ABSTRACT: A vane pump or motor having a rotatable cylindrical disc incorporated in a housing. The disc has radial grooves provided with radially movable vanes. The housing has at least one pair of associated inlet and outlet apertures, and the part of the inner wall of the housing situated between said apertures is cylindrical and has a larger diameter than the disc. The inner wall between the apertures also forms a boundary for a working space. The number of vanes in a disc is relatively large so that at least two vanes are present between an inlet aperture and an associated outlet aperture.
VANE PUMP OR MOTOR

This invention relates generally to a vane pump or vane motor. Specifically it comprises a cylindrical, rotatable disc accommodated in a housing surrounding the disc. The disc is provided with the disc a number of radial grooves which are regularly distributed about its circumference and extend in the axial direction. The grooves support herein radially movable vanes which, have their ends, remote from the disc, guided by the inner wall of the housing. The housing is provided with at least one pair of inlet and outlet apertures associated with each other for the passage of a fluid. The part of the inner wall of the housing situated between each associated pair of inlet and outlet apertures is cylindrical and has a larger diameter than the disc, and forms a boundary for a working space.

A vane pump or motor of the above-described type is known from Dutch Pat. specification No. 102,292. In this known vane pump or motor the grooves are arranged at such regular distances from each other that the distance between the adjacent vanes, measured on a circle the diameter of which corresponds to that of the cylindrical wall part of the housing which bounds a working space, is substantially equal to the dimension of said wall part viewed in the direction of its circumference. In such a pump or motor only one vane produces a seal between the inlet and the outlet. At the instant this vane leaves the relative cylindrical wall part, a subsequent vane will contact said wall part. The result of this is that the differential pressure across the first vane must be immediately assumed by the next vane. It has been found that this sudden taking over of the full differential pressure of one vane by the next produces certain disturbances in the operation of the pump or motor. In a motor, it is a disturbance in the number of revolutions and in a pump a disturbance in the supply of liquid. In case where a high degree of accuracy in the number of revolutions (for example, in driving precision machine tools) and in the supply of liquid (uniform supply without pressure ripples) is required, these disturbances are highly objectionable.

The present invention is based on the recognition of the fact that such a disturbance is caused as a result of a vane being "tilted backwards" in its groove due to the friction contact with the inner wall of the housing, viewed in the direction of revolution of the disc when there is no pressure difference across it. When such a vane contacts the wall part which forms a boundary of a working space, and the preceding vane leaves said wall part, the differential pressure will be across the vane which has just contacted said wall part. As a result of the prevailing pressure differential, the vane flips in its groove so that, viewed in the direction of revolution of the disc, it assumes a "tilted forward" position in the groove. During this flipping, the seal between the inlet and the outlet is momentarily broken thereby resulting in the above-mentioned disturbance.

It is accordingly an object of the invention to provide a vane pump or motor in which the disturbances of prior devices is fully avoided.

The vane pump or motor according to the invention is characterized in that the grooves in the disc are regularly distributed about its circumference in such a manner that the angle enclosed by radial planes passing through the center of two adjacent grooves and the axis of the disc is at most equal to half of the angle enclosed by two planes each passing through the axis of the disc and one of which passes through the end of the wall part of the housing bounding a working space adjacent to the inlet aperture and the other passes through the end of said wall part adjacent the outlet aperture.

In this manner a motor or pump is obtained in which two vanes will always contact the wall part of the housing which forms a boundary for the working space so that the seal between the inlet and the outlet is always ensured by two vanes arranged in series. The result of this is that the flipping over of a vane occurs when the succeeding vane in the direction of drum rotation has already flipped over so that no bypass situation or open communication between inlet and outlet, will occur. It has been found that the disturbance in the number of revolutions and the supply of liquid, found in prior devices, is avoided in the motor or pump of the present invention.

Since two sealing vanes are always present between an inlet and an associated outlet aperture, the contraction and expansion of the liquid in the parts of the working space communicating with the inlet and outlet, respectively, also becomes much more gradual. It will be obvious that this also contributes to a disturbance-free running of the motor and the pump, respectively.

In a further favorable embodiment, each cylindrical wall part which bounds a working space is provided, at its ends adjacent the inlet and outlet apertures, with equal circumferentially extending discharge grooves. The grooves extend over a distance equal to the arc length of the cylindrical wall part diminished by twice the distance between the vanes measured on the same diameter as that of the relative wall part in such manner that the resistance to flow across a vane which is in contact with a track of the wall part, in which the discharge grooves are situated, is substantially equal to half the resistance to flow across a vane which is in contact with the track of the wall part in which no discharge grooves are situated. As a result of this the contraction and expansion, respectively, of liquid in the parts of the working space which communicate with the inlet and outlet occurs even more gradually while the total resistance to flow between the inlet and outlet is always the same so that avoidance of the objectionable disturbances is further insured.

In order that the invention may be readily carried into effect one embodiment thereof will now be described in greater detail, by way of example, with reference to the accompanying drawings, in which

FIGS. 1 and 2 show two cross-sectional views at mutually right angles of a vane motor having two working spaces.

FIG. 3 shows a working space of the motor shown in FIG. 1 and FIG. 2 on an enlarged scale.

In FIGS. 1 and 2, reference numeral 1 denotes a cylindrical disc. This disc is provided on its circumference with a number of regularly spaced radial grooves 2. The grooves 2 have radially movable vanes 3. The disc 1 is surrounded by a housing 4 having a pair of associated inlet and outlet ports 5 and 6 and a pair of associated inlet and outlet ports 7 and 8.

The housing 4 is closed at its ends by covers 9 and 10 in which the shaft 11 of the disc is journaled in a sealed manner.

The inner wall of the housing 4 surrounds the disc in such a manner that together with the flanges 12 and 13 arranged on the disc two working spaces 14 and 15 are formed. The parts 16 and 17 of the inner wall of the housing 4 between the inlet ports 5 and 7 and the associated outlet ports 6 and 8 are concentric with the disc but situated at a larger diameter while the parts 18 and 19 of the inner wall of the housing situated between the outlet ports 8 and 6 and the inlet ports 5 and 7 cooperate in a sealing manner with the disc 1.

The number of grooves 2 and vanes 3 movable therein is chosen to be such that each angle φ enclosed by two radial surfaces passing through the axis and through the center of two adjacent grooves is smaller than half of the angle φ enclosed by a plane through the axis and through the end of the wall parts 16 and 17, respectively, which adjoins the inlet ports 5 and 7, respectively, and a plane through the axis and through the end of the wall parts 16 and 17, respectively, which adjoins the outlet ports 6 and 8, respectively.

In this manner at least two vanes are always in contact with each of the wall parts 16 and 17 so that the sealing between the inlet and outlet is always ensured by at least two vanes.

FIG. 3 shows the working space 14 on an enlarged scale. From this Figure it is apparent that when the vane 20 leaves the wall part 16, the vane 22 already contacts the wall part 16. In the inlet 5 and in the part 23 of the working space substantially the same high pressure prevails. So no differential pressure prevails across the vane 22 and as a result of the friction between said vane and the wall 16 said vane will assume a
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3 tilted backwards position (viewed in the direction of revolution of the disc 1). In the part 24 of the working space the pressure will have dropped due to leakage so that a differential pressure does occur across the vane 21 so that said vane (see drawing) is tilted forwards. A low pressure prevails in the outlet 6 so that the vane 20 is also tilted forwards.

When the disc 1 is further rotated, the space 24 comes in open communication with the outlet 6. The vane 21 will remain in its forward-tilted position as shown. The pressure in the space 23 will drop, the vane 22 flipping from its backwards-tilted position to its forward-tilted position. During this flipping over a considerable leak occurs for a moment across the vane 22 but since the vane 21 does not flip and remains in the sealing position, no liquid can flow from the high-pressure inlet to the low-pressure outlet. Therefore, no bypass situation will occur each time a vane flips over, in other words open communication between the inlet is avoided and the outlet. This results in a vane motor which operates without disturbances (very constant number of revolutions). When used in a vane pump, a uniform supply of liquid without pressure ripples, is produced.

In order to insure that the overall resistance to flow between the inlet 5 and the outlet 6 is always the same, the wall part 16, at the area of its communication with the inlet and outlet, is provided with a number of discharge grooves 26 and 27 extending in the circumferential direction. The length of said discharge grooves is equal to the length of the wall part 16 diminished by the distance between the vanes 20 and 22 so that when the vane 22 contacts the wall part 16, the vane 20 just arrives in the track provided with discharge grooves 27 while at the instant at which the vane 20 leaves the wall part 16, the vane 22 just passes the end of the discharge groove 26. The discharge grooves are constructed so that the resistance to flow across each of the vanes 20 and 22, when these are in the position shown in FIG. 3, is exactly half of the resistance to flow across the vane 21. In this manner the overall resistance to flow between the inlet and outlet will always be the same. Upon variation of this resistance to flow the number of revolutions would also vary. This is fully avoided by the existence of discharge grooves 26 and 27.

The discharge grooves 26 and 27 also provide that the expansion of the liquid from the space 24 (in a pump contraction of liquid) in the outlet occurs much more gradually, which is also favorable for a number of revolutions which is as constant as possible.

Although the drawing shows by way of example a vane motor, it will be obvious that the invention can be applied with the same advantage to a vane pump.

Furthermore it is to be noted that the invention can be applied to vane motors and pumps having any number of working spaces, the only requirement being that at least two sealing vanes be present between an inlet and an associated outlet.

What is claimed is:

1. A vane pump or motor comprising a cylindrical disc rotatably arranged in a housing surrounding it, said disc having a plurality of radial grooves extending in the axial direction and regularly distributed on its circumference, said grooves being provided with radially movable vanes which, with their ends remote from the disc are guided by the inner wall of the housing, said vanes being arranged for pivotal movement within said grooves, said housing comprising at least one pair of associated inlet and outlet apertures for liquid, and means producing pressure difference across said vanes, the part of the inner wall of the housing situated between each pair of associated inlet and outlet apertures being cylindrical and having a larger diameter than the disc, said wall part also forming a boundary for a working space, said grooves in the disc being regularly distributed about the circumference thereof in such manner that the angle enclosed by radial planes passing through the center of two adjacent grooves and the axis of the disc is equal to no greater than half of the angle enclosed by two planes each passing through the axis of the disc and one of which passes through the end of the wall part of the housing forming the boundary of the working space which communicates within the inlet aperture and the other passes through the end of said wall part which communicates with the outlet aperture, equal discharge grooves provided on each cylindrical wall part which forms a boundary for a working space communicating at its ends with inlet and outlet apertures, said discharge grooves extending in the circumferential direction over a distance equal to the arc length of the cylindrical wall part diminished by twice the distance between the vanes measured on the same diameter as that of the relative wall part, said grooves being arranged so that when a vane passes thereacross the resistance to flow across said vane is substantially equal to half the resistance to flow across a vane which contacts the track of the wall part in which no discharge grooves are arranged.

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