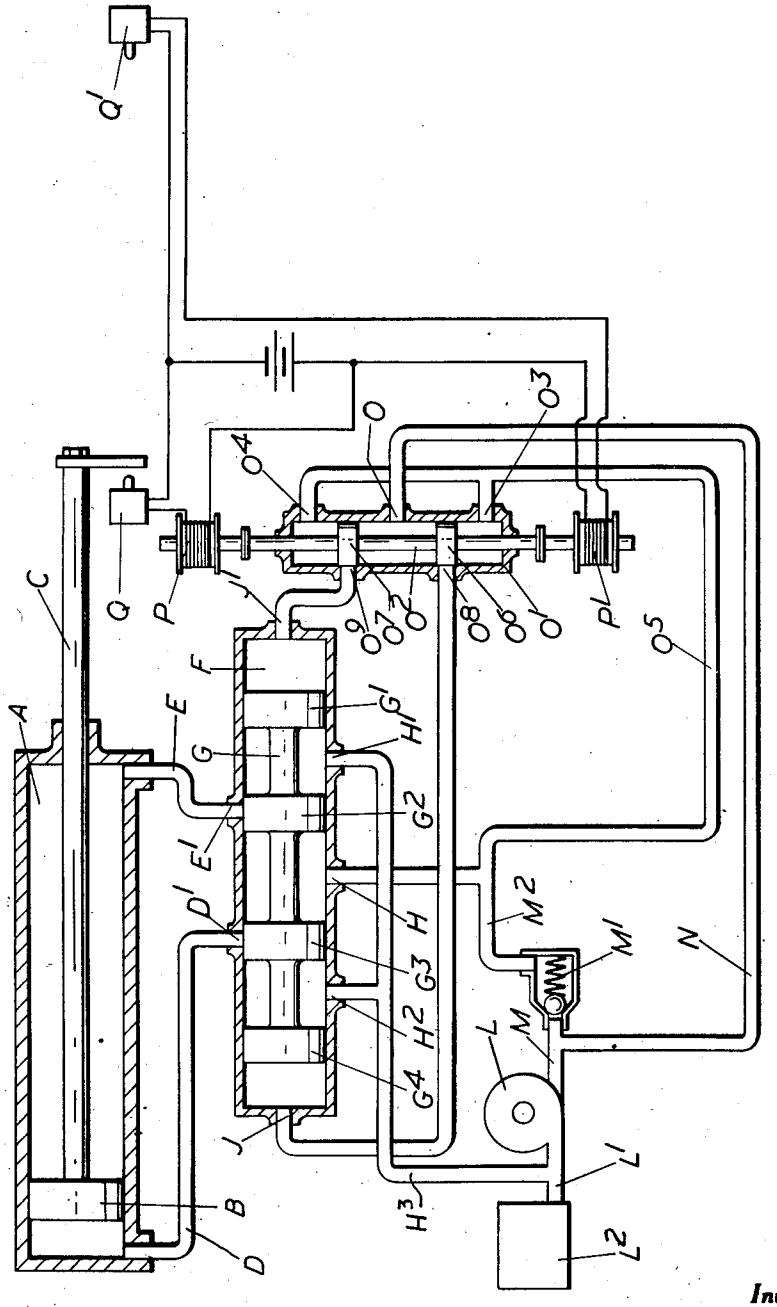
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HYDRAULIC POWER DRIVE FOR RECIPROCATING MEMBERS

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HYDRAULIC POWER DRIVE FOR RECIPROCATING MEMBERS

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This invention relates to hydraulic power transmission systems of the kind comprising one or more hydraulic motors of the displacement type, such as piston and cylinder assemblies (and which for convenience herein will be assumed to be in the form of hydraulic piston and cylinder assemblies and will therefore hereinafter for convenience be referred to as rams) by which one or more parts of a machine tool or other mechanism (hereinafter called the moving part or parts) are operated, one or more hydraulically operated shuttle type control members (which are usually shuttle type valves controlling the supply of working fluid to the ram or rams) and one or more pilot valves arranged to be operated directly or indirectly by the moving part or parts and to control the supply of operating fluid to and from the pressure chambers of the shuttle type control member or members so as to cause the control member, or each control member, to be moved at the appropriate times by connecting the appropriate one of its pressure chambers to a source of relatively high fluid pressure, constituting the source of operating fluid for the control member, and its other pressure chamber to a chamber or conduit in which the fluid pressure is lower.

It will be understood that by a "hydraulically operated shuttle type control member or valve" is meant a member or valve including a longitudinally movable member having a part or parts constituting in effect two pistons arranged in cylinders of the same diameter as one another and constituting pressure chambers the pressures in which tend to move the longitudinally movable member respectively in opposite directions, the longitudinally movable member either itself constituting or being arranged to act upon one or more members to be controlled, usually a valve or valves which control the supply of working fluid to the ram or rams.

In a large number of cases where shuttle type control valves are employed, these will be reversing valves which control the supply of working fluid to and from the rams in a manner well known per se. Although, therefore the invention is applicable to arrangements in which the hydraulically operated shuttle type control member or members perform some function other than the control of the flow of working fluid to and from the ram or rams since such control will usually be their function the invention will be described with particular reference to systems of the kind referred to in which one or more hydraulically operated shuttle type control valves control the flow of working fluid to and from a ram or rams. In such hydraulic systems it has been proposed to provide the necessary supply of operating fluid for operating the control valve or valves, under the control of the pilot valve or valves, by tapping fluid from the main working fluid delivery passage by which working fluid is supplied to the ram or rams, in which case the appropriate pressure chamber of the control valve to be operated is connected at the required time by a pilot valve to this source, while the other pressure chamber of the control valve is connected to a relief passage constituted by the low pressure part of the system on the exhaust side of the ram or rams.

Alternatively the operating fluid for the control valve or valves has been obtained from a separate pump.

Both these systems have certain disadvantages. Thus the provision of a separate pump to provide operating fluid for the control valve or valves is an added complication and entails in effect a separate hydraulic circuit for the control valve operating fluid, while the tapping of operating fluid for the control valve or valves from the main working fluid supply line results in a reduction in the rate at which working fluid is supplied to the ram or rams during the period when a control valve is being operated and thus causes undesirable variations in the speed of movement of the ram or rams and/or the stroke or strokes thereof.

The object of the present invention is to provide an improved system operated by fluid pressure of the general kind referred to above for reciprocating a ram or other mechanical device requiring power.

In a hydraulic operating system of the general kind referred to according to the present invention a pressure reducing valve is provided in the main working fluid supply line to the ram or rams, and the inlet side of the operating fluid system for the shuttle type control member or members, is connected to the main fluid supply line on the upstream side of such pressure reducing valve while the outlet side of the operating fluid system for the control member or members is connected to the main fluid supply line on the downstream side of such pressure reducing valve, so that, during movement of any control member, working fluid is displaced from that pressure chamber of such control member which is at the moment at lower pressure into the main working fluid supply line at a rate which is exactly equivalent to that at which the working fluid is entering the other pressure chamber of the control member from the main working fluid supply line.

It will therefore be seen that, although the operating fluid for the shuttle type control member or members is derived from the source of main working fluid supply, so that no separate pump has to be provided, the rate of flow of working fluid to the ram or rams remains entirely independent of the operation of the shuttle type control member or members.

Preferably the apparatus includes means whereby the ram causes operation of the shuttle type control member automatically to effect automatic reversal of movement of the ram at the ends of its travel.

In most cases the control of the supply of operating fluid to and from the pressure chambers of the shuttle type control member or members will be by means of pilot valves operated either directly or electromagnetically by movement of the ram or rams, for example when a ram or each ram reaches the end of its travel in one direction or the other, although the pilot valve or valves may in some cases be otherwise operated.

One example of the invention is illustrated diagrammatically and mainly in cross-section in the accompanying drawings.

In the form of the invention diagrammatically shown in the drawings the invention is applied to apparatus comprising a ram assembly including a ram cylinder A and a ram piston B connected to a connecting rod C which in turn may be assumed to be connected to a main reciprocating part of a machine tool, for example to a reciprocating bed or tool holder, so as to cause reciprocation thereof. The ram assembly is doubleacting, the two ends of the cylinder A being connected as shown by pipes D and E to the inflow and outflow ports D^1, E^1 of a shuttle type control valve comprising a cylinder F containing a shuttle type valve member G of known form having lands G^1, G^2, G^3, G^4 arranged as shown. The cylinder F is provided with an inlet port H by which

fluid under pressure is delivered to the annular chamber between the lands G^2, G^3 and spaced outlet ports H^1, H^2 leading to a common outlet passage H^3 and communicating with the annular chambers respectively between the lands G^1, G^2 and the lands G^3, G^4. Ports J, J^1 are provided in the ends of the cylinder F for the admission and exhaust of control fluid.

For convenience the valve member G is shown in a central position which in practice it will only occupy instantaneously.

A continuously driven pump L is arranged to draw fluid continuously from an inlet passage L^1 communicating with a reservoir L^2 and with the passage H^3 and to deliver this fluid continuously to the working fluid pressure line M. The pressure line M contains a pressure-reducing valve, indicated at M^1, through which working fluid is continuously delivered to the part M^2 of the working fluid supply line so that the pressure in the part M^2 is always lower by approximately a predetermined amount than the pressure in the part M. The part M of the working fluid supply line also communicates with a control fluid delivery passage N leading to a central inlet port O in the cylinder O^1 of a pilot valve assembly comprising the cylinder O^1 and a pilot valve member of the piston type O^2 operating in the cylinder O^1. Also formed in the cylinder O^1 are control fluid exhaust ports O^3, O^4 communicating with a control fluid exhaust passage O^5 which communicates with the part M^2 of the working fluid supply passage. The control fluid inlet and outlet ports in the ends of the cylinder F communicate respectively with control fluid inlet and outlet ports in the pilot valve cylinder O^1 while the valve member is so constructed with lands O^6, O^7 that, assuming it to occupy the intermediate position shown (which in practice it will only occupy momentarily), these cover the ports O^3 and O^9. As shown the port O opens into the chamber between the lands while the ports O^3 and O^4 open into the chambers lying respectively between each of the lands and the adjacent end of the cylinder. The valve member is arranged to be operated by solenoids indicated at P, P^1 which are arranged in an electric circuit so as to be controlled by micro-switches or the like indicated at Q, Q^1 arranged so that the switch Q is closed when the ram reaches one end of its travel while the switch Q^1 is closed when the ram reaches the other end of its travel.

The arrangement is such that when the switch Q is closed the solenoid P is energised to cause the pilot valve member to move upwards into a position in which the port O communicates with the port O^9 and the main shuttle valve is thus caused to move to the left hand end of its cylinder, in which position working fluid will be delivered to the left hand end of the ram cylinder and the ram will thus be caused to move to the right at a speed determined by the controlled rate at which fluid is delivered by the pump. When the ram approaches the end of its travel to the right, the switch Q^1 is closed and thus energises the solenoid P^1 to cause movement of the pilot valve member downwards and thus bring the port O into communication with the port O^3 and the port O^4 into communication with the port O^9, and hence causing the shuttle type main valve member to move to the righthand end of its cylinder so that hydraulic working fluid is now delivered through the pipe E to the righthand end of the ram cylinder while the lefthand end of the ram cylinder is brought into communication with the exhaust passage.

It will thus be seen that, during operation of the apparatus, the ram will be caused to reciprocate continuously backwards and forwards between its two end positions. Moreover, while the presence of the pressure-reducing valve provides the necessary difference between the pressure of fluid delivered through the pilot valve to one end of the main shuttle valve cylinder and that in the other end of the main shuttle valve cylinder, it will be apparent that during any movement of the shuttle valve in one direction or the other while fluid taken from the main working fluid line enters one end of the main shuttle valve cylinder from the pilot valve, fluid is exhausted into the main working fluid line at an exactly equivalent volumetric rate from the other end of the main control valve cylinder so that the speed of movement of the ram is unaffected by any movement of the main control valve. It will moreover be apparent that movement of the shuttle valve merely, in effect, causes flow of fluid from one end to the other of its cylinder through the passage connecting the ports so that this movement has no effect upon the volumetric rate of delivery of working fluid to the ram cylinder.

What I claim as my invention and desire to secure by Letters Patent is:

1. A hydraulic power transmission system comprising at least one hydraulic motor of the displacement type arranged to operate a moving part, at least one hydraulically operated shuttle type control valve device arranged to control the supply of working fluid to and from the hydraulic motor and to be moved back and forth by pressures applied to its opposite ends respectively in two pressure chambers, a hydraulic pump arranged to deliver working fluid through a working fluid passage to the shuttle type control valve device and through it to the hydraulic motor, a pressure reducing valve in the working fluid passage, and pilot valve apparatus controlling the supply of operating fluid to and from the said pressure chambers to cause operation of the shuttle type control member and having its inlet and outlet passages connected to the working fluid passage respectively on the upstream and downstream sides of the pressure reducing valve.

2. A hydraulic power transmission system as claimed in claim 1 including means whereby the moving part causes operation of the pilot valve apparatus automatically after a predetermined movement in each direction to effect automatic reversal of the hydraulic motor.

3. A machine tool having a main reciprocating part arranged to be operated by a double-acting ram the flow of working fluid to and from the ends of which is controlled by a shuttle type control valve, a continuously driven pump arranged to supply working fluid under pressure at a rate which can be controlled, a low pressure relief valve acting as a pressure-reducing valve in the delivery passage from the pump whereby an approximately predetermined pressure difference is maintained in the parts of the working fluid delivery passage on the two sides of the pressure-reducing valve, an auxiliary pressure line constituting a control valve operating fluid pressure line leading from the working fluid delivery passage on the upstream side of the pressure-reducing valve to a pilot valve while an auxiliary exhaust line constituting a control valve operating fluid exhaust line leads from the pilot valve to the main working fluid pressure passage on the downstream side of the pressure-reducing valve, inflow and outflow passages leading from the pilot valve to the pressure chambers of the control valve and arranged so that movement of the pilot valve in one direction or the other from a neutral position causes corresponding movements of the control valve to cause movement of the ram in one direction or the other, and means by which the ram during the latter parts of its movement in either direction causes appropriate movements of the pilot valve to cause reversal of the ram.

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