March 26, 1946. J. HALLER 2,397,106

FLUID TRANSMISSION SYSTEM FOR MACHINE TOOLS

Filed March 9, 1945 2 Sheets-Sheet 1

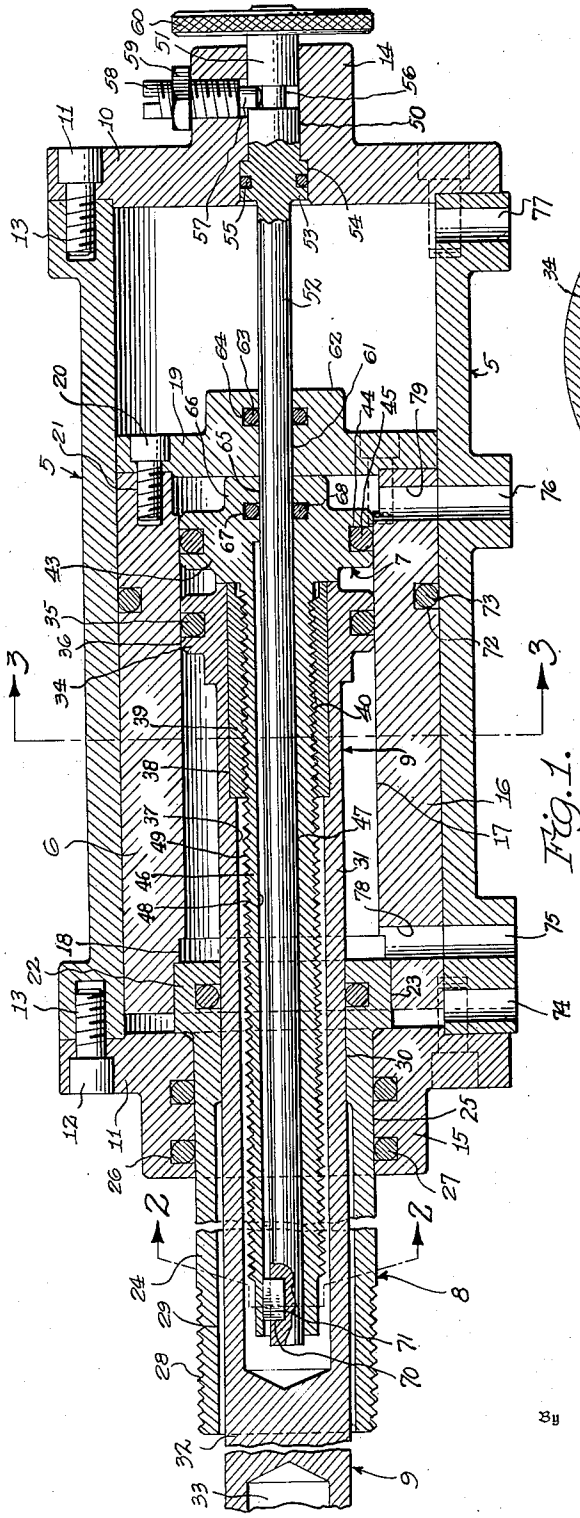


Fig. 1.

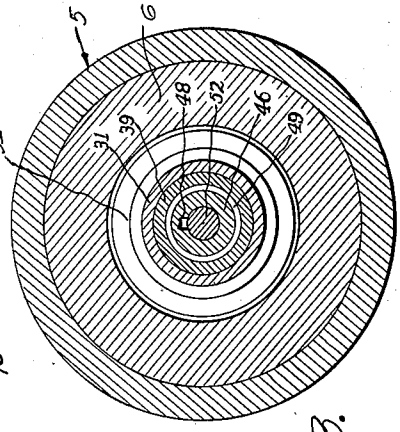


Fig. 3.

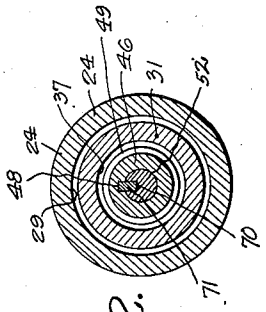


Fig. 2.

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FLUID TRANSMISSION SYSTEM FOR MACHINE TOOLS

Filed March 9, 1945 2 Sheets-Sheet 2

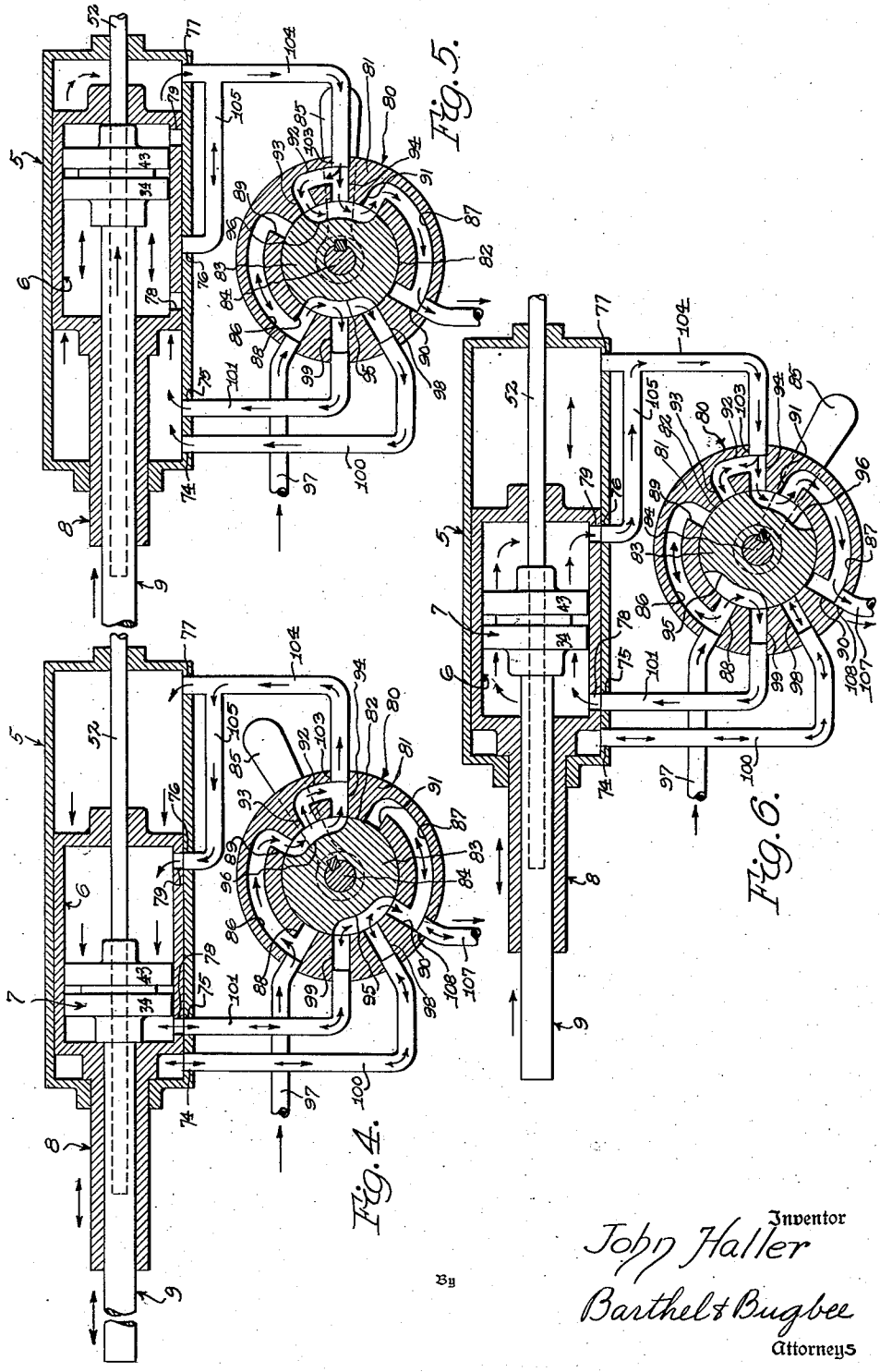


Fig. 4.

Fig. 5.

Fig. 6.

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UNITED STATES PATENT OFFICE

2,397,106

FLUID TRANSMISSION SYSTEM FOR MACHINE TOOLS

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8 Claims. (Cl. 60—97)

The present invention relates to fluid transmission systems and apparatus therefor, and more particularly to a fluid transmission system and apparatus for controlling machine tools and presses.

The primary object of the invention is to provide a fluid transmission control system and apparatus for machine tools, presses and the like which may be manually or automatically controlled to produce a series of machine tool or press motions so correlated as to obtain a nicety of control.

Another object of the invention is to provide a fluid transmission control system and apparatus as above set forth including a control cylinder having multiple expansion, compound duplex pistons arranged to provide a series of independent to and fro reciprocatory movements which may be imparted to a machine tool or press to obtain the desired movement and control thereof.

Another object of the invention is to provide a fluid motor and transmission system for controlling machine tools, punch presses and the like, which comprises a cylinder having compound duplex pistons arranged so that the pistons may be moved to and fro independently of one another or may be operated in unison.

Another object of the invention is to provide a fluid transmission motor for machine tools and the like in which the compound pistons are arranged so that they will be cut off from the source of fluid pressure during their to and fro reciprocatory motion as well as being controlled by a control valve so as to produce the desired series of motions for controlling the movement of the machine tool or the like.

Another object of the invention is to provide a fluid motor for machine tools, punch presses and the like having compound duplex pistons, one of which is arranged for adjustment to facilitate the increase or decrease of the piston stroke so as to obtain a nicety of control and a stroke of the desired length in proportion to the movement of the other compound piston.

Another object of the invention is to provide a fluid transmission system and motor as above set forth in which the compound duplex pistons are controlled by means of a reversing and control valve, so arranged and connected to the main cylinder of said compound duplex pistons as to permit movement of either of said duplex pistons in a desired direction, or movement thereof in unison.

Another object of the invention is to provide a fluid motor of the multiple expansion type having duplex pistons in which the fluid pressure may act on one of the duplex pistons until the same reaches the end of its stroke, whereupon said fluid pressure may then act on the other duplex piston to move the same through a predetermined stroke or portion thereof.

Another object of the invention is to provide a fluid transmission system and compound motor therefor having duplex pistons arranged so that said duplex pistons may be moved or retracted in unison or one of said duplex pistons may be retracted independently of the other piston.

Another object of the invention is to provide a compound multiple expansion type motor having duplex pistons and concentric connecting rods or plungers which are adapted to be attached to two or more moving parts of a machine tool or punch press to produce and impart various movements and motions to the moving parts of said machine tool and punch press in an economical and easy manner.

Other objects and advantages of the invention will become apparent during the course of the following description of the accompanying drawings, wherein:

Figure 1 is a longitudinal sectional view of the compound multiple expansion type motor illustrating the various details of construction and showing the manner in which the duplex pistons are arranged;

Figure 2 is a transverse cross sectional view taken on line 2—2 of Figure 1 looking in the direction of the arrows and illustrating the arrangement of the concentric piston rods or plungers;

Figure 3 is a transverse cross sectional view taken on line 3—3 of Figure 1 looking in the direction of the arrows and further showing the arrangement of the duplex pistons;

Figure 4 is a longitudinal cross-sectional view of the compound motor and control valve therefor, illustrating diagrammatically the manner in which fluid pressure is admitted to the duplex pistons to force the same toward one end of the multiple expansion cylinder;

Figure 5 is a cross sectional view of the fluid motor and control valve therefor illustrating diagrammatically the position of the control valve for forcing the duplex pistons in a direction opposite to the direction indicated in Figure 4; and

Figure 6 is a longitudinal cross-sectional view of the fluid motor and control valve therefor showing diagrammatically the manner in which

the control valve is arranged and positioned for retracting one of the duplex pistons while the remaining piston is retained or held stationary.

Detailed description of the invention

In the drawings, the reference character 5 will generally be employed to designate a cylinder having reciprocably mounted therein duplex pistons 6 and 7 having plunger shafts or piston rods 8 and 9 respectively.

The cylinder 5 is closed at its ends by end walls 10 and 11 which are fastened in place by machine screws 12 received in threaded bores 13 extending inwardly from the ends of the cylinder. The end plates 10 and 11 are provided with tubular bosses 14 and 15 respectively for a purpose which will be hereinafter more fully described.

The duplex piston 6 comprises a tubular body portion 16 having a longitudinal bore 17 enlarged slightly adjacent the ends by enlarged bore portions 18. One end of the duplex piston 6 is closed by a closure disc 19 held in place by a series of circumferentially spaced machine screws 20 received in suitable threaded openings 21 in the end of said piston. The other end of the bore 17 is adapted to receive the enlarged head portion 22 of the concentric plunger rod 8 and may be retained therein by means of a tight press fit within the slightly enlarged bore portion 23 of the bores 17 and 18. The plunger rod 8 is formed as an integral part of the enlarged head portion 22 and includes a sleeve-like member 24 slidably guided in the bore 25 of the tubular boss 15 so as to freely slide therein. Annular recesses 26 are formed in the bore 25 for receiving suitable packing rings as at 27. The free end of the tubular connecting rod 24 is screw-threaded as at 28 for attachment to one of the movable members of a machine tool, punch press or stamping machine in a manner which will be hereinafter more clearly described. The tubular connecting rod 24 is provided with a bore 29 having a reduced portion 30 for slidably receiving the concentric piston plunger 9 which includes a tubular body portion 31 having one end thereof formed with a bar portion 32 extending a slight distance beyond the outer end of the tubular concentric plunger 8. The free end of the concentric plunger 9 is provided with a socket 33 for receiving the tool, die or other machine tool element depending upon the type of machine upon which the invention is used.

The opposite end of the tubular plunger rod 9 is formed with a piston 34 which is reciprocably mounted within the bore 17 of the duplex piston 6 and said piston member 34 forms a part of the duplex piston 7. The peripheral surface of the duplex piston part 34 is provided with an annular groove 36 for receiving a piston packing or the like as at 35. The reciprocating plunger rod 9 is formed with a central bore 37 which terminates at its outer end in the solid rod portion 32, while the opposite end is provided with a slightly enlarged bore 38 for receiving a tubular sleeve 39 having an internally threaded surface 40. The tubular sleeve 39 is anchored in place within the enlarged bore 38 by means of being keyed therein or affixed by means of a tight frictional fit therebetween.

The other piston part of the duplex piston 7 is a piston 43 of substantially the same shape as the piston 34 and said piston part 43 is provided with a peripheral groove 44 for receiving the piston packing or the like as at 45. Formed integral with the piston part 43 of the duplex piston 7 is a tubular projection 46 having a longitudinal bore 47 and a longitudinally extending keyway 48. The tubular projection 46 is externally screw-threaded as at 49 and is threadedly fitted within the internally screw-threaded sleeve 39 in such a manner as to permit adjustment of the piston parts 34 and 43 relative to one another when the piston part 43 is rotated with respect to the piston part 34.

Extending through the tubular boss 14 in the bore 50 thereof is the enlarged portion 51 of an adjusting shaft 52 which is arranged for free rotary movement but held against longitudinal displacement by means of an enlarged portion 53 thereon and formed integral with the enlarged portion 51 of the shaft 52. The enlarged portion 53 of the shaft 52 is received in an enlarged portion 54 of the bore 50 and is provided with suitable packing element 55 to prevent fluid pressure escape through the bore 50. An annular recess 56 is formed in the enlarged portion 51 of the control shaft 52 and is adapted to receive the reduced end 57 of a screw plug 58 so as to prevent longitudinal movement of the control shaft 52 in a direction inwardly of the cylinder 5. A locking nut 59 is threaded on the screw 58 to securely hold the locking screw in position against displacement. Secured to the other end of the enlarged portion 51 of the control shaft 52 is a knurled control handle 60 to facilitate rotation of the shaft 52 and control of the piston parts 34 and 43 of the duplex piston 7.

The control shaft 52 extends through a bore 61 in the slide bearing boss 62 of the closure plate 19 and is sealed against fluid escape by means of a packing 63 received in an annular recess 64 in the bore 61. Similarly, the control shaft 52 extends through a bore 65 in a slide bearing boss 66 formed integral with the piston part 43 of the duplex piston 7 and is likewise sealed against fluid escape by means of a surrounding piston packing 67 received in a suitable recess 68 in the bore 65. The control rod 52 is of sufficient length to extend to the end of the externally threaded tubular projection 46 and the extreme free end thereof is provided with a recess 70 for receiving a key member 71 which is adapted to travel in the longitudinal keyway 48 formed in the bore 47 of said externally screw-threaded tubular projection 46.

The duplex piston 6 is provided with one or more annular grooves in the peripheral surface thereof as at 72 for receiving a fluid packing or sealing ring 73 to prevent the escape of fluid from one side of the duplex piston 6 to the other when the compound motor is in operation.

By reference to Figure 1, it will be seen that the duplex piston 6 is reciprocated in the cylinder 5 and similarly, the duplex piston 7 is reciprocated in the bore 17 of the duplex piston 6. In order to admit fluid under pressure to the bore of the cylinder 5 and the bore 17 of the duplex piston 6, a series of combined intake and exhaust ports 74, 75, 76 and 77 are formed in suitable bosses integrated with the cylinder 5 and arranged so that the ports 74 and 77 may facilitate the entrance and exhaust of fluid under pressure to either side of the duplex piston 6 so as to move said piston to and fro within the cylinder 5. When the duplex piston 6 is moved to the left-hand end of the cylinder 5, the combined intake and exhaust ports 75 and 76 will register with combined intake and exhaust ports 78 and 79 respectively formed in the duplex piston 6 and extending radially through the body portion 16 thereof to the bore

17 of said piston. In this manner, fluid under pressure may be admitted and exhausted with respect to the duplex piston 7 so as to force the piston parts 34 and 43 of the duplex piston 7 toward either end of the bore 17.

When the duplex piston 6 has been moved to the right hand end of the cylinder 5, both of the combined intake and exhaust ports 78 and 79 will be closed since they would be out of registry with the respective intake and exhaust ports 75 and 76.

In order to control the admission of fluid under pressure to the duplex pistons 6 and 7, a control valve 80 is provided and said control valve includes a body portion 81 having a central bore 82 for receiving a rotary valve plug 83 (Figures 4, 5 and 6). The rotary valve plug 83 is mounted on the rotary shaft 84 which extends through said valve plug and projects through the end wall of the valve body 81 so that the hub of a control handle 85 may be affixed to one end thereof.

The control valve 80 is similar to the reversing valve and is provided with diametrically disposed circumferentially extending passageways or ducts 86 and 87 which terminate at their ends in radially extending ports 88, 89 and 90, 91, so as to communicate with the bore 82 in the valve body 81. In addition, a circumferentially extending arcuately curved port or duct 92 is formed in the valve body 81 and is provided with radially extending ports 93 and 94 likewise communicating with the bore 82 of the valve body 81.

The rotary valve plug 83 is provided on its peripheral surface with circumferentially extending recesses 95 and 96 which are adapted to communicate with various ports in the valve body 81 to conduct fluid under pressure to and from the cylinder 5 and duplex piston 6.

Fluid under pressure may be supplied to the valve body 81 by means of a pipe or conduit 97 which has its end extending into the valve body in communication with the arcuately curved circumferentially extending duct 86 so that when the rotary valve plug 83 is in one of the preselected positions shown in Figures 4, 5 and 6, fluid under pressure may be admitted to the cylinder 5 as desired.

The valve body 81 is provided with a pair of radially extending ports 98 and 99 which have their inner ends in communication with the bore 82 of the valve body 81 and their other end in communication with one end of the cylinder 5 by means of combined intake and exhaust pipes 100 and 101 respectively. The combined intake and exhaust pipe 100 is received in the port 74 of the cylinder 5 and the combined intake and exhaust pipe 101 is received in the intake and exhaust port 75 of the cylinder 5. Similarly, the radially extending port or bore 103 is formed in the valve body 81 in diametrically opposed relation to the bore 99 for receiving one end of a combined intake and exhaust pipe 104 which has its other end extending into the combined intake and exhaust port 77 in the cylinder 5. A branch pipe or extension 105 of the intake and exhaust pipe 104 has its end received in the combined intake and exhaust port 76 in spaced relation with the combined intake and exhaust port 77.

A fluid return pipe 107 is received in a radially extending bore 108 in the valve body 81 and communicates with the circumferentially extending arcuate duct or passageway 87 similar to the fluid pressure supply pipe 97. The return pipe or conduit 107 may be connected to the reservoir chamber and fluid pressure supply source or may be directly connected to the intake of the pressure pump in a well-known manner (not shown).

It is intended to connect the threaded portion 28 of the reciprocating plunger rod 8 to the clamping or hold-down member of a punch or stamping press so as to hold the work in place while being operated upon by punching or stamping dies, one of which may be supported and carried by the reciprocating plunger rod 32 and mounted in the socket 33. This is merely an instance of the manner in which a fluid pressure motor may be used, and it is obvious that the device may be used upon machine tools where it is desired to hold the work or clamp the same in a position for being operated upon by a movable tool carried by the reciprocating plunger rod 32.

Description of the operation of the invention

Let it be assumed that the fluid pressure motor and fluid transmission system is employed in the manner above described such as in connection with a punching and stamping press, where the work is held in place by a clamping foot secured to the threaded portion 28 of the reciprocating plunger rod 8, and one of the die members is carried by the reciprocating plunger rod 31 connected to the duplex piston part 34. In order to control the relative movement between the plunger rods 24 and 31, the control handle 85 of the rotary plug valve 80 is first turned to the position shown in Figure 4 so that fluid under pressure will pass through the radially extending port 89 and circumferentially extending recess 96 to the combined intake and exhaust conduit 104. When the rotary valve plug 83 is in the position shown in Figure 4, fluid under pressure will be admitted to the right hand end of the cylinder 5 and force the duplex piston 6 in the direction shown in Figure 4 by the arrows, to the left. The fluid in the left-hand end of the cylinder may escape through the combined intake and exhaust pipe 100 to the circumferentially extending passageway 95 in the rotary valve plug 83 so as to pass in the direction indicated by the arrow to the reservoir or intake side of the fluid pressure supply pump through the conduit 107. During the movement of the duplex piston 6 toward the left-hand end of the cylinder 5, the plunger rod 24 will have moved a corresponding distance so that the clamping foot thereon will engage the work and hold the same against movement. After the duplex piston 6 has been moved to the left-hand end of the cylinder 5, the combined intake and exhaust ports 76 and 79 will register so that fluid under pressure will flow through the branch pipe 105 to the bore 17 of the duplex piston 6 and force the duplex piston 7 to the left so that the die member or other tool carried thereby can operate on the work previously clamped in position by the clamping foot carried by the reciprocating plunger rod 24. As this occurs, the combined intake and exhaust ports 75 and 78 will register and the exhaust fluid from the bore 17 of the duplex piston will pass out of the combined intake and exhaust conduit 101 to the radially extending bore 99 and thence through the circumferentially extending passageway 95 through the return conduit 107 to the source of fluid pressure.

In order to retract the plunger rod 31 prior to the retraction of the plunger rod 24 and the clamping foot carried thereby, the control handle 85 of the rotary plug valve may be moved to the position shown in Figure 6, whereupon fluid under pressure will be admitted to the left-hand end of the bore 17 of the duplex piston 6 and force the

duplex piston 7 to the right so as to completely retract the die member or the other tool carried by the reciprocating plunger rod 9 prior to the retraction of the clamping foot carried by the plunger rod 8. When the control handle 85 is in the position shown in Figure 6, fluid is admitted under pressure through the valve 80 to the circumferentially extending duct or passageway 86 in such a manner as to cause fluid under pressure to flow through the circumferentially extending passageway 95 in the rotary plug 83 of the valve, through the combined intake and exhaust port 75 and thence through the combined intake and exhaust port 78 in the duplex piston 6. Similarly, the combined intake and exhaust conduit 104 will connect the opposite end of the bore 17 of the duplex piston 6 with the fluid pressure return pipe or conduit 107 through the combined intake and exhaust ports 76 and 79, branch pipe 105, radially extending port 94 and thence through the circumferentially extending passageway 96 in the plug valve 83 to the radially extending port 91 of the arcuately curved circumferentially extending passageway 87 in the direction as indicated by the arrows. The duplex piston 6 is held against movement in the cylinder 5 by reason of the fact that the combined intake and exhaust conduit 100 is closed by the rotary plug valve 83 being disposed so as to close the radially extending port 98.

After the duplex piston 7 has been moved to the right-hand end of the bore 17 thereof, the control valve handle 85 may be turned to position the rotary valve plug 83 as shown in Figure 5, so that fluid under pressure will be admitted to the control valve 80 through the conduit 97 in such a manner as to connect the pressure supply conduit with the combined intake and exhaust conduit 100 through the radially extending port 88, circumferentially extending passageway 95 and radially extending passageway 98 in the valve body 81. Simultaneously, the combined intake and exhaust conduit 104 and branch conduit 105 will have communication with the return conduit 107 through the radially extending port 94, circumferentially extending passageway 96, radially extending passageway 91, and thence through the circumferentially extending curved duct 87 to the radially extending port or passageway 90. The combined supply and exhaust pipe 101 and the branch pipe 105 of the supply and exhaust conduit 104 will momentarily be in communication with the ends of the bore 17 in the duplex piston 6 so that after the duplex piston 6 has moved slightly to the right, fluid pressure will be admitted to the left-hand end of the cylinder 5 through the combined intake and exhaust conduit 101 by way of the radially extending port 99 which is shown in Figure 5 as already in communication with the circumferentially extending passageway 95 of the rotary valve plug 83 so as to connect the fluid pressure pipe 97 therewith. Simultaneously, the combined intake and exhaust ports 78 and 79 of the cylinder 5 of the duplex piston 6 will have moved apart a sufficient distance to break the passageway therethrough and close off the branch pipe 105 during continued travel of the duplex piston 6 to the right. However, this is immaterial since the duplex piston 7 has already been shifted to the right hand end of the bore 17 of the duplex piston 6 as previously described.

The duplex piston 6 may be allowed to travel the remaining portion of its stroke until it reaches the right hand end of the cylinder 5 and then the control handle 85 of the valve 80 may be rotated for another cycle of operation of the duplex piston 7.

In order to adjust the duplex piston 7 to produce the desired stroke of the reciprocating plunger rod 9, the knurled handle 50 of the rotary shaft 52 is turned in either direction to move the piston parts 34 and 43 of said duplex piston toward and away from one another. In this manner, the stroke of the duplex piston 7 may be regulated so as to impart the desired movement to the die member or other tool supported in the socket 33 in the end of the reciprocating plunger 9.

It is to be understood that the form of the invention herewith shown and described is to be taken as a preferred embodiment and that various changes may be made in the shape, size and arrangement of parts without departing from the spirit of the invention or the scope of the subjoined claims.

What I claim is:

1. A fluid transmission system for machine tools and the like where it is desirable to impart relative movement to the operative parts of said machine tool or the like, comprising a cylinder having combined intake and exhaust ports spaced axially therealong, duplex pistons mounted in said cylinder one within the other, the outer piston having an enclosed chamber with axially spaced ports cooperating with said cylinder ports, a source of fluid pressure for said system, and a control valve for admitting fluid under pressure from said pressure source alternately to the ends of said cylinder and to the ends of one of said duplex pistons.

2. A fluid transmission system for machine tools and the like where it is desirable to impart relative movement to the operative parts of said machine tool or the like, comprising a cylinder having combined intake and exhaust ports spaced axially therealong, duplex pistons mounted in said cylinder one within the other, the outer piston having an enclosed chamber with axially spaced ports cooperating with said cylinder ports, a source of fluid pressure for said system, a control valve for admitting fluid under pressure from said pressure source alternately to the ends of said cylinder and to the ends of one of said duplex pistons, and concentrically arranged connecting rods attached to said duplex pistons adapted to be attached to the operative parts of said machine tool.

3. A fluid pressure motor, comprising a cylinder having end walls, duplex pistons reciprocably mounted within said cylinder in concentric relationship, one of said duplex pistons being reciprocably mounted relative to the other piston within a cylinder chamber therein, concentric connecting rods attached to said duplex pistons and extending through one of said end walls of the cylinder, axially spaced ports in said cylinder for admitting fluid under pressure to the opposite ends of said cylinder, and axially spaced ports in the outer duplex piston cooperating with said cylinder ports for connecting the cylinder chamber in said duplex piston with said cylinder ports for admitting fluid under pressure to one end of the duplex piston reciprocably mounted therein when the duplex piston in said cylinder is in a predetermined position.

4. A fluid pressure motor, comprising a cylinder having end walls, duplex pistons reciprocably mounted within said cylinder in concentric relationship, one of said duplex pistons being reciprocably mounted relative to the other piston

within a cylinder chamber therein, concentric connecting rods attached to said duplex pistons and extending through one of said end walls of the cylinder, axially spaced ports in said cylinder for admitting fluid under pressure to the opposite ends of said cylinder, and axially spaced ports in the outer duplex piston cooperating with said cylinder ports for connecting the cylinder chamber in said duplex piston with said cylinder ports for admitting fluid under pressure to one end of the duplex piston reciprocably mounted therein when the duplex piston in said cylinder is in a predetermined position, said cylinder and piston ports being arranged to permit independent movement of one of said duplex pistons.

5. A fluid pressure motor, comprising a cylinder having a pair of axially spaced ports adjacent the opposite ends thereof and a pair of axially spaced intermediate ports therebetween, a hollow outer piston in said cylinder having a chamber therein with a pair of axially spaced ports communicable with said intermediate cylinder ports in one position of said outer piston, an inner piston reciprocably mounted in said chamber, and means connected to said pistons for passing through said cylinder for transmitting the power therefrom to power-operated devices outside said cylinder.

6. A fluid pressure motor, comprising a cylinder having a pair of axially spaced ports adjacent the opposite ends thereof and a pair of axially spaced intermediate ports therebetween, a hollow outer piston in said cylinder having a chamber therein with a pair of axially spaced ports communicable with said intermediate cylinder ports in one position of said outer piston, an inner piston reciprocably mounted in said chamber, and means connected to said pistons for passing through said cylinder for transmitting the power therefrom to power-operated devices outside said cylinder, one of said cylinder intermediate ports being adjacent one of said cylinder end ports.

7. A fluid pressure motor, comprising a cylinder having a pair of axially spaced ports adjacent the opposite ends thereof and a pair of axially spaced intermediate ports therebetween, a hollow outer piston in said cylinder having a chamber therein with a pair of axially spaced ports communicable with said intermediate cylinder ports in one position of said outer piston, an inner piston reciprocably mounted in said chamber, means connected to said pistons for passing through said cylinder for transmitting the power therefrom to power-operated devices outside said cylinder, and a fluid passageway connecting one of said cylinder intermediate ports with one of said cylinder end ports.

8. A fluid pressure motor, comprising a cylinder having a pair of axially spaced ports adjacent the opposite ends thereof and a pair of axially spaced intermediate ports therebetween, a hollow outer piston in said cylinder having a chamber therein with a pair of axially spaced ports communicable with said intermediate cylinder ports in one position of said outer piston, an inner piston reciprocably mounted in said chamber, means connected to said pistons for passing through said cylinder for transmitting the power therefrom to power-operated devices outside said cylinder, and a fluid passageway connecting one of said cylinder intermediate ports with one of said cylinder end ports, one of said cylinder intermediate ports being adjacent one of said cylinder end ports.

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