

Nov. 14, 1933.

W. J. GUILD

1,935,119

FLUID PRESSURE REVERSING VALVE MECHANISM

Filed July 21, 1930

2 Sheets-Sheet 1

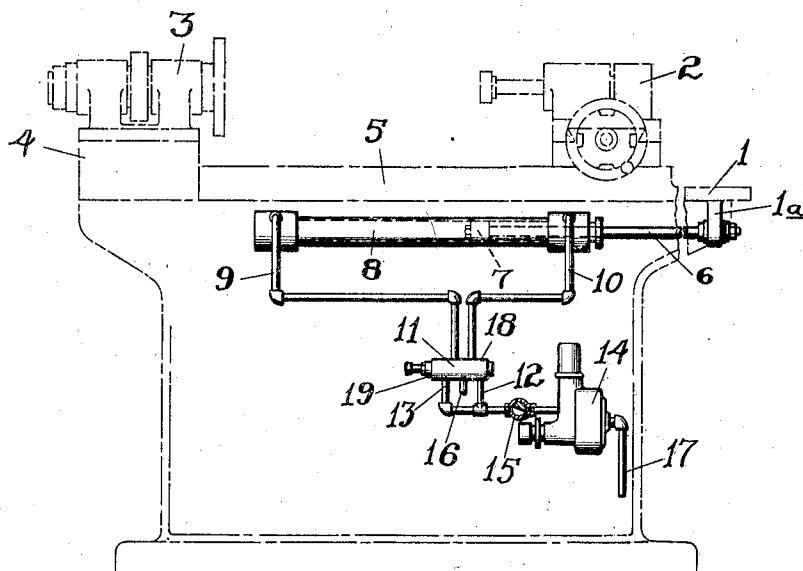


Fig. 1

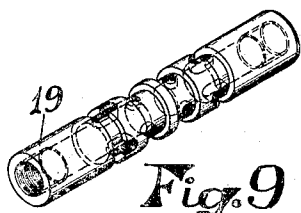


Fig. 9

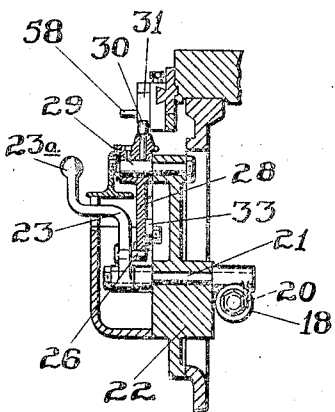


Fig. 3

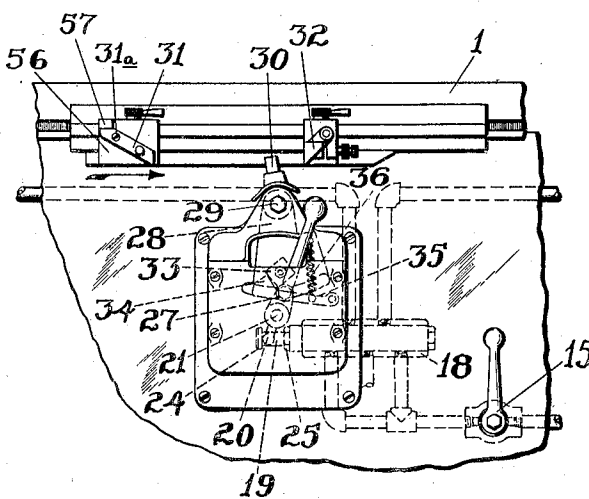


Fig. 2

Inventor

Waldo J. Guild

By *Owen H. Kennedy*
Attorney

Nov. 14, 1933.

W. J. GUILD

1,935,119

FLUID PRESSURE REVERSING VALVE MECHANISM

Filed July 21, 1930

2 Sheets-Sheet 2

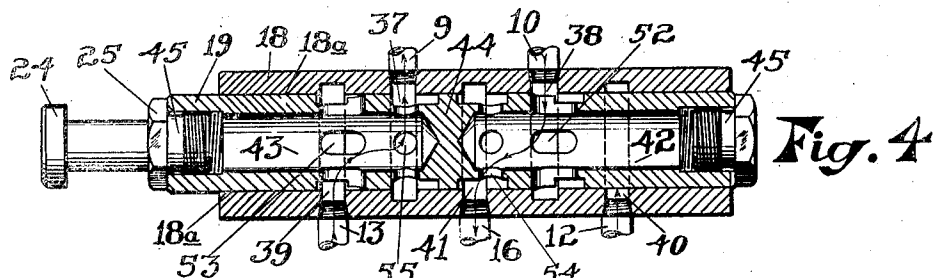


Fig. 4

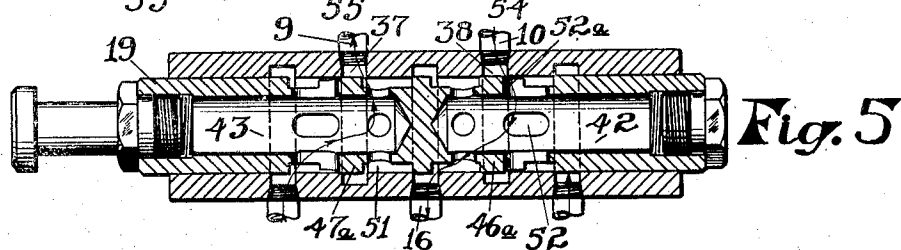


Fig. 5

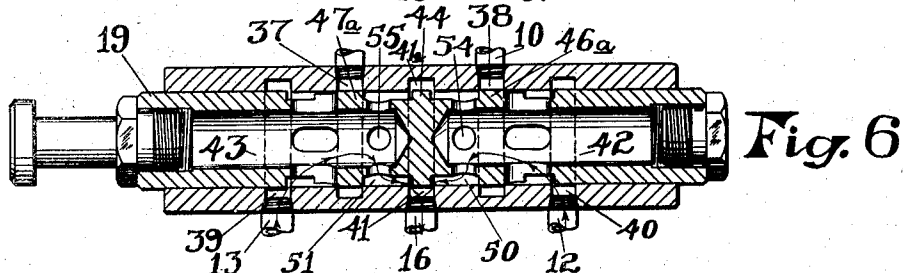


Fig. 6

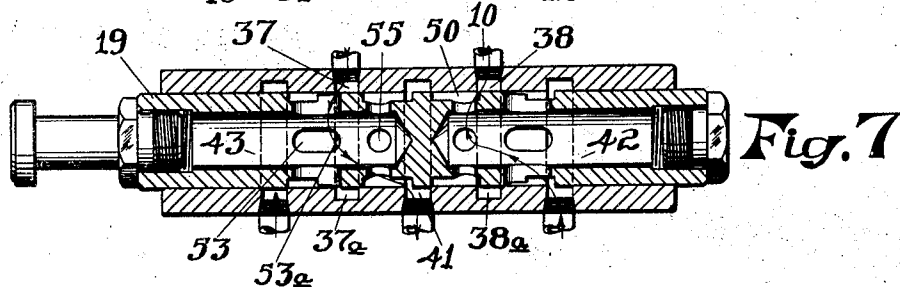


Fig. 7

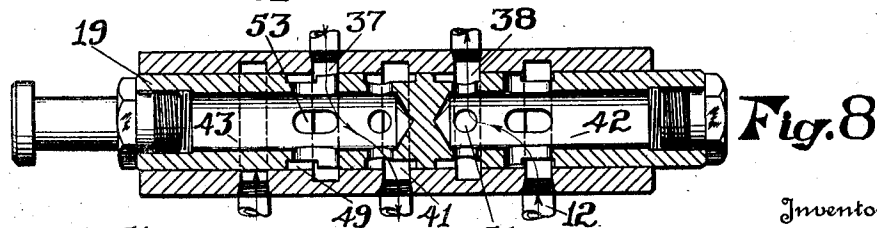


Fig. 8

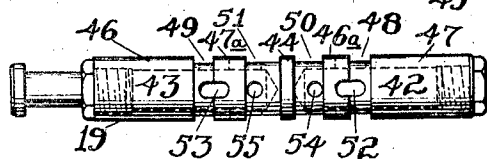


Fig. 10

Inventor

Waldo J. Guild

Owen W. Kennedy
Attorney

UNITED STATES PATENT OFFICE

1,935,119

FLUID PRESSURE REVERSING VALVE
MECHANISMWaldo J. Guild, Worcester, Mass., assignor to
The Heald Machine Company, Worcester,
Mass., a corporation of Massachusetts

Application July 21, 1930. Serial No. 469,498

14 Claims. (Cl. 121—45)

The present invention relates to fluid pressure valve mechanism for reversing, and otherwise controlling, the movement of a reciprocatory machine element such, for example, as the wheel carrying table of a grinding machine. The invention, however, is adapted to be applied to any machine wherein fluid under pressure is employed as an actuating medium to procure and control relative reciprocatory movement between a tool and the work.

Briefly stated, the present invention resides in the provision of an improved valve device adapted to control the reciprocation of a piston in a cylinder by the admission of fluid pressure at opposite ends of the cylinder, so as to impart a back and forth movement of predetermined amplitude to a machine element attached to the piston. In order that the direction of movement of the reciprocating element may be reversed, it is necessary for the control valve to connect first one end of the cylinder to the source of fluid pressure and then the other end, while at the same time providing for the exhaust of the pressure medium from the end of the cylinder towards which the piston is moving. This functioning of the control valve requires the reversal of the flow of the pressure medium through its ports, and in prior valve devices of this character difficulties have been encountered due to the building up of excessive pressure in the system when the valve assumes a neutral or middle position, with all of its ports closed, so that the movement of the piston is arrested by locking of the fluid in opposite ends of the cylinder. While previous attempts have been made to prevent the building up of excessive pressure in the system by connecting all the ports so that there is an even flow of pressure medium in both the pressure and exhaust pipes, it has been found that such valve devices tend to permit overrunning of the piston and its associated machine element, due to the fact that sufficient pressure is not built up against the piston to stop and reverse it until after the valve has passed through its middle position.

With the above described deficiencies of prior reversing mechanisms in mind, the object of the present invention is to provide an improved reversing valve that is adapted to control the admission and exhaust of pressure medium to and from the cylinder, so that the reversal of movement of the piston is effected without building up excessive pressure in the system, and without permitting overrunning of the machine element to which the piston is connected. In the operation of the improved valve device, the flow of the

pressure medium through the valve ports is controlled in a differential manner so that the piston is gradually slowed down and brought to rest just as the valve reaches its middle position, further movement of the valve causing the full force of the pressure medium to be exerted on the stationary piston to reverse it. The above and other advantageous features of the invention will hereinafter more fully appear with reference to the accompanying drawings, in which:—

Fig. 1 is a diagrammatic view of a fluid pressure actuating system, embodying the present invention, applied to the table of a grinding machine.

Fig. 2 is a fragmentary view of the control mechanism, indicated in Fig. 1, on an enlarged scale.

Fig. 3 is a transverse sectional view along the line 3—3 of Fig. 2.

Figs. 4, 5, 6, 7 and 8 are sectional views of the reversing valve showing the different positions of its parts during an operating cycle.

Fig. 9 is a perspective view of the valve plunger removed from its casing.

Fig. 10 is a view in side elevation of the valve plunger removed from its casing.

Like reference characters refer to like parts in the different figures.

Referring first to Fig. 1, the invention is shown diagrammatically as being embodied in a grinding machine providing a reciprocable table 1 carrying a grinding wheel head 2 with a work supporting head 3 carried by a bridge 4 which spans the slides 5 on which the table 1 moves. In a machine of this type, either the grinding wheel or the work to be ground may be carried by the table 1, with the reciprocations of the table 1 being utilized in either case to produce a relative traversing movement between the grinding wheel and the work, and the parts shown in dotted lines in Fig. 1 are merely illustrative of the utility of the present invention which resides in fluid pressure actuated mechanism for controlling the movement of the table 1.

The table 1 provides a lug 1a to which is connected a rod 6 carried by a piston 7 operable within a cylinder 8. The fluid under pressure is adapted to be admitted to each end of the cylinder 8 through pipes 9 and 10 leading from a control valve generally designated by the reference character 11, which valve forms the subject matter of the present invention. The valve 11 is connected by pipes 12 and 13 to a suitable source of fluid pressure represented by a pump 14, with a throttle valve 15 disposed between the pump

14 and the pipes 12 and 13 leading to the control valve 11. The valve 11 also provides an exhaust pipe 16 leading to a suitable reservoir, not shown, in the base of the machine from which the pump 5 14 draws the pressure medium through the intake pipe 17.

The control valve 11 comprises a stationary cylindrical body 18 with a plunger 19 longitudinally movable therein and, as best shown in Figs. 2 and 3, the plunger 19 is adapted to be moved within the body 18 by means of an arm 20 turnable with a shaft 21 journaled in a side portion 22 of the machine base. The other end of the shaft 21 carries a handle 23 by means of which the shaft 21 may be turned to cause the arm 20 to move the valve plunger 19 in either direction through the engagement of the arm 20 with collars 24 and 25 provided by the plunger 19 beyond the cylindrical body 18. The handle 23 provides means whereby the valve 11 may be operated manually, if desired, and in addition the handle 23 provides an inwardly projecting actuating pin 26 whereby the valve 11 may be operated automatically in response to movement of the table 25 1. To this end, the pin 26 is received in a notch 27 provided in the lower edge of a plate 28 pivotally mounted on a pin 29 with an operating portion 30 projecting above the pivot pin into the path of movement of a pair of dogs 31 and 32 carried by the table 1.

The dogs 31 and 32 are adjustably mounted on the table 1, in accordance with the usual practice, and obviously engagement of the operating portion 30 of the plate 28 by either dog will impart turning movement to the plate which will be converted into longitudinal movement of the valve plunger 19 in the valve body 18. In the position of parts shown in Fig. 2, the table 1 is moving in the direction of the arrow, with the plate 28 biased towards the left hand dog 31 and with the valve plunger 19 in its extreme left hand position as shown in dotted lines. Therefore, when the dog 31 strikes the operating portion 30, the plate 28 will be turned in a clockwise direction to cause the handle 23 to move the valve plunger 19 into the valve body 18 and thereby cause a reversal of the movement of the piston 7 in cylinder 8 through an arrangement of ports hereinafter to be described. Since movement of the valve plunger 19 must effect reversal of the flow of pressure medium through the pipes 9 and 10 leading to the cylinder 8 after the table 1 has come to rest, the plate 28 has associated therewith means for completing the throw-over of the lever 23 from one position to the other when once the reversing movement of the valve has been initiated by engagement of the operating portion 30 with either one of the dogs 31 or 32. For this purpose, the plate 28 carries an angular projection 33 that is adapted to be yieldingly engaged by a projection 34 carried at the end of a pivotally mounted arm 35. A spring 36 serves to maintain the projections 33 and 34 in engagement, and when the plate 28 is first turned by the dog 31, the arm 35 yields to permit sliding engagement between the surfaces of the projections. However, when the apex of the plate projection 3 reaches the apex of the arm projection 34, the pull of the spring 36 causes the arm 35 to quickly complete the pivotal movement of the plate 28, irrespective of the speed at which the table 1 may then be moving. This insures that the valve plunger 19 will be moved sufficiently into the body 18 to cause the stoppage and reversal

of the table 1 by the cooperation of the valve ports which will next be described.

As best shown in Fig. 4, the cylindrical valve body 18 provides a pair of spaced ports 37 and 38 connected to the cylinder 8 by the pipes 9 and 10 respectively, and a second pair of spaced ports 39 and 40 connected to the fluid pressure supply pipes 13 and 12 respectively. In addition, the body 18 provides an exhaust port 41 connected by the pipe 16 to the reservoir for the pressure medium. The valve plunger 19 is hollow for a greater portion of its length to provide chambers 42 and 43 separated by a partition 44 at substantially the center of the plunger 19. The ends of the valve chambers 42 and 43 are closed by plugs 45, 45 so that the chambers are entirely independent of each other when controlling the flow of pressure medium in response to longitudinal movement of the plunger 19 within the body 18.

As best shown in Fig. 10, the end portions 46 and 47 of the valve plunger 19 are of uniform diameter and fit closely within the bore 18a of the body 18. The plunger also provides pairs of spaced peripheral grooves 48 and 50, 49 and 51, symmetrically arranged with respect to the center of the plunger 19, and these grooves are in communication with the chambers 42 and 43 by pairs of ports 52 and 54, 53 and 55, respectively. The ports 52 and 53 are elongated in form with curved end portions 52a and 53a cutting into cylindrical portions 46a and 47a of the plunger which are of the same diameter as the end portions 46 and 47 respectively. On the other hand, the ports 54 and 55 are circular in form and are disposed entirely within the end walls of the grooves 50 and 51 respectively, and the differential functioning of the entire valve device in controlling the flow of pressure medium to and from the cylinder 8 is determined by the differences in form of the valve ports, as will next appear.

In Fig. 4, the valve plunger 19 is shown in its extreme left hand position, corresponding to the position of parts shown in Fig. 2 in which it is assumed that the table 1 is moving from left to right. In this position of the plunger 19, it is evident that the pressure medium is flowing unrestricted into the left hand chamber 43 through the aligned ports 39 and 53, and is flowing out of the chamber 43 into the pipe 9 leading to the left hand end of cylinder 8 through the aligned ports 37 and 55. At the same time, the pressure medium is being exhausted from the right hand end of cylinder 8 and pipe 10 through the aligned ports 38 and 52 leading into the right hand valve chamber 42 and through the ports 54 and 41 leading to the exhaust pipe 16. The direction of flow of the pressure medium is indicated by the arrows in Fig. 1 and it will be evident that with this condition of affairs, full pressure is exerted on the piston 7 to move the table 1 from left to right at a speed determined by the setting of the throttle valve 15.

Let it now be assumed that continued movement of the table 1 from left to right causes the dog 31 to engage the operating portion 30 of the plate 28 so as to turn the plate and the connected shaft 21 enough to move the valve plunger 19 into the position shown in Fig. 5. As this occurs, it is evident that the supply of pressure medium to the left hand end of the cylinder 8 through the pipe 9 will be slowly decreased through the closure of the port 37 by the unreduced portion 47a of the plunger, the pressure medium then flowing in the annular space between the right

hand edge of port 37 and the left hand edge of the groove 51. At the same time the flow of pressure medium from the right hand end of the cylinder 8 into the exhaust pipe 16 is also decreased, but at a faster rate than the flow of pressure medium is decreased in the pipe 9. This is due to the fact that when the plunger 19 is moved to the extent shown in Fig. 5, the unreduced portion 46a of the plunger 19 completely closes the body port 38 except for the very restricted flow of pressure medium through the curved end portions 52a of the ports 52 which, as clearly shown in Fig. 10, are cut into the unreduced cylindrical portion 46a. The flow of medium through this restricted opening is indicated in arrows in Fig. 5 from which it is evident that the exhaust of the pressure medium from the right hand end of the cylinder through the pipe 10 is cut off very rapidly as the plunger 19 nears its middle position shown in Fig. 6. This has the effect of gradually slowing down the piston 7, the port 37 being closed at the same time at a rate somewhat less than the closure of the port 38.

As the plunger 19 is moved to the middle position shown in Fig. 6, the ports 37 and 38 are completely closed by the unreduced portions 47a and 46a respectively, thereby locking the pressure medium in opposite ends of the cylinder 8 and bringing the piston 7 and the table 1 to rest. As the plunger 19 is moved to this position, the pressure medium delivered to the valve body ports 39 and 40 through the pipes 12 and 13 is simultaneously relieved from both valve chambers 42 and 43 through the circular plunger ports 54 and 55 and grooves 50 and 51 respectively. With the plunger 19 in its middle position, as shown in Fig. 6, it is evident that the central unreduced portion 44 of the plunger 19, which constitutes the partition between the chambers 42 and 43, is of less width than the port 41 and its associated groove 41a so that the pressure medium flows from the grooves 50 and 51 on opposite sides of the partition 44 into the exhaust pipe 16. Therefore, as the piston 7 comes to rest with the pressure medium locked in the ends of the cylinder 8, it is impossible for the pump 14 to build up excessive pressure in the system due to the relief of the pressure medium from both valve chambers 42 and 43.

As previously pointed out, when the dog 31, by its engagement with the operating portion 30 of the plate 28, moves the valve plunger 19 to its middle position, so as to bring the table 1 to rest, the cooperation between the angular portions 33 and 34 permits the spring 36 to complete the turning movement of the plate 28 irrespective of the rate of movement of the dog 31 as the table 1 slows down and comes to rest.

The effect of the continued movement of the plunger 19 from left to right past its middle position is shown in Figs. 7 and 8; Fig. 7 illustrating the conditions at the beginning of the reversal of the flow of pressure medium in the cylinder 8, and Fig. 8 illustrating the conditions when the flow of pressure medium to the right hand end of cylinder 8 is fully established. In Fig. 7 the port 38, connected to the right hand end of the cylinder 8 through the pipe 10, is shown as being rapidly placed in communication with the plunger chamber 42 as the right hand edge of groove 50 uncovers the left hand edge of the port 38 and its associated groove 38a, the flow of pressure medium being indicated by the arrows. As this occurs, the port 37, connected to the left hand

end of cylinder 8 by pipe 9, is more slowly placed in communication with the plunger chamber 43, then connected to the exhaust port 41 through plunger ports 55 by the movement of the curved end portions of ports 53a past the left hand edge of port 37 and its associated groove 37a. As a result, the pressure medium is supplied to the right hand end of cylinder 8 through port 38 somewhat more rapidly than it can be exhausted from the left hand end of cylinder 8 through port 37; consequently pressure is built up rapidly behind the right hand end of piston 7 and the table 1 starts to move evenly from right to left.

Since the spring 36, acting on the operating plate 28, completes the reversing movement of the plunger 19 rapidly, the condition of affairs illustrated in Fig. 7 is only momentary, although of sufficient duration to insure that the piston 7 will not start on its movement from right to left until sufficient pressure is built up behind the piston to start the table 1 evenly. As the plunger 19 completes this movement, as shown in Fig. 8, the body port 38 is open completely to the pressure supply pipe 12 since the ports 54 are then fully in register with the port 38. At the same time, the port 37 is open completely to the exhaust port 41 to the chamber 43, since the ports 53 and groove 49 are then fully in register with the port 37. Consequently, the piston 7 and table 1 are moved from right to left at a uniform rate determined by the setting of the throttle valve 15.

When continued movement of the table 1 from right to left causes the dog 32 to engage the operating portion 30 of plate 28, the previously described operating cycle of the valve 11 will be repeated in the reversed order, with the plunger 19 successively occupying the positions shown in Figs. 8, 7, 6, 5 and 4 respectively. In going through this cycle, the table 1 will be slowed up and brought to rest without overrunning and building up of excessive pressure in the system with the valve in its middle position.

In the normal operation of the machine, with the grinding wheel in contact with the work, the table 1 will be reversed at each successive engagement of the operating portion 30 of the plate 28 by the dogs 31 and 32 which are spaced apart on the table a distance substantially corresponding to the desired working stroke of the grinding wheel. However, when it is desired to interrupt the grinding operation, to enable the operator to remove the work from the machine and introduce a new piece of work, separation of the wheel and work is obtained by continuing the movement of the table 1 to the right. For this purpose, the left hand dog 31 is so constructed that it can be passed over the operating portion 30 of the plate 28, whenever desired, without operating the reversing valve 11, so that the valve plunger 19 will remain in the position illustrated in Fig. 4, wherein pressure is supplied to the left hand end of cylinder 8 through pipe 9. To this end, the dog 31 is pivotally mounted at 31a on its carrying block 56 with one end bearing against a stop 57 provided on the block 56, so that the lower end of the dog is in position to engage the operating portion 30 of the plate 28. The pivoted dog 35 also provides a projecting pin or handle 58, clearly shown in Fig. 3 by means of which the operator of the machine can, whenever desired, swing the striking end of the dog upwardly so as to clear the operating portion 30. When the pivoted dog 31 is thus turned, it prevents reversal of the table 1 which would otherwise take place upon engage-

ment of the dog 31 with the plate 28, so that the right hand movement of the table will be continued to withdraw the grinding wheel altogether from the working zone, as shown in Fig. 1, where it can be brought to rest manually by closing the throttle valve 15.

In order to return the grinding wheel to the work for the beginning of a new operation, it is necessary to shift the valve plunger 19 into its other extreme position so as to direct the flow of pressure medium through the pipe 10 to the right hand end of the cylinder 8, after reopening valve 15. The operator inaugurates this return movement by seizing the knob 23a on the handle 23 and moving it to the left from the position shown in Fig. 2, thereby moving the plunger 19 to the extreme right hand position shown in Fig. 8 in which the port 38, leading to the right hand cylinder pipe 10, is in full communication with the port 40 leading from the fluid pressure supply pipe 12. The table 1 thereupon starts to move to the left to return the wheel to the work and this movement is continued until the right hand dog 32 causes reversal of the table in the manner previously described. After this, the valve 11 resumes its normal cycle of operation under the control of both the dogs 31 and 32, the dog 31 having resumed its operative position as soon as it was released, following the manual lifting of the same just described.

From the foregoing, it is apparent that by the present invention there is provided an extremely effective fluid pressure actuated mechanism for automatically controlling the reversal of the movement of a reciprocatory machine element, each reversal being accomplished without overrunning, and without building up excessive pressure in the system.

I claim:

1. In a fluid pressure actuated mechanism, the combination with a cylinder, a piston movable therein and a source of fluid pressure, of a valve device including a movable valve member for controlling admission and exhaust of pressure medium to and from the ends of said cylinder, said valve device having means operable upon movement of said valve member for slowly diminishing the flow of pressure medium to one end of said cylinder and simultaneously rapidly diminishing the exhaust of pressure medium from the opposite end of said cylinder.

2. In a fluid pressure actuated mechanism, the combination with a cylinder, a piston movable therein and a source of fluid pressure, of a valve device including a movable valve member for controlling admission and exhaust of pressure medium to and from the ends of said cylinder, said valve device having means operable upon movement of said valve member for slowly diminishing the flow of pressure medium to one end of said cylinder and simultaneously rapidly diminishing the exhaust of pressure medium from the opposite end of said cylinder, and other means operable upon further movement of said valve member to lock the pressure medium in both ends of the cylinder and simultaneously to by-pass the pressure medium from the source through said valve device to a sump.

3. In a fluid pressure actuated mechanism, the combination with a cylinder, a piston movable therein and a source of fluid pressure, of a valve device including a movable valve member for controlling admission and exhaust of pressure medium to and from the ends of said cylinder,

said valve device having means operable upon movement of said valve member for slowly diminishing the flow of pressure medium to one end of said cylinder and simultaneously rapidly diminishing the exhaust of pressure medium from the opposite end of said cylinder, and other means operable upon further movement of said valve member for rapidly increasing the admission of pressure medium to the opposite end of the cylinder and for slowly increasing the exhaust of the pressure medium from the other end, thereby procuring a reversal of the piston movement.

4. In a fluid pressure actuated mechanism, the combination with a cylinder, a piston movable therein and a source of fluid pressure, of a valve device including a movable valve member for controlling admission and exhaust of pressure medium to and from the ends of said cylinder, said valve device having means operable upon movement of said valve member for rapidly increasing the rate of admission of the pressure medium to one end of the cylinder and simultaneously for slowly increasing the rate of exhaust of the pressure medium from the opposite end of said cylinder.

5. In a fluid pressure actuated mechanism, the combination with a cylinder, a piston movable therein and a source of fluid pressure, of a valve device including a movable valve member for controlling admission and exhaust of pressure medium to and from the ends of said cylinder, said valve device having means for the admission and exhaust of pressure medium to and from opposite ends of said cylinder at the same rate, and other means operable upon movement of said valve member for slowly diminishing the rate of admission of pressure medium to one end of the cylinder and rapidly diminishing the rate of exhaust of pressure medium from the opposite end of the cylinder.

6. In a fluid pressure actuated mechanism, the combination with a cylinder, a piston movable therein and a source of fluid pressure, of a valve device including a movable valve member for controlling admission and exhaust of pressure medium to and from the ends of said cylinder, said valve device having means for the admission and exhaust of pressure medium to and from opposite ends of said cylinder at the same rate, other means operable upon movement of said valve member for slowly diminishing the rate of admission of pressure medium to one end of the cylinder and rapidly diminishing the rate of exhaust of pressure medium from the opposite end of the cylinder, and other means operable upon further movement of said member for locking the pressure medium in opposite ends of the cylinder and providing for by-passing of the pressure medium from the source through said valve device.

7. In a fluid pressure system, a reversing valve comprising a body having spaced inlet and exhaust ports and other ports, and a movable valve member in said body for controlling the admission of fluid to said other ports, said valve member having means for providing fluid connection between said inlet port and one of said other ports and simultaneously providing fluid connection between said exhaust port and the other port, said valve member having means operable upon movement of said member for simultaneously reducing the effective areas of said other ports, said means reducing the area of the port connected to the inlet port slowly and reducing

the area of the port connected to the exhaust port rapidly.

8. In a fluid pressure system, a reversing valve comprising a body having spaced inlet and exhaust ports and other ports, and a movable valve member in said body for controlling the admission of fluid to said other ports, said valve member having means for providing fluid connection between said inlet port and one of said other ports and simultaneously providing fluid connection between said exhaust port and the other port, said valve member having means operable upon movement of said member for simultaneously reducing the effective areas of said other ports, said means reducing the area of the port connected to the inlet port slowly and reducing the area of the port connected to the exhaust port rapidly, and means operable upon further movement of said member for closing both of said other ports and providing fluid connection between said inlet port and said exhaust port.

9. In a fluid pressure actuated mechanism, the combination with a cylinder, a piston movable therein and a source of fluid pressure, of a valve device including a movable valve member for controlling admission and exhaust of pressure medium to and from the ends of said cylinder, means responsive to movement of said piston to procure movement of said valve member, said valve device having means operable upon movement of said valve member for slowly diminishing the flow of pressure medium to one end of said cylinder and simultaneously rapidly diminishing the exhaust of pressure medium from the opposite end of said cylinder.

10. In a fluid pressure actuated mechanism, the combination with a cylinder, a piston movable therein and a source of fluid pressure, of a valve device including a movable valve member for controlling admission and exhaust of pressure medium to and from the ends of said cylinder, means responsive to movement of said piston to procure movement of said valve member, said valve device having means operable upon movement of said valve member for slowly diminishing the flow of pressure medium to one end of said cylinder and simultaneously rapidly diminishing the exhaust of pressure medium from the opposite end of said cylinder, and other means operable upon further movement of said valve member to lock the pressure medium in both ends of the cylinder and simultaneously to provide for by-passing of the pressure medium from the source through said valve device to a sump.

11. In a fluid pressure actuated mechanism, the combination with a cylinder, a piston movable therein and a source of fluid pressure, of a valve device including a movable valve member for controlling admission and exhaust of pressure medium to and from the ends of said cylinder,

said valve device having means operable upon movement of said valve member for slowly diminishing the rate of flow of pressure medium to one end of said cylinder and simultaneously rapidly diminishing the rate of exhaust of pressure medium from the opposite end of said cylinder, other means operable upon further movement of said valve member for locking the pressure medium in both ends of the cylinder and simultaneously providing for exhaust of the pressure medium from the source through said valve device, and other means operable upon further movement of said valve member for rapidly increasing the rate of admission of pressure medium to said opposite end of said cylinder and for simultaneously slowly increasing the rate of exhaust of pressure medium from said one end, thereby procuring a reversal of the piston movement.

12. In a fluid pressure system, a reversing valve comprising a body having an inner cylindrical surface providing a plurality of spaced ports, and a piston movable within said body, said piston being provided with separate internal chambers, a plurality of external reduced portions and ports connecting each of said reduced portions with the chambers of said piston, whereby said piston is adapted to establish communication between said body ports and said piston chambers.

13. In a fluid pressure system, a reversing valve comprising a body having an inner cylindrical surface providing a plurality of spaced ports, a plurality of spaced annular recesses intersected by said ports and a hollow piston movable within said body, said piston being provided with a plurality of spaced reduced portions, adapted to cooperate with the recesses and ports of said body, and ports in each of said reduced portions communicating with the interior of said piston, certain of said last named ports being elongated so as to extend beyond the reduced portions of said piston.

14. In a fluid pressure system, a reversing valve comprising a body having an inner cylindrical surface providing a plurality of spaced ports, a plurality of spaced annular recesses intersected by said ports and a hollow piston movable within said body, said piston being provided with a plurality of spaced reduced portions adapted to cooperate with the recesses and ports of said body, and a plurality of ports in said reduced portions communicating with the interior of said piston, certain of said last named ports being elongated so as to extend beyond the reduced portions of said piston, whereby movement of the piston results in establishing communication between said body ports and the interior of said piston through openings of varying area.

WALDO J. GUILD.