April 29, 1958 C. E. ADAMS ET AL 2,832,199

VANE PUMP

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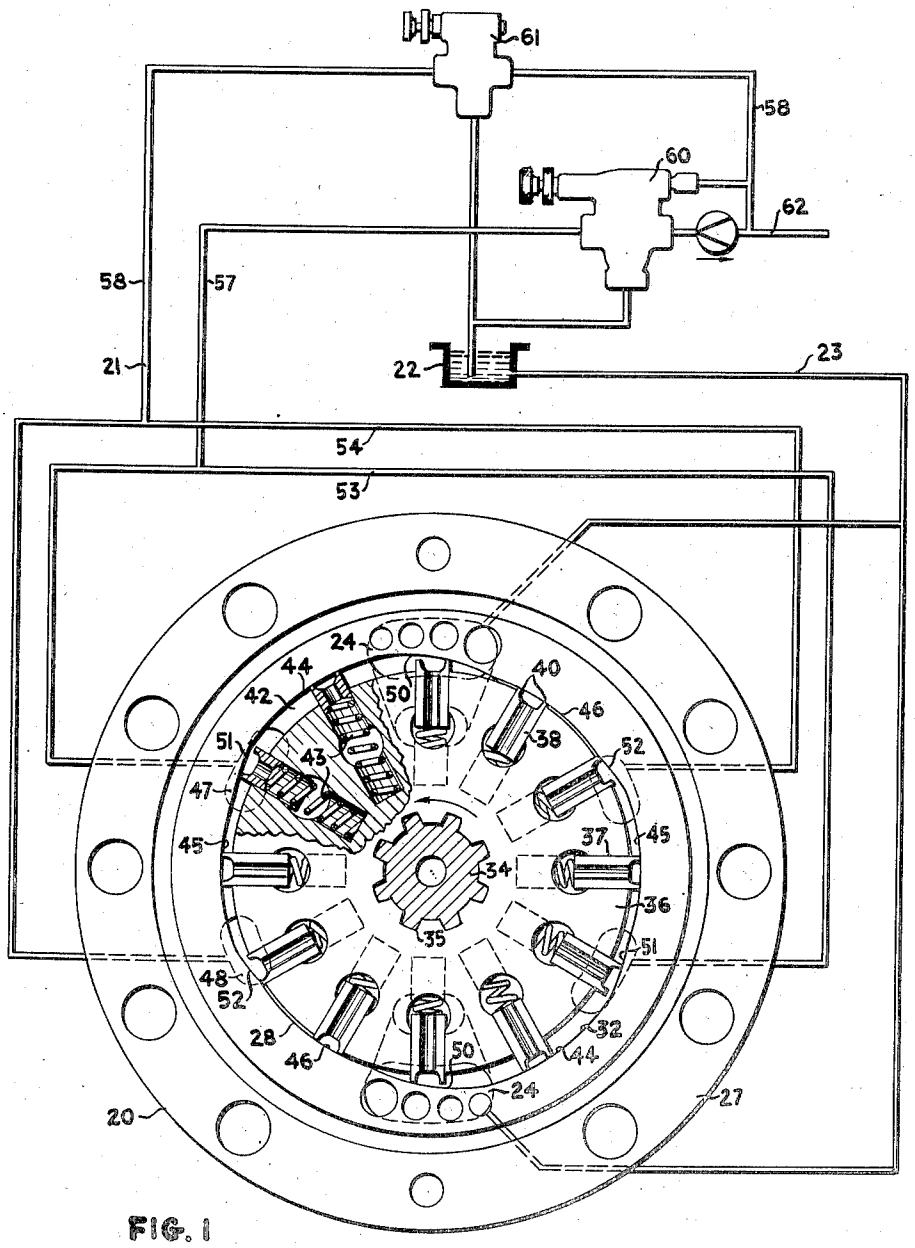

FIG. 1

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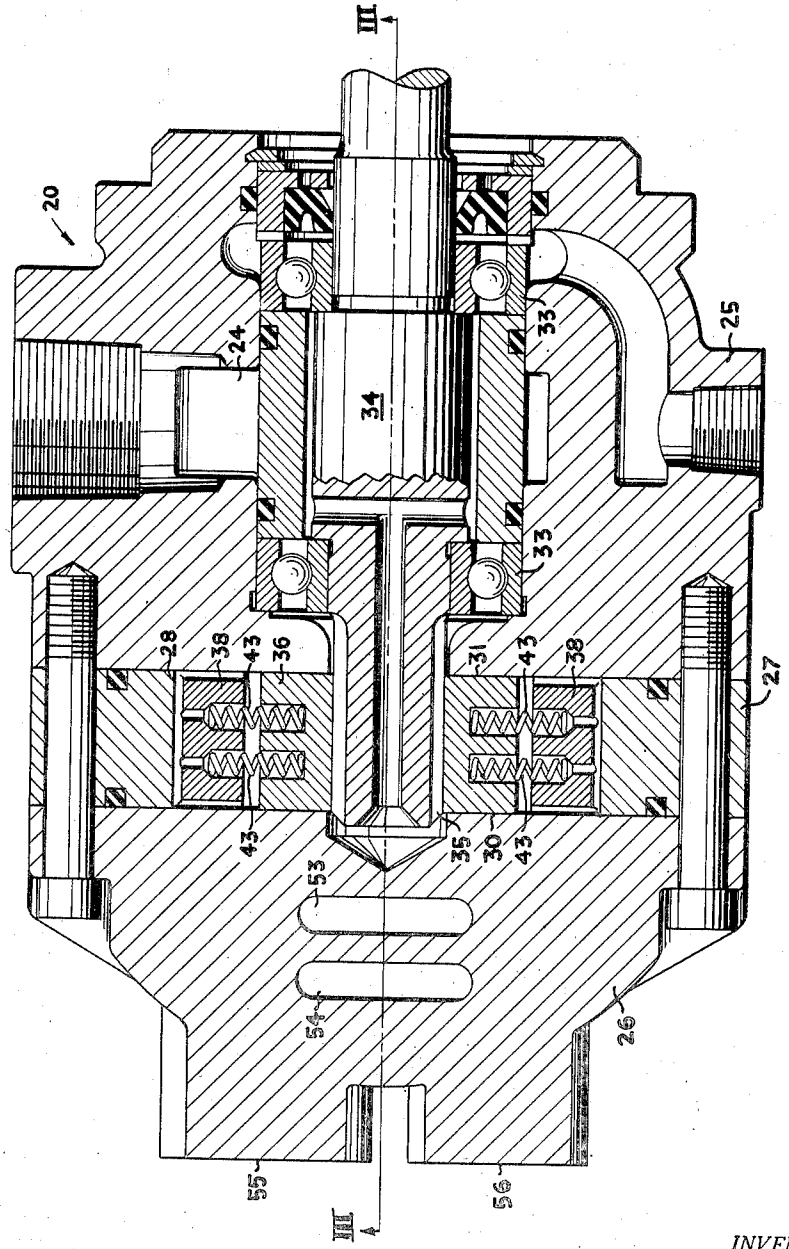

FIG. 2

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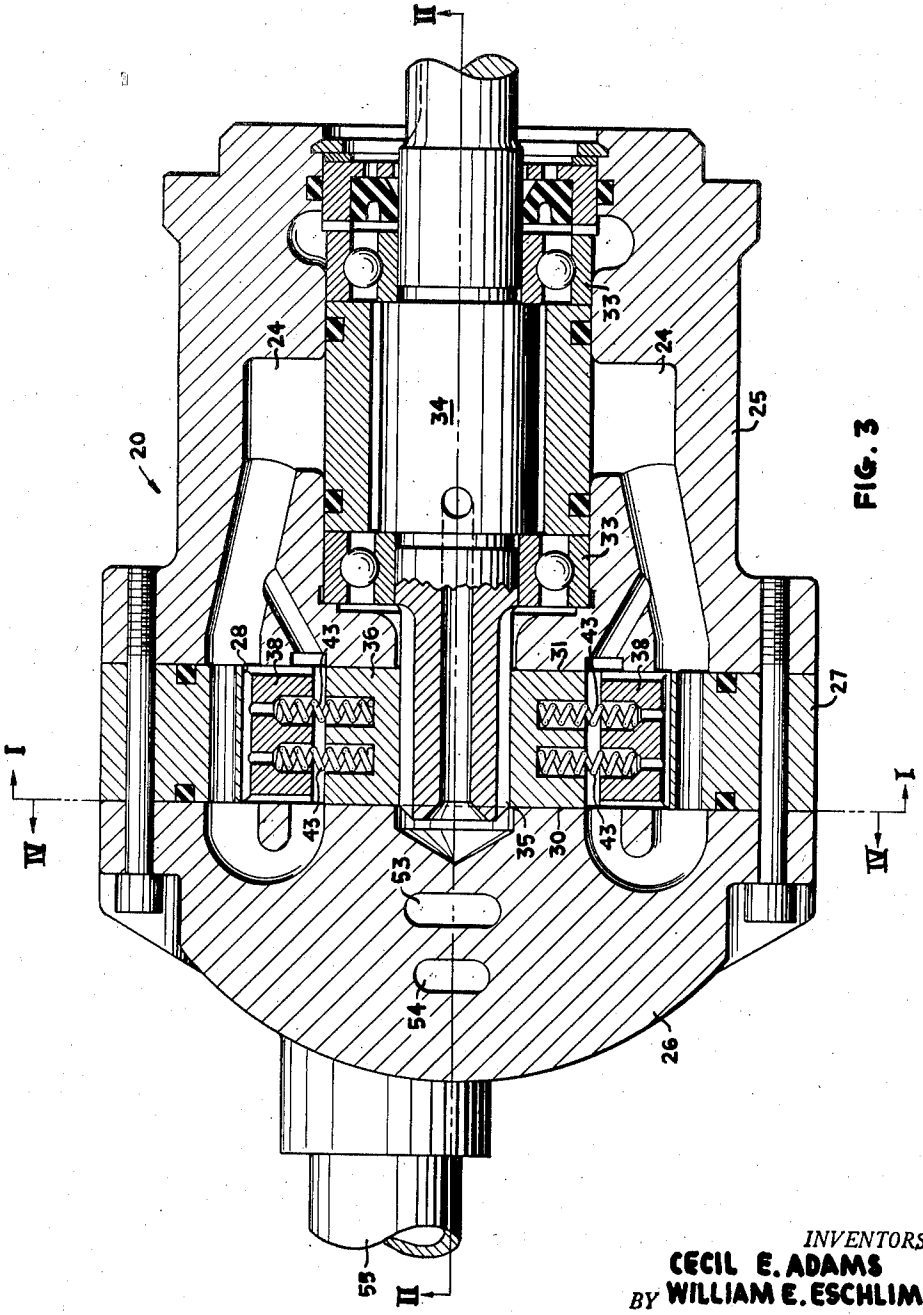

FIG. 3

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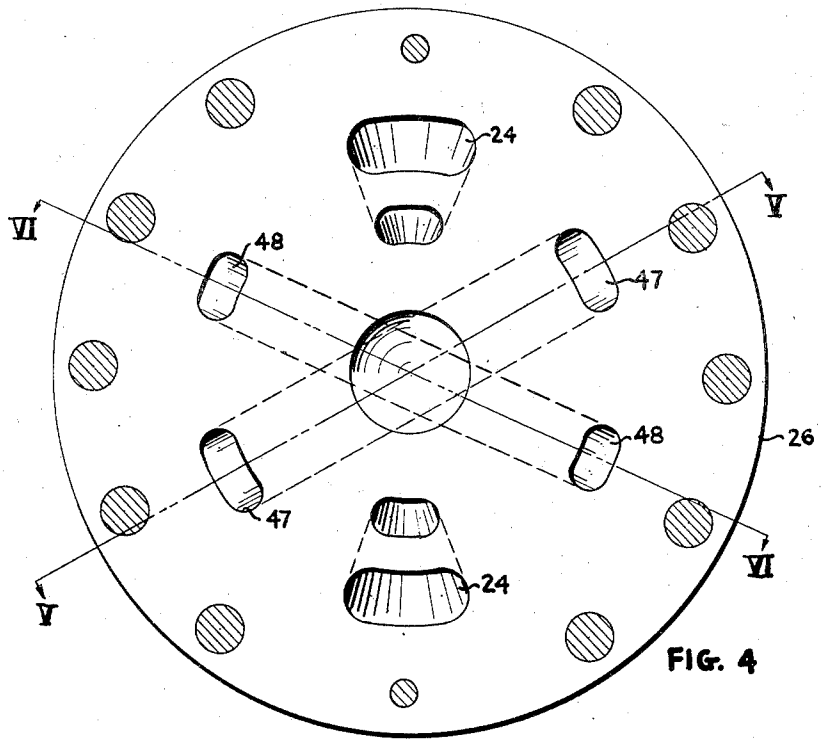

FIG. 4

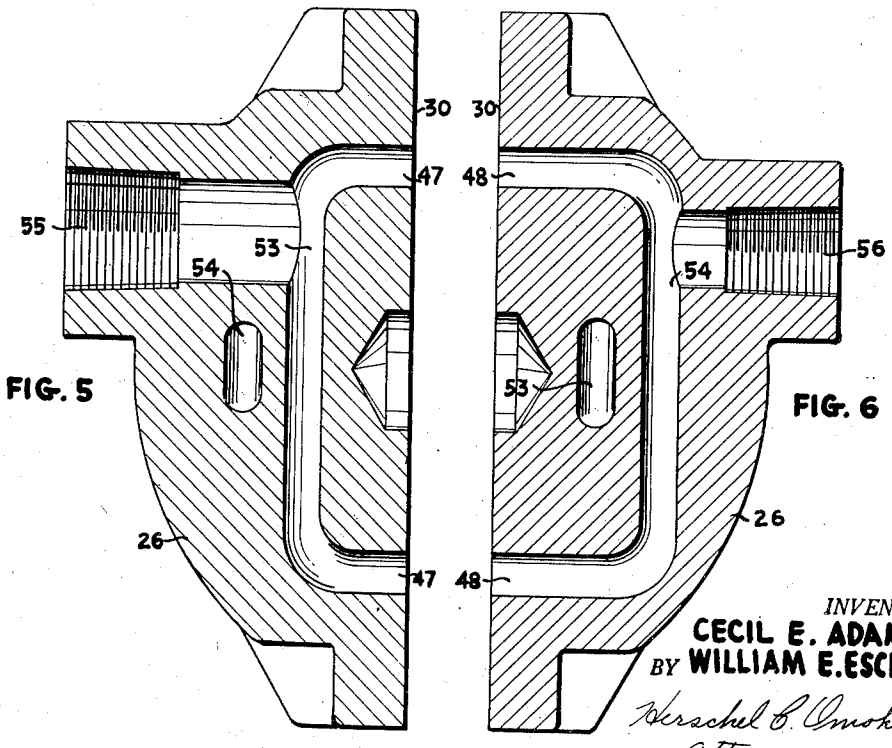

FIG. 5

FIG. 6

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VANE PUMP

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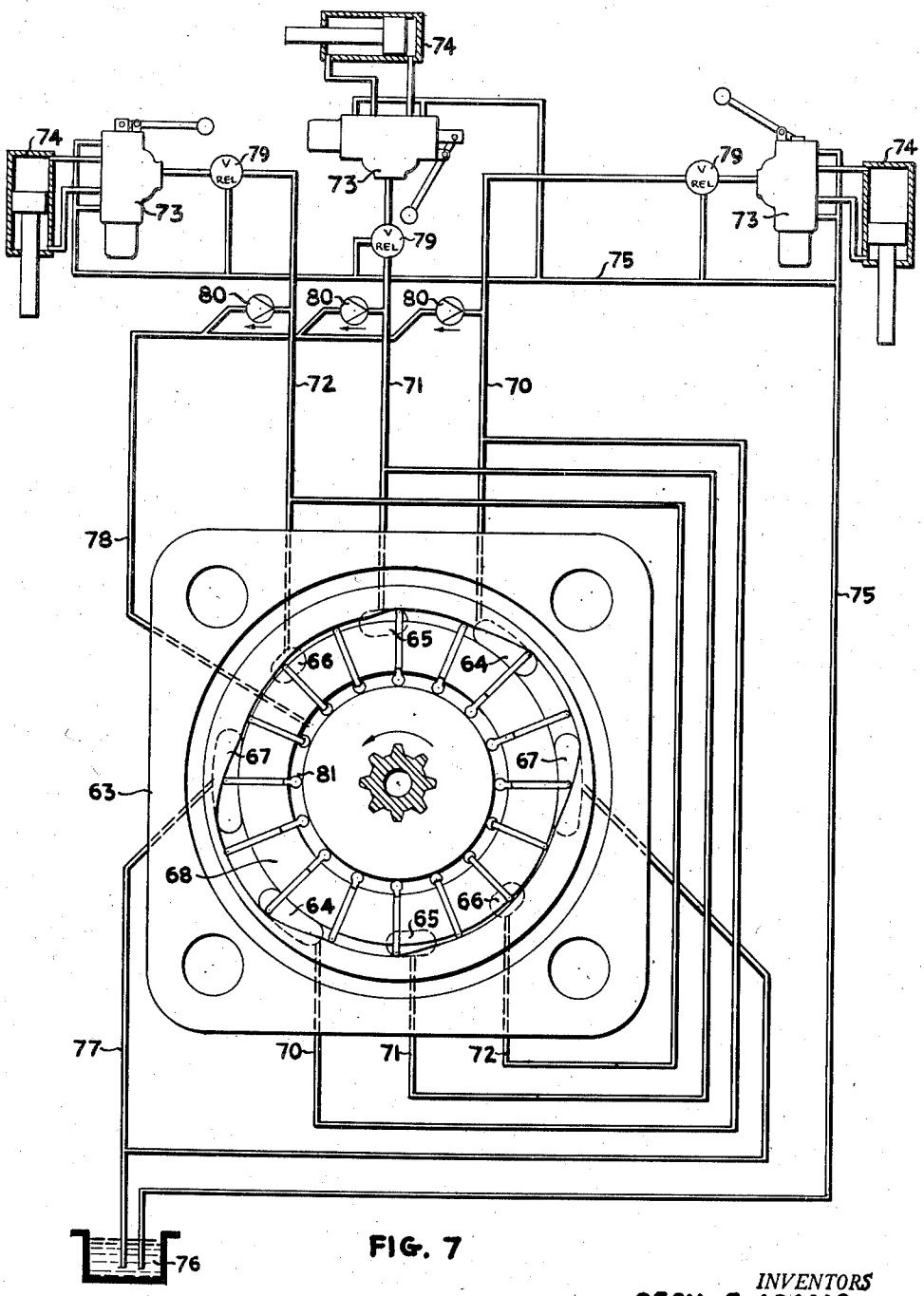

FIG. 7

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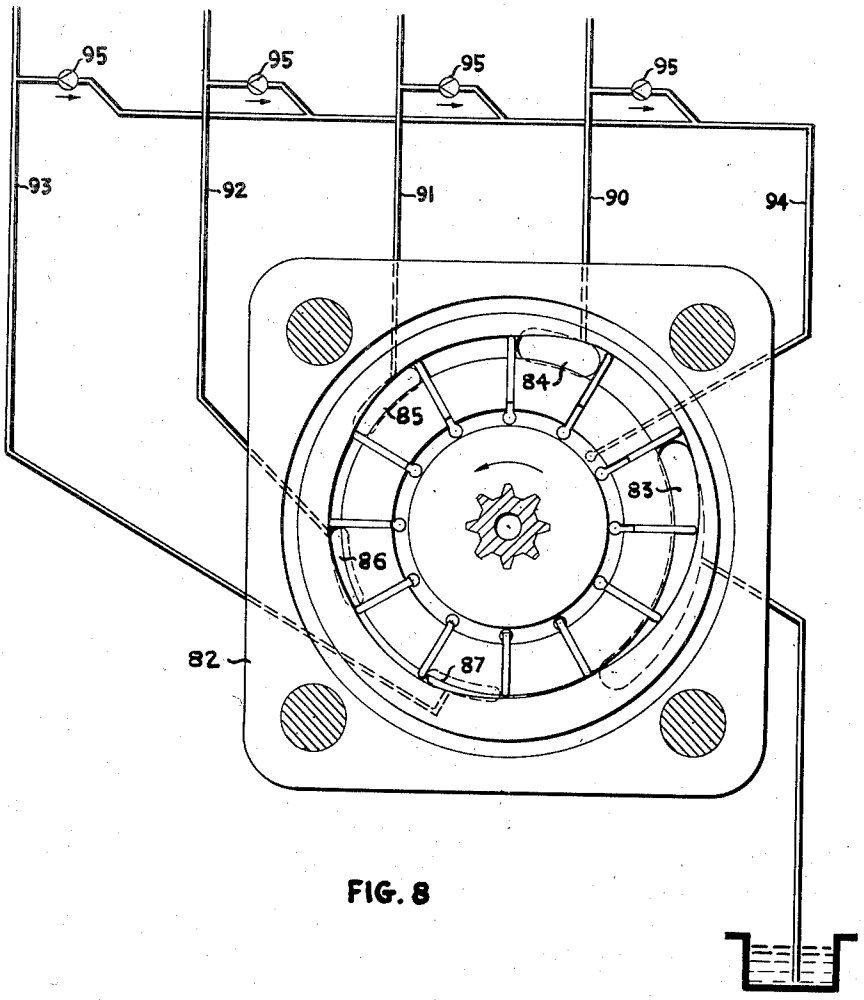

FIG. 8

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2,832,199

VANE PUMP

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Application April 30, 1953, Serial No. 352,102

5 Claims. (Cl. 60—97)

This invention relates generally to hydraulics and is particularly directed to improvements in fluid pressure energy translating devices capable of use as fluid pumps or motors.

An object of this invention is to provide a fluid pressure energy translating device particularly for use as a pump which is provided with a plurality of outlets independent of one another through which the fluid drawn into the pump through an inlet port, may be discharged in predetermined ratios, the pump having a single group of working parts which through the provision of the plurality of outlets ports, functions as a plurality of pumps.

A further object of the invention is to provide a fluid pressure energy translating device of the vane type, having a casing with a single inlet port and a plurality of outlet ports spaced from the inlet port, the vanes serving to transfer fluid from the inlet port and expel such fluid from the outlet ports, the mechanism being so formed that predetermined percentages of the total volume of fluid may be discharged through certain outlet ports, valve mechanism being provided to combine the fluid from all the outlet ports, so that such fluid may be used to effect the operation of a hydraulic device, and when a predetermined resistance is encountered, fluid discharged from certain of the outlet ports may be vented to exhaust, fluid from the remainder of the ports being employed at a higher pressure to operate the hydraulic device.

It is a further object of the invention to provide a vane type pump having a casing with end and peripheral walls to form a rotor chamber for the reception of a rotor having vanes projecting therefrom, these vanes cooperating with the peripheral and end walls to form fluid transfer pockets, the peripheral wall being formed to move the vanes relative to the rotor to vary the volumetric capacity of the fluid transfer pockets, the casing having inlet and outlet ports so disposed that when the transfer pockets are increased in size they will communicate with the inlet port, and when the pockets are being decreased in size they will communicate with the outlet ports so that predetermined fractional parts of the fluid drawn in through the inlet port will be expelled through each outlet port, these outlet ports being independent of one another so that the device will function as a plurality of pumps, yet have only one set of parts.

A further object of the invention is to provide a pump having a single set of operating parts which will deliver two or more separate volumes of fluid which may be combined or have one or more portions unloaded to exhaust to thereby reduce the horsepower required to operate the pump.

A still further object of the invention is to provide a balanced vane type pump with oppositely disposed sets of inlet and outlet ports, the ports of each set being in communication so that the device will operate as a plurality of pumps yet contain only a single set of operating parts.

Another object of this invention is to provide a fluid pump of the vane type with a plurality of separate outlets and means for causing the operating mechanism of the pump to discharge predetermined percentages of the total volume of fluid delivered by the pump through such outlets, the separate discharges being capable of independent use, combined for use as a single fluid pressure source or unloaded to exhaust in which event the horse power required would be proportionately reduced.

Another object of the invention is to provide a fluid pump of the vane type with a plurality of separate outlets and ramp means at the outlets to cause the discharge of a portion of the total volume of the pump through each outlet, the ramp means being of predetermined sizes so that the portion of fluid discharged from each outlet will bear a fixed ratio to the total volume delivered by the pump.

A further object of the invention is to provide a vane type fluid pump capable of simultaneously delivering a plurality of streams of liquid, the volumes of the streams bearing predetermined direct ratios to the total volume, each stream being independent to the others and capable of independent use at the same pressure as the others or at a different pressure.

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 embodiment of the invention is clearly shown.

In the drawings:

Fig. 1 is a diagrammatic view of a hydraulic system provided with a pump formed in accordance with the present invention, this pump being of the balanced type and having two sets of outlet ports.

Fig. 2 is a longitudinal sectional view taken through the pump shown in Fig. 1 the plane of this section being indicated by the line II—II of Fig. 3.

Fig. 3 is a similar view taken through the pump on the plane indicated by the line III—III of Fig. 2.

Fig. 4 is a vertical transverse sectional view taken through the pump on the plane indicated by the line IV—IV of Fig. 3.

Figs. 5 and 6 are detailed sectional views taken through an end cap of the pump on the planes indicated by the line V—V and VI—VI, respectively of Fig. 4.

Fig. 7 is a diagrammatic view of a hydraulic system provided with a pump embodying a modified form of the present invention, this pump being of the balanced type and having three separate sets of outlet ports, the hydraulic system having a plurality of separately operating hydraulic devices; and

Fig. 8 is a diagrammatic view of an unbalanced vane type hydraulic pump embodying the present invention.

Referring more particularly to Figs. 1 to 6, inclusive of the drawings, the numeral 20 designates the first form of pump illustrated in the drawings. This pump is arranged in a hydraulic system designated generally by the numeral 21, the system having a reservoir 22, from which fluid is drawn through line 23, to the oppositely disposed inlet ports 24, of the pump. As illustrated in Figs. 2 and 3 the pump 20 includes a body section 25, an end cap 26, and a cam ring section 27, these elements being secured together to form a casing containing a rotor chamber 28; this chamber is substantially circular in outline as shown in Fig. 1. The casing members 25 and 26 form parallel flat end walls 30 and 31, the ring-like cam member 27 forming a peripheral wall 32 for the chamber. This peripheral wall may be hereinafter termed a cam track.

The casing section 25 receives a plurality of bearing members 33 in which a shaft 34 is journalled for rotation, one end of this shaft projecting into the chamber 28 and

having splines as at 35 for connection with a circular rotor 36. This rotor is provided with a plurality of circumferentially spaced, radially extending slots 37 for the slidable reception of vane elements 38. In the first form of the invention these vane elements are relatively thick and are provided at the outer ends with spaced sealing edges 40, these sealing edges engaging the cam track or peripheral wall. The ends of the vanes 38 are also provided with spaced edges which engage the end walls 30 and 31, the engagement of the vanes with the walls serving to provide fluid transfer pockets 42. Any suitable mechanism may be provided to rotate the shaft 34 which will in turn impart rotary movement to the rotor 36; as this member revolves, the vanes 38 will slide along the peripheral wall being yieldably urged into engagement therewith by coil springs 43 arranged between the inner portions of sockets formed in the vanes and the rotor 36.

As illustrated in Fig. 1, the peripheral wall 32 is formed with a plurality of sets of concentric sections 44 to 46 inclusive, the sections 44 being spaced a greater distance from the axial center of the chamber than the other sections while sections 45 are disposed in intermediate distance between the sections 44 and 46. In the form of pump illustrated in Fig. 1, the effect of two separate pumps is desired. This effect is secured by providing the pump with two sets of outlet ports 47 and 48 and connecting the concentric sections of the peripheral wall by ramps 50, 51, and 52, the ramps 50 connecting the sections 46 and 44, ramps 51 connecting sections 44 and 45 and ramps 52 connecting sections 45 and 46. The ramps 50 are disposed in registration with the inlet ports 24, these ramps being inclined to cause the vanes to move outwardly in the slots 37 while traveling from the sections 46 to the sections 44. As the vanes move in this manner and the rotor revolves the fluid transfer pockets increase in size. When the vanes traverse the ramps 51 they will be moved a predetermined distance into the slots in the rotor to reduce the volumetric capacity of the fluid transfer pockets a predetermined amount. Due to this reduction, and the fact that during this reduction, the pockets communicate with outlet port 47, a certain volume of fluid contained in these pockets will be discharged through such outlet port. As the vanes move over the ramps 52, a similar effect will be produced, that is, the volumetric capacity of the fluid transfer pockets will be further reduced, the amount of reduction will depend upon the difference between the spacing of the sections 45 and 46 from the axial center of the rotor chamber. Since the fluid transfer pockets communicate with the outlet port 48 during this reduction, an additional quantity of fluid will be discharged through such outlet port.

In the balanced type of pump the inlet and outlet ports are arranged in oppositely disposed sets, these sets being connected by suitable passages 53 and 54. Figs. 5 and 6 show that the passages 53 and 54 communicate with separate outlets ports 55 and 56. In the hydraulic system shown in Fig. 1, the separate outlets are connected with lines 57 and 58, passage 53 being connected with the outlet ports 47, passage 54 being connected with outlet ports 48. Line 57 contains an unloading valve 60 of any suitable type, while line 58 contains a relief valve indicated by the numeral 61 which may be also of any suitable type. Fluid lines extend from the unloader and relief valves to the reservoir 22. Line 58 is connected with line 57 beyond the valves so that the entire volume of fluid delivered by the pump may be employed to operate a single device if desired. The system illustrated may be used when it is desired to operate a hydraulic device at a relatively rapid rate under low pressure, then at a slower rate under a high pressure. When the device is being initially operated all of the fluid from the pump will be delivered to the device to effect its operation. When the device meets a resistance and pressure increases in the supply line 62, this pressure will be transmitted to the controlling section of the unloader valve causing this valve to bypass or unload the portion of the pump delivering fluid through outlet ports 47. When this portion of the pump is unloaded, the horsepower requirement for operating the pump will be proportionately decreased.

It will be obvious that when the first portion of the pump is unloaded, the fluid pressure in passages 53 and 57 will be at a pressure substantially equal to atmospheric pressure. This pressure will also obtain in the ports 47 and, therefore, in the fluid transfer pockets communicating with such ports. The pressure in lines 62, 58, and passage 54, as well as the ports communicating therewith will be that determined by the setting of the relief valve 61. While portions of the pump are operating at different pressures, little or no deleterious effect will be imparted to the operating parts of the pump since the pump will be balanced by the oppositely disposed location of ports containing equal pressure.

It will be apparent from the foregoing that there has been proposed a fluid pump comprising a single set of operating parts which will deliver a plurality of independent streams of fluid under the same or different pressures. These streams of fluid may be combined to operate a single hydraulic device, and one or more may be unloaded to reduce the speed of operation when the pressure of the operating fluid is increased, the unloading of one or more sections of the pump effecting a consequent decrease in power requirements.

It should be obvious that more than two independent streams of fluid may be secured and to illustrate this fact Fig. 7 shows a pump indicated generally by the numeral 63 having three sets of outlet ports 64, 65, and 66. This pump is also of the balanced type, the corresponding outlet ports being connected in a manner similar to that shown in the first form of the invention. The pump 63, also has oppositely disposed inlet ports 67, the rotor 68 of this pump being provided with vanes that are relatively thinner than the vanes used in the pump illustrated in Fig. 1. When thinner vanes are employed, fluid pressure may be supplied to the inner ends thereof to continuously urge the vanes outward to engage the peripheral wall of the chamber. In pump 63, suitable ramps are employed to change the volumetric capacity of the fluid transfer pockets formed by the vanes and the walls contacted thereby. The sections of the peripheral wall between the ramps in this form of the invention are also concentric, the ramps being disposed in registration with the ports as in the first form of the invention. It should be apparent that the amount of fluid discharged through the respective outlet ports will be determined by the difference in the spacing of the peripheral wall sections from the axial center of the rotor chamber.

It is one of the objects to so space the concentric peripheral wall portions that predetermined percentages of the total volume of fluid will be discharged through selected outlet ports. As in the first form of the invention described corresponding ports are arranged diametrically opposite so that the pump will be balanced. These corresponding ports are connected by passages also as in the form first described. Fig. 7 illustrates the separately discharged volumes of fluid being used to operate independent hydraulic devices. In Fig. 7 the outlet ports 64, 65, and 66, are connected to fluid conductors 70, 71, and 72, respectively. Each of these conductors contains a reversing valve 73, indicated as being of the four-way type to control the flow of fluid to and from power cylinder 74. These power cylinders represent suitable reversible fluid motors the operation of which may be controlled by the valves 73. Exhaust lines 75 extend from the valves to the system reservoir 76. An inlet line also extends from this reservoir to the inlet ports 67 of the pump 63. It was previously pointed out fluid under pressure is supplied to the inner ends of the vanes to urge them into engagement with the peripheral wall. This fluid pressure is supplied through a passage 78, which is connected with each of the outlet lines 70, 71, and 72, check valves 80

being arranged between the line 78 and the outlet lines to permit the highest pressure being generated by the pump to be supplied through the line 78, to a groove 81, communicating with the inner ends of the slots for the vanes. In this manner the slots will be continuously supplied with pressure irrespective of which line is being employed. The check valves 80 prevent the connection of the lines containing higher pressure with the other lines. As is usual in hydraulic systems the pressure fluid conductors 70, 71 and 72 are provided with relief valves 79 to limit the pressure developed by the respective pump sections.

The invention is also applicable to vane pumps of the unbalanced type. Fig. 8 shows such a pump formed in accordance with the present invention. This pump 82 has a rotor chamber formed in a casing which is provided with an inlet port 83, and outlet ports 84 to 87, inclusive. These ports are spaced circumferentially around the rotor chamber as in the other forms of the invention described. The outlet ports 84 to 87 inclusive, each connect with a separate line 90 to 93, respectively to conduct the fluid to points of use. Also as in the other forms of the invention, the peripheral wall between the ports includes concentric portions connected by ramps so that the vanes will move smoothly from one elevation to another. The ramps also provide for the variation of volumetric capacity of the fluid transfer chambers formed by the vanes and the walls. As in the form of the invention shown in Fig. 7, thin vanes are employed and passage means 94 are provided to conduct fluid under pressure to the inner ends of the vanes to urge them in an outward direction. Check valves 95 are employed as in the form shown in Fig. 7 to prevent reverse flow of fluid from line 94 to any of lines 90 to 93, inclusive. The primary difference in the forms of the invention shown in Figs. 7 and 8 is that the latter, that is the form shown in Fig. 8, is unbalanced, having a single inlet port and a plurality of independent single outlet ports. As in the other forms of the invention, the spacing of the concentric portions of the peripheral wall from the axial center of the chamber determine the percentage of the fluid to be discharged through the respective outlet ports. In all forms of the invention the circumferential spacing of adjacent ports is at least as great as the spacing between adjacent vanes. This arrangement provides a seal between adjacent fluid transfer pockets and prevents loss of fluid pressure. In the form of the invention shown in Fig. 8, the fluid flowing from the separate outlets may be combined or used independently as in the other forms of the invention.

While the form of embodiment of the present 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.

We claim:

1. In hydraulic apparatus, a vane type pump comprising a casing having side and peripheral walls forming a rotor chamber with an inlet port and a plurality of separate outlet ports spaced circumferentially therefrom, there being a single inlet port for each plurality of outlet ports; a rotor supported for revolution in said chamber; vane elements extending from said rotor and engaging said side and peripheral walls to form fluid transfer pockets; means on said peripheral wall for moving said vane elements and varying the volumetric capacity of said pockets while they communicate with said ports, said means causing the capacity of said pockets to increase while communicating with said inlet port and decrease predetermined percentages of their maximum capacity while communicating with said outlet ports; fluid lines leading from said outlet ports; and an unloading valve in one of said lines, said lines being joined on the outlet side of said unloading valve.

2. In hydraulic apparatus, a pump comprising a casing having side and peripheral walls forming a rotor chamber with diametrically disposed inlet ports and a plurality of separate sets of outlet ports for each inlet port, said outlet ports of each set being spaced circumferentially from their inlet port, said outlet ports being arranged in diametrically disposed sets; passage means connecting the ports of each set with one another; a rotor supported for revolution in said chamber; a plurality of vane elements projecting from said rotor and engaging said side and peripheral walls to form fluid transfer pockets; means on said peripheral wall for moving said vane elements relative to said rotor and varying the volumetric capacity of said pockets while they communicate with said ports, said means causing said pockets to increase while communicating with said inlet port and decrease a percentage of their maximum capacity while communicating with each outlet port; fluid lines leading from each set of outlet ports; and an unloading valve in one of said lines, said lines being joined on the outlet side of said unloading valve.

3. In a hydraulic apparatus, a pump comprising a casing having side and peripheral walls joined to form a rotor chamber, at least one wall having openings adjacent the periphery and spaced circumferentially of said chamber to provide an inlet and a plurality of separate outlet ports, there being a single inlet port for each plurality of outlet ports, the portions of said peripheral wall between said ports being arcuate and having the centers of generation thereof coinciding with the axial center of said chamber, the peripheral wall portions on opposite sides of each port being spaced radially from the axis of said chamber different distances; a rotor having radially extending vane slots supported for a rotary movement in said chamber about the axial center thereof; vane elements disposed in the slots in said rotor for movement into engagement with said side and peripheral walls to form fluid transfer pockets; cam-like ramps connecting adjacent ends of said peripheral wall portions; a fluid conductor leading from said inlet port to a source of fluid; separate fluid conductors leading from said outlet ports; a fluid conductor communicating with said vane slots at the inner ends of said vanes, said last-mentioned conductor being connected with the conductors leading from each of said outlet ports; and check valve means between each conductor connected with an outlet port and the conductor communicating with said vane slots.

4. In a hydraulic apparatus, a pump comprising a casing having side and peripheral walls joined to form a rotor chamber, at least one wall having openings adjacent the periphery and spaced circumferentially of said chamber to provide an inlet and a plurality of separate outlet ports, there being a single inlet port for each plurality of outlet ports, the portions of said peripheral wall between said ports being arcuate and having the centers of generation thereof coinciding with the axial center of said chamber, the peripheral wall portions on opposite sides of each port being spaced radially from the axis of said chamber different distances; a rotor having radially extending vane slots supported for rotary movement in said chamber about the axial center thereof; vane elements disposed in the slots in said rotor for movement into engagement with said side and peripheral walls to form fluid transfer pockets; cam-like ramps connecting adjacent ends of said peripheral wall portions; a fluid conductor leading from said inlet port to a source of fluid; separate fluid conductors leading from said outlet ports; a plurality of fluid motors; and a control valve mechanism for each fluid motor, each of said control valve mechanisms being connected with a different one of the fluid conductors leading from said outlet ports.

5. In a hydraulic apparatus, a pump comprising a casing having side and peripheral walls joined to form a rotor chamber, at least one wall having openings adjacent the periphery and spaced circumferentially of said chamber to provide an inlet and a plurality of separate

outlet ports, there being a single inlet port for each plurality of outlet ports, the portions of said peripheral wall between said ports being arcuate and having the centers of generation thereof coinciding with the axial center of said chamber, the peripheral wall portions on opposite sides of each port being spaced radially from the axis of said chamber different distances; a rotor having radially extending vane slots supported for rotary movement in said chamber about the axial center thereof; vane elements disposed in the slots in said rotor for movement into engagement with said side and peripheral walls to form fluid transfer pockets; cam-like ramps connecting adjacent ends of said peripheral wall portions; a fluid conductor leading from said inlet port to a source of fluid; separate fluid conductors leading from said outlet ports; a fluid conductor communicating with said vane slots at the inner ends of said vanes, said last-mentioned conductor being connected with the conductors leading from each of said outlet ports; check valve means between each conductor connected with an outlet port and the conductor communicating with said vane slots; a plurality of fluid motors; and a control valve mechanism for each fluid motor, each of said control mechanisms

being connected with a different one of said fluid conductors leading from said outlet ports.

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