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Clerk

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[54] **PORTING ARRANGEMENTS OF AXIAL PISTON PUMPS AND MOTORS**

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[58] **Field of Search** 91/6.5, 487, 499

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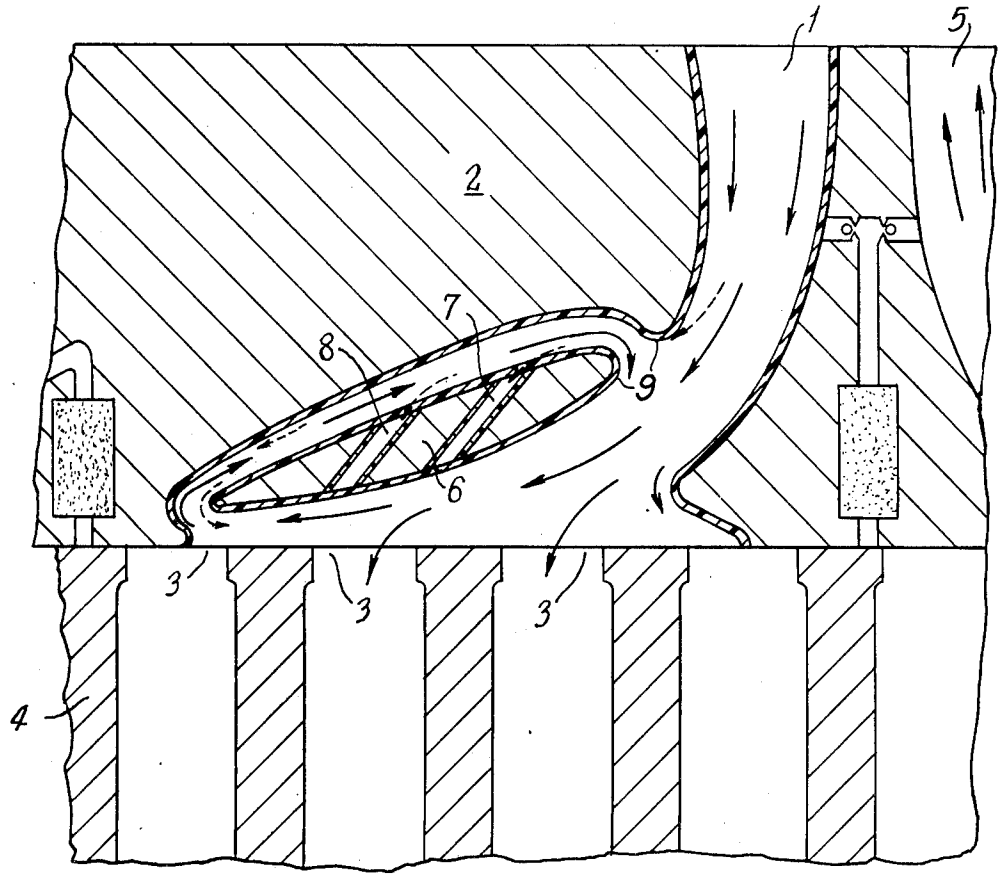
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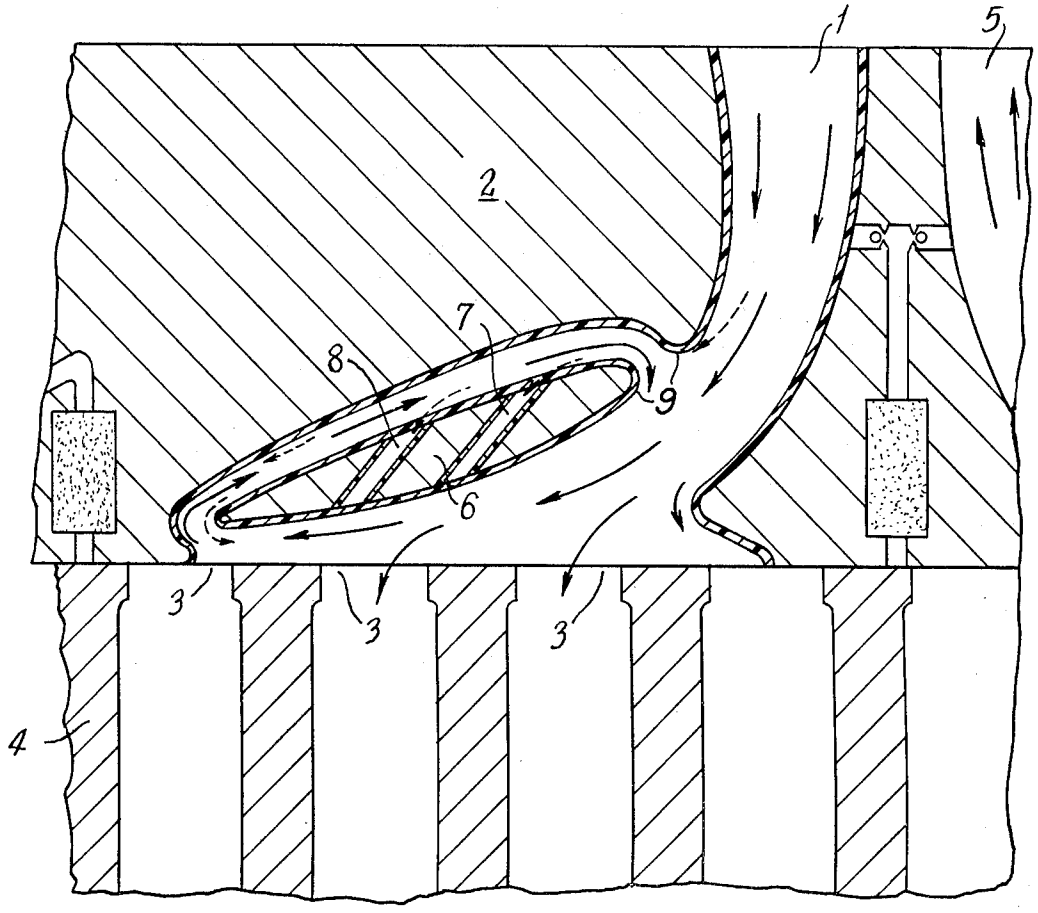
Primary Examiner—William L. Freeh

[57] **ABSTRACT**

The invention provides an axial piston pump/motor in which working fluid is distributed to and from ports in a stationary port face through galleries and each gallery in the vicinity of the ports is divided into two separate galleries by radial hydrofoil-shaped center bodies which act to control fluid flow rate to approximately that of the circumferential speed of cylinder barrel ports passing the stationary ports.

7 Claims, 1 Drawing Figure




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PORTING ARRANGEMENTS OF AXIAL PISTON PUMPS AND MOTORS

BACKGROUND OF THE INVENTION

This invention concerns improvements in the porting arrangements for fluid employed in axial piston pumps or motors.

In hydraulic pumps of the type where intake fluid is transferred, from fixed casing galleries to the rotary barrel or block carrying the cylinders, by a port-face interacting with cylinder ports in the rotating barrel-face, the "kidney-slot" ports, for intake and/or pumped delivery, each of which extends circumferentially for some 150° of the port-face, are necessary to feed or accept pressure fluid from the cylinders during substantially half of each revolution of the cylinder barrel.

It is well-know for such port-faces to be surrounded (except of course on the open side), by a large mass of casing metal to reduce the strain distortions of the port-face induced by the pressures in the delivery port. It is also well known for the port-face galleries to be formed to provide decreasing cross-sectional areas in the direction of rotation of the interacting barrel face in the case of the intake gallery, and conversely increasing in the case of the delivery gallery, with a view to maintaining constant tangential flow velocities over the extent of the galleries at any given quantity flow rate.

SUMMARY OF THE INVENTION

The object of the present invention is to provide a form of port-face gallery which, when acting as the intake, creates or assist in creating a flow of the working fluid at the port-face which bears a close relationship to the circumferential speed of the cylinder barrel ports passing the port-face, regardless of variations in the rotational speed of the cylinder barrel or of the intake volume or velocity of the incoming fluid.

A further object of the invention is to provide a means of restraint of the forces which might cause distortion of the port-face when this is subjected to pressue, so that the mass of metal around the port-face gallery required for stiffening and/or the modulus of alternative casing material, may be reduced without detriment, and in fact with advantage to stiffness and lack of distortion.

To this end what I propose is a pump casing or casing head incorporating a port-face, the port galleries of which emanate from pipe galleries juxtaposed at or near one of the pairs of nearly contiguous ends of two kidney-slot ports of the port-face, the port galleries substantially following the circumferential curvature of the kidney ports, the one in a clock-wise direction from its pipe gallery, and the other anti-clockwise, each with a varying cross-section which in the vicinity of the port face is divided by a radial hydrofoil-shaped center body extending between the inner and outer walls thereof into two separate galleries. The pipe galleries may enter the casing head either semi-tangentially in the plane of the port-face galleries or axially at right angles to this plane, and taper in cross-sectional area to provide an initial increase of flow velocity to fluid entering the pump. This area taper is continued throughout a curved portion of the pipe gallery merging into the beginning of the gallery open to the port-face which initially continues to taper but to a reducing degree.

The port-face gallery at the remote termination of the kidney-slot is so shaped as to deflect any residual

flow of fluid around the trailing edge to the hydrofoil so as to reverse its direction of flow over the block of the hydrofoil where the cross-sectional area first increases then decreases to a minor extent where it reaches the leading edge of the hydrofoil.

The hydrofoil leading edge is so positioned that it is just on the boundary of influence of the intake conveying mass flow, and preferably on the inside of the curved portion of the pipe gallery, such that the falling pressure of the accelerating kinetic flow provides the tendency to induce flow over the leading edge and over the back of the hydrofoil, so boosting the main flow at the port-face where it is fanned to increased velocity by the passing barrel ports thus leading to increased residual reversed flow behind the hydrofoil-shaped center body, and in this way building up "super-circulation" with boundary layer losses made up by the energy acquired by the "fanning" action of the rotating barrel face.

Although the simple hydrofoil above will meet most operational needs, there are special cases where the pump driving speed varies widely, by as much as three to one, though the maximum delivery is maintained constant. For such a case the accelerated intake velocity, without super-circulation, is arrived at at some intermediate speed between maximum and minimum barrel-port passing speed.

Below this intermediate speed, the fanning differential is negative, building up a back-pressure against the accelerated intake flow which consequently diverts over the leading edge and back of the hydrofoil, reversing around the trailing edge to make up and slow down the flow in the gallery open to the port face where it is further influenced by the slow revolving barrel-ports.

The slowing of the accelerated intake flow can be further improved by having one or more hydrodynamic slots in the hydrofoil between the separate galleries in the direction of barrel rotation and at an "incidence" angle dependant on the slowest anticipated barrel and flow speeds to be catered for. The flow through these from the gallery remote from the port face augments the flow into the gallery open to the port face with marked reduction in flow velocity therein.

If a pump or motor is designed to accommodate both directions of rotation of the drive shaft, either port may be intake or delivery and care must be taken in the design of the hydrofoils to allow efficient flow in either direction past the hydrofoil and through the galleries. Otherwise, the hydrofoil in a undirectional delivery port may be designed in association with its gallery to provide optimum pressure conservation.

Advantage may be taken to cast-insert hydrofoils of a high strength material within a casing matrix of a lower strength material having other required physical properties such as low density, or high shock-damping coefficient, or good corrosion resistance to a particular environment. Such casting-insert could incorporate the actual rubbing port-face, choosing a material having additionally a non-scoring surface characteristic to allow more latitude in filtration layout, such as, the adoption of by-pass rather than full-flow filtration systems.

To reduce surface-area boundary-layer flow-drag losses in the "pipe" and port-face galleries, a firmly tenacious plastics material may be gas-flowed blown and heat cured in the galleries to provide smooth low-friction surfaces. This is particularly important where the hydrofoil-shaped center body is cast as self-material

with the casing head and cannot be prepolished as can a cast-insert hydrofoil-shaped center body, because surface roughness of the convex upper face of the hydrofoil section could lead to premature incipient cavitation arising from spread of the minor turbulent vortices in the wake of any roughness.

BRIEF DESCRIPTION OF THE INVENTION

The FIGURE is a fragmentary cross-sectional view of a pump motor including a port formation according to the invention.

DETAILED DESCRIPTION OF THE INVENTION

The drawing shows diagrammatically the developed section of one half of a pump head **2** and the developed section of one half of its matching cylinder block **4,** both take at the pitch circle of the cylinders.

A fluid delivery pipe **1** enters the pump head **2** substantially axially and tapers as it bends to provide a flow path substantially parallel to the path of passing kidney-shaped ports **3** in the cylinder block **4.**

A fluid outlet pipe **5** (only partly shown) is formed as the mirror image of the inlet pipe **1.**

A hydrofoil-shaped center body insert **6** is either cast integrally with the pump head **2** or is cast separately and set in position in that head, in which case it may be highly polished and made of high strength metal, adding strength to the whole port-surface structure. In either case, it may be provided with a coating **9** of low friction plastics material.

Slots **7** and **8,** inclined in the direction of cylinder block movement are provided in the insert **6.**

At high speeds of cylinder block rotation, when overfanning by the passing ports **3** occurs, the fluid flow is as indicated by the longer full line arrows, which indicates that a recirculation occurs around the trailing edge of the insert induced by falling pressure of the accelerated kinetic flow, and the re-circulated flow boosts the main flow at the port-face.

At low speeds of cylinder rotation the flow pattern is modified as shown by the shorter broken line arrows.

These indicate that flow diverts over the leading edge of the insert, through the slots **7** and **8** and around the trailing edge of the insert **6,** thus making up and slowing down the flow beneath the insert.

I claim:

1. In an axial piston pump/motor including reciprocating pistons carried by a rotating cylinder block, a stationary port-face including inlet and outlet ports, each of said inlet and outlet ports having a leading edge and a trailing edge with respect to the direction of rotation of said rotating cylinder block, and a pair of port galleries communicating with said inlet ports and said outlet ports, respectively, whereby fluid entering said port gallery associated with said inlet port flows into said cylinder block as it passes said port-face during rotation, said galleries constructed in a manner such that fluid is directed from said leading edge of said inlet port towards said trailing edge of said inlet port, the improvement which comprises hydrofoil means mounted within said port galleries, so that during increased rotation of said cylinder block a portion of said fluid passing said trailing edge of said inlet port is recirculated around said hydrofoil means towards said leading edge of said inlet port, said hydrofoil means being mounted within said port galleries so that first and second recirculation paths are formed therein, said first recirculation paths being disposed between said hydrofoil means and said rotating cylinder block, and said second recirculation path being disposed between said hydrofoil means and the surface of said port galleries.

2. The axial piston pump/motor of claim **1** in which said inlet and outlet ports are kidney-shaped, and said port galleries substantially follow the circumferential curvature of said kidney-shaped inlet and outlet ports.

3. The axial piston pump/motor of claim **1** in which said hydrofoil means extend between the inner and outer walls of said port galleries.

4. The axial piston pump/motor of claim **1** in which said hydrofoil means includes slot means extending therethrough so that during reduced rotation of said cylinder block a portion of said fluid entering said port gallery associated with said inlet port passes through said slot means.

5. The axial piston pump/motor of claim **1** in which said hydrofoil means is coated with a low-friction plastics material.

6. In an axial piston pump/motor including axially reciprocating pistons carried by a rotating cylinder block, a stationary port-face including inlet and outlet ports, each of said inlet and outlet ports having a leading edge and a trailing edge with respect to the direction of rotation of said rotating cylinder block, and a pair of port galleries communicating with said inlet ports and said outlet ports, respectively, whereby fluid entering said port gallery associated with said inlet port flows into said cylinder block as it passes port-face rotation, said galleries constructed in a manner such that such fluid is directed from said leading edge of said inlet port towards said trailing edge of said inlet port, the improvement which comprises hydrofoil means mounted within said port galleries so that during increased rotation of said cylinder block portion of said fluid passing said trailing edge of said inlet port, said said hydrofoil means including slot means extending therethrough so that during reduced rotation of said cylinder block a portion of said fluid entering said port gallery associated with said inlet port passes through said slot means.

7. The axial piston pump/motor of claim **6** in which said hydrofoil means is coated with a low-friction plastic material.

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