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SLIDING VANE PUMP

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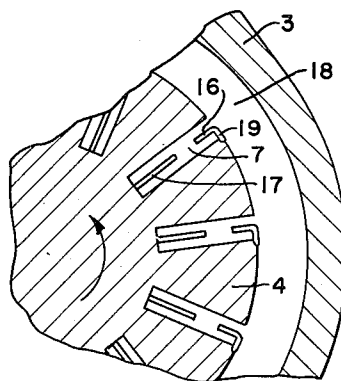
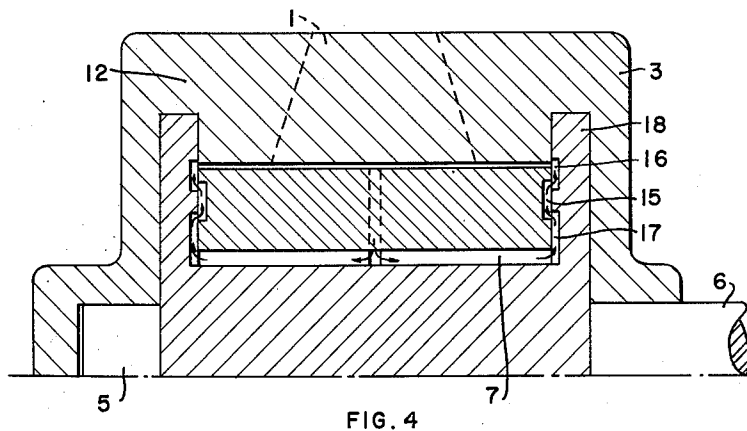
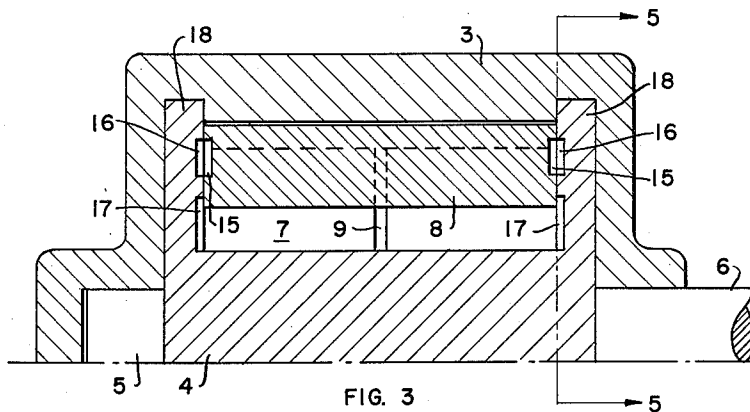


FIG. 5

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SLIDING VANE PUMP

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The invention relates to pumps and pertains more particularly to a sliding vane pump comprising a housing, a rotor having substantially radial slots, and radially slidable vanes in these slots.

The invention relates in particular to a sliding vane pump in which each slot space, i.e., the space formed in each rotor slot beneath the vane accommodated therein, communicates with the pump space which, relative to the direction of rotation of the rotor, is situated in front of the associated vane.

Since liquid can flow through these communication passages into and out of the slot spaces when the vanes in the slots move outwards and inwards respectively, the pressure prevailing in each slot space will be substantially equal to the pressure in the pump space which, relative to the direction of rotation of the rotor, is situated in front of the associated vane.

The centrifugal force caused by the rotation of the rotor forces the vanes outwardly to make contact with the inner wall of the housing. This thrust is further increased in that the communication passages enable the pressure prevailing in the pump space in front of each vane to be transmitted into the relative slot spaces.

When high rotor speeds are used in pumps where the slot formed between the outer wall of the rotor and the inner wall of the housing in the region where the high-pressure zone of the outlet port adjoins the low-pressure zone of the inlet port is only of narrow width, erosion is found to occur in the slots in the part nearest to the center line of the rotor, which erosion, judging from its outward appearance, is attributable to cavitation.

The primary object of the invention is to prevent erosion in the slots of a pump of the sliding-vane type. Another object of this invention is to minimize excessive wear in sliding-vane pumps, which wear occurs in the form of cavitation in the bottom of the slots in which the vanes are housed. This is attained by establishing communication between each slot space, the vane accommodated in the slot being in the slid-in position, and the pump space which, relative to the direction of rotation of the rotor, is situated behind the associated vane.

Tests with the sliding vane pump according to the invention have shown that the said erosion is entirely suppressed by the arrangement made. It was also found that the previous wear of the inner wall of the housing in the region where the high-pressure zone of the outlet port adjoins the low-pressure zone of the inlet port was reduced to nil.

Moreover, the wear of the outer edges of the vanes had been considerably reduced.

The said communication passages between the slot spaces and the pump spaces situated behind the relative vanes are preferably constituted by grooves or channels which are provided in the vanes and cooperate with the grooves or channels arranged in the walls of the relative slots when the vanes are in the slid-in position.

In a preferred embodiment of the sliding vane pump according to the invention the back of each vane is provided with a substantially radial groove which communicates with the pump space which is situated, relative to the direction of rotation of the rotor, behind the associated vane, while the slot wall cooperating with the said vane wall is provided with a groove which commu-

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nicates with the slot space and communicates with the other groove only when the vane is in the slid-in position.

In a second preferred embodiment of the sliding vane pump according to the invention at least one of the side or end walls of each slot is provided with two substantially radial grooves, one of the grooves communicating with the slot space, and the other communicating with the pump space which, relative to the direction of rotation of the rotor is situated behind the associated vane, while a substantially radial groove is provided in the adjacent side or end wall of the vane which cooperates with the grooved side or end wall of the slot, which groove only communicates with both grooves provided in the side or end wall of the slot when the vane is in the slid-in position.

The invention will be further elucidated with reference to the drawings, wherein:

FIGURE 1 is a cross-sectional view of a sliding vane pump according to the invention;

FIGURE 2 is a longitudinal sectional view taken along the line II-II of FIGURE 1;

FIGURE 3 is part of a longitudinal sectional view of another embodiment of the sliding vane pump according to the invention;

FIGURE 4 is part of a second longitudinal sectional view of the pump shown in FIGURE 3; and

FIGURE 5 is part of a cross-sectional view taken along the line V-V of FIGURE 3.

The sliding vane pump shown in FIGURES 1 and 2 is of the double-acting type, viz it has two inlet ports 1, 1' and two outlet ports 2, 2', disposed in a symmetrical arrangement in the housing 3.

In the housing 3 is mounted the rotor 4 which is supported in the housing by means of the shaft journal 5 and the shaft 6 and is driven by means of shaft 6 in the direction shown in FIGURE 1.

The rotor is provided with a plurality of radial slots 7, each of which accommodates a vane 8 slidably mounted therein. The inside of the housing is so shaped that a pump space A, crescent-shaped in cross-section, extends on the one hand over the space between this inside wall of the housing and the outer wall of the rotor 4, and on the other over the space between an inlet (1 and 1') and an associated outlet (2 and 2'). Since the pump shown in FIGURES 1 and 2 is a double-acting one, it has two pump spaces A and B of this type which are traversed by the parts of the vanes 8 protruding from the rotor 4 and are so divided into separate spaces that direct communication can never be established between the inlet 1 and the outlet 2 (or 1' and 2') and between the inlet 1 and the inlet 2' (or 1' and 2) on rotation of the rotor. The flow created by rotation of rotor 4 in the housing 3 is indicated by arrows in the inlet ports 1, 1' and the outlet ports 2, 2'.

One wall of each slot 7 is provided with a narrow conduit, fluid passageway or groove 9 extending from the bottom of the slot 7 to the part of the pump space A or B which, relative to the direction of rotation of the rotor is situated in front or on the downstream side of the vane 8 accommodated in slot 7. Alternatively, the groove 9 may be formed in the adjacent face of the vane and extend entirely across it in the same direction. Thus, in all positions of the vane 8 the slot space below the vane 8 communicates with the pump space A or B in front of the vane.

Each slot 7 is also provided with a narrow groove 10, extending from the bottom of the slot 7 to half-way along the height thereof in the wall opposite that containing groove 9. Moreover the back wall of the vane 8 (viewed in the direction of rotation of the rotor) is provided with a groove 11 extending from the top

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of the vane to approximately half-way along the height thereof. The placement and lengths of the grooves 10 and 11 are such that the grooves only communicate with each other when the vanes are in the slid-in position, viz in the position in which the vanes pass the dam 12 between the outlet port 2' and the inlet port 1 and the dam 13 between the outlet port 2 and the inlet port 1'. In all other positions of the vanes this communication is broken. In other words, the pump spaces on both sides of each vane communicate through the associated slot space when the associated vane is completely slid into the associated slot. In all other positions the said pump spaces do not communicate with each other, but whereas the pump space situated behind each vane is not in communication with the associated slot space, the pump space situated in front of each vane is in communication with the associated slot space.

The pump is provided with supply and discharge lines (not shown) connected to the ports, 1, 1', 2 and 2' and is also coupled by means of the shaft 6 to a driving motor (not shown).

When the pump is in operation the rotation of the rotor 4 and the movements of the vanes 8 cause liquid to be pumped from the inlet ports 1 and 1' to the outlet ports 2 and 2', respectively. During this rotation each slot space is in constant communication with the pump space situated in front of the associated vane. The result is that first of all the movement of the vanes in the slots is not hampered by pressure variations occurring in each slot space as a result of the fact that the volume of each slot space is periodically increased and decreased, while moreover a thrust is set up, forcing the vanes 8 against the inner wall of the housing 3.

A vane passing the outlet port 2 is gradually forced inwardly by the inner wall of the housing and kept in this inward position by the inner wall in its travel to the next inlet port 1'. The clearance between the rotor 4 and the inner wall of the housing 3 is as small as possible at this point, i.e., where the dam 13 is located, in order to reduce leakage of liquid from the high-pressure outlet port 2 to the low-pressure inlet port 1 to a minimum.

Accordingly, when the vanes pass the dam 13 each vane is almost completely slid into the associated slot 7, and the ends of the grooves 10 and 11 overlap in this position. As a result, communication is established between the pump spaces which, relative to the direction of rotation, are situated in front of and behind the vane, through the groove 9, the associated slot space 7, the groove 10, the overlap opening 14 and the groove 11.

It should be observed that, when passing the dam 12 on their travel from the outlet port 2' and the inlet port 1, the vanes 8 are also pressed into the position in which they are substantially slid in, so that communication is established between the pump spaces situated in front of and behind the associated vanes, in the same way as described above.

It is found that the attack of the dams 12 and 13 and of the walls of the slot spaces 7 in the case of sliding vane pumps not provided with the grooves 10 and 11, is completely suppressed in the sliding vane pump according to the invention.

The explanation of absence of galling between the edges of the vanes 8 and the dams 12 and 13 in the sliding vane pump according to the invention is as follows. When a vane 8 in the slid-in position moves from an outlet port (2, 2') to an inlet port (1, 1') it has to entrain the liquid present in the narrow slit between the rotor 4 and the housing 3, but the flow of liquid in this narrow slit is necessarily accompanied by a great difference in pressure, i.e., when the vane 8 is, for example, half-way on its travel between an outlet port and an inlet port, the pressure behind the

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vane is appreciably lower than that in the outlet port, and the pressure in front of the vane is appreciably higher than that in the inlet port. The high pressure in front of the vane is transmitted through the groove 9 to the slot space 7 under the vane and, if grooves 10 and 11 are absent, presses the outer edge of the vane with such force against the inner wall of the housing that galling occurs between the edge and the wall. If, however, the slot space 7 also communicates with the pump space behind the vane through the grooves 10 and 11 and the overlap opening 14, the pressure between the pump spaces on both sides of the vane will be at least partially equalized and no excessive pressures will prevail in the slot space 7, so that there is no galling. This advantage is admittedly obtained at the expense of fluid leaking through from the outlet port to the inlet port through the slot space, although the quantity of fluid leaking through is very small.

No obvious explanation can be given as to why the attack of the wall of the slot spaces under the vane is suppressed by the said provision. It is probably due to the fact that the magnitude of the sudden pressure fluctuations in the slot space 7 decreases when the latter approaches the inlet port. In the known construction there is then a maximum subatmospheric pressure behind the vane, whereas the pressure in front of the vane is almost equal to the pressure in the inlet port. If the low pressure prevailing behind the vane can exert its influence through the clearance between vane and slot wall (e.g. in the case of a vibrating movement of the partition in its slot) in the slot space where the centrifugal force causes a liquid pressure which is in any case lower than the outside pressure round the rotor, cavitation may occur in the slot space. By establishing communication between the slot space and the pump space at the back of the vane, as stated above, the pressure between the front and back of the vane is equalized, thus eliminating both the possible cause of vibrations of the vane in its groove (i.e. sudden pressure fluctuations) and the low pressure in the pump space behind the vane.

In the sliding vane pump shown in FIGURES 3, 4 and 5, the groove 9 through which the pump space situated in front of the vane 8 is in constant communication with the slot space 7 situated under the vane, is arranged in one of the slot walls in the same manner as shown in FIGURES 1 and 2. The sides or ends of each vane and the ends of the associated slot are provided with a system of grooves operating in the same manner as the grooves 10 and 11 of the pump shown in FIGURES 1 and 2. This system includes grooves 15 of which one is provided in each side of each vane 8, and the grooves 16 and 17 in each side of the rotor wall forming each slot 7.

In this pump the side walls of slots 7 and of the pump spaces are formed by the disk-shaped projections 18 of the rotor 3. Moreover, each groove 16 joins a transverse groove 19 (see FIGURE 5) through which each groove 16 communicates with the pump space situated behind the associated vane.

In the cross-sectional view of the sliding vane pump represented in FIGURE 3, the shown vane 8 is in the slid-out position. In this case the space in front of the vane communicates through the groove 9 with the slot space 7. The grooves 15, 16 and 17 are so provided in the ends or sides of the vane 8 and the end walls of slot 7 that in this position there is no communication between the slot space 7 and the pump space behind the associated vane.

However, when the partition or vane 8 passes one of the dams 12 or 13 provided between the outlet port and the inlet port (see FIGURE 4), communication is established between the slot space 7 and the pump space behind the associated vane through the grooves 17, 15 and 16 and the transverse groove 19. At the same time com-

munication is maintained between the slot space 7 and the pump space in front of the associated vane through the groove 9, so that in the position shown in FIGURE 4 in which a vane 8 passes one of the dams 12 and 13 communication is established between the spaces in front of and behind the relative vane, thus preventing, as stated above, fluid erosion or attack of the slot spaces, and also wear of the dams. Moreover, wear of the outer edges of the vanes is considerably reduced.

It will be understood that the invention is not limited to the shape and position, nor to the number of grooves establishing the required communication between the pump spaces on both sides of the vanes in the slid-in positions thereof. Nor is the invention restricted to the use thereof in a double-acting pump, as shown in the drawing, but also applies to a single-acting pump as well.

I claim as my invention:

1. A sliding vane pump comprising a housing forming a pump space, inlet and outlet means to said pump space, a rotor rotatably mounted within said housing and having substantially radial slots formed therein, radially slidable vanes carried in these slots of a size whereby slot spaces are formed under said vanes, and fluid conduit means in said rotor by which each slot space situated under each vane communicates at all times with the pump space which, relative to the direction of rotation of the rotor, is situated in front of the associated vane, characterized in that each slot space under each vane, the vane accommodated in the slot being in the slid-in position, communicates with the pump space which, relative to the direction of rotation of the rotor, is situated behind the associated vane.

2. A sliding vane pump comprising a housing forming a pump space, inlet and outlet means to said pump space, a rotor rotatably mounted within said housing and having substantially radial slots formed therein, radially slidable vanes carried in these slots of a size whereby slot spaces are formed under said vanes, and first fluid conduit means in said rotor by which each slot space situated under each vane communicates at all times with the pump space which, relative to the direction of rotation of the rotor, is situated in front of the associated vane, and second fluid conduit means in said rotor by which each slot space under each vane, the vane contained in the slot being in the slid-in position, communicates with the pump space which, relative to the direction of rotation of the rotor, is situated behind the associated vane.

3. A sliding vane pump comprising a housing forming a pump space, inlet and outlet means to said pump space, a rotor rotatably mounted within said housing and having substantially radial slots formed therein, radially slidable vanes carried in these slots of a size whereby slot spaces

are formed under said vanes, first fluid conduit means in said rotor in open communication at all times between the slot space under each of said vanes and the pump space within the housing downstream of said vane, and normally closed second fluid conduit means in said rotor in open communication between the slot space under each of said vanes and the pump space upstream of said vane only when the vane is substantially fully retracted within its slot.

4. A sliding vane pump as claimed in claim 3, wherein the said second fluid conduit means between the slot spaces and the pump spaces situated behind the associated vanes are in the form of grooves which are formed in the vanes and cooperate with other grooves formed in the walls of the relative slots when the vanes are in the slid-in position.

5. A sliding vane pump as claimed in claim 4, wherein the back of each vane is provided with a substantially radial groove which communicates with the pump space which, relative to the direction of rotation of the rotor, is situated behind the associated vane while the slot wall cooperating with the said vane wall is provided with a groove which communicates with the slot space and communicates with the other groove only when the vane is in the slid-in position.

6. A sliding vane pump as claimed in claim 4, wherein at least one of the side walls of each slot is provided with two substantially radial grooves, one of the grooves communicating with the slot space, and the other communicating with the pump space which, relative to the direction of rotation of the rotor, is situated behind the associated vane, while a substantially radial groove is provided in the side wall of the vane which cooperates with the grooved side wall of the slot, which groove only communicates with both grooves provided in the side of the slot when the vane is in the slid-in position.

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