which the feed wheel 19 may be rotated manually independent of the fluid pressure piston 76.

To facilitate operation of the clutch mechanism

above described, a manually operable clutch lever 160 having a hub portion 161 is arranged to rotate concentric with the axis of the feed wheel 19. The clutch lever 160 is provided with a downwardly extending arm 162 having a stud 163 projecting downwardly from its lower end. The stud 163 is arranged between a pair of adjustably mounted opposed actuating screws 164 and 165 which are adjustably mounted on a yoked member 166. The yoked member 166 is pivotally mounted on a stud 167 carried by a bracket 168 which is fixedly mounted on the front of the machine base. The yoked member 166 is provided with a downwardly extending yoked portion 169 which is provided with opposed studs 170 which ride within a groove 171 formed in an enlarged end portion of the shaft 79. It will be readily apparent from the foregoing disclosure that when the clutch lever 160 is rocked in a clockwise direction (Fig. 1), the yoked member 166—169 will be rocked in a counter-clockwise direction (Fig. 3) to slide the shaft 79 toward the right thereby moving the internal gear 157 toward the right out of mesh with the external gear 158.

A suitable detent mechanism is provided for holding the clutch parts either engaged or disengaged. This mechanism may comprise an arrow-pointed surface 172 formed on the lower end of the stud 163 (Fig. 4). The arrow-pointed surface 172 is arranged to engage a spring pressed arrow-pointed plunger 173 which serves to hold the stud 163 either in a clutched or declutched position.

The operation of the improved wheel feeding mechanism will be readily apparent from the foregoing disclosure. Assuming all of the valves to have been previously adjusted a workpiece mounted and in position for a grinding operation the gaging head 125 moved into operative engagement with the work piece. The cycle control lever 141 is rocked in a counter-clockwise direction to close the start switch 143. The closing of the start switch 143 serves to energize the solenoid 41 to shift the feed control valve 35 toward the left to energize an infeeding cycle. Fluid under pressure is passed from the valve 35 to the cylinder chamber 51 to cause a rapid approaching movement of the wheel slide 11 and grinding wheel 13 which continues until the port 66 is closed after which the rapid approaching movement is slowed down as controlled by the throttle valve 71 just before the stop member 25 engages the stop screw 26. At the same time fluid is admitted to the cylinder chamber 51 of the cylinder 33, fluid under pressure is also passed into the cylinder chamber 93 to move the piston 76 toward the right thereby starting a controlled rotary motion of the feed screw 15 as governed by the grinding feed control valve 98 and the finish feed control valve 97. The wheel slide continues to move at a grinding feed until the cam 115 engages the detent 116 and rocks the stop pawl 112 so as to close the limit switch 120, as above described. The closing of the limit switch 120 energizes the solenoid 106 to close the valve 100 thereby rendering the grinding feed control valve 98 inoperative so that thereafter fluid exhausting from the cylinder chamber 92 must exhaust through the finish feed control valve 97 which reduces the grinding feed to a slower finishing feed shortly before the stop abutment 111 engages the stop surface 114 on the pawl 112 to positively limit the infeeding movement of the grinding wheel. The grinding wheel 13

remains in grinding contact with the work until the work piece has been ground to a predetermined size as governed by the electric sizing head 125. When the contacts 134—135 in the sizing head close as the work piece 124 is ground to a predetermined diameter, the solenoid 41 is de-energized to admit fluid to the cylinder chamber 50 to cause a rapid rearward movement of the piston 32 together with the slide 11 and grinding wheel 13 to move the wheel 13 to an inoperative position. At the same time fluid under pressure is admitted through the check valve 96 into the cylinder chamber 92 to cause the piston 76 to move toward the left thereby rotating the feed screw in the reverse direction to re-set the feed mechanism for the next cycle of operation. As soon as the feed wheel 19 starts rotation in a clockwise direction, during the re-setting motion, the cam 115 moves out of engagement with the detent 116 thereby allowing the limit switch 120 to open to deenergize the solenoid 186 thereby opening the valve 100 for the next grinding cycle. This cycle of operation may then be successively repeated by merely actuating the cycle control lever 141.

If desired, the feeding mechanism may be operated without the use of the stop abutment 111. The parts are adjusted so that the cam 115 rocks the pawl 112 so that the detent 116 actuates the limit switch 120 to change from a grinding feed to a finishing feed as above described. When the workpiece reaches a predetermined size, the contacts 134—135 make a circuit after a predetermined finish grinding operation to cause a rearward movement of the grinding wheel 13 and wheel slide 11 to an inoperative position.

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.

I claim:

1. In a grinding machine having a transversely movable wheel slide, a rotatable grinding wheel thereon, a feeding mechanism to feed said slide, a rotatable feed wheel therefor, an adjustable stop abutment on said feed wheel, a movably mounted stop pawl positively to limit rotation of the feed wheel, power operated means to actuate said feeding mechanism, means to control said power means to produce a grinding feed, means to control said power means to produce a finishing feed, means including a limit switch actuated by said stop pawl before the stop abutment engages said pawl to render said grinding feed control means inoperative so as to reduce the feed to a predetermined finishing feed, and means including a sizing head having a movable contact member in engagement with the workpiece being ground to move the grinding wheel to an inoperative position when the workpiece has been ground to a predetermined size.

2. In a grinding machine having a transversely movable wheel slide, a rotatable grinding wheel thereon, a feed mechanism to feed said slide, a feed wheel therefor, an adjustable stop abutment on said feed wheel, a pivotally mounted stop pawl positively to limit rotation of the feed wheel, means including a fluid motor to actuate said

feed mechanism, an adjustable throttle valve to control the exhaust of fluid from the fluid motor so as to produce a grinding feed, a second adjustable throttle valve to control the exhaust of fluid from the motor so as to produce a finishing feed, means including a limit switch actuated by said pawl before the stop abutment engages said pawl to render said first throttle valve inoperative so as to reduce the feed to a predetermined finishing feed, and means including a sizing head including a work engaging contact member to move the grinding wheel to an inoperative position when a workpiece has been ground to a predetermined size.

3. In a grinding machine having a transversely movable wheel slide, a rotatable grinding wheel thereon, means including a fluid motor to move said slide rapidly to and from an operative position, a solenoid-actuated control valve therefor, means including a cycle start switch to energize said solenoid-actuated control valve to initiate a feeding cycle, a nut and screw mechanism to feed said slide, a manually operable feed wheel therefor, an adjustable stop abutment on said feed wheel, a pivotally mounted stop pawl to limit the rotation of the feed wheel and feed screw, means including a fluid motor to rotate said feed screw, an adjustable throttle valve to control the exhaust of fluid from the second motor so as to produce a grinding feed, a second throttle valve to control the exhaust of fluid from the second motor so as to produce a finishing feed, a solenoid-actuated valve to render the first throttle valve inoperative, a limit switch actuated by said pawl before the stop abutment engages said pawl to actuate the second solenoid-actuated valve to reduce the feed to a predetermined finishing feed, and a sizing head including a movable work contacting element to deenergize the first solenoid-actuated control valve when a workpiece is ground to a predetermined size to cause a rearward movement of the grinding wheel to an inoperative position.

4. In a grinding machine having a transversely movable wheel slide, a rotatable grinding wheel thereon, means including a fluid motor to move said slide to and from an operative position, a solenoid-actuated control valve therefor, means including a cycle start switch to energize said solenoid-actuated control valve to initiate a feeding cycle, a nut and screw mechanism to feed said slide, a rotatable feed wheel therefor, an adjustable stop abutment on said feed wheel, a pivotally mounted stop pawl positively to limit rotation of the feed wheel and said feed screw, means including a fluid motor to rotate said screw, said solenoid-actuated control valve to control the admission to and exhaust of fluid from both of said motors, an adjustable throttle valve to control the exhaust of fluid from the second motor so as to produce a grinding feed, a second adjustable throttle valve to control the exhaust of fluid from the second motor so as to produce a finishing feed, a second solenoid-actuated valve to render said first throttle valve inoperative, means actuated by said pawl before the stop abutment engages said pawl so as to actuate the latter solenoid-actuated valve to reduce the feed to a predetermined finishing feed, and a sizing head including a movable work engaging contact member which serves when a workpiece has been ground to a predetermined size to deenergize said first solenoid-actuated control valve to cause both of the fluid motors

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to return to initial positions thereby moving the grinding wheel to an inoperative position.

5. In a grinding machine having a transversely movable wheel slide, a rotatable grinding wheel thereon, means including a piston and cylinder to move said slide to and from an operative position, a solenoid-actuated control valve therefor, means including a cycle start switch to energize said solenoid-actuated control valve to initiate a feeding cycle, a nut and screw mechanism to feed said slide, a rotatable feed wheel therefor, an adjustable stop abutment on said feed wheel, a pivotally mounted stop pawl positively to limit rotation of the feed wheel and feed screw, means including a piston and cylinder to rotate said feed screw, said solenoid-actuated control valve serving to control the admission to and exhaust of fluid from both of said cylinders, an adjustable throttle valve to control the exhaust of fluid from the second cylinder so as to produce a grinding feed, a second adjustable valve to control the exhaust of fluid from the second cylinder so as to produce a finishing feed, a second solenoid-actuated valve to render said first throttle valve inoperative, a limit switch actuated by said pawl before the stop abutment engages said pawl so as to actuate the second solenoid-actuated valve to reduce the feed to a predetermined finishing feed, and a sizing head which serves when a workpiece has been ground to a predetermined size to deenergize the first solenoid-actuated control valve to cause both of the pistons to return to initial positions thereby moving the grinding wheel to an inoperative position.

6. In a grinding machine having a transversely movable wheel slide, a rotatable grinding wheel spindle thereon, a feeding mechanism to feed said slide, a rotatable feed wheel therefor, an

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adjustable cam on said feed wheel, a movable pawl arranged to be actuated thereby, power operated means to actuate said feeding mechanism, means to control said power means to produce a grinding feed, means to control said power means to produce a finishing feed, means including a limit switch actuated by said pawl to render the grinding feed control means inoperative so as to reduce the infeed to a predetermined finishing feed and means including a sizing head having a movable contact member in engagement with the workpiece being ground to move the grinding wheel slide to an inoperative position when the workpiece has been ground to a predetermined size.

7. In a grinding machine having a transversely movable wheel slide, a rotatable grinding wheel spindle thereon, a feeding mechanism to feed said slide, a feed wheel therefor, an adjustable cam on said feed wheel, a pivotally mounted pawl arranged to be actuated thereby, means including a fluid motor to actuate said feeding mechanism, an adjustable throttle valve to control the exhaust of fluid from the fluid motor so as to produce a grinding feed, a second throttle valve to control the exhaust of fluid from the motor so as to produce a finishing feed, means including a limit switch actuated by said pawl to render the grinding feed throttle valve inoperative so as to reduce the infeed to a predetermined finishing feed and means including a sizing head including a work engaging contact member to move the grinding wheel slide to an inoperative position when a workpiece has been ground to a predetermined size.

HOMER L. SWAINNEY.

No references cited.