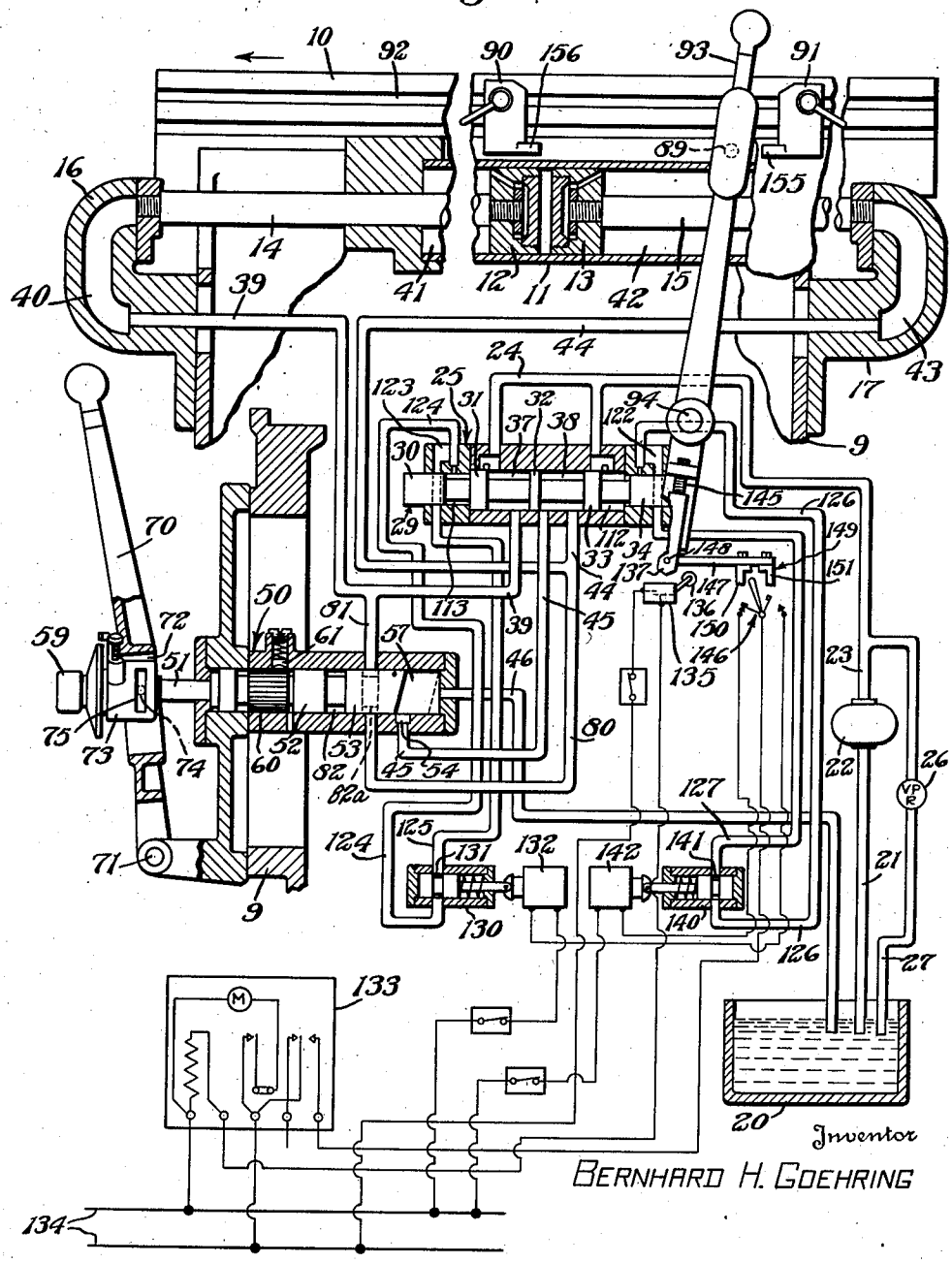
June 6, 1939. B. H. GOEHRING 2,161,156

HYDRAULIC TABLE RECIPROCATING MECHANISM

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Fig 1




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HYDRAULIC TABLE RECIPROCATING MECHANISM

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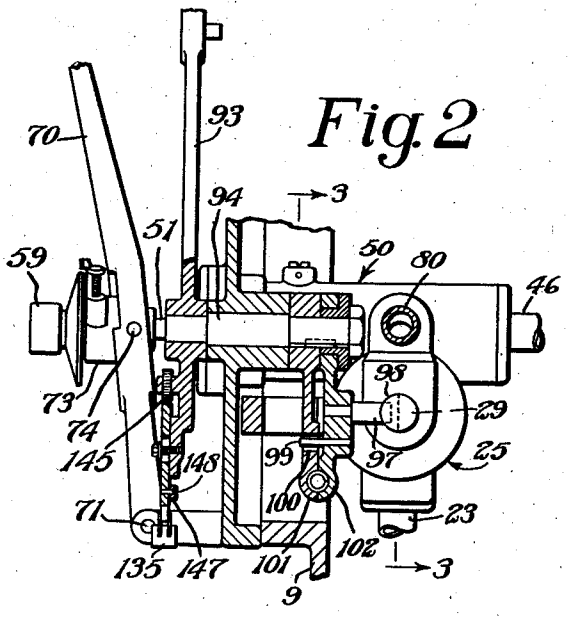



Fig. 2

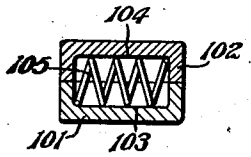
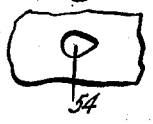



Fig. 4

Fig. 5.



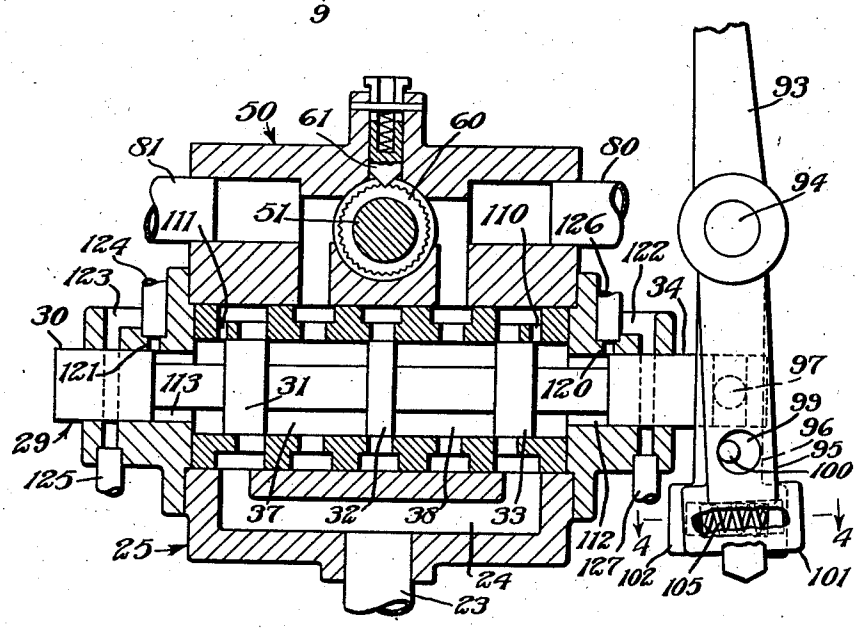




Fig. 3

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# UNITED STATES PATENT OFFICE

2,161,156

## HYDRAULIC TABLE RECIPROCATING MECHANISM

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Application March 8, 1938, Serial No. 194,610

5 Claims. (Cl. 121—45)

The invention relates to grinding machines, and more particularly to a table reciprocating mechanism for a grinding machine.

One object of the invention is to provide a simple and thoroughly practical table reciprocating and reversing mechanism. Another object of the invention is to provide a table reversing mechanism with an improved dwell control mechanism. Another object of the invention is to provide a table reversing mechanism with a mechanism whereby a variable dwell may be obtained at either or both ends of the table reciprocation. A further object of the invention is to provide an electrically controlled dwell control for a table reciprocating mechanism. A further object of the invention is to provide a hydraulically operated table reciprocating mechanism with an electrical time delay relay control therefor to control the extent of dwell at each end of the table stroke. 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 combined hydraulic and electrical diagram of the improved table reciprocating mechanism;

Fig. 2 is a cross sectional view through the table reciprocating mechanism, showing the valve actuating mechanism in cross section;

Fig. 3 is a longitudinal sectional view, on an enlarged scale, taken approximately on the line 3—3 of Fig. 2;

Fig. 4 is a sectional view taken approximately on the line 4—4 of Fig. 3; and

Fig. 5 is a fragmentary view showing the V-shaped port 54.

As illustrated in the drawings, the machine embodying this invention comprises a base 9 which supports a longitudinally reciprocable table 10 on the usual V-way and flat way (not shown) for a longitudinal reciprocatory movement relative to the base 9.

A fluid pressure operated reciprocating mechanism is provided to reciprocate the table 10, comprising a fluid pressure cylinder 11 which is fixedly mounted to the under side of the table 10. The cylinder 11 contains a pair of spaced pistons 12 and 13 which are connected by a pair of hollow piston rods 14 and 15, respectively, with a pair of hollow brackets 16 and 17, respectively, mounted on opposite ends of the base 9.

In the preferred construction, the base 9 is formed with a hollow box-like construction, in which the lower portion serves as a reservoir 20 for the fluid pressure system. Fluid is drawn from the reservoir 20 through a pipe 21 by a motor driven fluid pressure pump 22 and is forced through a pipe 23 and a pipe or passage 24 to a table control valve 25. A fluid pressure relief valve 26 is provided in the pipe line 23 and is arranged to allow excess fluid under pressure to by-pass through a pipe 27 into the reservoir 20 in case the pressure within the system increases above a desired predetermined pressure.

A control valve 25 is preferably of a piston type reversing valve which includes a movable valve member 29 having formed integrally therewith a plurality of valve pistons 30, 31, 32, 33 and 34. Fluid under pressure from the pump 22 is forced through the pipes 23 and 24 into a valve chamber 37, between the valve pistons 31 and 32, and passes outwardly through a pipe 39 into an aperture 40 in bracket 16, through the hollow piston rod 14 and piston 12, into a cylinder chamber 41, to cause the cylinder 11 and table 10 to move in a direction toward the left (Fig. 1). During movement of the table toward the left, fluid within a cylinder chamber 42 is exhausted through the piston 13, the hollow piston rod 15, an aperture 43 within the bracket 17, and through a pipe 44 into a valve chamber 38 between the valve pistons 32 and 33, and out through a pipe 45 which returns exhaust fluid through a pipe 46 into the reservoir 20.

A speed control valve 50, as illustrated in the drawings, is preferably formed integral with the valve 25. As illustrated in the diagram (Fig. 1), the valve is shown as a separate valve unit. The valve 50 is preferably located in the exhaust side of the system so as to maintain a uniform fluid pressure on the operative side of the main cylinder. This valve comprises a valve stem 51 which is provided with valve pistons 52 and 53. The casing for the valve 50 is provided with a V-shaped port 54 which is located at one end of the pipe line or passage 45, conveying fluid from either the valve chamber 37 or 39, depending upon the position of the valve 25. The passage or outlet pipe 46 serves to exhaust fluid from a throttle valve chamber 57 into the reservoir 20 within the base of the machine.

The throttle valve 58 is arranged so that it may be moved longitudinally from a full line to

a dotted line position. The valve is provided with an actuating knob 59 on the front end of the valve stem 51 which facilitates rotation of the valve. In the preferred construction, the end of the valve piston 53, instead of being a plane surface at right angles to the axis of the throttle valve, is arranged at an angle thereto. By providing an angularly positioned end surface on the valve piston 53, any rotation of the valve member serves as a fine adjustment to cut off more or less of the V-port 54 precisely to regulate the exhaust of fluid from the system and thereby permit a fine regulation of the table speed.

In order that the valve piston 53 may be maintained in the desired adjusted position so as to enable the table to be stopped and started as desired, without changing the speed adjustment, a serrated or notched portion 60 is provided which is formed integral with the valve stem 51. A spring pressed pawl 61 is carried by the valve casing 50 so that when the knob 59 is rotated to adjust the valve piston 53 to give the desired table speed, the detent 61 engages notches in the serrated portion 60 and serves to hold the valve piston in its adjusted position so as to permit longitudinal or axial movement of the valve stem 51 by means of a control lever 70 to stop and start the table movement without upsetting the speed adjustment of the valve.

The control lever 70 is pivotally mounted on a stud 71 fixedly mounted on the base 9 of the machine and serves to permit a rapid movement of the valve stem 51 to stop and start the table movement. The lever 70 is provided with an aperture 72 fitting loosely around a sleeve 73 which is mounted on the valve stem 51. A pair of opposed aligned trunnion pins 74 are provided at opposite sides of the aperture 72 on the lever 70 and are arranged to engage vertical slots 75 in the sleeve 73. It will be readily apparent from the foregoing disclosure that when the throttle valve lever is in the position indicated in full lines, the valve stem 51 is positioned so that the valve piston 53 uncovers all or a portion of the V-port 54, allowing the table to move at a predetermined speed. By moving the lever 70 into position 70a, as indicated in broken lines in Fig. 1, the valve piston 53 is moved into position 53a, thereby closing the V-port 54 and stopping the table movement.

When the throttle valve is in a closed position to stop the hydraulic table movement, it is desirable to provide a suitable fluid by-pass whereby fluid may readily pass from the cylinder chamber at one end of the cylinder to the cylinder chamber at the other end thereof to facilitate a manual traversing movement of the table. In the preferred construction, a pipe or passage 80 is provided to connect the pipe 44 and the valve chamber 38 with a passage or pipe 81 provided as an extension of the pipe 39. When the throttle valve 50 is in a closed position, as indicated in broken lines, fluid may readily pass from the cylinder chamber 41, through the pipe 39, the pipe 81, through a valve chamber 82 between the valve pistons 52 and 53, through the pipe 80, the pipe 44, and into the cylinder chamber 42. This by-pass in the throttle valve interconnects the cylinder chambers 41 and 42 so that when the fluid pressure system is shut off by closing the throttle valve 50, the table may be readily moved manually, if desired.

A manually operable table traverse mechanism may be of the type shown in the prior United States Patent No. 2,071,677 and may consist of a manually operable hand wheel and a rack and gear mechanism for moving the table longitudinally.

A suitable reversing mechanism is provided to change the direction of movement of the table, as desired. In the preferred construction, adjustable table dogs 90 and 91 are adjustably mounted in a T-slot 92 on the table 10. The dogs 90 and 91 are arranged to engage a pin 89 on the upper end of a reverse control lever 93 which is pivotally mounted on a stud 94 on the base 9 of the machine. The lever 93 is operatively connected to move the valve stem 29.

In order that the table may be reversed with a minimum amount of vibration, it is desirable to provide a lost motion connection between the reversing lever 93 and the reversing valve 25, so that during the initial movement of the reverse lever under the influence of the table dogs, the valve is not moved. This mechanism preferably comprises a short lever 95 fixedly keyed to the inner end of the stud 94. A short lever 96 is rotatably mounted on the stud 94 and is supported thereon by means of a bushing, so that the lever 96 is free to oscillate relative to the stud 94. The lever 96 carries a pin 97 engaging a groove 98 in an extended portion of the valve stem 29. The lever 95 is provided with an aperture 99. A pin 100 is fixedly mounted to the lever 96 and projects within the aperture 99 in the lever 95. The lower end of the levers 95 and 96 are provided with enlarged end portions 101 and 102, respectively, each of which is provided with a semi-cylindrical aperture 103 and 104, respectively. A spring 105 is provided within the semi-cylindrical apertures 103 and 104 and serves to hold the levers normally in a definite aligned relationship to each other.

Assuming the parts of the reversing mechanism to be in the position illustrated in Fig. 1, the table is moving in a direction toward the left, which movement continues until the reversing lever 93 is moved a sufficient distance to actuate the lever 95 through its lost motion movement until the aperture 99 engages the pin 100. This movement of the lever 95 relative to the lever 96 serves to compress the spring 105 and when the aperture 99 engages the pin 100, continued movement of the table serves to throw the reversing valve stem 29 into a central position, as indicated in Fig. 3, in which position fluid under pressure is cut off from opposite sides of the main cylinder 11. The compression of the spring 105 then tends to move the valve stem 29 toward the right, which movement is prevented by a means to be hereinafter described.

When the compression of the spring 105 is released, it shifts the valve from a central or neutral position so as to uncover a port 111 (as indicated in Fig. 3), decreasing the fluid pressure passing into a chamber 112 and increasing fluid pressure passing into a valve chamber 113. It should be noted that the valve pistons 30 and 31 are of different cross-sectional areas, and fluid under pressure entering the chamber 113 serves, through the differential piston areas on the pistons 30 and 31, to move the valve stem 29 toward the right, as viewed in Fig. 3, to throw the valve into its extreme reverse position and thereby cause a reversal in direction of movement of fluid under pressure to pass the same to the opposite end of the main driving cylinder 11 and thereby cause the table 10 to move in the opposite direction.

Due to the differential in the pressure areas be-

tween the valve pistons 30, 34 and 31, 33, respectively, the chambers 113 and 112 function as a pilot valve to cause a reversal of the reversing valve under the influence of fluid under pressure. The reversing lever 93 serves only to cause the reversing valve to move to a central or neutral position, as illustrated in Fig. 3, and the spring 105 then under compression serves to move the reversing valve slightly off center to change the respective openings of the ports 110 and 111 and cause fluid under pressure to operate through the chambers 112 and 113 to cause a fluid pressure reversal of the reversing valve, thereby combining the functions of a reversing valve and a pilot valve in a single valve unit and eliminating the piping connections and losses due to passages between the various valves as experienced heretofore.

Fluid within the valve chamber 112 may exhaust through a port 120 and similarly fluid within the valve chamber may exhaust through a port 113, into a port 121, into reservoirs 122 and 123, respectively. When the valve piston 29 is moved to either end of its stroke, as shown in the diagrammatical illustration in Fig. 1, fluid within the chamber 113 is free to exhaust through port 121, a pipe 124, and through a pipe 125, into the reservoir 123. Similarly, when the valve piston 29 is moved toward the right, fluid within the valve chamber 112 may exhaust through the port 120, a pipe 126, and a pipe 127, into the reservoir 122.

In a cylindrical grinding operation, it is frequently desirable to provide a sufficient dwell of the table at the end of its reciprocatory stroke so that the work piece may rotate at least one complete rotation before the table stops its movement in one direction and starts its movement in the reverse direction. The period of dwell necessary to accomplish this result varies with the size of the work being ground, the width of the grinding wheel being used, as well as the relative speeds of the work rotation and table reciprocation. It is, therefore, desirable to provide a variable dwell at either or both ends of the table stroke to accomplish the desired results. In the preferred construction, the dwell at the end of the table stroke may be accomplished by interrupting the reversal in movement of the control or reverse valve 25 and allowing it to dwell in a central position for a predetermined time interval.

In the preferred construction an electrical control mechanism is provided for controlling the delayed action of the reversing valve 25 so that a table dwell of any desired length may be obtained. This is preferably accomplished by providing a cut-off valve 130 between a pipe 124 and a pipe 125. The valve 130 is preferably a piston type valve, which is normally held open by means of a spring, allowing free passage of fluid from the pipe 124, through a valve chamber 131, into the pipe 125. The valve 130 is arranged so that it may be automatically closed by means of a solenoid 132. The solenoid is preferably controlled by an adjustable time delay relay 133 which is connected with power lines 134 and is set in motion by a normally open limit switch 135 having an actuating roller 136 arranged in the path of an adjustably positioned arrow point projection 137 carried by a downwardly extending projection of the reversing lever 93.

Similarly, a cut-off valve 140 of the piston type is provided which is normally held open by means of a spring so that fluid passing through the pipe 126 may pass directly through a valve chamber 141 into the pipe 127 and return to the reservoir 122. The valve 140 is arranged to be actuated by means of a solenoid 142 which is also controlled by the adjustable electrical time delay relay 133 which, as above described, is set in motion by the normally open limit switch 135. The limit switch 135 is instantaneously closed each time the reversing lever 93 is shifted to change the direction of movement of the table 10. The arrow point projection 137 of the lever 193 may be adjusted longitudinally relative to the lever 93 by means of an adjusting screw 145 to facilitate adjustment of the time of closing of the limit switch 135.

In order that a single time delay relay 133 may be employed to energize either the solenoid 132 or 142, depending upon the direction of movement of the table 10, a single pole double throw switch 146 is provided which serves alternately to connect either the solenoid 132 or the solenoid 142 with the time delay relay 133. In the position of the switch 146 illustrated in Fig. 1, the solenoid 142 is cut in to be actuated by the time delay relay 133. When the switch 146 is rocked in a clockwise direction, the solenoid 132 is cut in so that it may be energized when the circuit is closed by the closing of the switch 135. In order that the proper solenoid valve 132 or 142 may be connected automatically, it is desirable to provide a suitable connection whereby the switch 146 may be automatically actuated in timed relation with the table movement. This is preferably accomplished by providing a connection between the switch 146 and the reversing lever 93 so that when the reversing lever 93 is shifted either manually or by means of the table dogs 90 or 91, the switch 146 will be actuated to connect the proper solenoid 132 or 142 with the time delay relay 133 and the power lines 134. This is preferably accomplished by means of a connecting link 147 which is connected at one end by means of a stud 148 with the adjustable projection 137 on the lower end of the reversing lever 93. The other end of the link 147 is provided with a yoke-shaped projection 149 which has two downwardly projecting arms 150 and 151 which are arranged to actuate the switch 146 and shift it in timed relation with the movement of the reverse lever 93. The yoke-shaped projection 149 is preferably adjustably mounted on the link 147 and each of the arms 150 and 151 is adjustably mounted on said projection so that the time of actuation of the switch 146 relative to the movement of the reverse lever 93 may be varied as desired.

The operation of this table reciprocating mechanism will be readily apparent from the foregoing disclosure. Assuming all of the parts have been previously adjusted and the table 10 is traversing in the direction of the arrow, namely toward the left (Fig. 1), this movement continues until a projection 155 on the reversing dog 91 engages a pin or stud 89 on the reversing lever 93. When the projection 155 of the dog 91 engages the pin 89, the continued movement of the table 10 toward the left serves to rock the reversing lever 93 in a counterclockwise direction which serves through the downwardly projecting arm 150 of the yoke 149 to shift the switch 146 to render the solenoid 132 operative. At the same time, this movement of the reverse lever in a counterclockwise direction shifts the control valve 29 toward the right (Fig. 1) and the arrow point at the lower end of the projection 137 of the reversing lever 93 engages the roller 136 of the limit

switch 135 to close the switch and start the time delay relay 132 in operation. The reversing lever 93 shifts the valve 25 to a central position. The spring 105 is compressed during this movement of the reverse lever and the compressed spring serves to throw the valve 25 slightly beyond its central position. The valve 130, being closed by energizing the solenoid 132, serves to hold the reversing valve 29 in this position due to the fact that fluid within the valve chamber 113 cannot pass out through the pipe 124 since the solenoid valve 130 is closed. The solenoid 132 remains energized for a predetermined time interval as governed by the adjustable time delay relay 133 so as to cause the table 10 to dwell at the end of its reciprocatory stroke for a predetermined time interval before starting in the reverse direction. After a predetermined set time interval, the time delay relay 133 serves to break the circuit and deenergize the solenoid 132 which allows the passage of fluid from the valve chamber 113 through pipe 124, into pipe 125 which returns the fluid into the reservoir 123 at the end of the control valve 25, thus allowing the reversing valve 29 to shift from a central or neutral position toward the right due to the differential in piston areas between the valve piston 30 and 31 and thereby to reverse the direction of flow of fluid to the cylinder 11 to start the table 10 traversing in the reverse direction.

The table 10 starts moving toward the right, which movement continues until a projection 156 on the table dog 90 engages the stud 89 on the reversing lever and rocks the reversing lever in a clockwise direction again to shift the control or reverse valve 29 in a direction towards the left (Fig. 1) to stop the table 10. During this clockwise movement of the reversing lever 93, the downwardly extending projection 151 of the yoke 149 engages the switch 146 and shifts it into the position illustrated in Fig. 1 to close the circuit and thereby energize the solenoid 142, after which the arrow point projection 137 on the reversing lever 93 engages the roller 136 of the limit switch 135 again to close the limit switch 135 to set the time delay relay 133 in motion. The energizing of the solenoid 142 closes the valve 140 to prevent fluid from the valve chamber 112 passing through the pipe 126 into the pipe 127 and returning to the reservoir 122. The solenoid valve 140 remains closed for a predetermined time interval as governed by the adjustable time delay relay 133 which serves after the set time interval to break the circuit and thereby deenergize the solenoid 142 whereupon the released compression of a spring serves to open the valve 140 and allow fluid to pass from the valve chamber 112, through pipe 126 into the pipe 127 which flows into the reservoir 122 at the right-hand end of the valve 25. Due to the differential piston areas between the pistons 33 and 34, the control valve will then shift from a central or neutral position toward the left to reverse the direction of flow of fluid under pressure to the table cylinder 11 and thus start the movement of the table 10 toward the left.

By manipulation of the adjustable time delay relay 133, the dwell at each end of the table stroke may be adjusted as desired, that is so that an equal dwell of a variable extent may be obtained at both ends of the table reciprocation.

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, a longitudinally movable table, means including a piston and cylinder to reciprocate said table, a reversing valve therefor, means including a reversing lever to actuate said valve, a pair of independent electrically controlled valves, one of said valves being arranged to control the shifting movement of said reversing valve in one direction and the other of said valves being arranged to control the shifting movement of the reverse valve in the opposite direction, an adjustable time delay relay which is rendered operative by said reversing lever, and means actuated by said reversing lever to render one of said electrically controlled valves operative when the lever is moved in one direction and to render the other control valve operative when the lever is moved in the opposite direction.

2. In a grinding machine, a longitudinally movable table, means including a piston and cylinder to reciprocate said table, a reversing valve therefor, means including a reversing lever to actuate said valve to stop the table movement, a pair of independent solenoid valves, one of which serves to control the shifting movement of said valve in one direction and the other of which serves to control the shifting movement of the reverse valve in the opposite direction, an adjustable time delay relay which is rendered operative by said reversing lever to actuate said solenoid valves, and means including a switch actuated by said reversing lever to render one of said solenoid valves operative when the lever is moved in one direction and to render the other solenoid valve operative when the lever is moved in the opposite direction.

3. In a grinding machine, a longitudinally reciprocable table, means including a piston and cylinder operatively connected to reciprocate said table, a reversing valve which is arranged to admit fluid under pressure to either end of said cylinder, a pair of adjustable dogs on said table, means including a reversing lever operatively connected to move said valve to a central position when acted upon by one of said dogs, a pair of independent solenoid valves operatively connected with each end of said reverse valve to prevent movement of the reverse valve beyond a central position, an electrical switch which is actuated by said reversing lever to close one of said solenoid valves, a time delay relay which is set in motion by said switch to open said solenoid valve after a predetermined time interval, and means including a second switch actuated by said lever to render one or the other of said solenoid valves operative.

4. In a grinding machine, a longitudinally reciprocable table, means including a piston and cylinder operatively connected to reciprocate said table, a reversing valve which is arranged to admit fluid under pressure to either end of said cylinder, a pair of adjustable dogs on said table, means including a reversing lever operatively connected to move said valve to a central position to stop the table movement when actuated upon by one of said dogs, a pair of independent solenoid valves operatively connected one with each end of said reverse valve to prevent movement of the

reversing valve beyond a central position during a predetermined period of dwell, a limit switch, an adjustable projection on said reversing lever to actuate said switch to close one or the other of said solenoid valves, a time delay relay which is set in motion by the closing of said switch to open said solenoid valve after a predetermined time interval, and means including a second switch actuated by said reverse lever to render one or the other of said solenoid valves operative, depending upon the direction of movement of said reversing lever.

5. In a grinding machine, a longitudinally reciprocable table, means including a piston and cylinder operatively connected to reciprocate said table, a reversing valve associated therewith and arranged to admit fluid under pressure to either end of said cylinder, a control valve operatively connected to move said valve, adjustable dogs on said table which are arranged to actuate said lever to shift the reversing valve to a central or neutral position, means including a pair of solenoid controlled valves, one operatively connected with each end of said reversing valve and arranged to prevent shifting of the reverse valve beyond a central or neutral position, a normally open switch actuated by and in timed relation with said control lever, a single electrically operated time delay relay which is set in motion by the closing of said switch, and means including a double throw switch actuated by said reversing lever operatively to connect either one or the other of said solenoid valves in series with said time delay relay to render one or the other of said solenoid valves operative at each end of the table stroke, said parts being arranged to allow the reverse valve to shift into its reverse position after a predetermined period of dwell.

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