Dec. 6, 1938. M. ROMAINE ET AL 2,139,173

CONTROL CIRCUIT FOR BROACHING MACHINES

Original Filed March 1, 1933 3 Sheets-Sheet 1

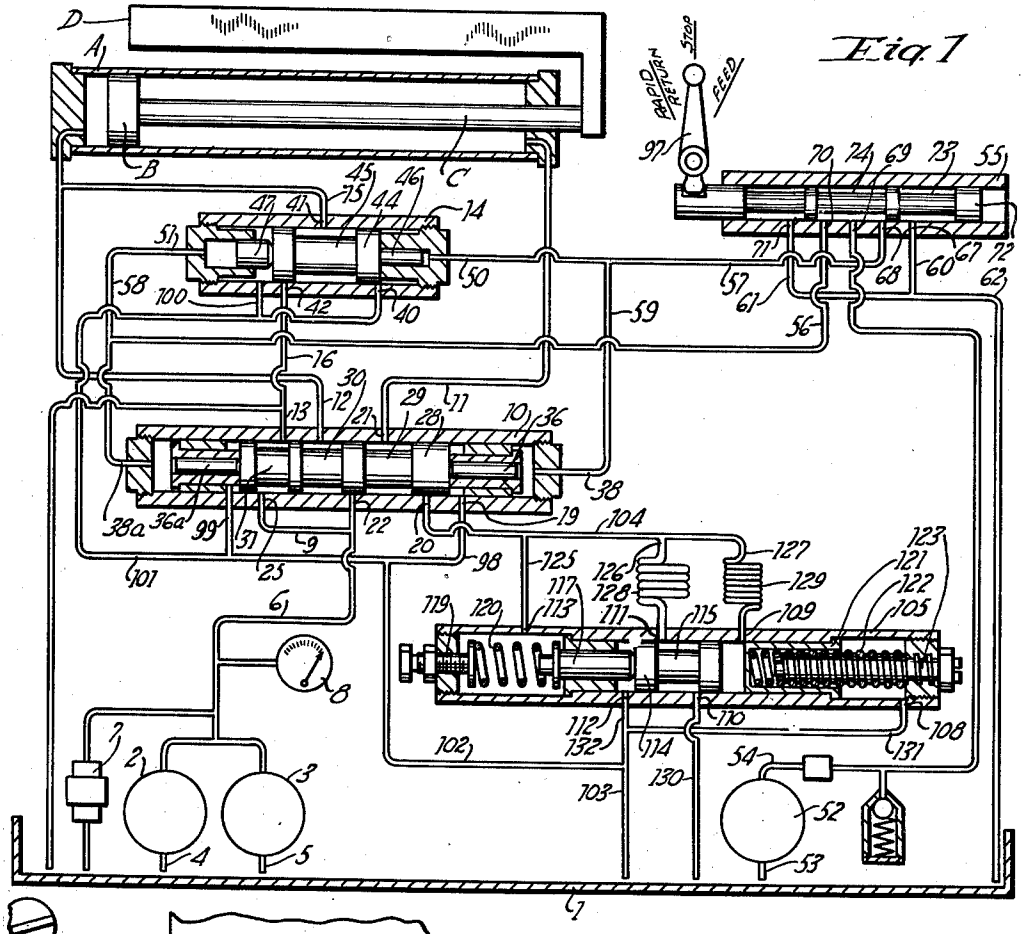

Fig. 1

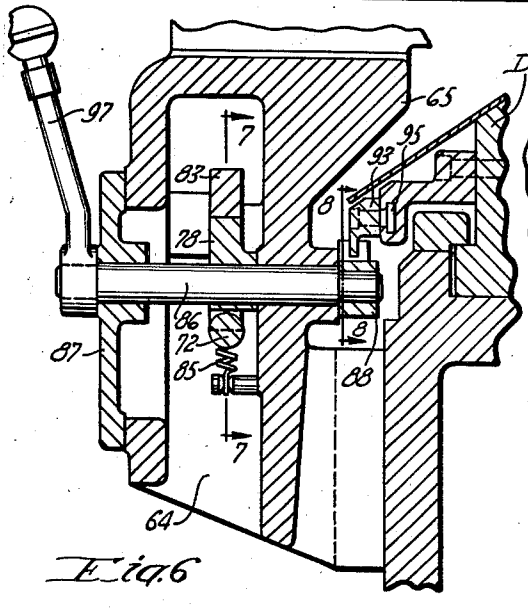

Fig. 6

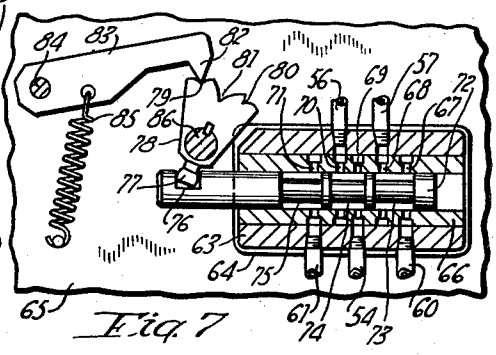

Fig. 7

INVENTOR.
MILLARD ROMAINE
ERWIN G. ROEHM

BY

H. K. Parsons
ATTORNEY.

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Fig. 2

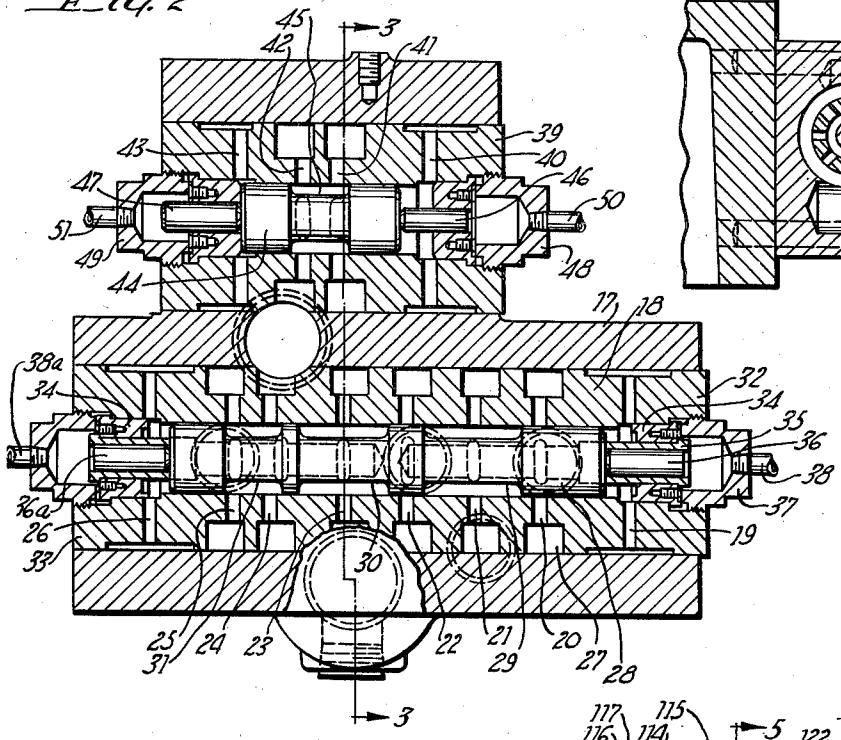


Fig. 5

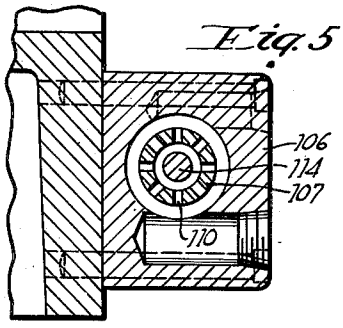


Fig. 4

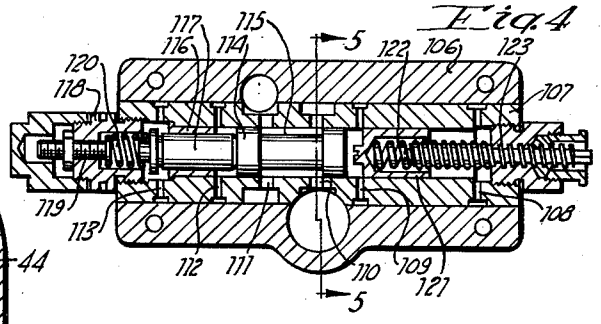


Fig. 3

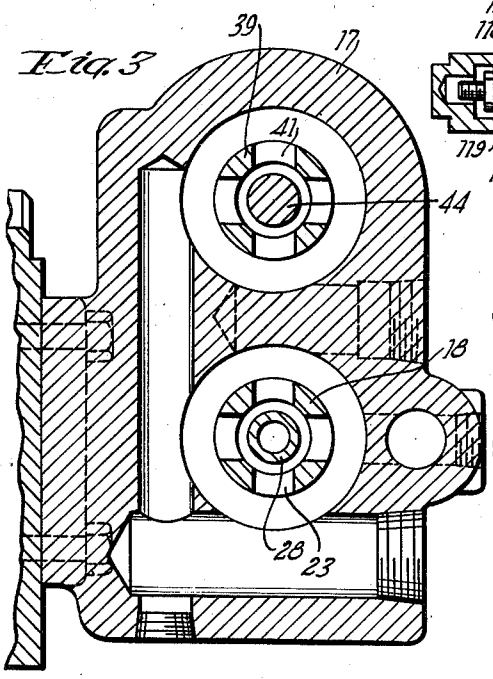
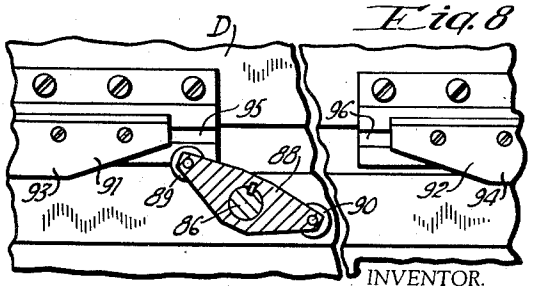


Fig. 8



INVENTOR.
MILLARD ROMAINE
ERWIN G. ROEHM

BY
O. K. Parsons
ATTORNEY.

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Fig. 9

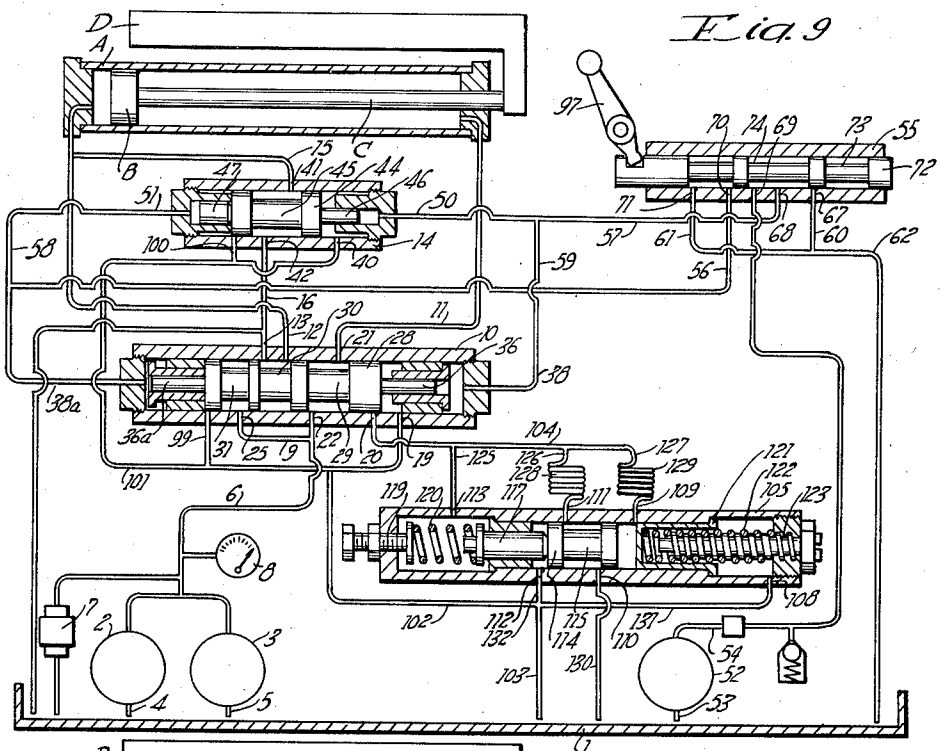
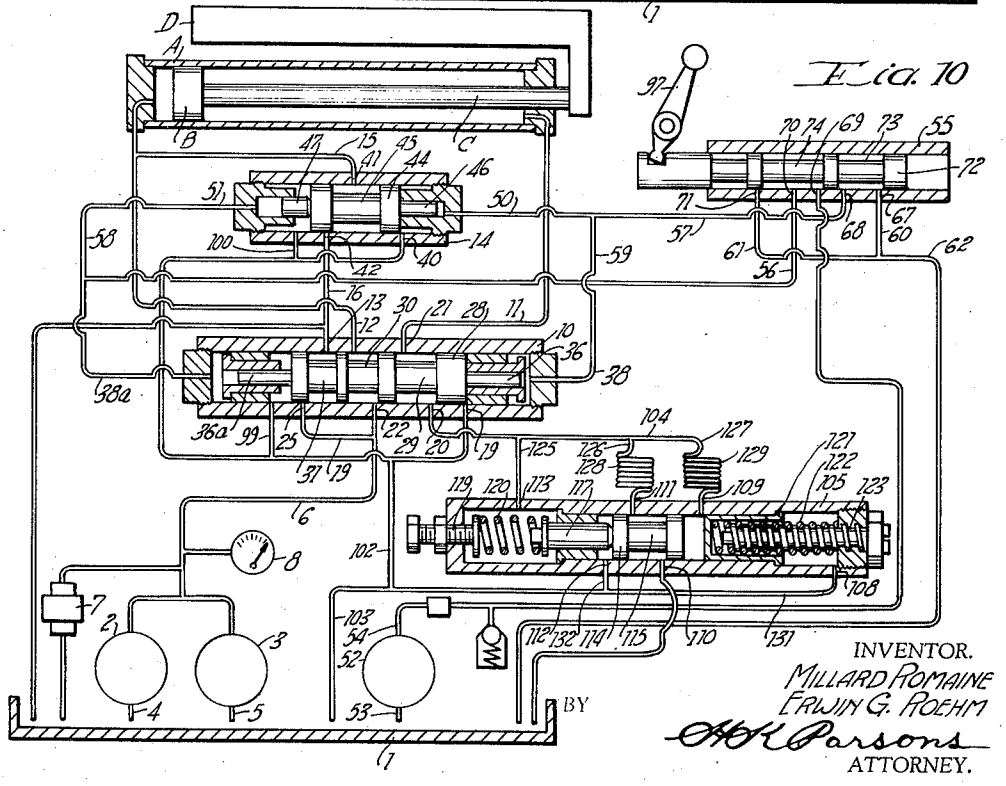


Fig. 10



INVENTOR.
MILLARD ROMAINE
ERWIN G. ROEHM
BY
H. K. Parsons
ATTORNEY.

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UNITED STATES PATENT OFFICE

2,139,173

CONTROL CIRCUIT FOR BROACHING MACHINES

Millard Romaine, Cincinnati, and Erwin G. Roehm, Norwood, Ohio, assignors to The Cincinnati Milling Machine Company, Cincinnati, Ohio, a corporation of Ohio

Original application March 1, 1933, Serial No. 659,226. Patent No. 2,063,756, dated December 8, 1936. Divided and this application March 31, 1936, Serial No. 71,904

14 Claims. (Cl. 121—45)

This invention relates to improvements in broaching machines and is a division of our application therefor filed March 1, 1933, Serial Number 659,226 and issued as Patent No. 2,063,756 on December 8, 1936.

One of the principal objects of the present invention is the provision in connection with a broaching machine of the reciprocating type of an improved hydraulic actuating mechanism for controlling the tooling and non-tooling movements of the broach.

A further object of the present invention is the provision in conjunction with a machine tool of the character described of an improved hydraulic actuating circuit for effecting satisfactory tooling and facilitating rapid retraction of the broach or tool member.

Other objects and advantages of the present invention should be readily apparent by reference to the following specification considered in conjunction with the accompanying drawings, forming a part thereof, and it is to be understood that any modifications may be made in the exact structural details there shown and described, within the scope of the appended claims, without departing from or exceeding the spirit of the invention.

In the drawings:

Figure 1 is a diagrammatic view of the complete hydraulic circuit and controls therefor.

Figure 2 is a sectional view illustrating the distributor and reversing valve for controlling the movement of the hydraulic motor device.

Figure 3 is a sectional view taken on the line 3—3 of Figure 2.

Figure 4 is a sectional view through the balancing valve.

Figure 5 is a sectional view taken on the line 5—5 of Figure 4.

Figure 6 is a fragmentary sectional view illustrating the valve controlling mechanism.

Figure 7 is a sectional view as on the line 7—7 of Figure 6.

Figure 8 is a further sectional view as on the line 8—8 of Figure 6.

Figure 9 is a diagrammatic view similar to Figure 1 of the hydraulic circuit and control therefor showing the system conditioned for rapid traverse of the motor to the left, and

Figure 10 is a similar view showing the system conditioned for feeding movement of the motor in a right hand direction.

In view of the fact that the general structural details of the broaching machine shown for purposes of illustration as actuable by our present improved hydraulic circuit and described and claimed in detail in our co-pending application above referred to, said general elements have been omitted herefrom with the exception that to facilitate general understanding of the invention there has been illustrated diagrammatically the cylinder A for the piston B having a piston rod C engageable with the reciprocable broach carrier or the like D said cylinder or hydraulic motor device potentially controllable by our improved mechanism as hereinafter described.

The hydraulic system for effecting and controlling the movement of the piston B and consequently of the table D connected thereto, is diagrammatically illustrated in Figure 1 and as there shown comprises a sump or tank 1 for containing the fluid, preferably oil, utilized in the system. In view of the large quantities of oil necessary to effect the operation of the parts, there is shown a pair of pumps 2 and 3 respectively having a suction line 4 and 5 for drawing the fluid from the tank and discharging said fluid under pressure into conduits or lines 6 connected with each pump.

A pressure control or relief valve 7 is provided for determining the pressure in the line 6 with which line is also connected a suitable gauge 8. The line 6 and its branch line 9 terminate in a valve, indicated generally by the numeral 10 and constituting a directional control or reversing valve. The valve 10 connects the line 6 or its branch line 9 with either of three conduits, 11, 12 and 13, the latter extending directly to the tank or sump 1 for short circuiting the system and the other two terminating respectively at the right and left hand ends of the cylinder A.

The valve 10 is shown in Figure 1 as in position to short circuit the system and return the fluid in the lines 6 and 9 to the sump or tank 1. As also shown in this figure, between the reversing valve 10 and the piston and cylinder there is provided a second valve for permitting, when in the proper position, the rapid escape of the fluid from one side of the piston and indicated generally by the numeral 14. This valve 14 is connected by a line or conduit 15 with the line or conduit 12 extending from the left hand end of the table cylinder. The other side of the valve 14 is connected by the line or conduit 16 with the conduit 13 terminating in the sump or tank 1.

The valves 10 and 14 are shown structurally in Figure 2 as enclosed within a single casing 17 having a pair of bores formed therein and disposed one above the other. Within the longer bore is the reversing valve which comprises a

valve bushing 18 having formed therethrough sets of radial ports 19, 20, 21, 22, 23, 24, 25 and 26, each set being connected by a circumferential groove 27 formed on the exterior of the bushing. Extending through the bushing bore is a spool type valve 28 having cannelures 29, 30 and 31 for connecting certain of the sets of radial ports in different combinations. The chamber containing the bushing 18 is closed at opposite ends by heads 32 and 33 which are substantially identical in construction and in each of which is mounted a guide 34 for a headed sleeve 35 and piston plungers 36 and 36a. The guides 32 and 33 are further provided with chambered plugs 37 through which the head of the sleeve 35 shifts and connected with the outer ends of the plugs are conduits 38 and 38a of a control hydraulic system to be later described and which effects the shifting of the valve 28.

The releasable blocking valve 14, for relieving the back pressure facilitating rapid exhaust of the hydraulic medium, is mounted in the shorter of the bores in the casing 17 and comprises a bushing 39 similar to the bushing 18 which has formed therethrough sets of radial ports 40, 41, 42, and 43. In the bore through the bushing is a spool type valve 44 having a cannelure 45 adapted in one position to connect the sets of ports 41 and 42 and in the other position to interrupt the connection thereof. The ends of the chamber containing the bushing 39 are closed in the same manner as the ends of the chamber containing the bushing 18 and said closures each have mounted therein the piston plungers 46 and 47 of different areas, whereby with equal pressures on the ends thereof, the valve will be shifted by the larger piston plunger 47 for a purpose that will be later made clear. The said chamber closures also include the plugs 48 and 49 with which are respectively connected one terminus of conduits 50 and 51 which are a part of the control hydraulic circuit.

The hydraulic control circuit above referred to comprises a pump 52 having a suction line 53 for drawing the hydraulic fluid or medium from the tank 1 and discharging same into the line or conduit 54. The line 54 terminates at a pilot valve indicated in its entirety in Figure 1 by the numeral 55. The valve 55 is adapted in one position to connect the hydraulic medium with a pair of lines or conduits 56 and 57 which respectively terminate in lines or conduits 58 and 59. The conduit 58 in turn connects with conduits 38a and 51 respectively actuating the piston plungers at the left hand ends of the valves, as seen in Figure 2, while the conduit 59 connects the conduits 38 and 50 extending from the right hand ends of said valves. The valve 55 is also adapted, in different positions thereof, to connect the line 54 independently with either line 56 or 57 and to connect the other with branch conduits or lines 60 and 61 which terminate in a common discharge line 62 that has its terminus in the sump or tank 1 whereby the reversing or directional control valve and the blocking-power actuated relief valve are shifted to different operative positions.

The pilot valve 55 and mechanism for controlling and operating it is shown structurally in Figures 6, 7 and 8, particularly in Figure 7. As there shown, the valve comprises a casing 63 mounted within a recess 64 formed in a bracket 65. The valve casing 63 has formed therein a bore in which is pressed the valve bushing 66 having formed therethrough a plurality of sets of radial ports 67, 68, 69, 70 and 71 with which the ends of conduits 60, 57, 54, 56 and 61 respectively connect. Extending through the bushing 66 is a spool type valve 72 having formed thereon cannelures 73, 74 and 75 which in the several positions of the valve connect the conduits or complete the different circuits above enumerated. The valve 72 has formed integral therewith a stem in which is formed a notch 76 receiving the ball end 77 of a load and fire dog 78. The dog 78 is provided with two shallow notches 79 and 80 intermediate which is a notch 81. The several notches are connected by contoured or cam shaped wells which co-operate with the nose 82 of a latch 83 pivoted at 84 within the recess 64 of the bracket 65. A spring 85 has its one end anchored to the bracket 65 and its other end connected with the latch 83 for yieldingly urging the latch about its pivot to cause engagement between the nose 82 thereof and the load and fire dog 78.

The operation of the load and fire dog is such that with the valve in the position as shown in Figure 7, the latch 83 engages the shallow notch 79 for holding the valve in its extreme left hand position and a slight movement of the valve to the right will disengage the notch 79 and latch, causing said latch to ride over the peak or apex of the joined walls of the notches 79 and 81 whereupon the valve will be actuated to its neutral position until the latch is in the deep notch 81 thereof. When the valve is in its extreme right hand position, the latch is engaged with the shallow notch 80 whereupon a slight movement of the dog or valve in the opposite direction results in the reverse movement of the parts until the latch again comes to rest in the large or deep notch 81.

The dog 78 is secured to a shaft 86 which spans the recess 64 and projects beyond the limits of the bracket 65 and is journaled at one end in said bracket and on the other end in a plate 87 secured to the face of the bracket 65. To the rear end of the shaft 86, which extends beyond the journal thereof in the bracket 65, is secured an elongated arm 88 having journaled in each end thereof a roller 89 and 90. The rollers 89 and 90 are adapted to be respectively engaged by cam faces 91 and 92 formed on reversing dogs 93 and 94 adjustable through slots 95 and 96 formed in or secured to the side of the table D.

The operation of these parts is as follows: With the dog 78 in the position shown in Figure 7 and the arm 88 in the position shown in Figure 8, the table D is moving to the right as seen in these figures. The table carries with it the dog 93 the cam face 91 of which will eventually engage the roller 89 and tend to depress same thereby oscillating the arm 88, shaft 86 and dog 78 in a counterclockwise direction, unseating the latch 83 from the shallow notch 79 whereupon the camming action or the firing of the latch 83 and dog 78 by the spring 85 is had, as above described for returning the pilot valve to its normal or neutral position. The dog 87 and consequently the valve 72 is initially shifted by manual means, for which purpose the shaft 86 journaled in the plate 87 projects beyond the said plate to receive a manually operable lever 97. The lever in addition to initially setting the valve and initially setting the load and fire mechanism also acts as a directional indication lever so that the table will move in the direction in which the lever is shifted.

In the operation of the control circuit or mechanism, the lever 97 has three positions, indicated

in Figure 1 as "rapid return", "stop" and "feed". The parts are shown with the lever 97 in its neutral or stop position at which time, as above described, the pressure from the pump 52 through the line 54 is connected by the cannelure 74 of the pilot valve 72 with the conduits or lines 56 and 57. The same pressure will therefore be in the lines 58 and 59 and consequently in the conduits 51, 50, 38a and 38. These conduits direct the pressure against piston plungers 47, 46, 36a, and 36. Since the piston plungers 36 and 36a are of the same cross section it will result in the centralization of the reversing valve 28, as shown in Figure 1, while since the piston plunger 47 is of a greater cross section than the piston 46, it will result in the valve 44 being shifted to its extreme right hand position. At this time then the pressure in line 6 from the pumps 2 and 3 will be short circuited through the branch line 9, cannelure 31 of the valve 28 with the return conduit 13 which terminates in the sump or tank 1, resulting therefore in no movement of the table. At the time of shifting of the piston plungers 36, 36a, and 47 the hydraulic medium ahead of these plungers was respectively exhausted through ports 19, 26 and 43 which respectively connect with branch exhaust lines 98, 99 and 100 each of which is connected with a conduit or port 101 and in turn emptying into a conduit or port 102 connected with a conduit 103 terminating in the sump or tank 1.

If the lever 97 is now shifted to the right or to the feed position, as shown in Figure 1, the pilot valve would be shifted to the left and thereby connect through the cannelure 74 the lines 54 and 56 and would connect through the cannelure 73 the lines 57 and 60. At this time the conduit 58 and conduits 38a and 51 would be under pressure while the conduit 59 and conduits 38 and 50 would be connected to the exhaust. Since the rapid traverse valve 44 would already be to its right hand limit of movement no further movement would be imparted thereto, but by relieving the pressure on the piston plunger 36 the reversing valve 28 would be shifted to its extreme right hand position. This then would uncover the port 23 and cover the port 25 so that the pressure in the line 6 would be coupled or connected through the cannelure 30 with the conduit 12 and act on the left hand face of the piston, thereby moving the table to the right. At this time the exhaust ahead of the piston would be connected through the conduit 11 to the port 21 and through the cannelure 29 with the port 20 and a conduit 104 connected therewith. The conduit 104 passes through a back pressure balancing valve indicated in its entirety by the numeral 105, which will be explained in detail later. The table will continue to move in a direction toward the right at a feeding rate of speed until one of the table dogs 92 or 93 engages with its roller on the arm 88 and thereby shifts the valve to its neutral or stop position, whereupon the table will be brought to a standstill.

The lever 97 is now shifted to the left or to the rapid traverse position for thereby connecting the control pressure line 54 with the line 57 and connecting the line 61 with the line 56. This then reverses the pressures in conduits 58 and 59 and consequently in the control conduits to the piston plungers. In other words piston plungers 46 and 36 are now under pressure for shifting the rapid traverse valve 44 to its left hand position and shifting the reversing valve 28 to its left hand position. At this time the full capacity of the pumps 2 and 3 is being discharged into the small end of the cylinder that is, the end through which the large piston rod is disposed. Since the capacity on both sides of the piston is thereby greatly changed, the piston and parts carried thereby will tend to move at a rapid rate. And to insure that the oil or other hydraulic medium can escape fast enough from the large end of the cylinder, use is made not only of the conduit 12 through the conduit 13, but also through the branch conduit 15 which is at this time connected with the conduit 16 and conduit 13. From this it will be seen that the piston and parts operated thereby are travelling at a rapid rate toward their initial position. This movement continues until the other dog 93 or 94 on the table engages the other of the rollers on the arm 88 and again returns the valve to its neutral or stop position.

The back pressure valve 105 is employed for insuring a continuous even movement of the table and consequently the cutters and to eliminate any possible surging or running ahead thereof. This valve is shown structurally in Figures 4 and 5 and comprises a casing 106 having formed therein a chamber containing the valve bushing 107 through which sets of radial ports 108, 109, 110, 111, 112 and 113 are formed. Extending through the bore in the bushing 107 is a spool type valve 114 having a cannelure 115 for controlling the connection of ports 110 and 111. Also mounted in the bore in the bushing 107 is a sleeve 116 in which is disposed for movement relative thereto a piston plunger 117 adapted to abut one end of the piston valve 114. Closing this end of the bushing bore is a plug 118 having threaded therein the screw 119 forming one abutment for a spring 120 that abuts on its other end with the piston plunger 117. Mounted in the bore of the bushing 107 on the other side of the valve 114 is a shiftable abutment 121 contacted on one side by a spring 122, whose characteristic and effective length may be varied by means of a screw 123 with the threads of which the spring 122 meshes. The screw 123 is threaded through a plug which closes this end of the bushing bore.

Referring now to the diagrammatic illustration in Figure 1, it will be noted that the normal discharge line from the reversing valve 10 has extending from it three conduits 125, 126 and 127. Conduit 125 is connected with the bushing port 113 and therefore places the pressure on the outer end of the piston plunger 117 equal to the pressure in the line 104. The conduit 126 connects with the port 111 and has a resistance therein which is relatively low and consists of a coil or pipe 128 having a comparatively small bore therethrough. The conduit 127 connects with the port 109 and also has a hydraulic resistance therein which is comparatively high as respects the hydraulic resistance 128 and also comprises a coil 129 having a bore therein smaller than that in the coil 128. The port 110 is connected by a discharge pipe 130 with the sump or tank 1. The ports 108 and 112 are connected by branch conduits 131 and 132 with the discharge conduit 103 and constitute drains for draining the hydraulic medium that may leak past the piston plunger 117 and spring abutment 121.

The operation of this valve is as follows: When the table is moving in a feeding direction the discharge of fluid from the piston and cylinder is, as above described, into the conduit 104 from which it passes through conduits 125, 126

and 127. Inasmuch as the chamber at the left hand end of valve 105, containing spring 120 into which the end of piston 117 projects, and the chamber between the right hand end of valve 144 and the shiftable abutment 121 are closed chambers, under any condition of constant pressure in the general line 104, the pressure effects in these chambers will be equal. Under these conditions, the right hand end of valve 114 having a greater area than the area of the piston plunger 117, the pressure will tend to move valve 114 to the left, as viewed in Figures 1 and 4. This would normally shut off the discharge port 110 to line 130, preventing escape of the back pressure fluid through line 126, resistance 128. Therefore, to supplement the pressure action against piston 117, use is made of the adjustable compression spring 120, also reacting on plunger 117, with the result that the combined effect of pressure and spring action on plunger 117 is sufficient in amount to counterbalance the pressure effect through line 127 on the right hand end of valve 114, causing a normal centralized positioning of the valve, as particularly brought out in Figure 1, such that the exhaust fluid will have an unrestrained return to reservoir through lines 126—130. However, in the event there is a sudden surge in piston movement, tending to displace a larger amount of fluid than the normal flow for which the parts are adjusted, resistance 128 will effect an increase of pressure in line 104 which will immediately react through line 125 increasing the pressure effect against piston 117, moving valve 114 to the right and thus increasing the resistance to discharge through port 111, maintaining the volumetric flow a constant. The pressure increase thus created will also be effective in line 127, tending to force an additional amount of the hydraulic fluid through line 127, resistance 129 into the space between the shiftable abutment 121 and the right hand end of valve 114. The fact that abutment 121 is positioned by the adjustable characteristic spring 122 permits this to act as an accumulator when the initial pressure reaction against 117 moves valve 114 to the right and permits instantaneous throttling movement, in spite of the fact that an increased pressure is being established through the resistance 129.

Conversely, when the pressure drops in line 104, the accumulator abutment 121 reacting on the substantially trapped quantity of oil will have an immediate effect to move valve 114 to the left prior to the reverse drainage of a portion of the trapped fluid through coil 129.

It will thus be seen that an improved pressure controlled rate determining valve structure has been provided which will insure discharge of the exhaust medium at a constant rate irrespective of existing back pressure conditions or attempted volumetric discharge fluctuations.

From the foregoing description considered in conjunction with the accompanying drawings, the structure, operation and advantages of our improved hydraulic control system as particularly applicable to broaching machines or other machine tools, should be clearly understood and it will be noted that we have provided an improved system particularly adapted for preventing surging of a movable tool during the cutting operation and for facilitating the rapid return thereof for a new cutting stroke.

What is claimed is:

1. An hydraulic circuit for control of the piston and cylinder mechanism of a machine tool including an hydraulic medium for operating the piston and cylinder, a reversing valve in said circuit for selectively directly the pressure medium to opposite ends of the cylinder, an hydraulic control circuit including a pilot valve for controlling the position of the reversing valve, a manually operable direction indication lever coupled with the pilot valve for operating same and simultaneously indicating the direction of movement of the table, a back pressure control valve in the circuit for controlling the back pressure from the piston and cylinder to insure uniform rate of movement of the table during feeding, a valve in the circuit for controlling the discharge of the medium from the other end of the cylinder and connections between the pilot and said valve for actuating the latter as the pilot is shifted to effect reversal of table operation whereby rapid movement of the table when moving in the opposite direction is facilitated.

2. An hydraulic circuit for control of the piston and cylinder mechanism of a machine tool including an hydraulic medium for operating the piston and cylinder, a reversing valve in said circuit for selectively directing the pressure medium to opposite ends of the cylinder, an hydraulic control circuit including a pilot valve for controlling the position of the reversing valve, a manually operable direction indication lever coupled with the pilot valve for operating same and simultaneously indicating the direction of movement of the table, a back pressure control valve in the circuit for controlling the back pressure from the piston and cylinder to insure uniform rate of movement of the table in one direction, a valve in the circuit for controlling the discharge of the medium from the other end of the cylinder to permit a rapid movement of the table when moving in the opposite direction, and means connecting the said valve with the pilot valve whereby the position of the valve is determined by the adjustment of the pilot valve.

3. An hydraulic motor control system of the character described including a source of hydraulic pressure medium including a transmitting conduit, a pair of motor conduits, a reversing valve intermediate the several conduits for selectively coupling the pressure transmitting conduit with one or the other of the motor conduits, said reversing valve having an intermediate stop position, means for selectively positioning the reversing valve in either of said three positions, a blocking valve permanently associated with one of the motor conduits, a reservoir connection associated with the blocking valve whereby the motor conduit is connected to reservoir when said valve is moved to unblocking position, and connections between the reversing valve and blocking valve effective to maintain the blocking valve in closed position as respects two positionings of the reversing valve and to shift the valve to unblocking position affording an outlet to reservoir when the reversing valve is moved to its third effecting position.

4. An hydraulic circuit for actuation of a piston and cylinder mechanism including a reversing valve for alternately connecting the circuit with opposite ends of the piston and cylinder mechanism, a pressure by-pass valve in the circuit for relieving the back pressure in one end of the cylinder to permit a rapid movement in one direction, hydraulically actuated pistons for reversely shifting said reversing and pressure by-pass valves, the pistons on the pressure by-pass valve being of unequal area whereby the said

valve is by application of pressure to both pistons thereof actuated in one direction, and a separate hydraulic control circuit including a control valve having portions for directing the pressure simultaneously to one or the other of the pistons of the reversing and pressure by-pass valves whereby the said valves are simultaneously shifted in accordance therewith, said control valve having portions for simultaneously connecting the pressure to both of the pistons of the valves for moving said valves into a position hydraulically to lock the piston and cylinder in a given position.

5. A control mechanism for a reversible hydraulic motor, including a source of hydraulic actuating medium, a pair of conduits oppositely coupled with the motor for input or withdrawal of actuating medium therefrom, a three-position reversing valve intervening said source and the conduits for selective coupling of either of said conduits with the motor for actuation thereof, a two-position reservoir connection control valve associated with one of said motor conduits, balanced piston members oppositely associated with the reversing valve for actuation thereof, whereby pressure against either of the pistons will effect maximum movement of the valve in one direction or the other, while equal pressures will effect centralization of the valve, and unbalanced piston members oppositely associated with the reservoir valve whereby equal pressures will cause a positive closing movement thereof, and a common pilot circuit for the pistons of both valves whereby pressure may be selectively correspondingly directed against the pistons at either or both termini of both of said valves, substantially as and for the purpose described.

6. In an hydraulic mechanism of the character described, the combination with a reversely hydraulic motor including a pair of conduits oppositely connected to the motor and alternatively employable for introduction in or exhaust of actuating hydraulic medium therefrom, of a normally closed reservoir connection for one of said conduits, a reservoir connection control valve therefor, a rate determining valve selectively coupleable with the other of said conduits, a control valve member for simultaneously coupling the hydraulic actuating medium with one of said conduits and coupling the other of said conduits with the rate determining valve, and means for simultaneously shifting the control valve member and the reservoir connection control valve.

7. The combination with a reversible hydraulic motor, of means for controlling the rate and direction of actuation thereof including a source of hydraulic medium under pressure, conduits oppositely coupled to the motor for conduction of medium to one side or the other thereof for effecting its reverse actuation, a first valve means shiftable into a position to couple the medium with one or the other of said conduits and into a third position to disconnect the medium from both of said conduits, a back pressure control valve, said first mentioned valve having a portion effective in one position to couple one of the motor conduits to said back pressure control valve when the other of the motor conduits is coupled to pressure whereby said back pressure control valve will determine the back pressure resistance to actuation of the motor, an auxiliary reservoir connection for the opposite motor conduit, valve means normally blocking the flow through said auxiliary reservoir connection, and hydraulically actuable means for determining the effective positionings of said first and third valves, said means including a first set of piston devices operatively related to the first mentioned valve effective to shift the same to an extreme position in one direction or the other when subject to hydraulic pressure, a second set of limited movement pistons associated with said first valve and effective when simultaneously subjected to pressure to shift said first valve to an intermediate position, opposed actuating pistons of unequal areas associated with the third valve whereby when the piston of greater area is subject to pressure either alone or in conjunction with the exertion of corresponding pressure against the other piston, said third valve will be shifted thereby in a given direction and will be hydraulically shiftable in the opposite direction only in the absence of pressure against the piston of greater area, a first hydraulic control circuit coupled in parallel with one pair of pistons of the first valve and one of the pistons of the third valve, a second hydraulic control circuit coupled in parallel with the other pistons of the first valve and third valve, and means for selectively directing pressure individually to either or both of said control circuits for effecting variable positionings of said first and third valves, substantially as and for the purpose described.

8. The combination with a reversible hydraulic motor, of means for controlling the rate and direction of actuation thereof including a source of hydraulic medium under pressure, conduits oppositely coupled to the motor for conduction of medium to one side or the other thereof for effecting its reverse actuation, a first valve means shiftable into a position to couple the medium with one or the other of said conduits and into a third position to disconnect the medium from both of said conduits, a back pressure control valve, said first mentioned valve having a portion effective in one position to couple one of the motor conduits to said back pressure control valve when the other of the motor conduits is coupled to pressure whereby said back pressure control valve will determine the back pressure resistance to actuation of the motor, an auxiliary reservoir connection for the opposite motor conduit, valve means normally blocking the flow through said auxiliary reservoir connection, and hydraulically actuable means for determining the effective positionings of said first and third valves, said means including a first set of piston devices operatively related to the first mentioned valve effective to shift the same to an extreme position in one direction or the other when subject to hydraulic pressure, a second set of limited movement pistons associated with said first valve and effective when simultaneously subjected to pressure to shift said first valve to an intermediate position, opposed actuating pistons of unequal areas associated with the third valve whereby when the piston of greater area is subject to pressure either alone or in conjunction with the exertion of corresponding pressure against the other piston, said third valve will be shifted thereby in a given direction and will be hydraulically shiftable in the opposite direction only in the absence of pressure against the piston of greater area, a first hydraulic control circuit coupled in parallel with one pair of pistons of the first valve and one of the pistons of the third valve, a second hydraulic control circuit coupled in parallel with the other pistons of the first valve and third valve, means for selectively directing pressure individually to either or both of

said control circuits for effecting variable positionings of said first and third valves, trip operable means for determining the effective action of the control circuit coupling means, and trip devices shiftable by the motor for actuation of said trip operable means.

9. In a mechanism of the character described, the combination with a reversible hydraulic motor and a source of actuating pressure therefor, a pair of conduits coupled with opposite ends of the motor, an intervening control mechanism including a first valve mechanism having inlets from the source of pressure and outlets to both of said conduits, said valve mechanism including a shiftable part movable to a first position to couple one of said conduits to pressure, to a second position disconnecting pressure from both of said conduits, and a third position coupling the pressure to the other of said conduits, said valve being further provided with an exhaust flow conduit, means on the movable member effective in one position thereof for coupling one of said motor conduits to the exhaust conduit, an auxiliary exhaust connection for the other motor conduit including a valve for prevention of flow through said exhaust conduit, and an hydraulic couple between said valve and the movable member of the first mentioned valve whereby said valves are simultaneously actuable, said valves having portings inversely effective as respects establishment of exhaust connections therethrough for the respective motor conduits.

10. In a hydraulic transmission of the character described, a back pressure line control valve including a pressure actuable throttling device for varying the effective discharge passage through the valve, a direct pressure connection subject to varying conditions in the back pressure line coupled with the valve for reaction in a direction to increase the restriction thereof, an accumulator associated with the valve for yieldingly resisting said closing action, and means for effecting variable pressures in said accumulator.

11. In a hydraulic transmission of the character described, a back pressure line control valve including a pressure actuable throttling device for varying the effective discharge passage through the valve, a direct pressure connection subject to varying conditions in the back pressure line coupled with the valve for reaction in a direction to increase the restriction thereof, an accumulator associated with the valve for yieldingly resisting said closing action, means for effecting variable pressures in said accumulator, said means including a hydraulic couple between the back pressure line and the accumulator, and means in the couple for effecting a time delay in the pressure variations of the accumulator as respects pressure variations in the direct pressure connection.

12. In a hydraulic transmission of the character described, the combination with the motor of a back pressure conduit extending therefrom, means for controlling both constant and surge effects of discharge in the back pressure line comprising a valve body having inlet and discharge ports, a valve therein shiftable variably to restrict the discharge from the back pressure line by way of said ports, a plunger, resilient means for urging the plunger into engagement with the valve for effecting a restrictive movement thereof, means impounding a back pressure fluid adjacent the plunger whereby the latter has an hydraulic piston effect supplementing the yielding means in urging the valve into a restricting position, said valve having a piston portion effective in opposition to the plunger and of greater area than said plunger, means providing a chamber enclosing the piston, and means coupling the back pressure to said chamber for reactance on the piston, said means including a resistance creating pressure drop during flow of liquid into the chamber, whereby a temporary differential in the effective pressures on the plunger and piston is created, substantially as and for the purpose described.

13. In a hydraulic transmission of the character described, the combination with the motor of a back pressure conduit extending therefrom, means for controlling both constant and surge effects of discharge in the back pressure line comprising a valve body having inlet and discharge ports, a valve therein shiftable variably to restrict the discharge from the back pressure line by way of said ports, a plunger, resilient means for urging the plunger into engagement with the valve for effecting a restricting movement thereof, means impounding a back pressure fluid adjacent the plunger whereby the latter has an hydraulic piston effect supplementing the yielding means in urging the valve into a restricting position, said valve having a piston portion effective in opposition to the plunger and of greater area than said plunger, means providing a chamber enclosing the piston, means coupling the back pressure to said chamber for reactance on the piston, said means including a resistance creating pressure drop during flow of liquid into the chamber, whereby a temporary differential in the effective pressures on the plunger and piston is created, said chamber forming means including a shiftable element for varying the effective size of the chamber, and yieldable means urging said member in a direction to reduce the effective area of the chamber substantially as and for the purpose described.

14. In a hydraulic transmission of the character described, the combination with the motor of a back pressure conduit extending therefrom, means for controlling both constant and surge effects of discharge in the back pressure line comprising a valve body having inlet and discharge ports, a valve therein shiftable variably to restrict the discharge from the back pressure line by way of said ports, a plunger, resilient means for urging the plunger into engagement with the valve for effecting a restricting movement thereof, means impounding a back pressure fluid adjacent the plunger whereby the latter has an hydraulic piston effect supplementing the yielding means in urging the valve into a restricting position, said valve having a piston portion effective in opposition to the plunger and of greater area than said plunger, means providing a chamber enclosing the piston, means coupling the back pressure to said chamber for reactance on the piston, said means including a resistance creating pressure drop during flow of liquid into the chamber, whereby a temporary differential in the effective pressures on the plunger and piston is created, said chamber forming means including a shiftable element for varying the effective size of the chamber, yieldable means urging said member in a direction to reduce the effective area of the chamber, and means for individually adjusting the yielding pressure devices oppositely effective as respects said passage restricting valve.

MILLARD ROMAINE.
ERWIN G. ROEHM.