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HYDRAULIC DRIVE

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2 Sheets-Sheet 1

Fig. 1.

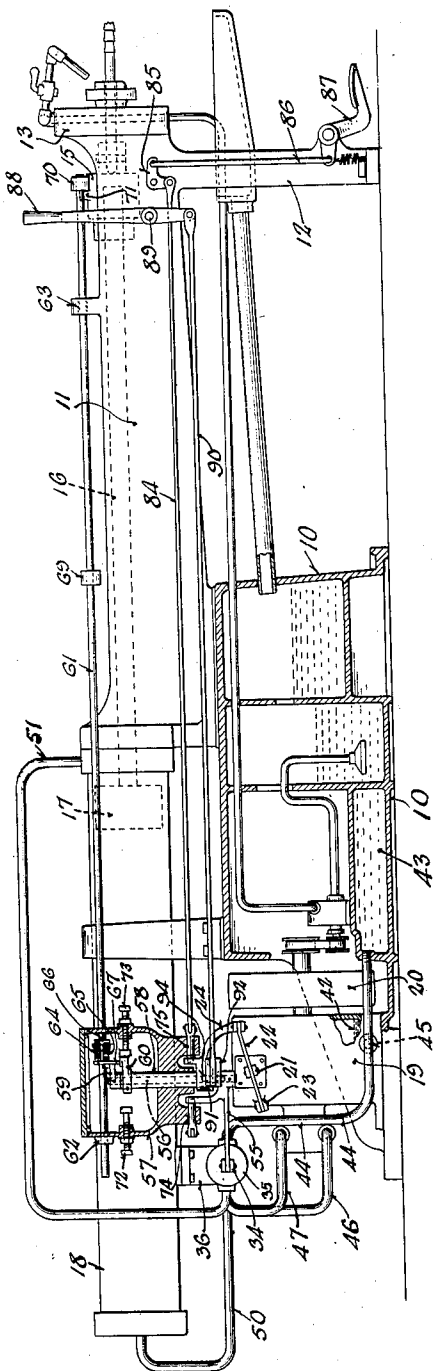
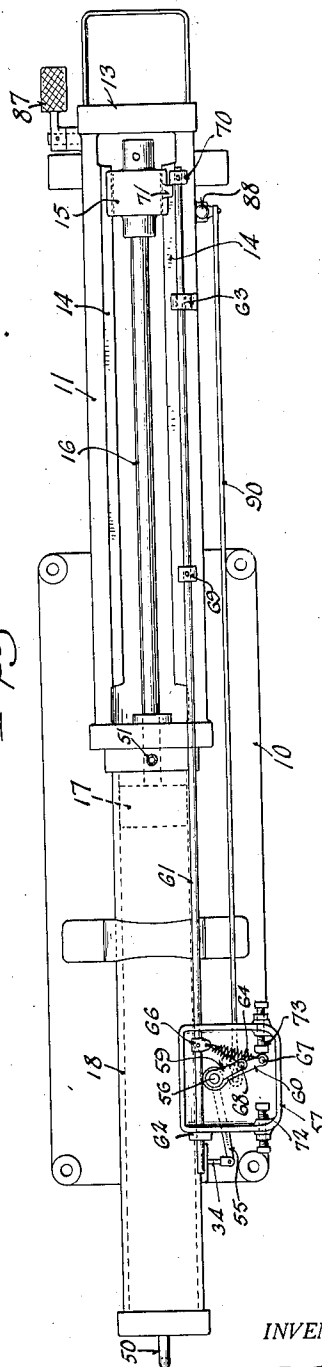


Fig. 2.



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HYDRAULIC DRIVE

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This invention relates to hydraulic drives for broaching machines, presses and other types of reciprocating machines.

One general aim of the present invention is to improve the operation and control of hydraulic machines of the character mentioned.

A more specific object is the provision of a novel hydraulic circuit and control therefor for effecting a high speed return of the reciprocating part.

Another object is the provision of improved means for taking care of variations in the volumetric capacity of hydraulic circuits.

Another object is the provision in a hydraulic transmission system of a unitary means for controlling the fluid connections between the pump and motor and between the pump and fluid source under the various conditions of operation of said system.

Other objects and advantages will appear from the following description of an illustrative embodiment of the present invention.

In the accompanying drawings:

Figure 1 is a side elevation, partly in section, of a broaching machine embodying the present invention.

Figure 2 is a plan view.

Figs. 3, 4 and 5 are sectional views of a valve employed, showing three characteristic positions thereof.

Fig. 6 is a horizontal sectional view of the control mechanism shown in vertical section in Figure 1.

The broaching machine illustrated comprises a base 10 preferably of hollow form in order to provide oil reservoirs to be hereinafter described. The usual longitudinal trough 11 is mounted upon the base 10 and supported at its overhanging end by an upright frame 12. The trough 11 is provided with the usual face plate 13 for sustaining the pressure of the work and with the usual longitudinal ways 14 for supporting and guiding the tool reciprocating crosshead 15. The crosshead 15 is driven by a ram 16, connected with a piston 17 reciprocating in a cylinder 18, fixed at one end to an end of the trough 11 and supported by the base 10.

The piston 17 is driven by fluid delivered from a pump 19 of a well known type. The pump represented in Figures 1 and 6 is a rotary, multiple cylinder, reversible flow pump such as described in the patent to Walter Ferris, No. 1,468,595 issued September 18, 1923. It will suffice here to say that this pump is driven at substantially constant speed through a belt and pulley 20, and that the direction and rate of flow of fluid delivery is controlled by a stem 21. When the stem 21 is in the intermediate position shown in Figure 6, pump displacement is zero, and by shifting the stem inwardly or outwardly with respect to the pump casing the pump is caused to deliver fluid in one direction or the other and at a rate dependent upon the extent of movement of the stem from the intermediate neutral position. In this instance the position of the stem is controlled by a lever 22 pivotally mounted at one end 23 upon the pump casing and connected at its other end with an arm 24 to be hereinafter described.

A valve is interposed between the pump 19 and the cylinder 18 to control the flow of fluid therebetween. The valve shown is of the piston type having five heads, 25, 26, 27, 28 and 29, connected by intermediate reduced portions 30, 31, 32, and 33, and controlled by a stem 34. The valve has a close sliding fit in the cylindrical bore of a valve casing 35 carried by a bracket 36 fixed to the cylinder 18. A longitudinal duct 37 in the valve communicates with ports 38, 39, and 40 in the reduced portions 30, 31 and 33, respectively. The opposite ends of the bore in the valve casing are connected through a passage 41. The passage 41 is in open communication with a sump 42 in the bottom of the pump casing and with a fluid reservoir 43 in the base 10 through a pipe 44 leading from the reservoir 43 and having a connection 45 with sump 42.

The opposite sides of the pump circuit are connected through pipes 46 and 47, respectively, with ports 48 and 49, in the valve casing 35. The opposite ends of the cylinder 18 are connected through pipes 50 and 51, respectively, with ports 48 and 52 in the valve

casing. A passage 53, controlled by piston head 27, and a passage 54, controlled by piston heads 28 and 29, communicate with passage 41.

5 The arrangement is such that when the valve is in the intermediate position of Figure 3, piston head 28 covers the port 52 so as to prevent flow of liquid through pipe 51 toward or from the forward end of cylinder 18. A solid body of liquid is thus trapped within the pipe 51 and the forward end of the cylinder, which serves to effectively retain the piston 17 against movement. It will also be noted that in this position of the valve, port 48 communicates through port 38, duct 37 in the valve, port 40, and passage 54 with passage 41, and port 49 communicates through passage 53 with passage 41, so that the two sides of the pump circuit are short circuited and in open communication with the pipe 44 leading to the sump. It is thus impossible to build up pressure in the pump circuit in this position of the valve. Pipe 50 is always in communication with pipe 46 so that the rear end of cylinder 18 is always in open communication with the pump circuit and, in this position of the valve, the rear end of cylinder 18 is in communication with the sump.

30 When the valve is shifted toward the right into the position indicated in Figure 4, ports 49 and 52 are in open communication so that fluid delivered by the pump through pipe 47 may pass through pipe 51 into the forward end of cylinder 18. In this position of the valve, port 48 communicates through port 38, duct 37, port 39, passages 53 and 41 and pipe 44 with the sump, so that communicating pipes 50 and 46 are connected with the sump and the rear end of the cylinder 18 is connected with the return side of the pump circuit and with the sump.

45 When the valve is shifted toward the left into the position shown in Figure 5 port 48 communicates through port 39, duct 37, ports 40 and 52 with the pipe 51 leading to the forward end of cylinder 18. Both ends of the cylinder are thus in open communication with each other and with the pipe 46 from the pump. The other pump pipe 47 communicates through port 49, passages 53 and 41, and pipe 44 with the sump.

50 The valve and the pump control stem 21 are placed under the control of mechanism for effecting the simultaneous adjustment thereof. In the machine shown this mechanism includes an arm 55 connected at one end with the valve stem 34 and fixed at its other end upon the lower end of a vertical spindle 56, mounted in a casting 57 fixed to the cylinder 18. The arm 24, hereinabove referred to, is connected at one end with the pump control stem 21 and fixed at its other end upon the lower end of a sleeve 58 rotatably mounted upon the vertical spindle 56. An arm 59

is fixed to the upper end of spindle 56 and an arm 60 is fixed to the upper end of sleeve 58.

Both arms 59 and 60 are actuated by a rod 61 mounted for lengthwise reciprocation in appropriate brackets 62 and 63. Two coiled springs 64 and 65, one above the other, are connected to a clamp 66 carried by rod 61. The upper spring 64 is connected to an upwardly extended pin 67 rigidly fixed in the free end of arm 60 and the lower spring 65 is connected to a short pin 68 fixed in the free end of arm 59. The rod 61 carries two stops 69 and 70 adjustably fixed thereto and projecting into the path of travel of a lug 71 carried by the crosshead 15.

The arrangement is such that, with the rod 61 in the position shown in Figures 1 and 2, springs 64 and 65 are disposed at one side of the vertical spindle 56, in such position as to retain arms 59 and 60 in the positions shown. These are the positions assumed during travel of the crosshead 15 toward the left in performing a pulling stroke. As the crosshead approaches the end of its pulling stroke the lug 71 thereon engages the stop 69 and forces the rod 61 toward the left until the clamp 66 thereon has shifted the springs 64 and 65 beyond the other side of the vertical spindle 56, into such positions that the tension therein tends to rock the arms 59 and 60 toward the left. The rod 61 retains this left extreme position during the return stroke of the crosshead 15 toward the right, until shifted by the engagement of the lug 71 on the crosshead with the stop 70 on the rod. This engagement causes the rod 61 to return to the position shown to thereby return the springs 64 and 65 into such positions that the tension therein tends to rock the arms 59 and 60 toward the right into the positions shown.

The rocking action of arm 59 is transmitted through spindle 56 to the arm 55 to effect shifting of the valve stem 34 and the rocking action of the arm 60 is transmitted through the sleeve 58 to the arm 24 to effect shifting of the pump control stem 21. Stop screws 72 and 73, adjustably fixed in the casting 57 in the plane of movement of arm 60, limit the movement of this arm, and, consequently, the pump control stem 21, in either direction. Screws 72 and 73 thus constitute adjustable means for determining pump displacement and, consequently, the rate of flow of fluid in pipes 46 and 47, in either direction of operation of the machine. It will thus be noted that both the valve stem 34 and the pump control stem 21, respond simultaneously to the action of rod 61, but due to the separate operating connections between them the extent of movement of the arm 60, and of the pump control stem 21, may be varied without interfering with the full stroke of the valve stem 34 necessary to effect complete reversal of the valve.

In order that the operator may have ample time in which to remove and replace the work or to remove and replace the tool between the working and return strokes of the machine, mechanism is preferably provided for preventing actual complete automatic reversal of the machine at the end of a stroke. In the machine shown this is accomplished by the use of latch mechanism automatically operable to interrupt the rocking action of the arms 59 and 60 under the influence of the springs 64 and 65. This mechanism includes spring loaded latch bolts 74 and 75 slidably mounted in the casting 57 and adapted to engage in sockets 76 and 77, respectively, formed in sectors 78 and 79 carried by the arm 55 and 24. (See Figures 1 and 6) Latch bolt 74 is connected to one end of a lever 80, pivotally mounted intermediate its ends upon a bracket 81 fixed to the casting 57. Latch bolt 75 is connected to one end of a floating lever 82. The other ends of levers 80 and 82 are connected through a link 83. A pull rod 84 connected intermediate the ends of lever 82, extends to the forward end of the machine, where it is connected to one arm of a bellcrank 85. The other arm of the bellcrank is connected by appropriate linkage 86 with a control pedal 87.

The arrangement is such that when the arms 59 and 60 and connected parts are rocked by the springs 64 and 65 from either extreme position, they are interrupted in their intermediate position by the automatic engagement of the latch bolts 74 and 75 in the respective sockets 76 and 77. The valve stem 34 and pump control stem 21 are thus both shifted from one extreme position into a neutral position, which brings the machine to rest. By depressing the pedal 87 the pull rod 84 is actuated to simultaneously withdraw both latch bolts 74 and 75 from their sockets 76 and 77, respectively, to thereby release the sectors 78 and 79 and permit the arms 59 and 60, and connected parts, to complete their rocking action into the other extreme position.

For purposes of describing the operation of the machine let it be assumed that the pump 19 is operating and that the control mechanism is in the intermediate neutral position shown in Figure 6 with the latch bolts 74 and 75 in engagement with the sockets 76 and 77. In this position the valve is in the intermediate position shown in Figure 3 and the pump control stem 21 is in intermediate position so that pump displacement is zero. As hereinabove pointed out the valve in this position provides an open communication between pipes 46 and 47, so that no pressure can be built up in the pump circuit, and the piston head 28 of the valve covers the port 52 so that the piston 17 is locked against movement in the cylinder 18.

Before beginning a working stroke the

nose of the tool is passed through the work and face plate 13 and secured in the crosshead 15 in the usual manner. The rod 61 is in the right extreme position shown in Figures 1 and 2, so that the springs 64 and 65 are disposed to the right of the spindle 56 and tend to rock the arms 59 and 60 toward the right.

To begin a working stroke the operator depresses the pedal 87 to effect the simultaneous release of the latch bolts 74 and 75 permitting the arms 59 and 60 and connected parts to rock toward the right, under the action of springs 64 and 65, into the position shown in Figures 1 and 2. This action, transmitted through arm 55 and valve stem 34, shifts the valve into the position shown in Figure 4. At the same time this action, transmitted through arm 24 and lever 22, shifts the pump control stem 21 inwardly, causing the pump 19 to deliver fluid through pipe 47, ports 49 and 52, and pipe 51 into the forward end of the cylinder 18. Since the rear end of the cylinder is open to the other side of the pump circuit through pipes 50 and 46, the piston 17 is forced to the left, pulling the tool through the work, at a rate corresponding to pump displacement. It will be noted that during this movement of the piston a greater volume of fluid is discharged from the rear end of the cylinder than is delivered to the forward end thereof, due to the presence of the piston rod or ram 16 in the forward end thereof. In this position of the valve all excess fluid discharged from the rear end of the cylinder is free to pass to the sump through port 48, port 38, duct 37, port 39, passages 53 and 41, and pipe 44.

The pulling stroke continues until the lug 71 on the crosshead engages detent 69 on rod 61 and forces the rod to the left until springs 64 and 65 are shifted to the left of spindle 56 a distance sufficient to cause the arms 59 and 60 to rock toward the left. As above pointed out this rocking action of these arms, and connected parts, is interrupted by the latch bolts 74 and 75, and the valve and pump control stem come to rest at their intermediate neutral positions. The crosshead then comes to rest.

To begin a return stroke the operator merely again depresses the pedal 87 to again release the latch bolts, and the arms 59 and 60 complete their rocking action into their left extreme positions. The valve is thus shifted to the extreme left position shown in Figure 5 and the pump control stem 21 is forced outwardly to cause the pump to deliver liquid through pipes 46 and 50 into the rear end of cylinder 18. In this position of the valve the forward end of the cylinder is in open communication with the rear end thereof through ports 52 and 40, passage 37 and ports 39 and 48, so that both sides of the piston 17 are sub-

jected to the same fluid pressure. Since the effective area of the right side of the piston is reduced by the cross-sectional area of the piston rod, the total pressure applied to the left side of the piston is greater than that on the right and the piston moves toward the right to perform a return stroke. Since the fluid discharged by the forward end of the cylinder enters the rear end thereof and thus supplements the fluid actually delivered by the pump, the piston travels at a relatively high rate during the return stroke. In this position of the valve fluid is supplied to the pump from the sump through passages 41 and 53, port 49 and pipe 47.

Movement of the piston and crosshead to the right continues until the lug 71 on the crosshead engages the detent 70 and forces the rod 69 toward the right until the springs 64 and 65 have been returned to the right side of spindle 56 and exert a pull on the arms 59 and 60 to rock them toward the right. This rocking action is interrupted in the manner above described by the latch bolts 74 and 75 so that the valve is again returned to neutral position and pump displacement reduced to zero.

Provision is preferably made for enabling the operator to stop or reverse the movement of the crosshead in any point in its travel. In the machine shown, mechanism for this purpose comprises a hand lever 88 mounted upon a fixed pivot 89 and connected at its lower end with the forward end of a rod 90. The rear end of rod 90 is interposed between a pair of projections 91 and 92, disposed one above the other, and carried by the arm 24 and 55, respectively. Each of the projections has an arcuate slot 93 into which projects one of the ends of a vertical pin 94 carried by the interposed end of rod 90. The length of the slots are such that when the hand lever 88 and rod 90 are in the intermediate neutral position shown both projections 91 and 92 are free to rock with the arms 24 and 55 without interfering with the pin 94 on the rod 90, during the automatic action above described. However, by rocking the hand lever 88 in either direction, the pin 94 by its engagement with one end or the other of the slots 93 may be caused to effect any desired simultaneous rocking action of the arms 24 and 55.

Various changes may be made in the embodiment of the invention hereinabove specifically described without departing from or sacrificing any of the advantages of the invention as defined in the appended claims.

I claim:—

1. In a hydraulic drive for machine tools and the like the combination of a driven member, a hydraulic motor cylinder, a differential piston therein coacting therewith to drive said member, said piston having two opposite faces having unequal pressure areas,

a hydraulic pump, and hydraulic connections through which the entire discharge from said pump is delivered directly to said cylinder to effect operation of said member, said connections including valve means selectively operable to subject one only of said faces or both of said faces to the delivery pressure of said pump, the difference in the areas of said faces being such as to effect operation of said member at a greater rate when both of said faces are subjected to said pressure than when said one only of said faces is subjected to said pressure.

2. In a hydraulic drive for machine tools and the like the combination of a driven member, a hydraulic motor cylinder, a differential piston therein coacting therewith to drive said member, said piston having two opposite faces having unequal pressure areas, a hydraulic pump, and hydraulic connections through which the entire discharge from said pump is delivered directly to said cylinder to effect operation of said member, said connections including valve means selectively operable to subject the smaller one only of said faces or both of said faces to the delivery pressure of said pump, the difference in the areas of said faces being such as to effect operation of said member at a greater rate when both of said faces are subjected to said pressure than when said smaller one only of said faces is subjected to said pressure.

3. In a hydraulic drive for machine tools and the like the combination of a driven member, a hydraulic motor cylinder, a differential piston therein coacting therewith to drive said member, said piston having two opposite faces having unequal pressure areas, a hydraulic pump, and hydraulic connections through which the entire discharge from said pump is delivered directly to said cylinder to effect operation of said member alternatively in two directions, said connections including valve means selectively operable to subject the smaller one only of said faces to the discharge pressure of said pump to effect operation of said member at a definite rate in one of said directions or to subject both of said faces to the delivery pressure of said pump to effect the operation of said member in the other of said directions, the difference in the areas of said faces being such as to effect operation of said member in the direction last named at a rate at least as great as the rate of operation in the direction first named.

4. In a hydraulic broaching machine the combination of a tool driving member, a differential piston and cylinder for driving said member, a pump, hydraulic connections through which the entire discharge of said pump is delivered to said cylinder to effect operation of said member in either of two directions, said connections including a valve

operable to connect the discharge side of said pump to one end or both ends of said cylinder, and means controlled by said member for operating said valve.

5 5. The combination of a hydraulic motor cylinder provided with a piston having different pressure areas on the opposite faces thereof, a hydraulic pump, a pair of separate liquid conducting channels connected to said
10 pump and alternately acting as intake and discharge channels, one of said channels being connected to that side of the piston having the greater pressure area and having a branch channel, and valve means selectively
15 operable to connect said branch channel or the other of said pair of channels to that side of said piston having the lesser pressure area.

In witness whereof, I hereunto subscribe my name at Milwaukee, Wisconsin, this 2nd
20 day of September, 1925.

JOHN P. FERRIS.

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