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T. VAN METER

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POWER TRANSMISSION

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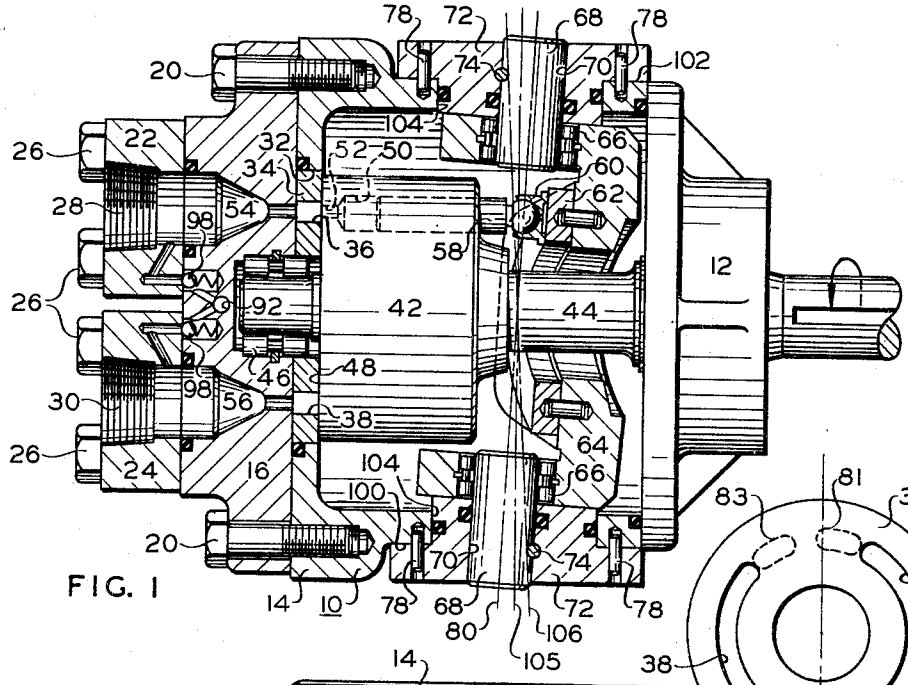

FIG. 1

FIG. 3

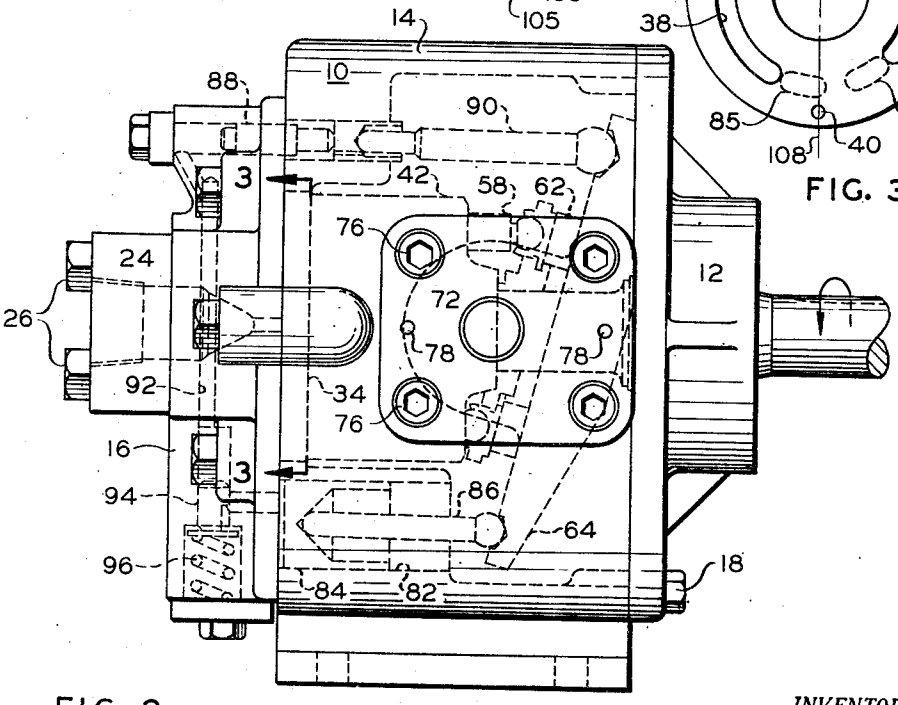

FIG. 2

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POWER TRANSMISSION

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5 Claims. (Cl. 103—3)

This invention relates to power transmissions, and is particularly applicable to those of the type comprising two or more fluid pressure energy translating devices, one of which may function as a pump and another as a fluid motor.

More particularly the invention relates to an improved variable displacement pump unit for use in such transmissions and especially to pumps of the axial cantilever piston type. In such units valve mechanism is provided to afford properly phased communication between the cylinder and the inlet and outlet ports of the unit. Probably the most commonly used form of valve mechanism is that which utilizes a plate type valve having arcuate ports in the face thereof. The cylinder barrel of the unit is located so as to axially abut the valve plate and has ports in the abutting face communicating with the individual cylinders in the barrel. As the piston in any cylinder moves inward on the discharge stroke, rotation of the barrel places the port of that cylinder in communication with the outlet port of the device. In like manner those cylinders in which the piston is on the inlet stroke are connected to the inlet port of the device.

Hydraulic fluids are liquids and normally regarded as incompressible. However, at pressures of the magnitude at which hydraulic units are currently operated, compressibility of the fluid medium becomes a very real consideration. For example, as a cylinder passes from communication with the outlet port, where pressures may be of the order of 5000 p. s. i., into communication with the low pressure at the inlet port, the fluid still in the cylinder will abruptly expand, forcing a small amount of fluid into the inlet port. The turbulence thus created is highly detrimental to proper filling of the cylinder during the inlet stroke.

In fixed displacement units, these problems have been met by providing a closed center zone in the valving wherein each cylinder is isolated from communication with both the inlet and the outlet port, and during which time the piston in that cylinder is moved sufficiently to precompress the fluid therein prior to communication with the outlet port, or decompress the fluid therein prior to communication with the inlet port. Such an arrangement permits a relatively gradual increase or lowering of pressure in the cylinder to the level of that in the port with which it is about to communicate, thus avoiding the heretofore mentioned difficulties resulting from abrupt pressure changes.

In variable displacement type units the problem is greatly complicated since as the displacement is varied, the amount of inward or outward movement of each piston while its cylinder is in the closed center position also varies. Thus a closed center zone of adequate extent to permit sufficient piston movement to properly precompress or decompress at a particular displacement of the unit may be either inadequate or too great at some other displacement.

One of the more common types of piston units is the swash plate, or cantilever piston, type. The swash plate

forms a track against which the pistons are biased to induce their inward and outward movement in the cylinders. The magnitude of the movement is determined by the amount of inclination of the swash plate relative to the cylinder barrel axis. In variable displacement units the swash plate is so mounted as to permit varying the inclination of swash plate to thus vary the output of the pump.

It is known in the art that proper precompression and decompression of the fluid in the cylinder bores can be obtained throughout a wide range of displacement variation by inclining the swash plate face and the valve plate face relative to each other, about an axis which is parallel to one of the faces and transverse with respect to the axis about which the displacement varying movement is made. The desired result is obtained since this auxiliary tilt results in a changing piston dead center position as the displacement is varied.

When the direction of rotation is reversed, the angle of auxiliary tilt must also be reversed. In the past it has been customary to provide two housings, the unit being assembled in one housing, when intended for right hand rotation, and then the other housing when intended for left hand rotation. Such an arrangement is both inconvenient and costly. It is an object of this invention to provide pumping mechanism of a character hereinbefore discussed in which a single housing is provided which is suitable for either right or left hand rotation.

More particularly it is an object of this invention to provide means for pivotally supporting the displacement varying member, which support means is simply and easily indexable to adapt the unit for rotation in the opposite direction.

It is another object of this invention to provide such pumping structure which is of a low cost and rugged nature.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawing wherein a preferred form of the present invention is clearly shown.

In the drawing:

Figure 1 is a longitudinal section through pumping mechanism embodying the present invention.

Figure 2 is an elevation of the pumping mechanism of Figure 1.

Figure 3 is an elevation view of the valve disc.

Referring now to Figure 1, there is shown a variable displacement cantilever type pump embodying the present invention. The pump is shown assembled for left hand rotation when viewed from the shaft and as indicated by the arrow. The pump includes a housing, or body, generally designated **10** which includes an end bell **12**, a central body member **14**, and a head **16**. The end bell **12** is secured to the central body portion **14** by a plurality of bolts **18**, only one of which is shown. The head **16** is secured to the body **14** by a plurality of bolts **20**. A pair of connection flanges **22** and **24** are secured to the head **16** by bolts **26**. Flanges **22** and **24** include a pair of threaded external connection ports **28** and **30**, respectively. Suitable O-ring seals insure against leakage from the interior of the housing at the juncture of the various parts.

A circular opening **32** in that end of the body **10** adjacent to the head **16**, has a valve plate member **34** inserted therein which abuts the head **16**. The valve plate member **34** includes a kidney shaped inlet port **36** and a kidney shaped outlet port **38**. A dowel pin **40** maintains valve plate **34** in the desired angular relation with the pump head **16**. The valve plate forms an abutment member having a plurality of planar points in contact with a cylinder barrel **42** to locate the barrel as to axial and angular disposition.

The cylinder barrel 42 is rotatably supported in the housing 10 by a drive shaft 44. Drive shaft 44 is supported between a bearing 46 in the head 16 and a bearing, not shown, in the end bell 12. The face 48 of the cylinder barrel 42 axially abuts the valve plate 34. Cylinder barrel 42 has a plurality of cylinder bores 50 therein, only one of which is shown. Each of the cylinder bores 50 has a cylinder port 52 associated therewith which extends to the face 48 of the cylinder barrel. The ports 52 are located as to alternately communicate with outlet port 38 and inlet port 36 during rotation of the cylinder barrel. Passage means 54 and 56 in the pump head 16 establish communication between the inlet port 36 and the external connection port 28, and between the outlet port 38 and the external connection port 30, respectively.

Each of the cylinder bores 50 in the cylinder barrel 42 has a piston 58 therein. Pistons 58 are provided with ball ends which are swaged into socketed shoes 60. Pistons 58 and shoes 60 are biased rightwardly by conventional means, not shown, so that the shoes 60 abut the wear plate 62 of a swash plate 64. The swash plate 64 provides an abutment member having a plurality of planar points in contact with the shoes 60 to induce inward movement of the pistons 58.

Swash plate 64 is pivotally supported on roller bearings 66 which contact pintles, or trunnions, 68. Pintles 68 are presed into bores 70 in a pair of flanges 72. The pintles are maintained rigidly in the bores 70 by drive pins 74. The flanges 72 are secured to the central body member 14 by a plurality of screws 76. A pair of dowel pins 78 maintains the desired positional relation between body member 14 and the flanges 72. The pintles 68 are so positioned in the flanges 72 that they are coaxial and their axis 80 lies in the plane of Figure 1 and is inclined with respect to the face of the valve plate 34. It is this angle of inclination of the pintles 68 with respect to the valve plate 34 which provides greatly improved performance by ensuring proper precompression and decompression of fluid in the cylinder bores prior to communication with the outlet and inlet ports respectively. More specifically, as any particular cylinder port moves from the position 81 to the position 83 the piston in that cylinder will move sufficiently to properly precompress the fluid in that cylinder. Similarly, proper decompression results from movement from position 85 to position 87.

A control cylinder bore 82 is provided in the housing 10 and has therein a control piston 84. A push-rod 86 extends from the control piston 84 to contact the swash plate. There is also provided a biasing piston 88 which, through a push rod 90 exerts force on the other end of the swash plate 64 in a direction such as to induce full displacement.

A transverse drilled passage 92 in the head 16 contains a pilot valve 94 at one end and communicates directly with the biasing piston 88 at the other end. Pilot valve 94 is biased by a spring 96 to a normal position wherein the passage 92 is isolated from the control cylinder 82. It can be seen that when pressure in the passage 92 reaches a predetermined maximum, the pilot valve 94 will be opened and fluid ported to the control cylinder 82 to moves the control piston 84 rightwardly thus reducing the displacement of the pumping mechanism. A pair of check valves 98 are provided to insure that whichever of the ports 28 and 30 has the higher pressure is connected to the transverse passage 92. Thus regardless of which of the ports 28 or 30 is utilized as the outlet port of the unit, operating pressure will exist in the passage 92 and be effective on the pilot valve 94. The pump is thus pressure compensated since displacement is reduced as operating pressure tends to exceed a predetermined maximum.

The opposed faces 100 and 102 of the intermediate body member 14, against which the flanges 72 abut, are flat, parallel to each other, and perpendicular to the plane

of the face of the valve plate 34. The bores 104 through which the flanges 74 extend, are coaxial and perpendicular to the faces 100 and 102. With an arrangement such as that described, the flanges 72 can be indexed 180° about their common axis 105 and the common axis 80 of the pintles 68 will occupy a new position, namely that indicated by the line 106 wherein the angle of inclination of the pintle axis with respect to the valve plate will be reversed. Having reversed the auxiliary tilt of the swash plate it is only necessary to turn the valve plate 180° about the axis 108 and, on reassembly, the pumping unit will be completely modified for rotation in a direction opposite to that indicated in the drawing. In the modified assembly, connection port 28 would be the outlet port and connection port 30 would be the return port. The check valves 98 as previously noted, automatically maintain outlet pressure in the traverse passage 92 to control the pressure compensated operation of the device.

There is thus provided pumping structure which is of a relative, low cost nature, and which is easily adapted to either direction of rotation in which the superior operating characteristics resulting from the auxiliary angle of tilt are retained.

It should be further noted that an angle of inclination of the swash plate tilt axis which is correct for maximum operation at say 5000 lbs. per square inch will not be proper at operation for say 2000 lbs. per square inch, since less piston movement is necessary to precompress or decompress the fluid in the cylinders. The unit described is adaptable for use at varying pressures by replacement of the flanges 72 by other flanges having pintles 68 extending therefrom at angles different than that illustrated. Thus by replacing only these two relatively low cost members, the unit may be adapted for best operation at any required pressure.

While the form of embodiment of the invention as herein disclosed constitutes a preferred form, it is to be understood that other forms might be adopted, all coming within the scope of the claims which follow.

What is claimed is as follows:

1. A fluid pressure energy translating device, comprising: a body member; a cylinder barrel having a plurality of axial cylinder bores therein; pistons slideable in the bores; spaced apart inlet and outlet valve port means to provide properly phased communication with the cylinder bores; an abutment member having a series of planar points of contact with the cylinder barrel to restrain axial movement thereof; a second abutment member forming a cam track having a series of planar points of contact in a driving relation with the pistons; support means, carried by the body member, on which one of said abutment members is pivotally mounted to permit varying the displacement of the device, the axis of pivotal movement being inclined with respect to the plane of one of said series of planar points; and two-position means for securing said support means to the body member, said means being moveable from one to the other of said two positions to reverse the inclination of said pivotal axis relative to said plane, whereby the device may be adapted for either direction of rotation.

2. A fluid pressure energy translating device, comprising: a body member; a cylinder barrel having a plurality of axial cylinder bores therein; pistons slideable in the bores; spaced apart inlet and outlet valve port means to provide properly phased communication with the cylinder bores; an abutment member having a series of planar points of contact with the cylinder barrel to restrain axial movement thereof; a second abutment member forming a cam track having a series of planar points of contact in a driving relation with the pistons; pintle means, carried by the body member, on which one of said abutment members is pivotally mounted to permit varying the displacement of the device, the axis of pivotal movement being inclined with respect to the plane of one of said series of planar points; and two-position means

for securing said pintle means to the body member, said means being moveable from one to the other of said two positions to reverse the inclination of said pivotal axis relative to said plane, whereby the device may be adapted for either direction of rotation.

3. A fluid pressure energy translating device, comprising: a body member; a cylinder barrel having a plurality of axial cylinder bores therein; piston slideable in the bores; spaced apart inlet and outlet valve port means to provide properly phased communication with the cylinder bores; an abutment member having a series of planar points of contact with the cylinder barrel to restrain axial movement thereof; a second abutment member forming a cam track having a series of planar points of contact in a driving relation with the pistons; means forming a bore in said body member, having its axis parallel to the plane of one of said series of planar points; support means carried by the body member, on which one of said abutment members is pivotally mounted to permit varying the displacement of the device, the axis of pivotal movement being inclined with respect to the plane of the other of said series of planar points; and two-position means in said bore for securing said support means to the body member, said means being indexable in said bore from one to the other of said two positions to reverse the inclination of said pivotal axis relative to said other plane, whereby the device may be adapted for either direction of rotation.

4. A fluid pressure energy translating device, comprising: a body member; a cylinder barrel having a plurality of axial cylinder bores therein; pistons slideable in the bores; spaced apart inlet and outlet valve port means to provide properly phased communication with the cylinder bores; an abutment member having a series of planar points of contact with the cylinder barrel to restrain axial movement thereof; a second abutment member forming a cam track having a series of planar points of contact in a driving relation with the pistons; spaced apart walls in said body; means forming a bore in each of said walls, said bores being coaxial and having their common axis parallel to the plane of one of said series of planar points; support means, carried by the body member, on which one of said abutment members is pivotally mounted to permit varying the displacement of the device, the axis of pivotal movement being inclined with respect to the plane of the other of said series of planar points; and two-position means in each of said bores for securing said support means to the body member, said means being moveable from one to the other of said two positions to reverse the inclination of said pivotal axis relative to said other plane, whereby the device may be adapted for either direction of rotation.

5. A fluid pressure energy translating device, comprising: a body member; a cylinder barrel having a plurality of axial cylinder bores therein; pistons slideable in the bores; spaced apart inlet and outlet valve port means to provided properly phased communication with the cylinder bores; an abutment member having a series of planar points of contact with the cylinder barrel to restrain axial movement thereof; a second abutment member forming a cam track having a series of planar points of contact in a driving relation with the pistons; spaced apart walls in said body; means forming a bore in each of said walls, said bores being coaxial and having their common axis parallel to the plane of one of said series of planar points; pintle means, carried by the body member, on which one of said abutment members is pivotally mounted to permit varying the displacement of the device, the axis of pivotal movement being inclined with respect to the plane of the other of said series of planar points; and two-position means in each of said bores for securing said pintle means to the body member, said means being moveable from one to the other of said two positions to reverse the inclination of said pivotal axis is relative to said other plane, whereby the device may be adapted for either direction of rotation.

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