(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 085 212 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
21.03.2001 Bulletin 2001/12

(51) Int Cl.[7]: **F04D 1/06**, F04D 17/12

(21) Application number: **00850140.5**

(22) Date of filing: **23.08.2000**

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: **15.09.1999 SE 9903278**

(71) Applicant: **ITT MANUFACTURING ENTERPRISES, INC.**
Wilmington, Delaware 19801 (US)

(72) Inventor: **Arbeus, Ulf**
181 60 Lidingö (SE)

(74) Representative: **Larsson, Sten**
ITT FLYGT AB
Box 1309
171 25 Solna (SE)

(54) High-pressure centrifugal pump

(57) The invention concerns a pump or a compressor of centrifugal type for obtaining a high pressure.

The device according to the invention comprises an impeller having a circular disc (3) which is provided with radially directed vanes (5) and (6) on each side which constitute two pressure steps. The vanes are provided with cover discs (8) and (9) respectively, which on there outwardly directed sides have radially directed vanes (4) and (7) respectively, which form another two pressure steps.

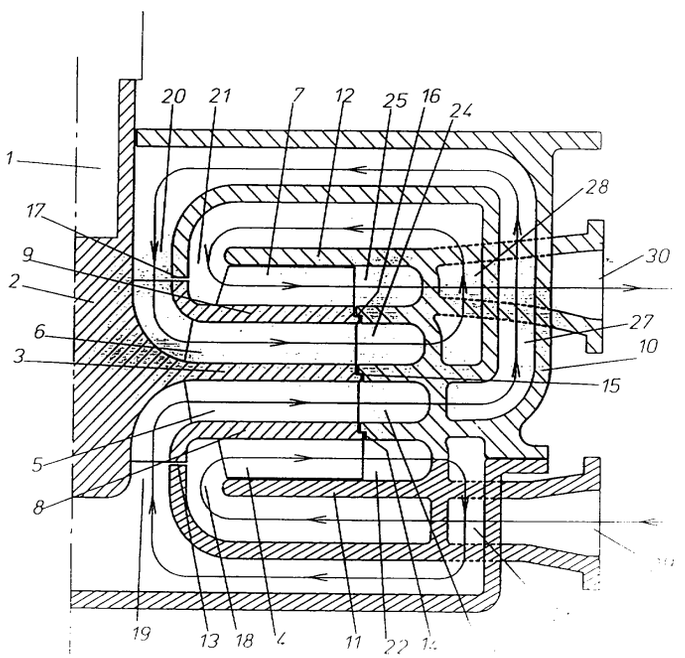

FIG 1

EP 1 085 212 A2

Description

[0001] The invention concerns a high-pressure machine, namely a pump for liquids or a compressor for obtaining a media transport under high pressure.

[0002] In the following is referred to pumps for liquids, but the invention is also applicable in machines for transport of gaseous media.

[0003] When pumping liquids to high levels where consequently a high pressure is needed, a pump of the centrifugal type is to prefer. Such a pump comprises a pump impeller on a rotating shaft, said impeller being designed with a hub and a circular disc provided with one or several impeller vanes. The liquid enters in an axial direction in the center and leaves the impeller at the periphery. A pump housing surrounding the impeller, transforms the kinetic energy to pressure energy which obtains the transport to a higher level.

[0004] At higher heads it is common to use pumps with high rotation speeds and relatively small diameters. It is also possible to connect a number of pumps in series by connecting the outlet from a first step to the inlet in a second step and so on. An example is shown in EP-A-355781, where five steps are connected in series.

[0005] When a certain operation point at a certain rotation speed is chosen, it can be an advantage to use several steps, as the pump impellers can operate at rotation speeds which are superior with regard to efficiency. This increase of efficiency is mainly related to the fact that the friction losses at the back sides of the impeller hubs, as a part of the total losses, decrease. On the other hand the linking losses between the steps are added. One disadvantage is further, that the relatively complicated design means that service and maintenance become complicated and in addition long shafts bring about increased mechanical stress.

[0006] Another way to obtain high pump heads is to connect two identical pressure steps in series as is shown in US-A-958 765 and DE-353 698. The pump impellers are here arranged mirror-inverted, but have in other respects conventional designs. US-A-2 136 939 discloses a pump with two pressure steps having a common hub disc, thereby obtaining a reduction of the disc losses. This solution, as well as the one previously mentioned, have in common that the principle only allows two pressure steps, which is not always sufficient for obtaining the desired pump head.

[0007] The purpose of the invention is thus to obtain a pump or a compressor having more than two pressure steps having a very high efficiency thanks to the fact that the disc losses are minimized. The device according to the invention is also characterized in that the design is very compact, easy to mount and being possible to adapt with regard to axial force and seal pressure.

[0008] The invention is disclosed below with reference to the enclosed drawings. Fig 1 shows a an axial cut through a pump according to the invention, while Fig 2 shows the cut according to Fig 1 inserted in a view over a submersible pump.

[0009] In the drawings 1 stands for a rotary shaft, 2 a pump impeller hub having a disc 3. 4, 5, 6 and 7 stand for impeller vanes, 8 and 9 cover discs and 10 a part of a pump housing comprising walls 11 and 12 opposing the impeller. 13, 14, 15, 16 and 17 symbolize seals, 18, 19, 20 21 stand for inlets to the pressure steps. 22, 23, 24 and 25 stand for diffusors in the pump steps. 26, 27 and 28 stand for flow conduits, 29 and 30 inlet and outlet respectively for the pump and 31 finally, a motor unit.

[0010] According to the invention the high-pressure pump comprises a pump housing 10 within which a rotating hub 2 with a connected disc 3 is arranged. The disc 3 is on each side provided with vanes 5 and 6 respectively, each group of vanes being provided with a cover disc 8 and 9 respectively and creating a double-sided closed pump impeller. The cover discs 8 and 9 are on their respective opposite sides provided with additional vanes which form another double sided pump impeller together with the pump housing walls 11 and 12 respectively. In this way a four-step pump impeller is created having two closed and two open channels.

[0011] The pump operates in the following way: the liquid is sucked in through the inlet 29 and flows to the inlet 18 of the first pressure step. This step is formed by the vanes 4, the cover disc 8 and the pump housing wall 11. A flow conduit 26 goes from the diffusor 22 of said first pressure step to the inlet 19 of a second pressure step, said second step being formed by the vanes 5, the underside of the hub disc 3 and the cover disc 8. A second flow conduit 27 goes from the diffusor 23 of said second pressure step to the inlet 20 of a third pressure step, said third step being formed by the vanes 6, the upside of the hub disc 3 and the cover disc 9. A third flow conduit 28 goes from the diffusor 24 of said third pressure step to the inlet 21 of a fourth pressure step, said fourth step being formed by the vanes 7, the cover disc 9 and the pump housing wall 12. Finally the liquid leaves the pump via the diffusor 25 of the fourth pressure step through the inlet 30.

[0012] The pump according to the invention provides a number of advantages when compared with conventional high-pressure pumps having one or several pressure steps.

[0013] The efficiency is very high thanks to the fact that several pressure steps bring about a more favorable specific rotation speed and that the disc losses are reduced considerably.

[0014] The mounting of the pump is much simpler in a comparison with mounting of conventional multi-step pumps. In addition, trimming of the very compact pump means possibilities to reduce axial forces as well as seal pressures thanks to the symmetrical design.

[0015] In the embodiment of the invention that is described above, the importance of minimizing the pressure difference between two adjacent pressure steps has been stressed. If it is more important to minimize the axial forces, another order between the steps might

be to prefer. The scope of the invention also includes an embodiment where all channels in the impeller are closed.

[0016] As previously mentioned, the invention is not limited to pumps for liquids, but is also possible to apply for pressurizing of gaseous media.

[0017] Within the scope of the invention there is also a possibility to increase the number of pressure steps by providing the outer vanes 4 and 7 with cover discs. Said discs may in their turn be provided with additional vanes which form additional pressure steps in cooperation with additional pump housing walls and so on, the different pressure steps being connected via single or multiple flow conduits.

Claims

1. A pump or a compressor of centrifugal type for providing high pressures, comprising a rotary shaft (1) connected to a motor (31) and provided with an impeller surrounded by a housing (10), characterized in,

   that the impeller comprises a circular disc (3) connected to a hub (2), said disc being provided on each side with vanes (5) and (6) respectively, which together with opposing parts of the housing (10) create two pressure steps,
   that the edges of said vanes (5) and (6) respectively are provided with cover discs (8) and (9) respectively, which on their outwardly directed sides are provided with additional vanes (4) and (7) respectively, which together with opposing parts of the housing (10) form two additional pressure steps
   and that single or multiple flow conduits (26), (27) and (28) respectively are arranged between the outlet (22) of a first pressure step and the inlet (19) of a second pressure step, between the outlet (23) of said second pressure step and the inlet (20) of a third pressure step and between the outlet (24) of said third pressure step and the inlet (21) of a fourth pressure step, the mutual order between said pressure steps being arbitrary.

2. A pump or a compressor according to claim 1, characterized in,
   that the pressure steps are arranged in an ascending order with the last step adjacent the motor (31).

3. A pump or a compressor according to claim, characterized in,
   that it has a ring-formed inlet.

4. A pump or compressor according to claim 1, characterized in,
   that it has a radially to tangentially directed outlet connected to the last pressure step.

5. A pump or a compressor according to claim 1, characterized in,
   that the vanes (4) and (7) are provided with cover discs having on their respective outwardly directed sides additional vanes which form additional pressure steps together with additional pump housing parts.

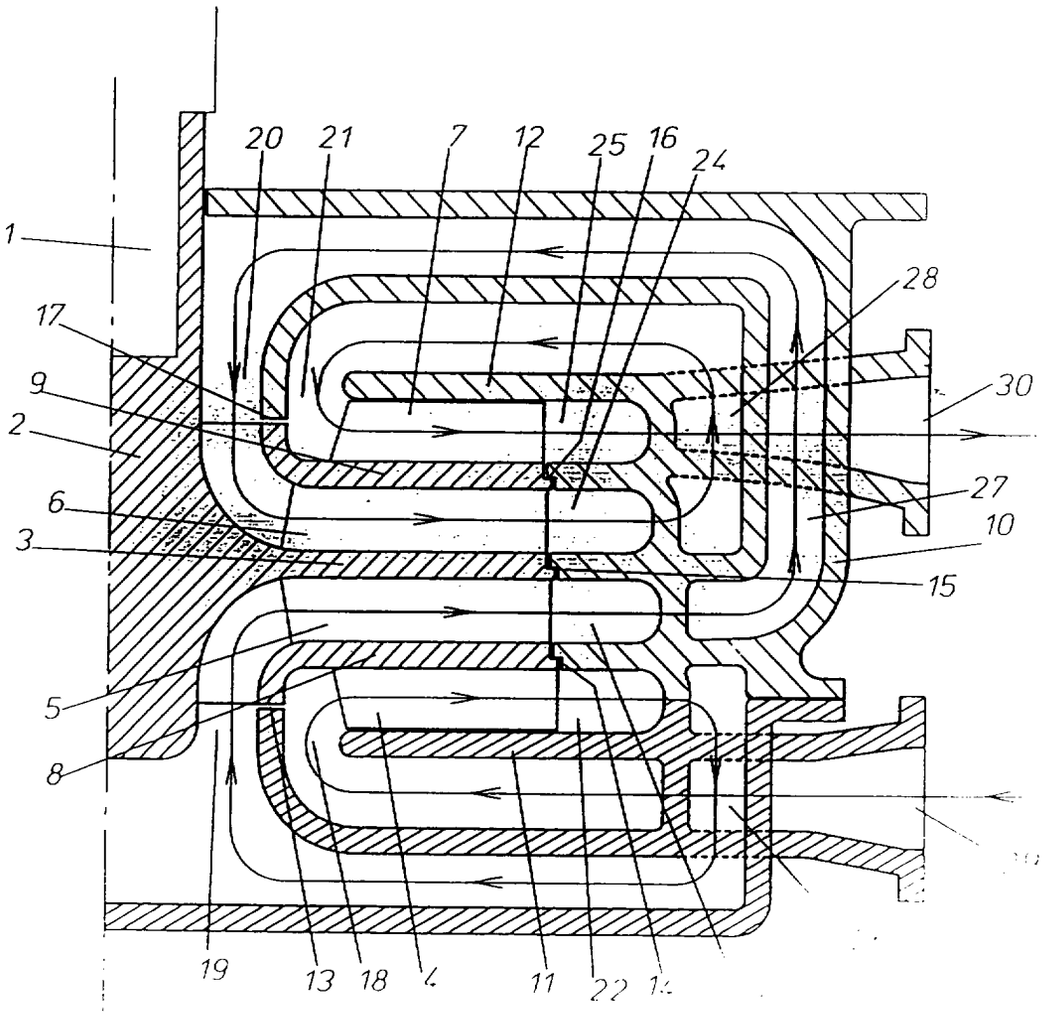

FIG 1

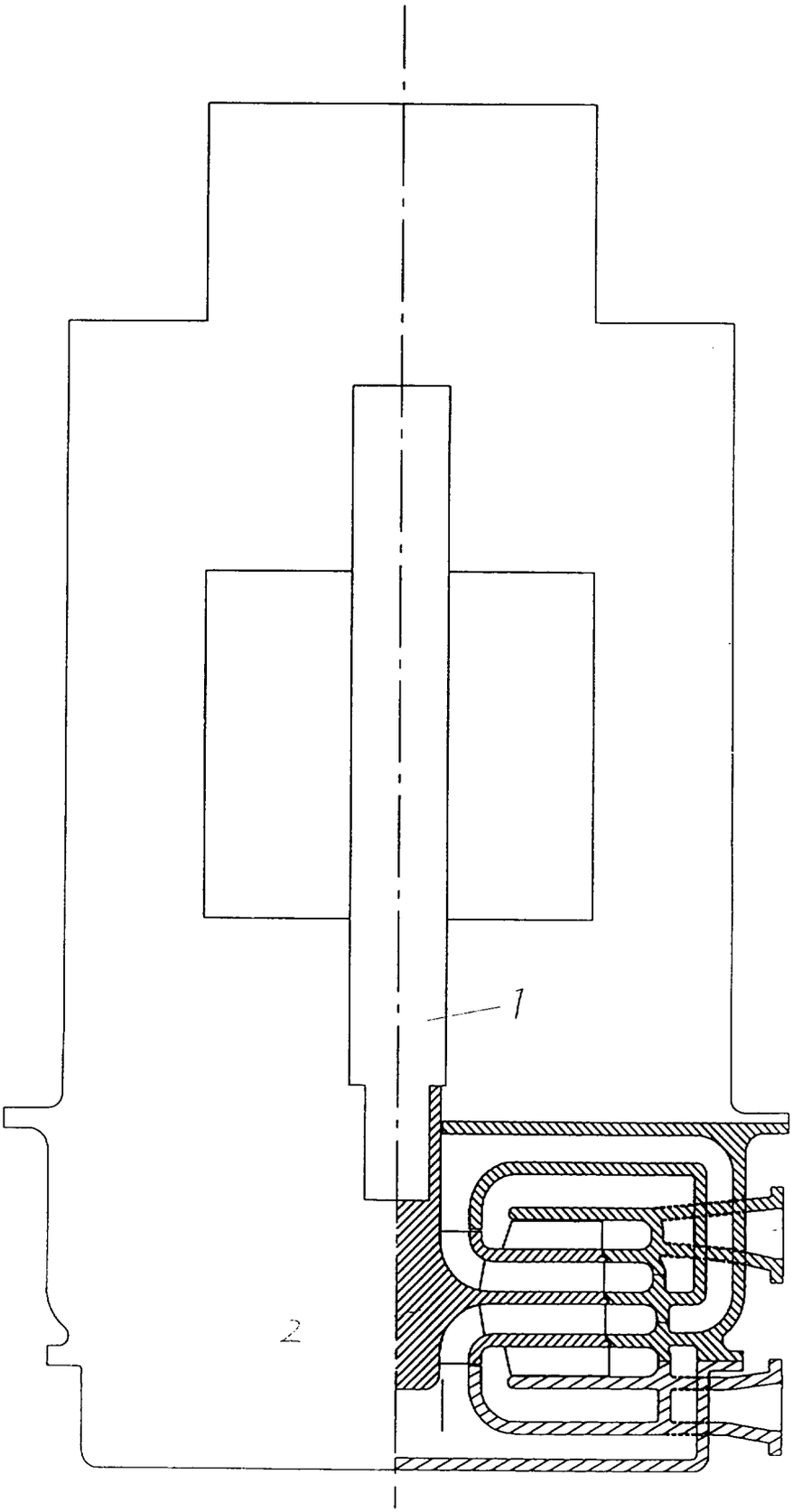

FIG 2