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Description

The invention relates to a liquid ring compressor, in particular for the operating range of intake pressures of below 1 bar, with a control disc disposed closely adjacent to at least one end face of the impeller of the optionally last compressor stage and having a pressure port for the delivery medium.

The minimum intake pressures to be achieved by liquid ring compressors depend, firstly, on the structural design and, secondly, on the vapour pressure of the medium used as the operating liquid. If a compressor is operated at a pressure on the intake side which is near to the vapour pressure of the operating liquid, the mass rate of gas flow which is delivered by the pump will be correspondingly low and the proportion of vapour occurring on the compressor intake side will be correspondingly high. This can then result in cavitation phenomena in the compressor, which become apparent in particular at the control disc in the vicinity of the pressure port of the optionally last compressor stage and at the impellers. This is caused by the fact that at such minimal mass rates of flow a relatively high underpressure prevails in the vane compartments shortly before the opening leading to the pressure chamber of the compressor. As a result of low gas flow, liquid accumulates in the pressure chamber and this liquid eventually also extends over the initial region of the pressure port, so that when the impeller compartments are opened towards the pressure chamber there occurs an abrupt back flow of liquid through the pressure port into the compartment, whereupon such high velocities are attained that erosion and cavitation damage occur.

It has been endeavoured (DE-A 32 07 507) to obviate this phenomenon by providing on that side of the control disc facing the impeller, viewed in the direction of rotation, a recess or depression just in front of the pressure port in the operating chamber, for the controlled back flow of the

gas delivered; however, the disadvantage of this is that compressor performance is reduced when the intake pressure is higher. The same disadvantage arises if air or gas is added from the exterior on the compressor intake side or between the stages in multi-stage compressors. In this case it is very difficult for the addition of air or gas to be controlled correctly in such a way that the addition occurs at quite specific intake pressures of the compressor. It may be necessary to use correspondingly sensitive valves which operate within narrow pressure ranges and, therefore, are very expensive.

It has also been endeavoured to obviate cavitation and erosion damage in these compressors in that, particularly at substantial underpressures, liquid and gas are discharged separately from the pressure chamber, whereby the pressure port is maintained free of liquid even at low intake pressures of the compressor. It is a disadvantage here that the separated discharge of gas and liquid from the pressure chamber of the compressor is correspondingly expensive and it is necessary to provide a control means which enables the separate discharge to be effective at low intake pressures.

In a further embodiment in a special compressor with a vertical shaft, it is known to recirculate gas and/or air into the pressure chamber of the compressor; however, this is a measure which has been only partly successful and has proven to be completely ineffective in other compressors. On the other hand, the invention is based on the object of devising a liquid ring compressor of the type indicated at the beginning, in which the disadvantages brought about by cavitation are obviated by means of simple and inexpensive structural measures.

The object according to the invention is achieved in that a passage discharges at the wall of the first quarter (viewed in the direction of rotation) of the permanently open portion of the pressure port of the optionally last compressor stage, which passage communicates on the other

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side directly with a gas chamber in which the compressor final pressure substantially prevails.

At low mass rates of flow of the compressor a slight underpressure prevails in this region of the pressure port, which is caused by the impeller compartments in which the compressor final pressure has not yet been reached being continually open. The gas flowing in as a result of the underpressure and/or the inflowing air then prevents liquid from flowing back into the impeller compartments in this region, thereby preventing the cavitation and erosion damage described above.

In order to adapt the size of the pressure port to different pressure conditions, it is known to provide parts of the pressure port with valves which open only under certain operating conditions. The pressure port then comprises a permanently open part and one or more parts provided with valves or flaps. Accordingly, in accordance with the invention, the indication of the location for the discharge of the passage refers exclusively to the permanently open part of the pressure port.

Preferably, the passage discharging into the pressure port of the compressor stage communicates with the gas chamber of a separation vessel connected downstream of the compressor, whereby it is possible to ensure in a particularly simple manner that a pressure is available at this location in the pressure port which corresponds substantially to the compression pressure of the compressor.

It has also been found to be advantageous for the orifice of the passage in the pressure port to be arranged spaced at a distance from the end face of the impeller which corresponds approximately to one vane thickness or less of the impeller in the vicinity of the pressure port. Troublesome flow noise occurs if the passage is disposed too close to the impeller end face, whereas some of the cavitation and erosion-preventing action is lost if the distance from the end face of the impeller is too great.

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A preferred position for the orifice of the passage in the pressure port of the optionally last compressor stage is the radially outer boundary of the pressure port of the control disc. From here the passage can be directed, in a particularly simple manner, outwards through the control disc and from there via an external connection to a chamber in which the compressor final pressure substantially prevails.

Another preferred embodiment of the invention is the arrangement of the passage in the pressure port of the optionally last compressor stage in the chamfer, optionally provided in this region, of the radial pressure port boundary which is of substantially straight or else curved shape. Firstly, with this arrangement the passage orifice is very close to the start of the pressure port and, secondly, because of the corresponding position of the orifice it is also possible for the distance from the end face of the impeller to be accurately determined.

A particularly simple embodiment of the invention is also to be found in that the passage discharging into the pressure port of the optionally last compressor stage is in the form of a simple bore. It will be readily apparent that this offers the least difficulties in respect of production methods.

To prevent any escape of liquid and gas, when the compressor is operating at relatively high mass rates of flow, through the passage discharging into the pressure port of the optionally last compressor stage it is proposed to install a non-return valve in a duct communicating with the exterior. This would then open a path for gas or air respectively into the compressor under corresponding operating conditions, i.e. at correspondingly low intake pressures of the compressor.

The invention will be illustrated by way of example below with reference to the accompanying drawings:

Figure 1 shows a cross-section through part of a compressor along the section line BB in Figure 2;

Figure 2 shows a plan view of part of a control disc of the compressor along the section line AA in Figure 1;

Figure 3 shows a cross-section through part of a compressor with intake and pressure connectors arranged on one side of the compressor, along the section line EE in Figure 4;

Figure 4 shows a plan view of part of a control disc along the section line CC in Figure 3;

Figure 5 shows a detail enlargement along the section line DD in Figure 4.

In Fig. 1 an impeller 2 is mounted on a shaft 1 and it rotates in a housing 3 and is bounded at the end face by a control disc 4.

A pressure port 5 connecting the impeller compartments to a pressure chamber 6 is disposed in the control disc 4, the chamber 6 being bounded by a pressure housing 7. The shaft passage to the exterior is sealed by a packing 8.

In accordance with the invention, a passage 9 is provided in the control disc 4 and its orifice is situated at a distance a from the end face of the impeller, this distance corresponding approximately to one vane width or less in the vicinity of the pressure port.

The shaft 1 is again shown in Fig. 2, as is also in plan view the control disc 4 with the pressure port 5 provided therein. The passage 9 leading to the pressure port in the control disc is shown in dash lines and, as evident here, it discharges at the first quarter of the pressure port. Both the liquids expelled from the impeller compartments and the gas leave the compressor through the pressure connector 10.

Figures 3 and 5 illustrate sections of part of a compressor, in which the suction and pressure connectors are disposed on one side of the compressor. The impeller 2 is again mounted on the shaft 1 and the pump delivery chamber is bounded by the housing 3 and at the impeller end face by the control disc 4. The compressor housing 7 comprises both the intake connector 13 and the pressure connector 10 of the



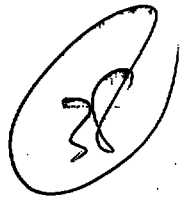
compressor and it is divided by a rib 12 into an intake chamber 14 and the pressure chamber 6. The gas flows through an intake port 11 into the impeller compartments and then exits therefrom, as before, through the pressure port 5. The start of the pressure port 5 is here in the form of a chamfer 16 and the passage 9 according to the invention discharges thereinto; the passage is directed to the exterior through a corresponding housing cam 15. A non-return valve (not shown) can be provided in the passage 9 in the form of a bore or in the adjoining communicating duct; this non-return valve prevents the escape to the exterior of liquid from the pump compartments when the pump is delivering in operating ranges with relatively high mass rates of flow.



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CLAIMS:

1. A liquid ring compressor, in particular for the operating range of intake pressures of below 1 bar, with a control disc disposed closely adjacent to at least one end face of the impeller of the optionally last compressor stage and having a pressure port for the delivery medium, characterised in that a passage (9) discharges at the wall of the first quarter (viewed in the direction of rotation) of the permanently open portion of the pressure port (5) of the optionally last compressor stage, which passage communicates on the other side directly with a gas chamber in which the compressor final pressure substantially prevails.
2. A liquid ring compressor according to Claim 1, characterised in that the passage (9) communicates with the gas chamber of a separation vessel connected downstream of the compressor.
3. A liquid ring compressor according to Claim 1 or 2, characterised in that the distance (a) of the orifice of the passage (9) from the end face of the impeller (2) corresponds approximately to one vane thickness or less of the impeller in the vicinity of the pressure port (5).
4. A liquid ring compressor according to any one of Claims 1 to 3, characterised in that the passage (9) in the radially outer boundary of the pressure port (5) discharges at the control disc (4).
5. A liquid ring compressor according to any one of Claims 1 to 4, characterised in that the radial pressure port boundary containing the orifice of the passage (9) is in the form of a chamfer (16).
6. A liquid ring compressor according to Claims 1 to 5, characterised in that the passage (9) is in the form of a simple bore.



7. A liquid ring compressor according to Claims 1 to 6, characterised in that a non-return valve is installed in the passage (9).