

Description

Pump arrangement

- 5 The invention relates to a pump arrangement, in particular magnetic clutch pump arrangement, having an interior space formed by a pump casing of the pump arrangement, having a containment can which hermetically seals off a chamber surrounded by said
- 10 containment can with respect to the interior space formed by the pump casing, having an impeller shaft which can be driven in rotation about an axis of rotation, having an impeller which is arranged on one end of the impeller shaft, having an inner rotor
- 15 arranged on the other end of the impeller shaft, having an auxiliary impeller arranged in the chamber, and having an outer rotor which interacts with the inner rotor.
- 20 DE 27 54 840 A1 has disclosed a magnetic clutch pump arrangement of said type with an auxiliary impeller. The auxiliary impeller is of disk-shaped construction and is equipped with radial bores. However, said embodiment, with regard to its efficiency, constitutes
- 25 an inefficient impeller or delivery variant, and lowers the overall efficiency of the pump arrangement. Furthermore, a not inconsiderable level of outlay is required to produce the auxiliary impeller.
- 30 It is the object of the invention to provide a magnetic clutch pump arrangement with a forced-lubrication flow drive which is simple to produce and which exhibits improved efficiency.
- 35 The object of the invention is achieved in that the auxiliary impeller is fastened to the inner rotor.

Since the auxiliary impeller is fastened by way of its open side to that face side of the inner rotor which faces toward the base of the containment can, it is possible for the advantages of a closed channel-type
5 impeller to be utilized by way of an open impeller, which is much easier to produce. Furthermore, the impeller does not have a hub and is easy to assemble and disassemble.

10 In one refinement, the containment can has a main body with an open side and with a side which is situated opposite the open side and which is closed by way of a domed base, and the auxiliary impeller has a rear shroud, whose outer surface facing toward the base of
15 the containment can has a domed form.

By virtue of the fact that the domed form of the outer surface of the rear shroud substantially corresponds to the domed form of the base of the containment can, the
20 dead space that is normally spanned by the domed base of the containment can is filled, whereby no additional axial structural space required by the magnetic clutch is taken up. Furthermore, the pressure resistance of the containment can is not unnecessarily reduced.

25 To improve the flow guidance of the medium as it enters a fluid inlet region of the auxiliary impeller, a paraboloid-like elevation is ideally provided in the center of the rear shroud.

30 In a further refinement, it is provided that, on the rear shroud, at a radial distance from the elevation, there are formed multiple raised portions which form vanes and corresponding impeller channels of the
35 auxiliary impeller.

In a further refinement, it is proposed that the impeller channels have a channel base which is similar

in form to a rampant three-center arch. This leads to an improvement in flow guidance.

5 In a further refinement of the invention, it is provided that the upper side, which is averted from the rear shroud, of the vanes has a step close to the channel inlet edge. The step serves as an abutment shoulder and centering device for precise alignment of the auxiliary impeller fastened to the inner rotor.

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For simple and inexpensive production, the impeller shaft and the inner rotor form a cover shroud, situated opposite the rear shroud, of the auxiliary impeller.

15 In a further advantageous refinement, in the raised portions which form the vanes, there are formed further impeller channels which extend in a radial direction from the outer lateral surface as far as a point close to the step.

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To improve the flow guidance of the medium, the further impeller channels have a channel base which, at least in part, has a domed form which corresponds substantially to the domed form of the outer surface of the rear shroud.

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According to the invention, the impeller shaft has an axial channel which is connected to the fluid inlet region of the auxiliary impeller.

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In the context of the invention, it is proposed that, in a further embodiment, in the inner rotor, there are provided fluid channels which issue into the further impeller channels of the auxiliary impeller.

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Exemplary embodiments are illustrated in the drawings and will be described in more detail below. In the drawings:

figure 1 shows the longitudinal section through a magnetic clutch pump arrangement having an auxiliary impeller according to the invention,

figure 2 shows the longitudinal section through the magnetic clutch pump arrangement as per figure 1 in a plane rotated through 90° in relation to figure 1,

figure 3 shows an auxiliary impeller, corresponding to figure 1, in an enlarged illustration,

figure 4 is a detailed three-dimensional illustration of the auxiliary impeller as per figure 3,

figure 5 is a detailed three-dimensional illustration of a further embodiment of the auxiliary impeller according to the invention,

figure 6 shows a longitudinal section through a magnetic clutch pump arrangement having an auxiliary impeller according to the invention as per figure 5,

figure 7 shows the longitudinal section through a magnetic clutch pump arrangement as per figure 6, with an inner rotor rotated through 45° in relation to figure 6, and

figure 8 shows the longitudinal section through the magnetic clutch pump arrangement as per figure 6, in a plane rotated through 90° in relation to figure 6.

Figures 1 and 2 show a pump arrangement 1 in the form of a magnetic clutch pump arrangement. The pump

arrangement 1 has a multi-part pump casing 2 of a centrifugal pump, which pump casing comprises a hydraulic casing 3 in the form of a spiral casing, a casing cover 4, a bearing carrier cage 5, a bearing carrier 6 and a bearing cover 7.

The hydraulic casing 3 has an inlet opening 8 for the intake of a delivery medium and has an outlet opening 9 for the discharge of the delivery medium. The casing cover 4 is arranged on that side of the hydraulic casing 3 which is situated opposite the inlet opening 8. The bearing carrier cage 5 is fastened to that side of the casing cover 4 which is averted from the hydraulic casing 3. The bearing carrier 6 is mounted on that side of the bearing carrier cage 5 which is situated opposite the casing cover 4. The bearing cover 7 in turn is fastened to that side of the bearing carrier 6 which is averted from the bearing carrier cage 5.

A containment can 10 is fastened to that side of the casing cover 4 which is averted from the hydraulic casing 3, and said containment can extends at least partially through an interior space 11 delimited by the pump casing 2, in particular by the casing cover 4, by the bearing carrier cage 5 and by the bearing carrier 6. The containment can 10 hermetically seals off a chamber 12, which is enclosed by said containment can and by the casing cover 4, with respect to the interior space 11.

An impeller shaft 13 which is rotatable about an axis of rotation A extends from a flow chamber 14, which is delimited by the hydraulic casing 3 and by the casing cover 4, into the chamber 12 through an opening 15 provided in the casing cover 4.

An impeller 16 is fastened to a shaft end, situated within the flow chamber 14, of the impeller shaft 13, and an inner rotor 17 arranged within the chamber 12 is arranged on the opposite shaft end, which has two shaft sections 13a, 13b with increasing diameters in each case. The inner rotor 17 is equipped with multiple magnets 18 which are arranged on that side of the inner rotor 17 which faces toward the containment can 10. An auxiliary impeller 20 is fastened to the inner rotor 17 by way of screws 19 or other suitable fastening means.

Between the impeller 16 and the inner rotor 17 there is arranged a bearing arrangement 21 which is operatively connected to the impeller shaft 13, which can be driven in rotation about the axis of rotation A.

A drive motor, preferably an electric motor, which is not illustrated drives a drive shaft 22. The drive shaft 22, which can be driven about the axis of rotation A, is arranged substantially coaxially with respect to the impeller shaft 13. The drive shaft 22 extends through the bearing cover 7, through the bearing carrier 6, and at least partially into the bearing carrier cage 5. The drive shaft 22 is mounted in two ball bearings 23, 24 which are accommodated in the bearing carrier 6. On the free end of the drive shaft 22 there is arranged an outer rotor 26, which bears multiple magnets 25. The magnets 25 are arranged on that side of the outer rotor 26 which faces toward the containment can 10. The outer rotor 26 extends at least partially over the containment can 10 and interacts with the inner rotor 17 such that the rotating outer rotor 26, by way of magnetic forces, sets the inner rotor 17 and thus likewise the impeller shaft 13 and the impeller 16 in rotation.

The containment can 10, illustrated on an enlarged scale in figure 3, has a substantially cylindrical main

body 27. The main body 27 is open on the side facing toward the casing cover 4, and is closed by way of a domed base 28 on the side situated opposite the open side. On the open side, there is arranged a ring-like attachment flange 29 which is formed integrally with the main body 27 or which is fastened to the latter by welding or other suitable fastening means or devices, for example screws, rivets or the like. The attachment flange 29 has multiple bores 30 which extend parallel to the axis of rotation A and through which screws 31 can be passed and screwed into corresponding threaded bores in the casing cover 4. The base 28 of the containment can 10 is formed by a substantially spherical segment-shaped spherical cap region 32 and an outer rim region 33 which forms the transition region between main body 27 and spherical cap region 32.

As can be seen from figures 3 and 4, the auxiliary impeller 20 has a rear shroud 34, whose outer surface, facing toward the base 28 of the containment can 10, has a domed form. The domed form of the outer surface of the rear shroud 34 substantially corresponds to the domed form of the base 28 of the containment can 10. In the center of the rear shroud 34, a paraboloid-like elevation 35 is provided in a fluid inlet region 36. Furthermore, multiple raised portions are formed on the rear shroud 34 at a radial distance from the elevation 35, which raised portions form vanes 37 with a channel inlet edge 38, facing toward the elevation 35, and corresponding impeller channels 39 of the auxiliary impeller 20. The elevation 35 is conducive to improving the flow guidance of the medium as it enters the impeller channels 39 of the auxiliary impeller 20. In the exemplary embodiment shown, the vanes 37 extend in curved fashion from the fluid inlet region 36 to an outer lateral surface 40 of the auxiliary impeller 20. The impeller channels 39 have a channel base 41, which in turn has a domed form substantially corresponding to

the domed form of the outer surface of the rear shroud 34. The channel base 41 of the impeller channels 39 is, in the longitudinal section shown, similar in form to a rampant three-center arch, as illustrated in figure 6.

5 The impeller channels 39 have a first width $W1$ at the fluid inlet region 36 and have a second width $W2$ at the outer lateral surface 40, wherein the second width $W2$ is greater than the first width $W1$ or at least corresponds to the first width $W1$.

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The upper side, which is averted from the rear shroud 34, of the vanes 37 has a step 42 close to the channel inlet edge 38, which step serves as an abutment shoulder and centering device for the auxiliary
15 impeller 20 fastened to the inner rotor 17. A cover shroud which is situated opposite the rear shroud 34 and which closes off the impeller channels 39 formed between the vanes 37 can be dispensed with, as the impeller shaft 13 and the inner rotor 17 form the cover
20 shroud of the auxiliary impeller 20. Owing to its semi-open construction, the auxiliary impeller 20 is easy to produce both by casting, as it is easily demoldable, and by mechanical machining, as the impeller channels can be easily milled out.

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At a distance radially outward from the steps 42, installation holes 43 are provided which extend through the rear shroud 34 and the vanes 37, through which
30 installation holes the screws 19 are passed and screwed into the threaded bores 44 formed on that side of the inner rotor 17 which faces toward the base 28 of the containment can 10. The auxiliary impeller 20 can thus be fastened by way of its open side to that face side
35 of the inner rotor 17 which faces toward the base 28 of the containment can 10. On the side situated opposite the channel inlet edge 38, each vane 37 preferably has at least one recess 45. An additional pressure increase is generated in this way.

As shown in figure 2, in the casing cover 4, there are provided at least one passage opening 46 and, in a bearing ring carrier 47 which fixes the bearing arrangement 21, at least one radial passage opening 48. The passage opening 48 extends through a flange-like region 49 by means of which the bearing ring carrier 47, which is positioned coaxially with respect to the axis of rotation A and which extends into the chamber 12, is fastened to the casing cover 4 by way of a screw connection (not illustrated). The passage openings 46 and 48 connect the flow chamber 14 to an inner region 50 of the bearing ring carrier 47.

Thus, for the cooling and lubrication of the bearing arrangement 21, delivery medium can be extracted from the flow chamber 14 and supplied by the passage openings 46 and 48 to the bearing arrangement 21. Via at least one radial bore 51, the delivery medium is delivered from the inner region 50 into an axial channel 52, which extends from a region of the impeller shaft 13 surrounded by the bearing arrangement 21 to that end of the impeller shaft 13 which is situated within the chamber 12, and thus to the auxiliary impeller 20. The axial channel 52 is thus connected to the fluid inlet region 36 of the auxiliary impeller 20. If necessary, at least one further radial bore 53 is formed which is likewise connected to the axial channel 52 formed in the impeller shaft 13. The auxiliary impeller 20 delivers the medium used for cooling and lubrication radially outward into the chamber 12, from where said medium is delivered back into the flow chamber 14 via multiple axial passage openings 54 formed in the flange-like region 49 and passage openings 55 formed in the casing cover 4, said passage openings being shown in figure 1.

Figures 5 to 8 show a further exemplary embodiment of the invention. The auxiliary impeller 20, illustrated in detail in figure 5, has vanes 37 which are formed by raised portions on the rear shroud 34 and which define
5 impeller channels 39 which extend radially outward from the fluid inlet region 36. In the exemplary embodiment shown, the vanes 37 extend rectilinearly from the fluid inlet region 36 to the outer lateral surface 40 of the auxiliary impeller 20. The impeller channels 39 have a
10 first width $W1$ at the fluid inlet region 36 and a second width $W2$ at the outer lateral surface 40, wherein the second width $W2$ is greater than the first width $W1$ or at least corresponds to the first width $W1$.

15 Further impeller channels 56 are formed in the raised portions which form the vanes 37, which further impeller channels extend in the radial direction likewise in substantially straight form, that is to say without a curvature or without a significant curvature,
20 from the outer lateral surface 40 to a point close to the step 42, and which further impeller channels have a channel base 57 which, at least in part, has a domed form which substantially corresponds to the domed form of the outer surface of the rear shroud 34. As viewed
25 in longitudinal section, the channel base 57 of the impeller channels 56 is similar in form to a rampant three-center arch, as illustrated in figure 7. The impeller channels 56 widen toward the outer lateral surface 40 proceeding from the region adjacent to the
30 step 42, and said impeller channels have a first width $W3$ at a fluid inlet region 56a and a second width $W4$ at the outer lateral surface 40, wherein the second width $W4$ is greater than the first width $W3$ or at least corresponds to the first width $W3$.

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Figures 6 to 8 show a pump arrangement 1 which is equipped with an auxiliary impeller 20 as illustrated in figure 5. Here, the view in figures 6 and 7

corresponds to the view in figure 1. The view in figure 8 corresponds to the view in figure 2. As can be seen from figure 6, there is at least one radial bore 53 leading into an axial channel 52 which is shorter than in figures 1 and 2. Furthermore, the bearing ring carrier 47 has fluid channels 58 running parallel to the axis of rotation A, which fluid channels connect the inner region 50 of the bearing ring carrier 47 to the chamber 12 which is enclosed by the containment can 10 and by the casing cover 4.

Figure 7 shows the pump arrangement 1 shown in figure 6 with an inner rotor 17 rotated through 45° about the axis of rotation A. In the inner rotor 17 there are provided fluid channels 59 which are arranged approximately at the same radial distance from the axis of rotation A as the fluid channels 58 of the bearing ring carrier 47, and which are thus substantially in alignment with said fluid channels 58 at least in the position illustrated. The fluid channels 59 issue into the impeller channels 56 of the auxiliary impeller 20, which is arranged on that face side of the inner rotor 17 which faces toward the base 28 of the containment can 10.

For the cooling and lubrication of the bearing arrangement 21, delivery medium is extracted from the flow chamber 14 and, as shown in figure 8, is supplied to the bearing arrangement 21 via the at least one passage opening 46 in the housing cover 4 and via the at least one passage opening 48 in the flange-like region 49 of the bearing ring carrier 47. Via the at least one radial bore 53, the delivery medium is delivered from the inner region 50 of the bearing ring carrier 47 into the axial channel 52 and to the auxiliary impeller 20. By way of the impeller channels 39, the auxiliary impeller 20 delivers the medium used

for cooling and lubrication radially outward into the chamber 12.

At the same time, as per figure 7, the delivery medium
5 extracted from the flow chamber 14 is delivered from
the inner region 50 of the bearing ring carrier 47, via
the fluid channels 59 formed in the inner rotor 17,
into the impeller channels 56 of the auxiliary impeller
20, and radially outward into the chamber 12.

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From the chamber 12, the medium is delivered back into
the flow chamber 14 via the at least one passage
opening 55 (shown in figures 6 and 7) formed in the
casing cover 4.

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In the exemplary embodiments shown, the auxiliary
impeller 20 is shown either with the impeller channels
39 or with the impeller channels 39 and the impeller
channels 56. It is self-evident that the auxiliary
20 impeller 20 may also be equipped only with the impeller
channels 56.

List of reference designations

1	Pump arrangement	31	Screw
2	Pump casing	32	Spherical cap region
3	Hydraulic casing	33	Rim region
4	Casing cover	34	Rear shroud
5	Bearing carrier cage	35	Elevation
6	Bearing carrier	36	Fluid inlet region
7	Bearing cover	37	Vane
8	Inlet opening	38	Channel inlet edge
9	Outlet opening	39	Impeller channel
10	Containment can	40	Outer lateral surface
11	Interior space		
12	Chamber	41	Channel base
13	Impeller shaft	42	Step
13a	Shaft section	43	Installation hole
13b	Shaft section	44	Threaded bore
14	Flow chamber	45	Recess
15	Opening	46	Passage opening
16	Impeller	47	Bearing ring carrier
17	Inner rotor	48	Passage opening
18	Magnet	49	Flange-like region
19	Screw	50	Inner region
20	Auxiliary impeller	51	Radial bore
21	Bearing arrangement	52	Axial channel
22	Drive shaft	53	Radial bore
23	Ball bearing	54	Passage opening
24	Ball bearing	55	Passage opening
25	Magnet	56	Impeller channel
26	Outer rotor	57	Channel base
27	Main body	58	Fluid channel
28	Base	59	Fluid channel
29	Attachment flange		
30	Bore	A	Axis of rotation

Patent claims

1. A pump arrangement, in particular magnetic clutch pump arrangement, having an interior space formed by a pump casing of the pump arrangement, having a
5 containment can with a base which hermetically seals off a chamber surrounded by said containment can with respect to the interior space formed by the pump casing, having an impeller shaft which
10 can be driven in rotation about an axis of rotation, having an impeller which is arranged on one end of the impeller shaft, having an inner rotor arranged on the other end of the impeller shaft, having an auxiliary impeller arranged in
15 the chamber, and having an outer rotor which interacts with the inner rotor,

characterized in that

- 20 the auxiliary impeller (20) which has a semi-open construction is fastened by way of its open side to that face side of the inner rotor (17) which faces toward the base (28) of the containment can (10).

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2. The pump arrangement as claimed in claim 1, characterized in that the containment can (10) has a main body (27) with an open side and with a side which is situated opposite the open side and which
30 is closed by way of a domed base (28), and the auxiliary impeller (20) has a rear shroud (34), whose outer surface facing toward the base (28) of the containment can (10) has a domed form.
- 35 3. The pump arrangement as claimed in claim 2, characterized in that the domed form of the outer surface of the rear shroud (34) substantially corresponds to the domed form of the base (28) of the containment can (10).

4. The pump arrangement as claimed in one of claims 2 to 3, characterized in that a paraboloid-like elevation (35) is provided in the center of the rear shroud (34).
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5. The pump arrangement as claimed in claim 4, characterized in that, on the rear shroud (34), at a radial distance from the elevation (35), there are formed multiple raised portions which form
10 vanes (37) and corresponding impeller channels (39) of the auxiliary impeller (20).
6. The pump arrangement as claimed in claim 5,
15 characterized in that the impeller channels (39) have a channel base (41) which is similar in form to a rampant three-center arch.
7. The pump arrangement as claimed in claim 5,
20 characterized in that the upper side, which is averted from the rear shroud (34), of the vanes (37) has a step (42) close to a channel inlet edge (38).
8. The pump arrangement as claimed in one of claims 2 to 7, characterized in that the impeller shaft (13) and the inner rotor (17) form a cover shroud, situated opposite the rear shroud (34), of the auxiliary impeller (20).
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9. The pump arrangement as claimed in claim 5, characterized in that, in the raised portions which form the vanes (37), there are formed further impeller channels (56) which extend in a
35 radial direction from the outer lateral surface (40) as far as a point close to the step (42).
10. The pump arrangement as claimed in claim 9, characterized in that the further impeller

channels (56) have a channel base (57) which, at least in part, has a domed form which corresponds substantially to the domed form of the outer surface of the rear shroud (34).

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11. The pump arrangement as claimed in one of claims 1 to 10, characterized in that the impeller shaft (13) has an axial channel (52) which is connected to a fluid inlet region (36) of the auxiliary
10 impeller (20).

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12. The pump arrangement as claimed in claim 9, characterized in that, in the inner rotor (17), there are provided fluid channels (59) which issue
15 into the further impeller channels (56) of the auxiliary impeller (20).

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