May 26, 1953 H. L. SWAINEY 2,639,563

GRINDING WHEEL FEEDING MECHANISM

Filed Oct. 21, 1950 2 Sheets-Sheet 1

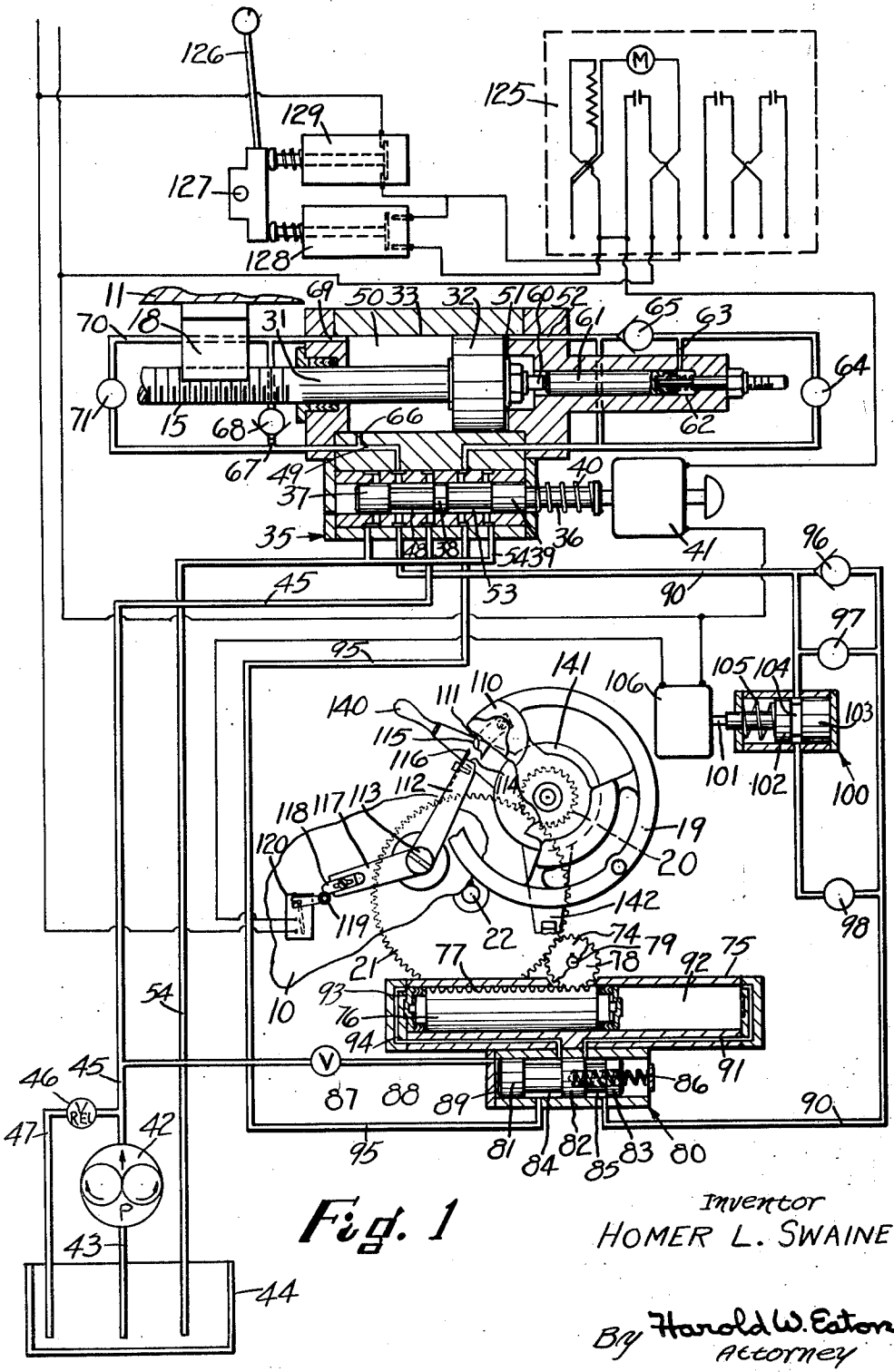


Fig. 1

Inventor
HOMER L. SWAINEY

By Harold W. Eaton
Attorney

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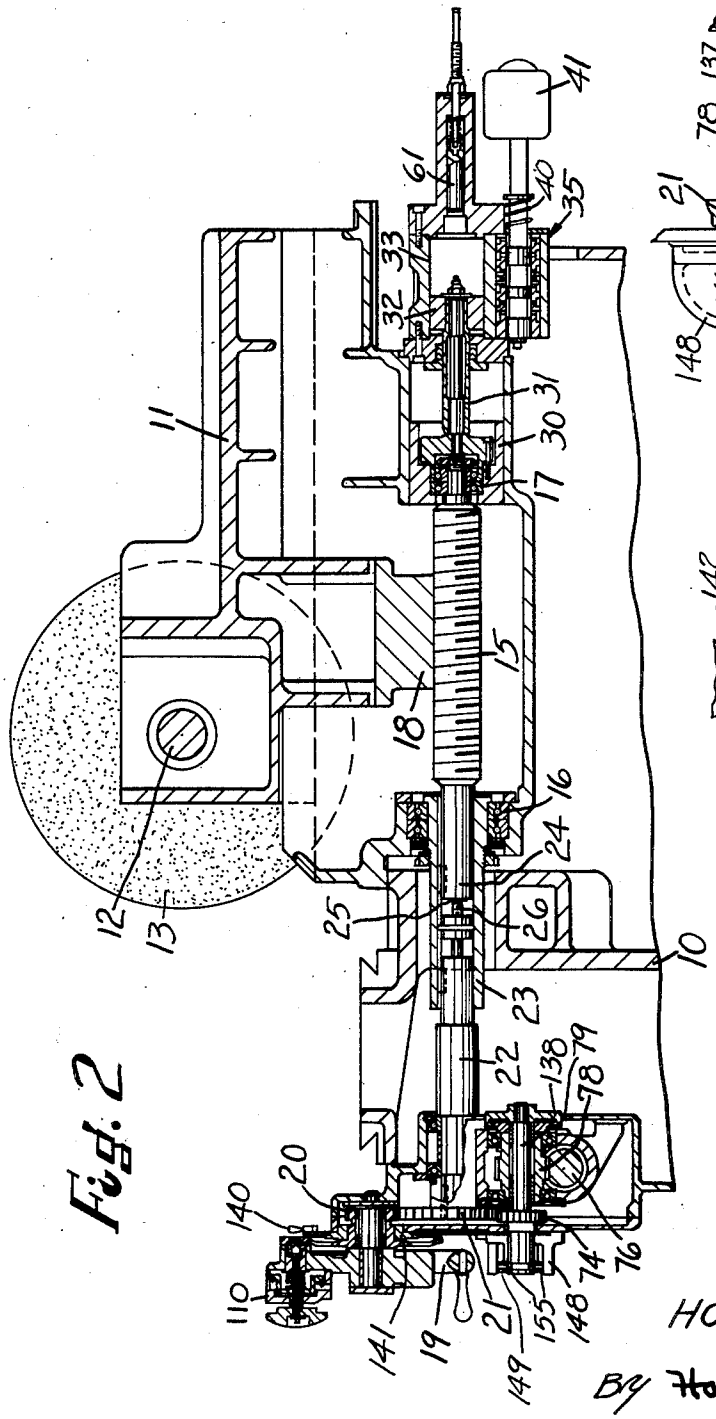


Fig. 2

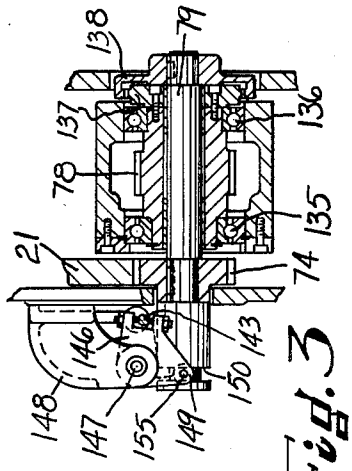


Fig. 3

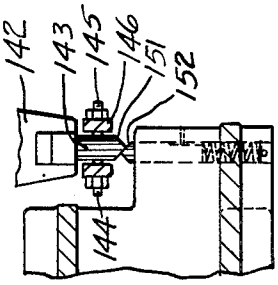


Fig. 4

Inventor
HOMER L. SWAINEY

By Harold W. Eaton
Attorney

Patented May 26, 1953

2,639,563

UNITED STATES PATENT OFFICE

2,639,563

GRINDING WHEEL FEEDING MECHANISM

Homer L. Swainey, Cleveland, Ohio, assignor to Norton Company, Worcester, Mass., a corporation of Massachusetts

Application October 21, 1950, Serial No. 191,386

10 Claims. (Cl. 51—165)

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The invention relates to grinding machines, and more particularly to a grinding wheel feeding mechanism.

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 then automatically to reduce the rate of infeed to a finishing feed prior to positively stopping the infeeding movement. Another object is to provide a feeding mechanism with an electric time delay relay for controlling the overall feeding movement so as to provide a predetermined grinding feed, a predetermined reduced finishing feed, a positive stop to limit the infeeding movement, and thereafter to control a period of dwell prior to withdrawal of the grinding wheel.

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. Other objects will be apparent from the foregoing disclosure.

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 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 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

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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 journalled 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 provided comprising a motor driven fluid pump 42 which draws fluid through a pipe 43 from a reservoir 44 and forces fluid under pressure 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 readward 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 right 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 98 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 right-hand end position (Fig. 1) so that fluid may exhaust through both of the valves 98 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 impart 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 left 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 workpiece.

An automatic control mechanism is provided for automatically controlling the duration of the grinding cycle comprising an electric timer which is preferably an automatic re-set type adjustable timer such as for example the Microflex timer manufactured by the Signal Electric Corporation of Moline, Illinois. A feed cycle control lever 126 is pivotally supported by a stud 127 on the front of the lever base. The lever 126 is arranged to actuate a start switch 128 and a stop switch 129. When it is desired to start a grinding cycle, the lever 126 is rocked in a counter-clockwise direction to close the start switch 128 which serves to start the timer 125 and at the same time to energize the solenoid 41 to shift the feed control valve 35 so as to admit fluid under pressure to the cylinder chamber 51 to cause a rapid approaching movement of the piston 32, the wheel slide 11, and the grinding wheel 13. At the same time, the feed control valve 35 passes fluid under pressure to the cylinder chamber 93 to start movement of the piston 76 toward the right (Fig. 1) to start a rotary motion of the feed screw. The rotary motion of the feed screw continues at a grinding feed rate as governed by the setting of the grinding feed valve 98 and the finish feed valve 97 until the cam 115 engages the detent 116 and closes the limit switch 120 thereby energizing the solenoid 106 to close the valve 100. After the valve 100 closes the grinding feed is automatically reduced to a finishing feed as governed by the finish feed control valve 97. The finish feed continues until the stop abutment 111 engages the stop surface 114 to positively stop the rotation of the feed screw 15 thereby limiting the infeeding movement of the grinding wheel 13. The grinding wheel 13 remains in operative grinding engagement with the workpiece being ground for a sparking-out period as governed by the electric timer 125. After a predetermined time interval has elapsed from the start of the grinding cycle, the timer 125 times-out thereby deenergizing the solenoid 41 to release the compression of the spring 40 which returns the valve 135 to the position as illustrated in Fig. 1. This movement of the valve 35 serves to admit fluid under pressure to the cylinder chamber 50 to cause a rapid movement of the piston 32, the wheel slide 11 and the grinding wheel 13 to an inoperative position. At the same time fluid under

pressure is passed into the cylinder chamber 92 to move the piston 76 toward the left to rotate the feed wheel 19 and feed screw 15 in the reverse direction to return the parts to their initial position.

It is desirable to provide a suitable clutch mechanism whereby the feed wheel may, if desired, be operated independent of the cylinder 76 for setting up the machine, or for manual operation thereof when desired. The gear 78 is supported by anti-friction bearings 135 and 136 (Fig. 3). The shaft 79 is provided with an internal gear 137 which is arranged to mesh with an external gear 138 which is fixedly mounted to rotate with the gear 78. As shown in Fig. 3, the gears 137 and 138 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 137 out of mesh with the external gear 138, 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 140 having a hub portion 141 is arranged to rotate concentric with the axis of the feed wheel 19. The clutch lever 140 is provided with a downwardly extending arm 142 having a stud 143 projecting downwardly from its lower end. The stud 143 is arranged between a pair of adjustably mounted opposed actuating screws 144 and 145 which are adjustably mounted on a yoked member 146. The yoked member 146 is pivotally mounted on a stud 147 carried by a bracket 148 which is fixedly mounted on the front of the machine base. The yoked member 146 is provided with a downwardly extending yoked portion 149 which is provided with opposed studs 155 which ride within a groove 150 formed in an enlarged end portion of the shaft 79. It will be readily apparent from the foregoing disclosure that when the clutch lever 140 is rocked in a clockwise direction (Fig. 1), the yoked member 146—149 will be rocked in a counter-clockwise direction (Fig. 3) to slide the shaft 79 toward the right thereby moving the internal gear 137 toward the right out of mesh with the external gear 138.

A suitable detent mechanism is provided for holding the clutch parts either engaged or disengaged. This mechanism may comprise an arrow-pointed surface 151 formed on the lower end of the stud 143 (Fig. 4). The arrow-pointed surface 151 is arranged to engage a spring pressed arrow-pointed plunger 152 which serves to hold the stud 143 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 and a workpiece mounted in position for a grinding operation. The cycle control lever 126 is rocked in a counter-clockwise direction to close the start switch 128. The closing of the start switch 128 serves to energize the timer 125 and thereby to energize the solenoid 41 to shift the feed control valve 35 toward the right 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 for a predetermined time interval as governed by the timer 125. When the timer 125 times-out, the solenoid 41 is deenergized 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 106 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 126.

If desired, the electric timer 125 may be connected so that it is energized by the closing of the limit switch 120 at the same time the slow feed is initiated to set the timer in motion so that after a predetermined time interval, the timer 125 will operate to deenergize the solenoid 41 thereby completing the grinding cycle. In this latter arrangement, the timer 125 instead of controlling the over-all grinding cycle would control the slow down or finish grinding operation and the time interval in which the grinding wheel is held stationary.

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 continuously to actuate said feeding mechanism to cause a continuous feeding movement of the grinding wheel, 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 to render said grinding feed control means operative, and means on said feed wheel for moving said pawl after a predetermined grinding feed and before the stop abutment engages said pawl to actuate said limit switch so as to reduce the infeed to a predetermined finishing feed.

2. In a grinding machine, as claimed in claim 1, in combination with the parts and features therein specified of a cam on said wheel, and an adjustable detent on said stop pawl which is engaged by said cam to move the pawl so as to actuate said limit switch thereby reducing the grinding feed to a finishing feed.

3. In a grinding machine, as claimed in claim 1, in combination with the parts and features therein specified of a cam on said feed wheel, an adjustable detent on said pawl which is engaged by said cam so as to move said pawl, a second detent on said stop pawl to engage and actuate said limit switch thereby reducing the grinding feed to a finishing feed.

4. In a grinding machine having a transversely movable wheel slide, a rotatable grinding wheel thereon, means to move said slide rapidly to and from an operative position, a feeding 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 in one direction, power operated means continuously to actuate said feeding mechanism to cause a continuous speeding movement of the grinding wheel, 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 to render said grinding feed control inoperative, and means on said feed wheel to rock said pawl before the stop abutment engages said pawl after a predetermined grinding feed to actuate said limit switch so as to reduce the feed to a predetermined finishing feed.

5. 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 continuously to actuate said feed mechanism to cause a continuous feeding movement of the grinding wheel, an adjustable throttle valve to control the exhaust of fluid from the 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 to render the first adjustable throttle valve in operative, and means including a cam on said feed wheel to rock said pawl after a predetermined grinding feed and before the stop abutment engages said pawl to actuate said limit switch so as to reduce the feed to a predetermined finishing feed.

6. 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 feed mechanism to feed said slide, a feed wheel therefore, 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 continuously to actuate said feed mechanism to cause a continuous feeding movement of the grinding wheel, 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 solenoid-actuated valve to render the first throttle valve inoperative, means including a limit switch to actuate said solenoid valve, and a cam on said wheel to rock said pawl after a predetermined grinding feed and before the stop abutment engages said pawl so as to actuate said limit switch and solenoid-actuated valve to reduce the feed to a predetermined finishing feed.

7. 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 nut and screw feed 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 continuously to rotate said feed screw to cause continuous feeding movement of the grinding wheel, an adjustable throttle valve to control the exhaust of fluid from the 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 solenoid-actuated valve to render the first throttle valve inoperative, means including a limit switch operatively connected to actuate the solenoid-actuated valve, and a cam on said stop abutment to actuate said pawl after a predetermined grinding feed and before the stop abutment engages said pawl so as to actuate said limit switch and solenoid-actuated valve to reduce the feed to a predetermined finishing feed.

8. 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, an electric timer to control the grinding cycle, means including a cycle start switch to energize said timer and said control valve to initiate a feeding cycle, a nut and screw feed 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, and a limit switch actuated by said pawl before the stop abutment engages said pawl so as to actuate said second solenoid-actuated valve to reduce the feed to a predetermined finishing feed, said timer serving after a predetermined time interval to cause a rearward movement of the grinding wheel to an inoperative position.

9. 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 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, a solenoid-actuated control valve to control the admission 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 solenoid-actuated valve to render the first throttle valve inoperative, and a limit switch actuated by said pawl before the stop abutment engages said pawl so as to actuate the solenoid-actuated valve to reduce the feed to a predetermined finishing feed.

10. In a grinding machine having a transversely movable wheel slide, a rotatable grinding wheel therein, means including a piston and cylinder to move said slide to and from an operative position, a solenoid-actuated control valve therefor, an electric timer to control the over-all grinding cycle, means including a cycle start switch to energize said timer and said 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 screw, means including a piston and cylinder to rotate said feed screw, a solenoid-actuated control valve 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 solenoid-actuated valve to render said first throttle valve inoperative, and a limit switch actuated by said pawl before the stop abutment engages said pawl so as to actuate the solenoid-actuated valve to reduce the feed to a predetermined finishing feed, said timer serving after a predetermined time interval to deenergize said solenoid-actuated control valve to cause both of the pistons to return to initial positions thereby moving the grinding wheel rearwardly to an inoperative position.

HOMER L. SWAINEY.

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