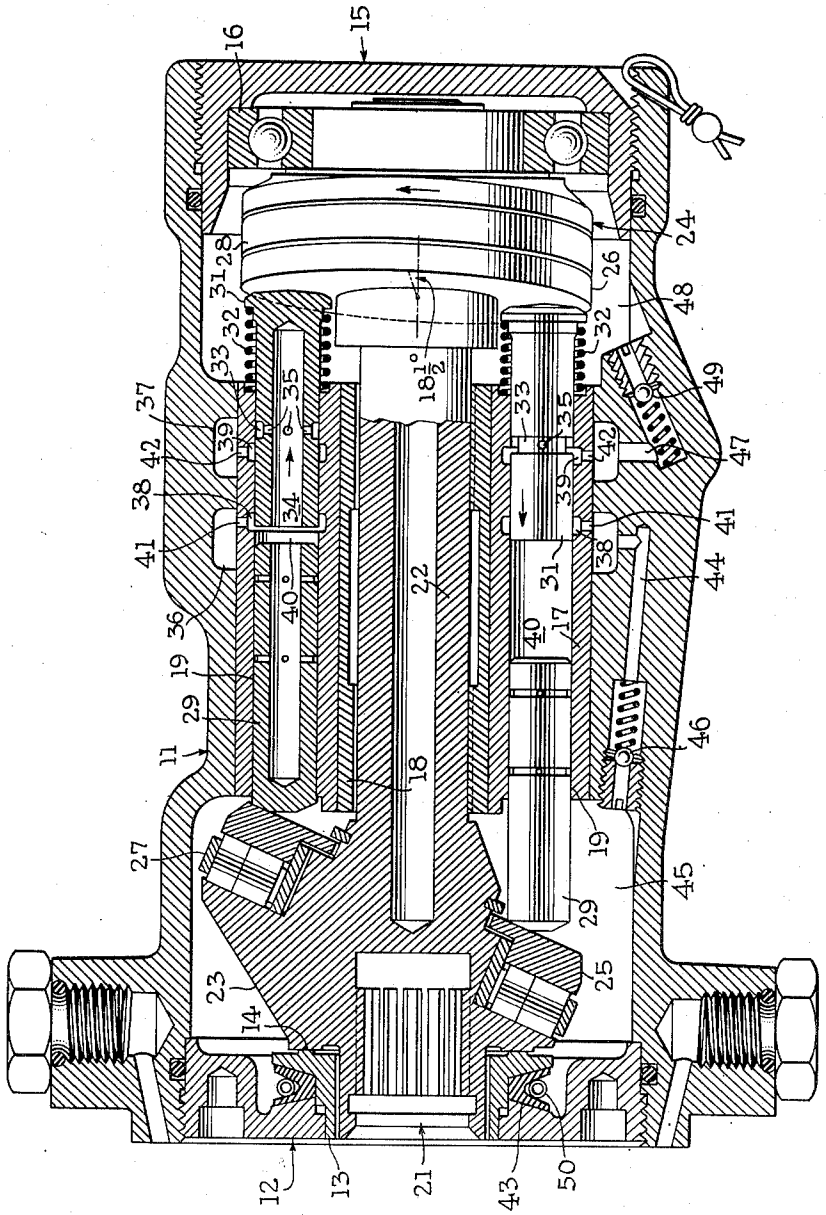
March 19, 1957 M. W. HUBER 2,785,639

ROTARY ENGINE

Filed April 6, 1956



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United States Patent Office 2,785,639 Patented Mar. 19, 1957

2,785,639

ROTARY ENGINE

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Application April 6, 1956, Serial No. 576,670

2 Claims. (Cl. 103—173)

This invention relates to rotary engines of the swash plate type. Specifically it relates to an improvement to applicant's issued Patent 2,391,575, dated December 25, 1945, and assigned to the assignee of this invention.

The engine described and claimed in the patent referred to, may comprise an open-ended generally cylindrical housing having a cylinder block mounted therein. The cylinder block contains a plurality of cylinder bores which extend therethrough. The opposite ends of each bore are closed respectively by a displacement piston and by a distributing valve of the piston type. A rotary shaft extends through and is journalled in the cylinder block. Screw threaded abutments close the open ends of the housing. Two swash plates are provided on the shaft, one of which controls reciprocation of the displacement pistons, and the other of which controls reciprocation of the distributing valve pistons.

Each of the bores is encircled by two axially spaced grooves one of which is connected with one manifold and the other of which is connected with another manifold. These grooves coact with the distributing valve pistons to control the flow of liquid to and from the engine. It is imperative that the distributing valves cause port reversal at points which are separated by 180° of swash plate rotation. The ports in the cylinder bores and the control edges formed on the pistons must be relatively so positioned that port reversal occurs when the piston valve is at midstroke. Since the supply and discharge ports are formed in the cylinder block and are fixed, the swash plate controlling the valve must be so located relatively to the cylinder block that the desired timing is established.

The present invention concerns a construction in which the swash plate which controls the valve pistons may be shifted axially relatively to the cylinder block so that it may be adjusted to afford the desired timing. This axial movement must however be accomplished without changing the phase relationship between the swash plates. This phase relationship is determined in accordance with the teachings of the co-pending application of Howard A. De Laney, Serial No. 575,400, filed April 2, 1956, and assigned to applicant's assignee.

Applicant's structure is such that the entire shaft assembly including both cams is axially shiftable relatively to the cylinder block a distance sufficient to permit proper valve timing despite errors which arise from variations in the size of the parts which result from the tolerances allowable in their manufacture.

The invention will be described having reference to the accompanying drawing in which the single figure is a view partly in axial section and partly in elevation of a motor embodying the invention.

As shown, the motor comprises a housing 11 in the form of an open-ended cylinder. A shoulder is formed adjacent one end of the housing and serves as a stop for annular end wall 12 threaded into the housing 11. A sealing ring 13 is mounted in the central opening of the

end wall 12 and includes a sealing surface 14. A screw threaded abutment 15 closes the other end of the housing 11 and is provided with a recess which receives the outer race of ball bearing 16. A cylinder block 17 is mounted with a shrink fit in the housing 11. The cylinder block 17 is provided with a central opening in which a bearing bushing 18 is secured and with a plurality of cylinder bores 19 arranged in circular series around the axis of the opening.

A shaft assembly 21 is journalled in the bushing 18. This assembly 21 includes a shaft 22 journalled in bushing 18. A swash plate 23 is formed integrally with the shaft 22 and is provided with a sealing surface which is engaged by the sealing surface 14 of sealing ring 13. A second swash plate 24 is removably mounted on the opposite end of the shaft 22 and engages the inner roll of bearing 16. The swash plates are provided with thrust plates 25 and 26 sustained thereon by means of antifriction bearings 27 and 28. A displacement piston 29 in thrust engagement with the thrust plate 25 is reciprocable in each of the cylinder bores 19. A distributing valve 31 of the piston type is reciprocable in each of the cylinder bores 19 and is in thrust engagement with the thrust plate 26. Springs 32 are provided and bias the valves 31 against plate 26 at all times.

Each distributing valve 31 is encircled by a groove 33. This groove communicates with a counterbore 34 in the valve piston 31 by way of drilled ports 35.

Spaced grooves 36 and 37 are formed in the housing 11. Each cylinder bore 19 is encircled by annular grooves 38 and 39, which respectively are in communication with grooves 36 and 37 by means of drilled ports 41 and 42. The distributing valve 31 serves to connect the grooves 38 and 39 alternately with the working spaces 40 defined between the displacement pistons and the valve pistons. The grooves 36 and 37 may be connected one with supply and one with discharge, and depending upon which is connected with supply the motor may be caused to rotate in either direction.

A flexible sealing ring 43 reacts between the end wall 12 and sealing ring 13. A small amount of axial separation is provided between the end wall 12 and ring 13 and a garter spring 50 encircles the resilient sealing member 43 and acts to maintain the seal.

A drain connection 44 is provided from the swash plate chamber 45 to the groove 36. A check valve 46 inhibits reverse flow through this connection. A second drain connection 47 is provided from the swash plate chamber 48 and the groove 37. A check valve 49 inhibits reverse flow. The swash plate chambers 45 and 48 communicate with one another through grooves formed in the bushing 18.

It will be assumed that pressure liquid is supplied to the groove 36 and that groove 37 is connected by a discharge connection, not shown, with a sump, not shown.

Each distributing valve 31 is so designed that it has a zero lap position in which both grooves 38 and 39 are cut off from the working space 40, so that motion of the piston valve in one direction will connect the working space 40 either with the supply groove 38 or with the exhaust groove 39.

Each working space 40 should be connected with supply throughout 180° of swash plate rotation and with discharge throughout the remaining 180° of swash plate rotation. This requirement is met by causing the zero lap condition to occur when the piston valves 31 are at midstroke. To assure that the desired valve timing can be achieved despite variations in the sizes of the parts and despite minor misplacement of the cylinder block in the housing, the end wall 15 is attached to the housing 11 by screw threads and may be moved axially in either direction.

In the drawing the displacement pistons **29** are shown in their extreme positions and the valve pistons **31** are moving in the direction of the arrows thereon and each has passed midstroke. It will be apparent that if end wall **15** were displaced to the right from the illustrated position, the zero lap condition would occur too late in the upper working space **40** and too early in the lower working space **40**. If end wall **15** is shifted to the left, the reverse condition will result.

Although the position of the piston valves **31** in the assembled pump cannot be observed, the properly timed condition can be determined by the noise which the motor makes during operation. This noise results from the fact that if port reversal occurs too early, e. g., when the working space **40** is still increasing, it is connected with the discharge connection and a partial vacuum will be created which will momentarily cause the displacement piston to be out of engagement with swash plate **23** and when they re-engage there will be an impact. A similar impact will result if port reversal occurs too late and the working space is not connected with inlet (high pressure) until after it has begun to increase in volume. During adjustment the motor is driven in each direction and the noise which indicates the described impacts is reduced to a minimum. Once properly adjusted the end wall **15** is wired or otherwise secured against rotation. This adjustment then remains unchanged during the use of the motor.

It should be noticed that the entire shaft assembly **21** is shifted by motion of end wall **15**, such motion being accommodated by the axial clearance between sealing ring **13** and end wall **12** and by the flexible sealing ring **43**. By moving the swash plates and shafts as an assembly it will be seen that the two swash plates **23** and **24** cannot rotate relatively to one another to upset the phase relationship between them. Furthermore since the swash plates and shaft form a rigid assembly, the necessity of a sliding fit between the swash plate **24** and shaft **22** is eliminated and the possibility that these surfaces might shift relatively to one another during use of the motor is substantially eliminated.

The bearings illustrated at **27** and **28** are of the type described and claimed in applicant's co-pending application Serial No. 573,420, filed March 23, 1956, and assigned to the assignee of the present invention.

While the invention has been illustrated and described as it is embodied in a motor, it will be apparent to those skilled in the art that it could be used in a pump. The word engine in the claims is intended to designate both pumps and motors.

What is claimed is:

1. A rotary engine comprising a housing, a cylinder block therein; a shaft assembly journalled in said cylinder, and rotatable relatively thereto; said assembly including a shaft and two swash plates carried thereby, said cylinder block having a plurality of cylinder bores therein, the axes of said bores being parallel with the axis of said shaft; a piston type distributing valve reciprocable in and closing one end of each bore, and engaging one of said swash plates; a displacement piston reciprocable in and closing the other end of each bore and engaging the other swash plate; said distributing valves and pistons defining a working space in each bore, the side walls of the bores having axially spaced inlet and discharge ports formed therein and controlled by said distributing valves so as to connect the working spaces alternately with an inlet or discharge port; and an abutment in the wall of said housing and engaging said assembly and adjustable to shift said shaft assembly axially relatively to said cylinder block.

2. A rotary engine comprising in combination a housing; a cylinder block sustained therein and having a central bearing surface extending therethrough and a plurality of cylinder bores extending therethrough and arranged parallel with and in circular series around the axis of said bearing surface, said bores being provided with axially spaced supply and discharge ports; an axially adjustable abutment closing one end of the housing; bearing means carried by the adjustable abutment; a rotary shaft assembly journalled on said bearing surface and sustained at one end by said bearing means and including a shaft which extends through the cylinder block, and two swash plates on said shaft, one on each side of the cylinder block; a displacement piston in thrust engagement with one of said swash plates and reciprocable in and closing one end of each cylinder bore, a distributing valve of the piston type in thrust engagement with the other swash plate and reciprocable in and closing the other end of each cylinder bore, whereby a working space is defined in each bore between the piston and piston valve therein, the valve pistons serving to connect the working space alternately with said supply and discharge ports, and axial adjustment of said adjustable abutment serving to shift said piston valves in unison relatively to the supply and discharge ports in the cylinder block.

No references cited.