Feb. 16, 1965 TAKASHI NAMIKAWA 3,169,487

HIGH PRESSURE VANE PUMP

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FIG. 1

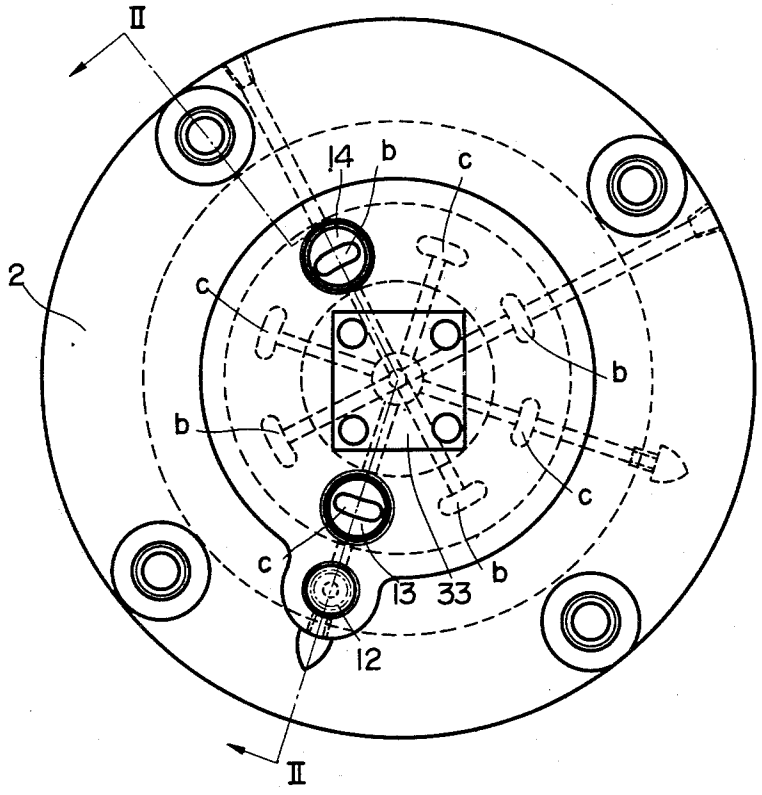

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FIG. 2

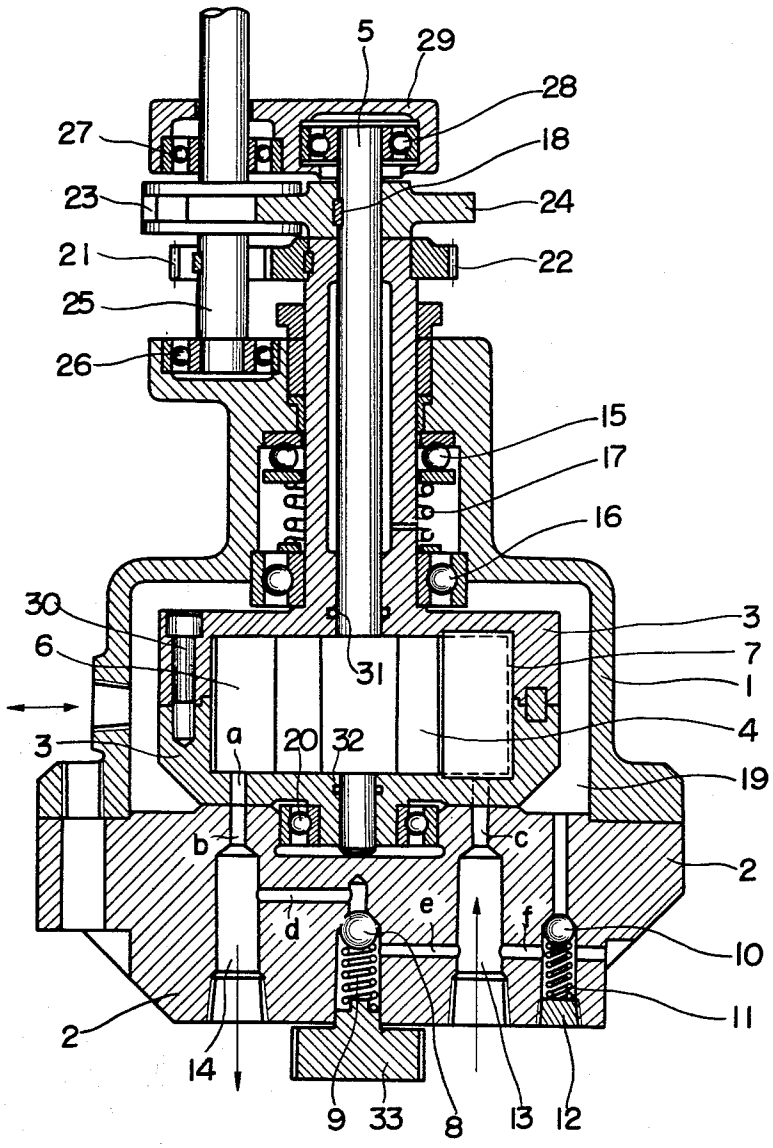

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FIG. 3

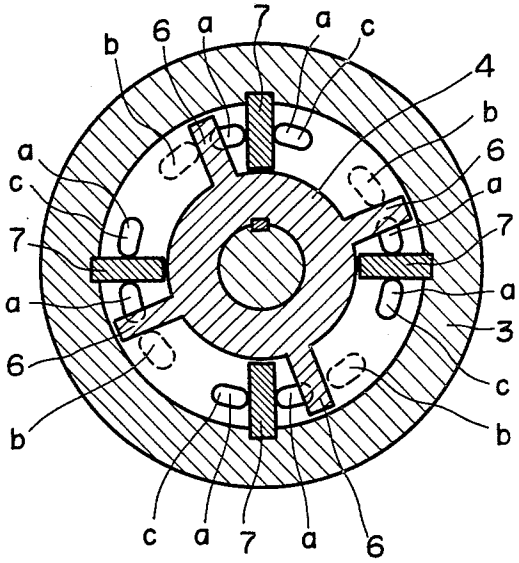

FIG. 14

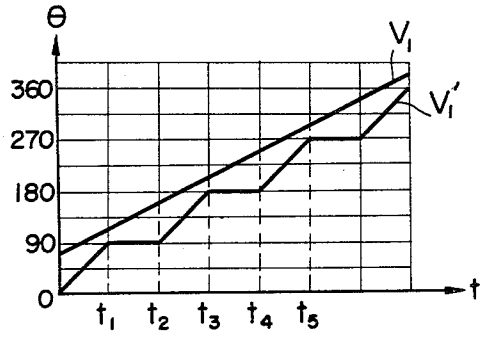

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FIG. 4

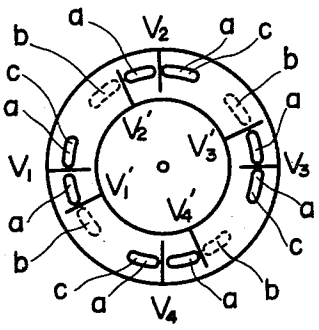

FIG. 5

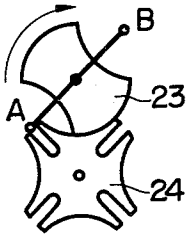

FIG. 6

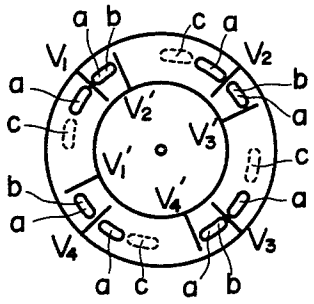

FIG. 7

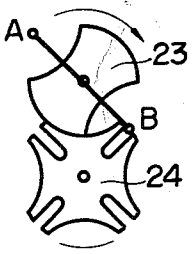

FIG. 8

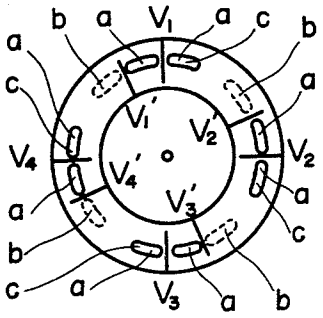

FIG. 9

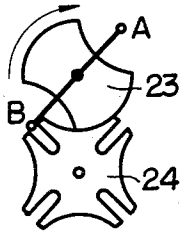

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FIG. 10

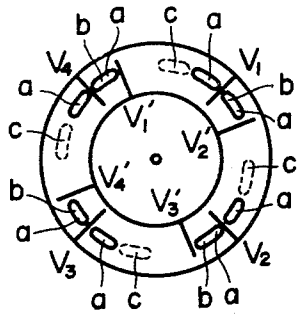


FIG. 11

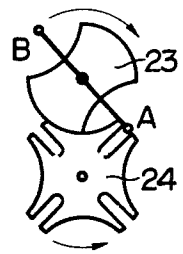


FIG. 12

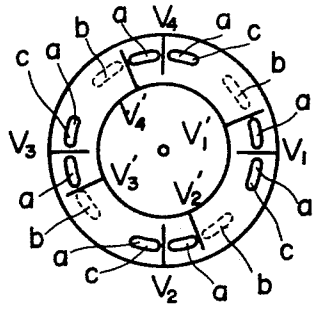
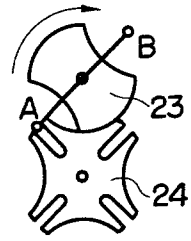


FIG. 13



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3,169,487

HIGH PRESSURE VANE PUMP

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Filed June 15, 1962, Ser. No. 202,717
Claims priority, application Japan, Nov. 29, 1961, 36/42,379
1 Claim. (Cl. 103—129)

My invention relates to a high pressure vane pump comprising a valve plate and an intermittently driven rotor.

In this pump the pump cylinder is continuously rotated and a concentric rotor is intermittently rotated. The cylinder and rotor are provided with overlapping vanes, and these define the end walls of chambers which expand and contract due to the difference between the movements of the cylinder and rotor. During expansion, these chambers register with the inlet ports of the valve plate, and during compression with the outlet ports.

The pump thus has over reciprocating pumps the advantage that it may be directly driven from a rotating shaft, yet its mechanism is simpler than that of centrifugal pumps.

Since some chambers are in the compression stage while others are expanding there is a relatively even flow of fluid, a decreased pulsation of oil pressure, and excellent radial balancing of the load relative to the axis.

The pump is well suited to high-speed, high pressure applications, operating at pressures as high as 300 kg./cm.^{2} and speeds as high as 500 r.p.m.

Other objects and advantages of the invention are in part obvious and will in part be set forth in the course of the following description of a preferred embodiment of the invention. This embodiment is described in conjunction with the annexed drawings, in which:

FIG. 1 is an end view of my new pump;

FIG. 2 is an axial section taken through the entire pump, except for the valve plate, which is sectioned along the line II—II of FIG. 1;

FIG. 3 is a schematic cross-section through the pump cylinder and rotor;

FIGS. 4, 6, 8, 10 and 12 schematically show various positions assumed by the vanes relative to the ports;

FIGS. 5, 7, 9, 11 and 13 show the positions of the members of the Geneva movement when the vanes occupy the positions shown in FIGS. 4, 6, 8, 10 and 12, respectively;

FIG. 14 is a graph showing the angular positions of the cylinder and rotor as a function of time.

Like reference characters denote like parts throughout the several views, except that in FIGS. 4, 6, 8, 10 and 12 the characters V1, V2, V3 and V4 are used to identify individual vanes identified as a class by the reference numeral 7 in FIGS. 1–3, and reference characters V1′, V2′, V3′ and V4′ are used to identify individual vanes identified as a class by reference numeral 6 in FIGS. 1–3.

Referring now to FIG. 2, it will be seen that the pump comprises a stationary casing 1 closed at one end by the valve plate 2. A cylinder 3 is carried by bearings 16 and 20, located in the casing 1 and valve plate 2 respectively. Within this cylinder is mounted the rotor 4, carried by the shaft 5. As best seen in FIG. 3, the inner wall of the cylinder is provided with inwardly projecting vanes 7, and the rotor carries peripherally radiating vanes 6. These vanes overlap to form with the cylinder walls a plurality of expansible chambers. The volume of these chambers is varied by rotating the cylinder 3 at a constant speed, while driving the rotor 4 intermittently at an angular speed twice that of the cylinder.

The cylinder 3 is biased against the valve plate 2 by the spring 17 which is compressed between the bearing 16 and thrust bearing 15. Between the cylinder 3 and casing 1 is an oil reservoir 19. The valve plate 2 is provided with four exhaust ports *b* and four suction ports *c*. As best seen in FIG. 2, each exhaust port *b* is connected through the outlet 14 and passage *d* to a safety valve 8, which is connected through the passage *e* to the inlet 13 and thus to the suction ports *c*.

When the delivery pressure exceeds a prescribed limit, the valve member 8 is forced open against the resistance of the spring 9, and oil passes through the passage *e* and suction port *c*, and thence back into the cylinder 3. The pressure required to open the valve 8 may be adjusted by turning the threaded plug 33 so as to increase or relieve the compression of the spring 9.

The valve 10 controls the passage *f* between the oil reservoir 19 and the inlet 13. This valve, which is biased shut by the spring 11, automatically opens when the suction pressure falls too low, and the pressure differential required to actuate it may be regulated by turning the threaded plug 12.

The cylinder 3 is formed in two parts to permit insertion of the rotor 4, and these two parts are held together by bolts 30. The shaft 5 rotates in the cylinder, leakage therefrom being prevented by the sealing rings 31 and 32. One end of the shaft projects beyond the cylinder into bearing 28 in journal box 29. Both rotor shaft 5 and cylinder 3 are driven from a drive shaft 25 carried in bearings 26 and 27. The cylinder is driven through reduction gearing 21, 22, and the rotor shaft 5 through Geneva gearing 23, 24, so that it rotates intermittently, turning during only half the time that the cylinder turns, but at twice the speed. While Geneva gearing is shown to produce this relationship, it will be appreciated that any other means which produces the same effect may be used. The Geneva gear 24 is keyed to the rotor shaft 5 by the key 18.

The operation of the pump will now be explained with reference to FIGS. 4–14. FIGS. 4, 6, 8, 10 and 12 show successive positions of the vanes relative to the valve plate and the apertures therein. FIGS. 5, 7, 9, 11 and 13 show the positions of the driving member 23 and driven member 24 corresponding to each of these vane positions. For convenience, each of the cylinder vanes 7 has been assigned one of the reference characters V1, V2, V3, V4 and each of the rotor vanes 6 one of the reference characters V1′, V2′, V3′, V4′. The angle θ, through which a representative vane (V1 and V1′) from each group turns, is plotted as a function of time intervals *t*1, *t*2, etc., on FIG. 14.

From these it will be seen, that proceeding from the position at *t*1, shown in FIGS. 4–5, the cam 23 swings through half a revolution without affecting the position of the gear 24. During this time, the cylinder 3 is nevertheless being constantly driven, so that its vane V1 advances from the position shown in FIG. 4 to that shown in FIG. 6, while the rotor vane V1′ remains stationary and thus occupies the same position on both figures. During this time oil is drawn in through the ports *c* and *a* into the chambers formed between vanes V1′ and V1, V2′ andV2, V3′ and V3, V4′ and V4, but simultaneously expelled from the chambers between V1 and V2′, V2 and V3′, V3 and V4′, V4 and V1′, through the ports *b* and *a*.

Next when the cam 23 turns 90° from the position of FIGS. 6 and 7 in the direction of the arrow into the *t*3 position shown in FIGS. 8 and 9, oil is drawn into the chambers between vanes V1 and V2′, V2 and V3′, V3 and V4′, V4 and V1′, while it is being expelled from between V1 and V1′, V2 and V2′, V3 and V3′, V4 and V4′.

Further, while the cam 23 turns 90° from the *t*3 position of FIGS. 8 and 9 in the direction of the arrow, into the *t*4 position of FIGS. 10 and 11, oil is drawn into the chambers between vanes V1 and V1', V2 and V2', V3 and V3', V4 and V4', while simultaneously expelled from those between V1 and V2', V2 and V3', V3 and V4', V4 and 1'.

Finally, when the cam turns another 90° from the *t*4 position of FIGS. 10 and 11 to the *t*5 position of FIGS. 12 and 13, the chambers between the vanes 1 and V2', V2 and V3', V3 and V4', V4 and V1' draw in the oil while those between V1 and V1', V2 and V2', V3 and V3', V4 and V4' expel it. Thus for every rotation of the pump cyclinder each vane repeats 8 cycles of suction and exhaust, thereby reducing the pulsation in the oil pressure.

The pump may obviously be modified as to structural details without thereby departing from the spirit of the invention as defined by the following claim.

What is claimed is:

A pump comprising a casing, a cylinder rotatably mounted within said casing and carrying a plurality of vanes projecting radially inward from its circumferential wall, an independently rotatable rotor coaxially mounted to turn within said cylinder and provided with a plurality of vanes which project radially outward between the vanes carried by the cylinder, a transverse wall closing one end of said cylinder and pierced by a ring of spaced ports, with two of said ports disposed between each pair of cylinder-carried vanes, a valve plate forming one end of said casing and positioned adjacent said transverse wall, resilient means biassing said transverse cylinder wall against said valve plate, said valve plate being likewise provided with a ring of spaced ports, alternate ports being connected to outlet means and the remainder being connected to inlet means, said valve plate ports being positioned to successively register with said cylinder ports during each revolution of said cylinder, means for rotating one of said cylinder and rotor at a constant first speed, means for driving the other intermittently at twice said speed for half of each cycle, a pressure responsive safety valve mounted in said valve plate, those of said valve plate ports connected to an outlet being also connected to one side of said pressure responsive safety valve and those connected to an inlet being also connected to the other side of said safety valve, so that an excessive outlet pressure is relieved by passage of fluid from said outlet connected ports to said inlet connected ports through said safety valve, and means accessable from outside said casing for adjusting the loading of said pressure responsive valve.

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