Nov. 14, 1950 F. T. HARRINGTON 2,530,242

PUMP OR MOTOR FOR POWER TRANSMISSIONS

Filed Nov. 16, 1945 3 Sheets-Sheet 1

FIG 1

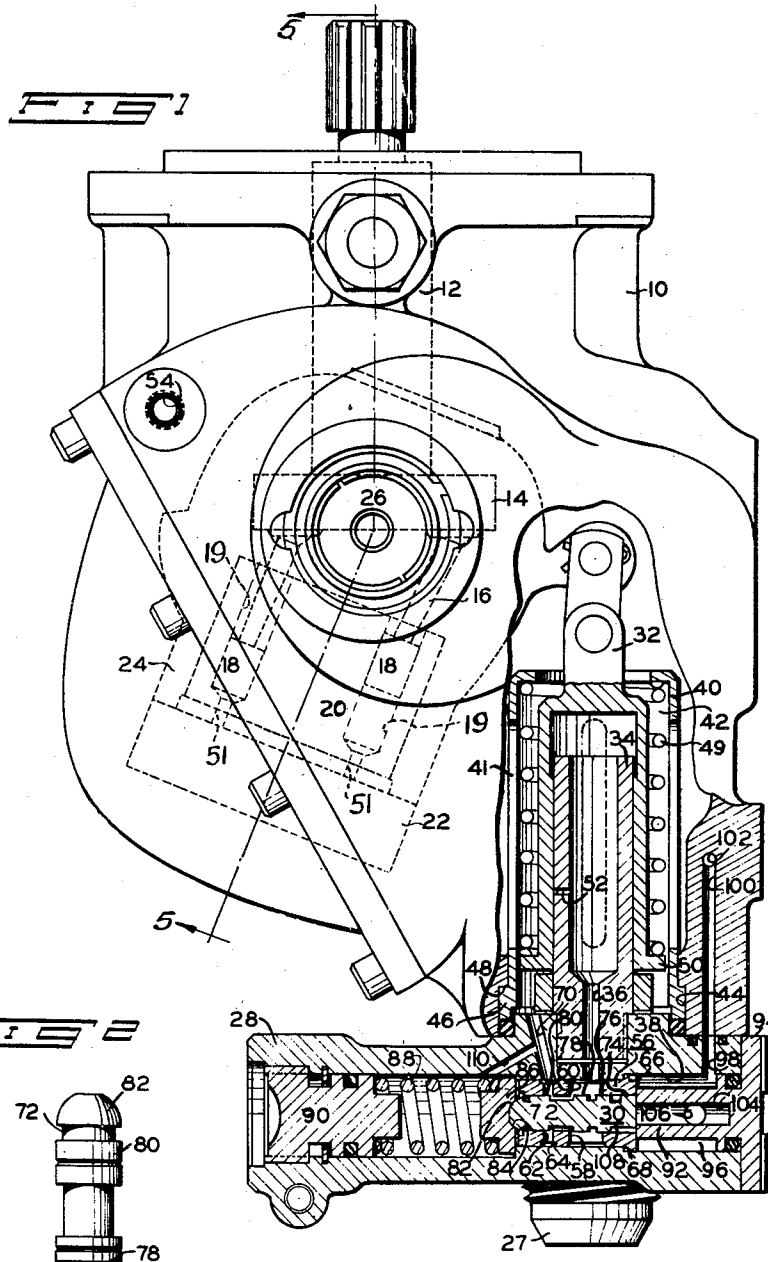


FIG 2

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Nov. 14, 1950 F. T. HARRINGTON 2,530,242

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Filed Nov. 16, 1945 3 Sheets-Sheet 2

FIG 3

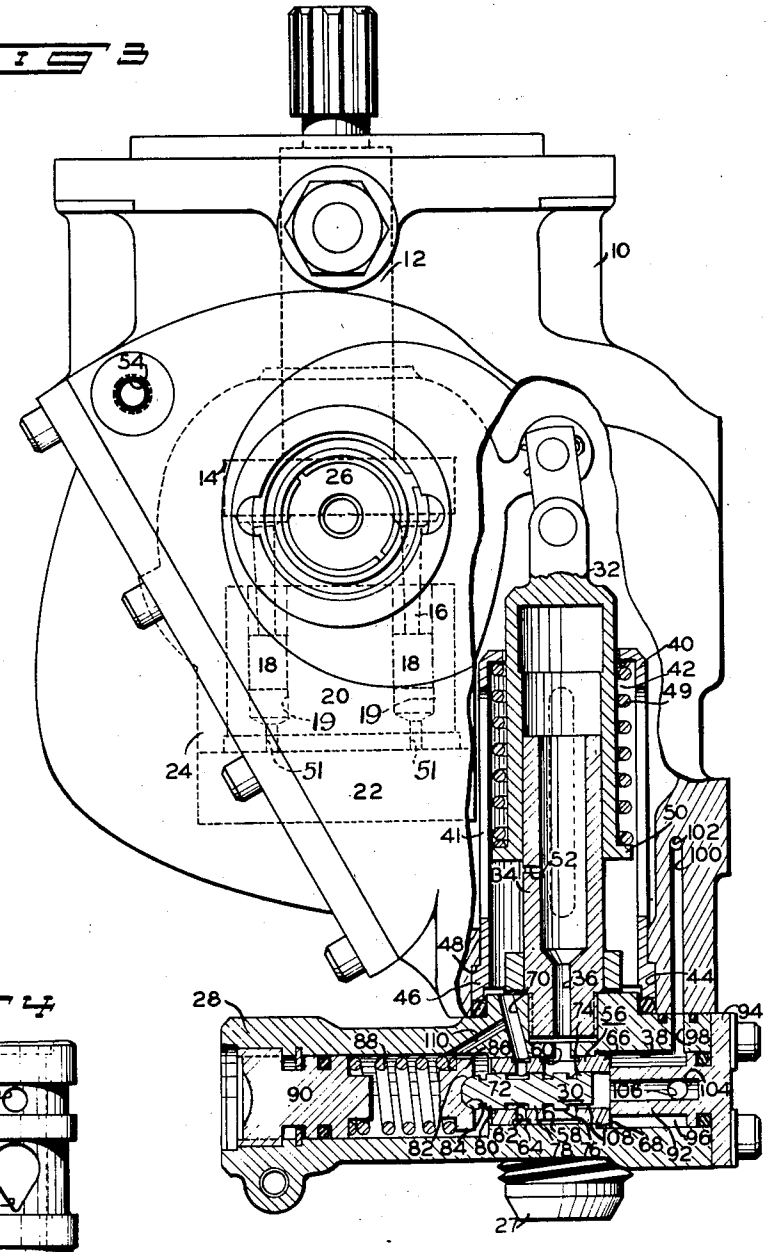
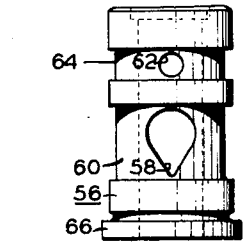


FIG 4



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Nov. 14, 1950 F. T. HARRINGTON 2,530,242

PUMP OR MOTOR FOR POWER TRANSMISSIONS

Filed Nov. 16, 1945 3 Sheets-Sheet 3

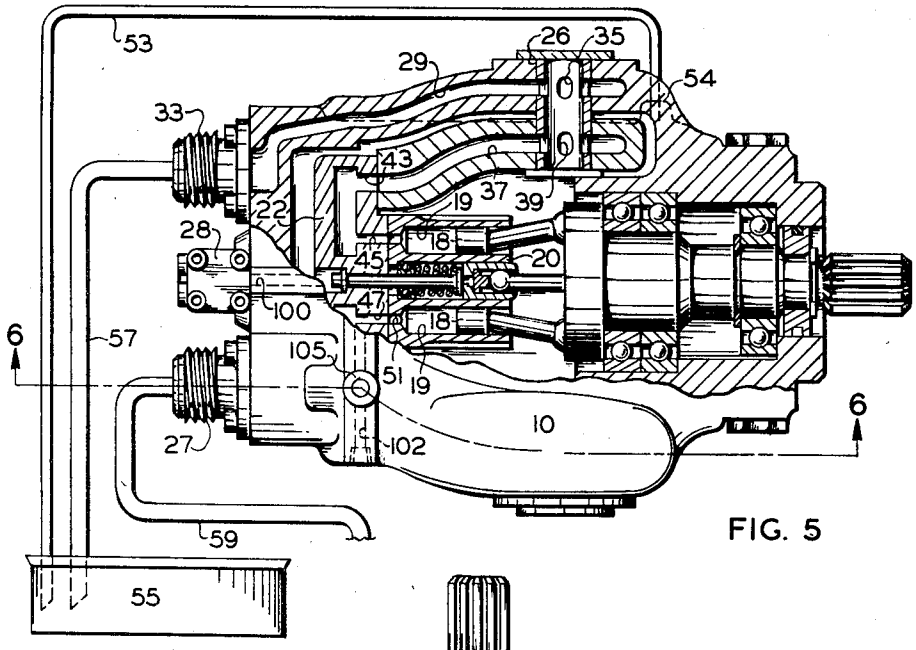


FIG. 5

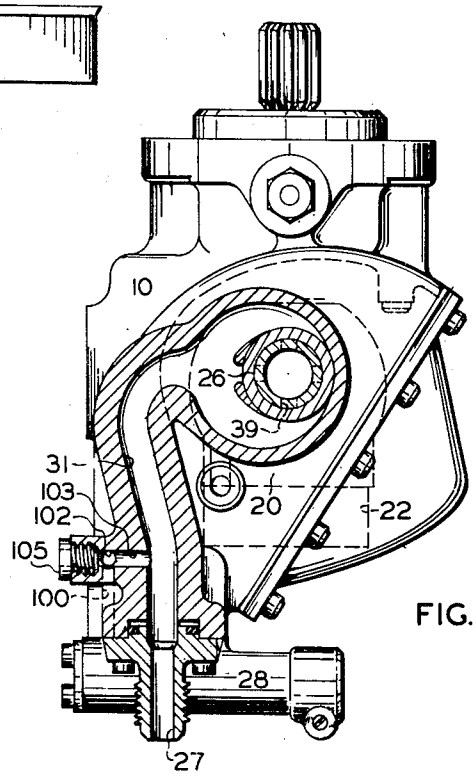


FIG. 6

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UNITED STATES PATENT OFFICE

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PUMP OR MOTOR FOR POWER TRANSMISSIONS

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7 Claims. (Cl. 103—38)

1

This invention relates to power transmissions, particularly 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.

The invention relates specifically to a pressure-operated, volumetric control device for use with fluid pumps and motors of the axial piston type having a swinging yoke for varying the displacement of the device. In pumps of this general class, the pumping action is created by pistons reciprocating within bores of a cylinder block, the angle of which with respect to the drive shaft may be changed by swinging the yoke. As the angle of the cylinder block with respect to the drive shaft is decreased, the length of stroke of the pistons is decreased, resulting in a relatively diminished volumetric output. If the yoke is swung to the completely neutral position, the cylinder block will be in axial alignment with the drive shaft, and, although the rotation of the block continues, there is no relative motion between the pistons and the valve block, and the output becomes zero.

It has ben the practice in the past to provide pressure-operated, volumetric control mechanisms with variable displacement devices of this general class which serve the purpose of maintaining pressure within a predetermined range, but varying the volume of fluid as required by the hydraulic system. In some applications the pump may be required to operate for long periods at zero displacement and full pressure which may, because of the heavy loading of the bearings and other parts, cause overheating of the pump mechanism unless special provisions are made to cool the pump casing or the fluid in it.

It is an object of the present invention to provide an improved pressure-operated, volumetric control device for use with pumps and motors of the general class mentioned.

It is also an object of this invention to provide for this general class of fluid devices an improved pressure-controlled, volumetric control mechanism which is capable of automatically diminishing volumetric output to practically zero while, at the same time, maintaining the pressure at a predetermined, constantly regulated value.

It is also an object of this invention to provide an improved pressure-operated, volumetric control mechanism which, while reducing volumetric output to practically zero, will not only maintain maximum pressure in the system but which is provided with a novel means for preventing

2

the case temperature from increasing excessively when the device operates for long periods of time in the neutral position.

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

In the drawings:

Figure 1 is a sectional view of a fluid energy translating device incorporating a preferred form of the present invention.

Figure 2 is a plan view of a portion of the invention shown in Figures 1 and 3.

Figure 3 is a view similar to that of Figure 1 but showing the parts of the invention in a different position.

Figure 4 is a plan view of a portion of the invention shown in Figures 1 and 3.

Figure 5 is a partial sectional view taken on line 5—5 of Figure 1.

Figure 6 is a partial sectional view taken on line 6—6 of Figure 1.

Referring now to Figure 1, there is shown a pump of the axial piston type having a casing member 10 in which is journalled a main drive shaft 12 having a flange 14. Connected to the flange 14 in sockets, not shown, are a plurality of piston rods 16 having pistons 18 at their opposite ends shiftable within bores 19 of a cylinder barrel 20 which is connected to the drive shaft 12 for rotation thereof in the well-known manner.

The cylinder barrel 20 is adapted to rotate against a valve plate 22 rigidly connected to a swinging yoke 24, the latter being pivotally connected within the casing member 10 by means of a suitable pintle construction 26. As the cylinder barrel 20 rotates, the pistons 18 will cooperate with ports in the valve plate which are connected to inlet and outlet passages, within the casing member 10, so as to take in fluid from the inlet passage on the suction stroke and force fluid out through an outlet passage and an outlet connection 27 on the pressure stroke of said pistons.

Thus, as shown in Figures 5 and 6, the casing 10 is provided with duplicate passages 29 and 31, the former of which is connected to an inlet connection 33 and the latter of which is connected to the outlet connection 27. Each pintle assembly 26 is provided with a plurality of ports 35 with which the inlet and outlet casing passages 29 and 31 are adapted to register.

Likewise, the yoke arms are provided with duplicate passages 37 which register with another

set of ports 39 provided in the pintle assemblies 26. Only one of the yoke arm passages 37 is shown in Figure 5 which is adapted to serve as an inlet passage through which fluid flows from the upper pintle assembly to one of duplicate ports 43 in the valve plate 22. One of the ports 43 is connected to an arcuate inlet port 45 in the valve plate 22 while an arcuate outlet port 47 in the valve plate 22 is connected to a duplicate of the port 43, not shown. The latter port is connected by a duplicate of the yoke arm passage 37 to the ports 39 of the opposite pintle assembly 26. The valve plate inlet and outlet ports 45 and 47 cooperate with ports 51 formed at the end of the piston bores 19 on the suction and pressure stroke of the pistons.

The interior of the casing 10 may be bled by means of a conduit 53 connected to a drain port 54 of the casing member 10 and to a tank 55. The tank 55 is connected to the inlet connection 33 by a conduit 57. A pressure delivery conduit 59 is connected to the outlet connection 27 and is adapted to be connected to the power side of the transmission, not shown, in the conventional manner.

Mounted on the casing member 10 is a pressure control housing 28 within which is shiftably mounted a pressure control valve 30 for the purpose of limiting the maximum pressure of the pumping device and controlling the admittance of pressure fluid to an actuating piston 32. Piston 32, the closed end of which is linked to yoke 24, is shiftably mounted upon a piston guide 34 which is connected to housing 28 and extends into the interior of casing 10. Piston guide 34 has a longitudinal stepped passage 36 intersecting a longitudinal bore 38 of housing 28 which is controlled by valve 30 in such a manner as to normally block communication between the discharge side of the pumping device and passage 36, the latter of which leads directly to the closed end of piston 32. A hollow cylinder 40 having a plurality of elongated ports 41 surrounds piston 32 within casing member 10 so that a chamber 42 is formed therein and is rigidly mounted within a bore 44 of casing member 10 so that a flange 46 of cylinder 40 abuts a shoulder 48 of bore 44. A spring 49 mounted within chamber 42 abuts a flange 50 of piston 32 biasing the piston 32 to one limit of its travel and setting the original maximum angle of yoke 24 for maximum output of the pumping device. A transverse passage 52 in guide portion 34 which intersects passage 36 is normally blocked from communication with chamber 42, and consequently the interior of casing member 10, by piston 32. Transverse passage 52 is so placed that upon the control valve 30 admitting pressure fluid to piston 32 the latter will have to shift yoke 24 almost to the neutral position before flange 50 will break over the passage 52.

It should be noted that transverse passage 52 may be so placed in guide portion 34 so that the angle of the yoke 24 may be reduced to any angle between maximum and zero so as to limit the minimum output of the pumping device to the volume desired.

As is more clearly shown in Figure 4 valve 30 is shiftable within a hollow sleeve 56 provided with tear drop shaped ports 58 in alignment with a groove 60 and ports 62 spaced apart from ports 58 in alignment with a groove 64. Sleeve 56 is inserted in bore 38 of housing 28 so that a flange 66 of said sleeve abuts a shoulder 68 of bore 38 and so that groove 60 registers with and overlays

passage 36 and groove 64 registers with and overlays a passage 70 in housing 28 connecting chamber 42 to bore 38.

Control valve 30 consists of a piston 72 provided with spaced apart lands 74, 76, 78 and 80. Lands 74 and 76 control the admission of pressure fluid to passage 36. Lands 78 and 80 control passage 70 permitting fluid to escape from piston 32 upon valve 30 shifting back to its original position when pressure decreases below the setting of valve 30. Piston 72 is provided with a head 82 which is partially rounded so as to rest properly against a seat 84 formed in a shiftable seat and spring retainer member 86. A spring 88 placed within the left end of bore 38 abutting retainer 86 determines the maximum pressure attainable by the pumping device and normally biases valve 30 so that land 76 blocks port 58 of sleeve 56 from communication with passage 36. An adjustable screw 90 abuts the left end of spring 88 and closes the left end of bore 38. Valve 30 is adapted to be limited in its rightward movement by a portion 92 of a closure member 94 which extends into bore 38, the latter closing the right end of bore 38.

Portion 92 being smaller in diameter than that of bore 38 a chamber 96 is formed in the right end of bore 38 between closure member 94 and the right end of sleeve 56. A passage 98 in housing 28 intersects chamber 96. A passage 100 intersecting a passage 102 which connects to the outlet passage 31, by means of a passage 103 (Figure 6), registers with passage 98 so as to place chamber 96 in communication with the discharge side of the pumping device. The terminus of the passage 103 opening to the exterior of the casing 10 is closed by a suitable plug 105. Portion 92 is provided with a longitudinal passage 104 which intersects a transverse passage 106 in communication with chamber 96 providing a means of communication between the right end of valve 30 and the discharge side of the pumping device.

Land 74 of valve 30 is provided with a plurality of notches 108 which permits pressure fluid entering chamber 96 to be metered into tear drop ports 58 into passage 36 through the medium of said notches as land 76 breaks over ports 58. A diagonally drilled passageway 110 connects the left end of bore 38 with passage 70 in order to take care of the fluid displacement caused by leftward shifting of valve 30 into said bore.

In operation, with the pump running and the angle of the yoke 24 as shown in Figure 1 the volumetric output of the pump is at maximum value. Pressure fluid which is discharging through outlet connection 27 acts against the right end of valve 30 by means of passage 103 connected to the outlet passage 31, passage 102, passage 100, housing passage 98, chamber 96, transverse passage 106 and longitudinal passage 104 in portion 92. Pressure fluid in chamber 96 is prevented from entering passage 36 through the medium of notches 108 and tear drop ports 58 by land 76 of valve 30. This predetermined volumetric output will continue until the pressure in the system reaches a point high enough to overcome the resistance of spring 88 when valve 30 will begin to shift to the left. As the left end of piston 30 shifts through sleeve 56 into the bore 38 the slight quantity of fluid displaced thereby may flow into passage 70 by means of passage 110 and to drain port 54 by means of chamber 42 and cylinder ports 41. As land 76 breaks over ports 58 pressure fluid will begin to

be metered through notches 100 into ports 58 through grooves 60 to passage 36 and by means of passage 36 to the closed end of piston 32. As land 76 continues to break over ports 58 a gradually increasing amount of fluid entering passage 36 will continue to shift piston 32 against the resistance offered by spring 49 to change the angle of yoke 24, shortening the length of stroke of pistons 18 and decreasing the volumetric output of the pumping device. Piston 32 will continue to shift until the flange portion 50 thereof breaks over transverse passage 52 in guide portion 34.

As shown in Figure 3 the complete output of the pump, which is now nearly zero because of the angle of the cylinder barrel in relation to the drive shaft, is now by-passed into the interior of the casing member 10 by means of passage 52, chamber 42 and ports 41. From the interior of the casing 10 this fluid may bleed out of drain port 54 to the tank 55 by means of the conduit 53.

When the pressure in the system decreases to a point below the resistance of spring 88 control valve 30 will be shifted rightwardly by the force of said spring. At the point that flange 50 of piston 32 closes transverse passage 52 and land 76 of valve 30 blocks ports 58 of sleeve 56 from the discharge side of the pump, land 78 no longer blocks communication between ports 58 and ports 64. Trapped fluid in piston 32 and passage 36 may then escape to the interior of the casing 10 in order to allow piston 32 to shift by the force of spring 49 to the position shown in Figure 1. Fluid escapes from piston 32 through passage 36, groove 60 of sleeve 56, ports 58, and is guided by lands 78 and 80 of valve 30 to ports 62 and by means of groove 64 of sleeve 56, passage 70, chamber 42, and ports 41 and cylinder 40 to the interior of the casing from where it is discharged through drain port 54. When piston 32 has shifted completely the angle of yoke 24 is as shown in Figure 1 and the volumetric output of the pump is again at maximum value.

It should be noted that when the maximum pressure in the system as determined by spring 88 has been reached and control valve 30 has shifted sufficiently so as to permit fluid to enter passage 36 to shift piston 32, that the volumetric output of the device will be practically zero. Due to the fact that this small output is bled into casing 10 and from casing 10 back to the tank 55 by means of drain port 54 and conduit 57, the heat created by such operation will be practically nil.

It should also be noted that the transverse passage 52 may be placed in piston guide 34 relative to the cracking point of the flange portion 50 of piston 32 so that the minimum volumetric output of the pumping device may be regulated to supply just the right amount of minimum output necessary to maintain the desired pressure in the system or to fit the minimum needs of any installation.

It should also be noted that the invention is adaptable to be used with practically any fluid energy translating device having a swinging yoke for varying the displacement of the device simply by connecting the discharge side of the device to passage 98 of housing 28 and so that ports 41 of cylinder 40 are in communication with the interior of the casing member.

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 energy translating device of the variable displacement type comprising in combination a casing having high and low pressure terminals, a shiftable member for varying the displacement of the device and a discharge outlet for circulation of a small flow of fluid for cooling purposes, a volume control mechanism comprising pressure responsive actuating means connected to the member for shifting the same and having an expansible pressure chamber in communication with the high pressure terminal of the device, and means forming a by-pass passage hydraulically connected to said chamber and controlled by the actuating means, said by-pass passage being connected to said discharge outlet through the interior of the casing and being opened and closed by the actuating means at predetermined points within its range of movement.

2. A fluid energy translating device of the variable displacement type comprising in combination a casing having high and low pressure terminals, a shiftable member for varying the displacement of the device and a discharge outlet for circulation of a small flow of fluid for cooling purposes, a volume control mechanism comprising pressure responsive actuating means connected to the member for shifting the same, and having an expansible pressure chamber in communication with the high pressure terminal of the device, means forming a by-pass passage hydraulically connected to said chamber and controlled by the actuating means, and means resiliently biasing the actuating means to one limit of its travel and closing the by-pass passage, said by-pass passage being connected to said discharge outlet through the interior of the casing and being opened by the actuating means in response to increases of pressure at a predetermined point within its range of movement.

3. A fluid energy translating device of the variable displacement type comprising in combination a casing having high and low pressure terminals, a shiftable member for varying the displacement of the device and a discharge outlet for circulation of a small flow of fluid for cooling purposes, a volume control mechanism comprising pressure responsive actuating means mechanically connected to the member for shifting the same and having an expansible pressure chamber, valve means hydraulically connected to the expansible chamber and to the high pressure terminal of the device for connecting and disconnecting the high pressure terminal from the expansible pressure chamber, and means forming a by-pass passage hydraulically connected to the expansible chamber and controlled by the actuating means, said by-pass passage being connected to the discharge port through the interior of the casing and being opened and closed by the actuating means at predetermined points within its range of movement.

4. A fluid energy translating device of the variable displacement type comprising in combination a casing having high and low pressure terminals, a shiftable member for varying the displacement of the device and a discharge outlet for circulation of a small flow of fluid for cooling purposes, a volume control mechanism comprising pressure responsive actuating means mechanically connected to the member for shifting the same and having an expansible pressure

chamber, valve means hydraulically connected to the expansible chamber and to the high pressure terminal for connecting and disconnecting the high pressure terminal from the expansible chamber, means forming a by-pass passage hydraulically connected to said chamber and controlled by the actuating means, and resilient means biasing the actuating means to one limit of its range of travel and closing the by-pass passage, said by-pass passage being connected to the discharge outlet through the interior of the casing and being opened and closed by the actuating means at predetermined points within its range of movement.

5. A fluid energy translating device of the variable displacement type comprising in combination a casing having high and low pressure terminals, a shiftable member for varying the displacement of the device and a discharge outlet for circulation of a small flow of fluid for cooling purposes, pressure responsive actuating means connected to said member for shifting the same and having an expansible pressure chamber hydraulically connected to the outlet, and means forming a by-pass passage hydraulically connected to the chamber and to the interior of the casing and controlled by the actuating means, said actuating means normally closing the passage and opening the passage in response to predetermined increases of pressure at the outlet within its range of movement whereby when the device is operating at small displacement, a small fluid circulation may be established through the casing for cooling purposes.

6. A fluid energy translating device of the variable displacement type comprising in combination, a casing member having an inlet and an outlet, a shiftable member for varying the displacement of the device and a separate discharge port leading from the interior of the casing, pressure responsive actuating means connected to said member for shifting the same and having an expansible pressure chamber in communication with the outlet, means forming a by-pass passage hydraulically connected to the pressure chamber and to the interior of the casing and controlled by the actuating means, said actuating means normally closing the passage and opening the passage in response to predetermined increases of pressure at the outlet within its range of movement whereby when the device is operating at small displacement a small fluid circulation may be established through the casing for cooling purposes, and means for supplying fresh cooled fluid to the inlet of the device.

7. A fluid energy translating device of the variable displacement type comprising in combination a casing member having an inlet and an outlet, a shiftable member for varying the displacement of the device, and a separate discharge port leading from the interior of the casing, pressure responsive actuating means connected to said member for shifting the same and having an expansible pressure chamber hydraulically connected to the outlet, means forming a by-pass passage hydraulically connected to the actuating means and to the interior of the casing and controlled by the actuating means, said actuating means normally closing the passage and opening the passage in response to predetermined increases of pressure at the outlet within its range of movement, and a casing fluid circulating and cooling circuit including a fluid supply source connected to the inlet of the device, and a conduit connecting the separate discharge port to the fluid supply source whereby when the device is operating at small displacement a small fluid circulation may be established through the casing for cooling purposes, and the device is continually supplied with fresh cooled fluid.

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