June 6, 1939. W. H. WOOD 2,161,216

HYDRAULIC TABLE RECIPROCATING MECHANISM

Filed Aug. 16, 1937 2 Sheets-Sheet 1

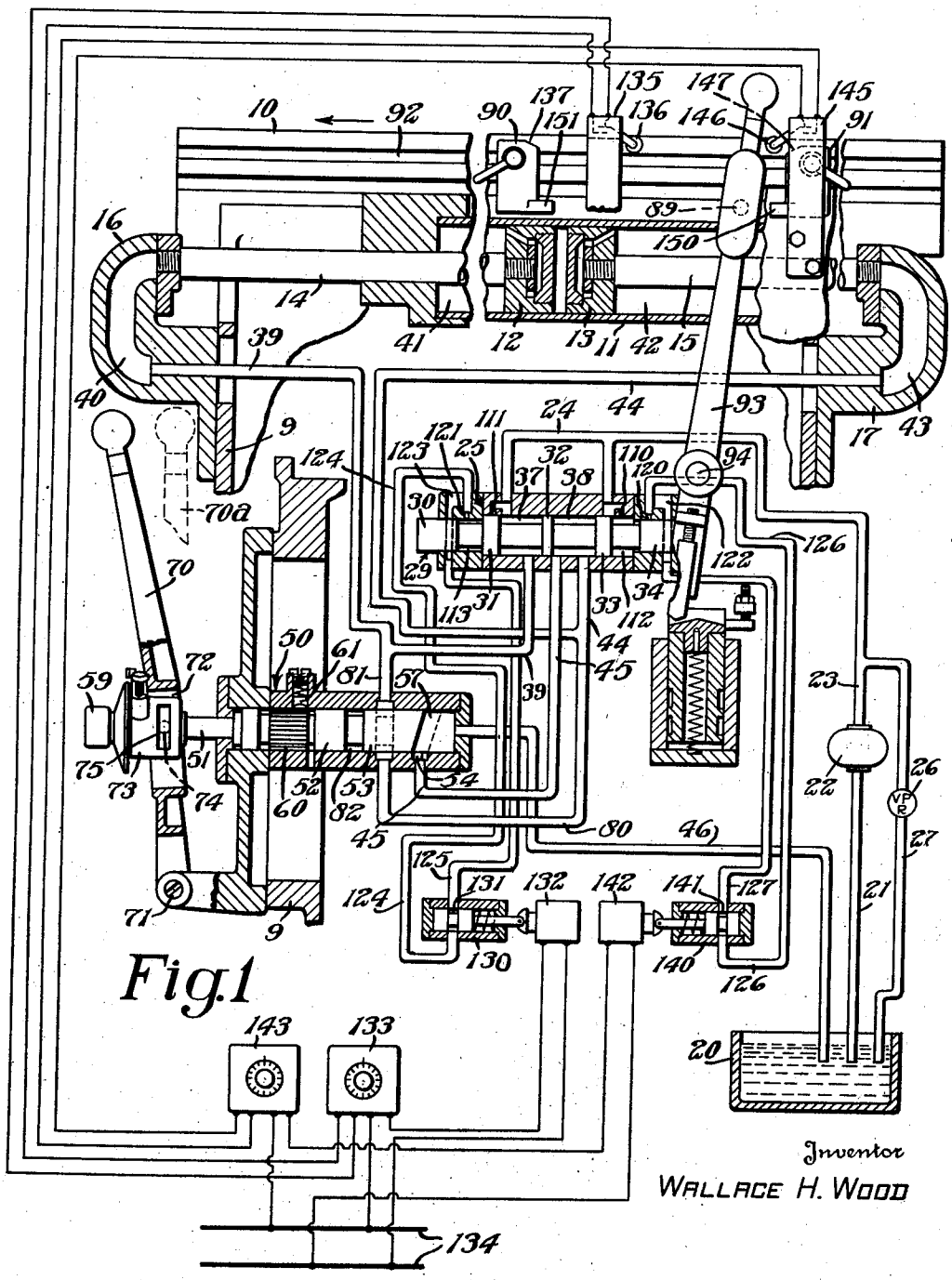


Fig.1

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HYDRAULIC TABLE RECIPROCATING MECHANISM

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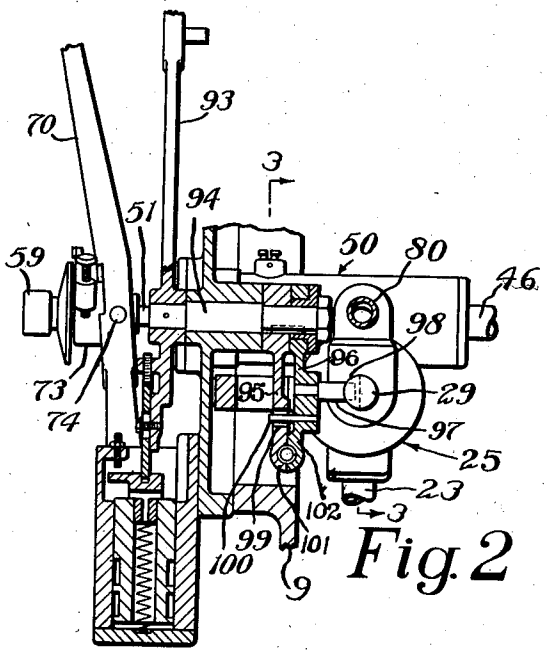


Fig. 2

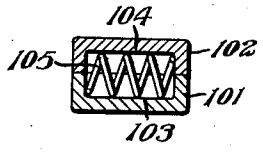


Fig. 4

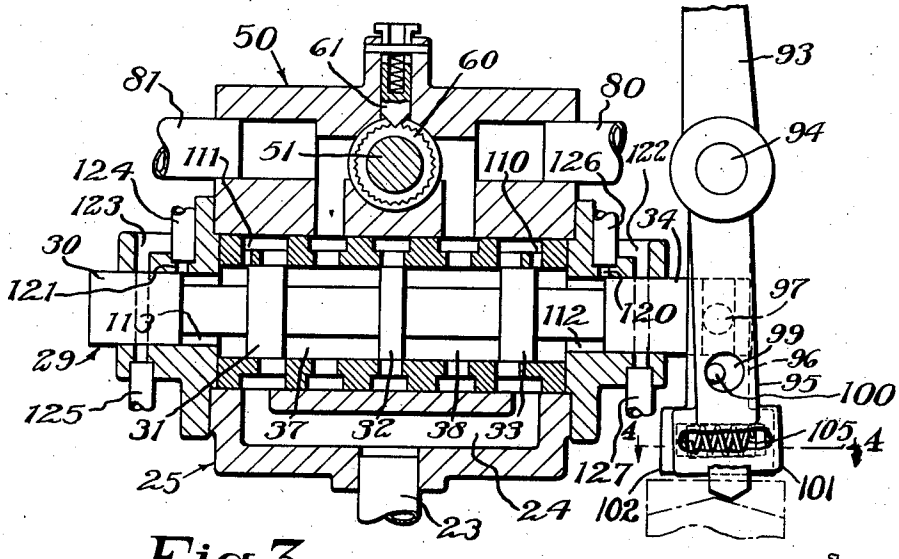


Fig. 3

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HYDRAULIC TABLE RECIPROCATING MECHANISM

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10 Claims. (Cl. 121—45)

This 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 variable dwell may be obtained at either or both ends of the table reciprocation. A further object is to provide an electrically controlled dwell control for the table reversing mechanism. A further object 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; and

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

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

A fluid pressure operated reciprocating mechanism is provided to reciprocate the work 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 which are fixedly 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 passage or pipe 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.

The 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 the 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, and 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 50 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 38, 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 50 is arranged so that it

may be moved longitudinally from a full line position to a dotted line position. The valve is provided with an actuating knob 59 on the front end of the valve stem 51, which permits the valve to be rotated. In the preferred construction, the end of the valve piston 53, instead of being a plain surface at right angles to the axis of the throttle valve, is arranged at an angle thereto. By providing an angularly positioned end surface to 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, and 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 pawl 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 of the machine 9 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. 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 70 is in the position indicated in full lines, the valve stem 51 is positioned so that the valve piston 53 uncovers all of or a portion of the V-port 54, allowing the table to move at a predetermined speed. By moving the lever 70 into position 70*a*, as indicated in broken lines (Fig. 1), the valve piston 53 is moved into position 53*a*, 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 traverse 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, through 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 10 may then be moved manually, if desired.

A manually operative table traverse mechanism may be of the type shown in my 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 similar 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 ends 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 positions 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 or neutral position, indicated in Fig. 3, in which position the pressures are balanced on 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 serves to shift the valve from a central or neutral position so as to uncover a port 111, 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 area, and fluid under pressure entering the chamber 113 serves, through the differential pressure area 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 between 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 reverse valve to move to a central or neutral position, as illustrated in Fig. 3, and the spring 105 then being under compression serves to draw 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.

When the valve piston 29 is moved to the left end of its stroke, as shown in the diagrammatic illustration in Fig. 1, fluid within the valve 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 and starts 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 wheel being used, as well as the speeds of 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 well at the end of the table stroke may be accomplished by interrupting the reversal in movement of the control valve 25 and allowing it to dwell in a central position for a predetermined adjustable time interval.

In the preferred construction, an electrical control mechanism is provided to control the delayed action of the reversing valve 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 electrical 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 a cam surface 137 on the adjustable dog 90.

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 a solenoid 142 which is controlled by an adjustable electrical time delay relay 143 which is set in motion by a normally open limit switch 145 having an actuating roller 146 arranged in the path of a cam surface 147 on the adjustable table dog 91. The limit switches 135 and 145 are preferably fixedly supported on the base 9 of the machine by means of bolts. If desired, however, these limit switches may be readily provided with elongated slots to facilitate adjustment thereof in setting up the machine.

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 150 on the reverse dog 91 engages a pin or stud 89 on the reverse lever 93. Just before the dog engages the pin 89 on the reverse lever 93, the roller 146 engages the cam surface 147 on the dog and continued movement of the table serves to close the limit switch 145 which operates to energize the solenoid 142 and instantly closes the valve 140, thereby preventing flow of fluid between the pipe 126 and the pipe 127. The reversing lever shifts the valve to a central or neutral position such as shown in Fig. 3 and at the same time compresses the spring 105 so that the spring tends to throw the valve slightly beyond a central position.

The reversing lever throws the valve piston 29 to a central position, in which position fluid passing through the pipe 24 may, as shown in Fig. 3, enter both the valve chambers 37 and 38 and passes through the ports 110 and 111 into valve chambers 112 and 113. The valve 130 being open, fluid entering the valve chamber 113 may pass through the pipe 124 and valve chamber 131 and the pipe 125 into the reservoir 123. Fluid entering the valve chamber 112 cannot pass out through the port 120 since the valve 140 is closed. The valve 29 remains in a central position until the time delay relay 43 functions, that is, for a predetermined time interval to deenergize and break the circuit and thereby deenergize the solenoid 142 to open the valve 140, thus allowing fluid to pass from the pipe 126 to the pipe 127 in the reservoir 122. As soon as the valve 140 opens, the released compression of the spring 105 serves to throw the valve piston 29 slightly beyond the central position and the fluid under pressure within the valve chamber 112, due to the differential piston areas of the valve pistons 33 and 34, serves to complete the reversal of the valve so as to change the direction of flow of fluid within the system. The fluid under pressure from the pipe 24 then flows into the valve chamber 38 and through pipe 44 to the right-hand cylinder chamber to cause the table 10 to move in a direction toward the right (Fig. 1).

The table 10 continues to move toward the right until the roller 136 of the limit switch 135 engages the cam surface 137 to close a circuit, thereby energizing the solenoid 132 to close the cut-off valve 130, and at the same time a projection 151 on the dog 90 engages the pin 151 on the reverse lever 90 to throw the reverse valve 29 into a central or neutral position and to complete the reverse movement of the table pin in a manner similar to that above described at the other end of the table stroke.

By manipulation of the adjustable time delay relays 133 and 143, the dwell at each end of the

table movement may be adjusted as desired, that is, so that an equal dwell of the desired extent may be obtained at both ends of the table stroke or with no dwell at one end and a predetermined dwell at the other or a short dwell at one end and a relatively long dwell at the other, depending upon the conditions and operation being performed by the machine.

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 reciprocable table, means including a fluid pressure piston and cylinder to reciprocate said table, means including a control valve to control the admission of fluid to said cylinder, a lever operatively connected to move said valve, adjustable dogs on said table to move said lever and shift the valve to a central or neutral position to stop the table movement, and an electrically controlled mechanism which is actuated in timed relation with the table movement at either end of its reciprocatory stroke to control the reverse movement of said valve so as to start the table moving in the reverse direction after a predetermined period of dwell.

2. In a grinding machine, a longitudinally reciprocable table, means including a fluid pressure piston and cylinder to reciprocate said table, means including a control valve to control the admission of fluid to said cylinder, a lever operatively connected to move said valve, adjustable dogs on said table to move said lever and shift the valve to a central or neutral position to stop the table movement, and an electrically controlled mechanism which is actuated in timed relation with the table movement at the ends of the reciprocatory stroke to hold said reversing valve in a neutral position for a predetermined time interval before allowing the valve to shift into reverse position to start the table moving in the opposite direction.

3. In a grinding machine, a longitudinally reciprocable table, means including a fluid pressure piston and cylinder to reciprocate said table, a reversing valve to control the admission of fluid to said cylinder, adjustable dogs on said table, means including a lever actuated by said dogs to shift the valve to a central or neutral position to stop the table movement, and electrically controlled mechanism actuated by the table movement at the ends of the reciprocatory stroke to control the shifting of said valve and start the table moving in the reverse direction after a predetermined time interval.

4. In a grinding machine, a longitudinally reciprocable table, means including a fluid pressure piston and cylinder to reciprocate said table, a reversing valve to control the admission of fluid to said cylinder, adjustable dogs on said table, means including a lever actuated by said dogs to shift the valve to a central or neutral position to stop the table movement, and a pair of adjustable independent electrically controlled mechanisms which are actuated by the table movement at either end of its reciprocatory stroke to control the shifting of said valve and start the table moving in the reverse direction after independently adjustable time intervals at either end of the table stroke.

5. In a grinding machine, a longitudinally reciprocable table, means including a fluid pressure piston and cylinder to reciprocate said table, a reversing valve to control the admission of fluid to said cylinder, adjustable dogs on said table, means including a lever actuated by said dogs to shift said valve to a central or neutral position to stop the table movement, fluid pressure means to hold said valve in a central or neutral position, and electrically controlled mechanism actuated by the table movement at the ends of the reciprocatory stroke to control the shifting of said valve and start the table moving in the reverse direction after a predetermined time interval.

6. In a grinding machine, a longitudinally reciprocable table, means including a fluid pressure piston and cylinder to reciprocate said table, a reversing valve to control the admission of fluid to said cylinder, adjustable dogs on said table, means including a lever actuated by said dogs to shift said valve to a central or neutral position to stop the table movement, an independent fluid pressure mechanism to hold said valve in a central or neutral position when moved in opposite directions, and electrically controlled mechanism actuated by the table movement at the ends of the reciprocatory stroke to control the shifting of said valve and start the table moving in the reverse direction after a predetermined time interval.

7. In a grinding machine, a longitudinally reciprocable table, means including a fluid pressure piston and cylinder to reciprocate said table, a reverse valve to control the admission of fluid to said cylinder, adjustable dogs on said table, means including a lever actuated by said dogs to shift said valve to a central or neutral position to stop the table movement, an electrically controlled fluid pressure means to hold said valve in a central or neutral position, and electrically controlled mechanism actuated by the table movement at the ends of the reciprocatory stroke to actuate said electrically controlled fluid pressure means so as to control the shifting of said valve and start the table moving in the reverse direction after a predetermined time interval.

8. In a grinding machine, a longitudinally reciprocable table, means including a fluid pressure piston and cylinder to reciprocate said table, a reverse valve to control the admission of fluid to said cylinder, adjustable dogs on said table, means including a lever actuated by said dogs to shift said valve to a central or neutral position to stop the table movement, a pair of independent electrically controlled fluid pressure mechanisms to hold said valve in a central position when moved in opposite directions, and a pair of independent electrically controlled mechanisms which are actuated by the table at either end of its reciprocatory movement to actuate said independent electrically controlled fluid pressure mechanisms so as to control the shifting of said valve and start the table moving in the reverse direction after independently adjustable time intervals at either end of the table stroke.

9. In a grinding machine, a longitudinally reciprocable table, means including a piston and cylinder operatively connected to reciprocate said table, a control valve therefor which is arranged

to admit fluid under pressure to either end of said cylinder, a pair of adjustable dogs on said table, a lever operatively connected to said valve and arranged to move said valve to a central or neutral position when acted upon by one of said dogs, an electrically controlled valve which is operatively connected to prevent movement of said control valve beyond a central or neutral position, a limit switch actuated by said table dogs to operate said electrically controlled valve, and a time delay relay rendered operative by said limit switch to open said electrically controlled valve and thereby permit completion of the reversal after a predetermined time interval.

10. 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 lever 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 solenoid controlled valve to prevent shifting of the reverse valve beyond a central or neutral position, a normally open limit switch actuated by said dogs to close a circuit to energize said solenoid and thereby hold the reverse valve in a central or neutral position, and an electrically operated time delay relay set in motion by the closing of said limit switch which is arranged to deenergize said solenoid after a predetermined time interval to allow the reverse valve to shift into its reverse position after a predetermined period of dwell.

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