

Description

Pump arrangement and method for producing a containment
shell for the pump arrangement

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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 has a
10 central longitudinal axis and 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 can be driven in rotation about an axis of rotation, having an impeller
15 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 outer rotor which is arranged on a drive shaft and which interacts with the inner rotor, wherein the containment can has a base with at
20 least one bead which projects into the chamber. The invention also relates to a method for producing a containment can of a pump arrangement.

In the case of such pumps, the rotating magnetic field
25 induces eddy currents in the metallic containment can situated between inner rotor and outer rotor. Said statically positioned containment can, together with the casing cover and the pump casing itself, forms the pressure-bearing pump part, whereby the inner rotor,
30 which is situated within said enclosure, is in constant contact with the delivery medium. To reduce the eddy currents and the associated continuous heating of the medium to the point of evaporation, use is firstly normally made of metallic containment can materials
35 with high electrical resistance. Particularly expensive nickel-based alloys (Hastelloy) have become established for this purpose. Secondly, the heat losses are dissipated by way of a cooling flow. Said flow, which is branched off as a bypass from the main delivery

flow, is, owing to the pressure distribution in the chamber, transported over the outer diameter of the inner rotor, in a radially inward direction between inner rotor and containment can base to the impeller shaft, and back to the main hydraulic system via a hollow bore in said impeller shaft. Owing to the rotation of the inner rotor and the resulting formation of vortices in the bypass flow of the delivery medium, an excessive pressure gradient arises between the inner rotor outer diameter and the inlet, situated coaxially with respect to the axis of rotation, of the hollow bore of the impeller shaft. The cooling flow rate and thus the heat dissipation are restricted. Integration of a geometry, which has the effect of impeding or breaking up vortices in the delivery medium, on the static containment can base can prevent or limit this, whereby the inertial rotor chamber temperature remains at a corresponding level below the vapor pressure curve of the delivery medium.

DE 91 00 515 U1 has disclosed a magnetic coupling pump in which it is intended to reduce the formation of swirl phenomena in the delivery medium by way of a bead provided in the base of the containment can. The pressure loading-optimized geometry or shape of the base without beads results from the expandability or deformability of the convex-ellipsoidal base under load. This is however impeded owing to the centrally provided beads, which thus have a stiffening action. This results in increased stresses in the containment can material of the bead region. In relation to convex-ellipsoidal shapes without beads, and using the same wall thicknesses or starting material thicknesses, the disclosed bead contour achieves a compressive strength of only approximately 40%. In this way, an equal compressive strength can be attained only through the use of more material, with an associated increase in costs.

It is the object of the invention to provide a pump arrangement in which the formation of vortices in the delivery medium within the containment can is further reduced, without reducing the stability of the containment can.

The object of the invention is achieved in that the at least one bead is arranged with a radial spacing to the central longitudinal axis of the containment can, wherein the ratio of inner radius of the containment can to spacing of bead outer edge and central longitudinal axis of the containment can lies in a range from 1.3 to 1.6.

The ratio of inner radius of the containment can to spacing of bead outer edge and central longitudinal axis of the containment can preferably lies in a range from 1.38 to 1.57.

The spacing of the bead inner edge to the central longitudinal axis of the containment can is advantageously $\frac{1}{7} * \text{containment can inner radius}^Y$, wherein Y preferably lies in a range from approximately 1.14 to 1.17.

Through such a specification of the ratio of inner radius of the containment can to radius of the bead outer edge, or of the spacing of the bead inner edge to the central longitudinal axis, the axial expandability or deformability of the containment can base is maintained, whereby the pressure-withstanding capability is maintained to a degree of 90 to 95% in relation to a containment can base of the same wall thickness without beads.

In a preferred implementation of the invention, for a high compressive strength of the preferably deep-drawn

or cast containment can, the base thereof is formed by a substantially spherical - segment-shaped spherical cap region and by a rim region which forms the transition region between main body and spherical cap region.

According to the invention, for an optimum spacing between inner rotor and the bead base, the bead base runs in a plane which is situated substantially parallel to the plane in which the transition from the spherical cap region to the rim region is situated. The imaginary planes lie substantially perpendicular to a central longitudinal axis of the containment can.

Here, in a particular refinement, it is provided that the inner wall of the containment can in the region of the bead base lies substantially in the same plane as the transition from the spherical cap region to the rim region.

In an alternative refinement, the bead base is formed so as to run parallel to the spherical cap region.

A good mode of operation with regard to the reduction of vortex formation is achieved if, in the region of the bead base, the maximum spacing of the inner wall of the containment can to the face side, facing toward the base of the containment can, of the inner rotor is approximately 20 mm.

It is preferable if, in the region of the bead base, the maximum spacing of the inner wall of the containment can to the face side of the inner rotor is approximately 10 mm, in order to further reduce vortex formation.

Since the mechanical stresses are at their greatest at the transition from the spherical cap region to the

bead region, and sharp-edged transitions are the most effective for preventing the formation of vortices, it is provided according to the invention that the transitions between the spherical cap region and the
5 bead walls have greater radii than the transitions from the bead walls to the respective bead base. At the same time, it is possible for the pressure acting outwardly in the chamber enclosed by the containment can to be accommodated in a particularly effective, that is to
10 say low-stress manner.

If the at least one bead extends in a radial direction to a point close to the rim region, or extends as far as the latter, the vortices that arise in the chamber
15 enclosed by the containment can, said vortices being most pronounced at the inner rotor in a region with the greatest circumferential speed, that is to say close to the outer diameter of the rotating inner rotor, are effectively reduced.

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A method according to the invention provides that the containment can is produced by way of a deep-drawing process or by way of a casting process, wherein at least one bead is produced in the base, which bead is
25 arranged with a radial spacing to the central longitudinal axis of the containment can.

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

figure 1 shows the longitudinal section through a magnetic clutch pump arrangement having a containment can according to the invention,
35 which has beads in its base,

figure 2 shows the longitudinal section through the containment can according to the invention in an enlarged illustration,

5 figure 3 is a three-dimensional illustration of the containment can according to the invention,

figure 4 shows the longitudinal section through the containment can according to the invention,
10 with a different embodiment of the beads,

figure 5 is a three-dimensional illustration of the containment can according to the invention,
15 with a further embodiment of the beads.

Figure 1 shows 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 hydraulics casing 3 in
20 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 hydraulics casing 3 has an inlet opening 8 for the
25 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 hydraulics casing 3 which is situated opposite the inlet opening 8. The bearing carrier cage 5 is fastened to that side
30 of the casing cover 4 which is averted from the hydraulics 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
35 carrier 6 which is averted from the bearing carrier cage 5.

A containment can 10, preferably produced by deep drawing or by casting, is fastened to that side of the casing cover 4 which is averted from the hydraulics 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, 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 hydraulics 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.

Between the impeller 16 and the inner rotor 17 there is arranged a bearing arrangement 19 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 20. The drive shaft 20, which can be driven rotatably about the axis of rotation A, is arranged substantially coaxially with the impeller shaft 13. The drive shaft 20 extends through the bearing cover 7 and through the bearing carrier 6 and is mounted in two ball bearings 21, 22

which are accommodated in the bearing carrier 6. On the free end of the drive shaft 20 there is arranged an outer rotor 24, which bears multiple magnets 23. The magnets 23 are arranged on that side of the outer rotor 24 which faces toward the containment can 10. The outer rotor 24 extends at least partially over the containment can 10 and interacts with the inner rotor 17 such that the rotating outer rotor 24, 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 figures 2 and 3, has a substantially cylindrical main body 25 with a central longitudinal axis B arranged substantially coaxially with respect to the axis of rotation A as per figure 1. The main body 25 is open on one side, 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 27 which is formed integrally with the main body 25 or which is connected to the latter by welding or other suitable fastening means or devices, for example screws, rivets or the like.

The attachment flange 27 has multiple bores 28 which extend parallel to the central longitudinal axis B and through which screws (not shown) can be passed and screwed into corresponding threaded bores in the casing cover 4 as per figure 1.

The base 26 is formed by a substantially spherical - segment-shaped spherical cap region 29 and an outer rim region 30 which forms the transition region between main body 25 and spherical cap region 29. In the spherical cap region 29 there are provided multiple beads 31 which project into the chamber 12 and which have a bead base 32 and a bead wall 33. The beads 31

have a bead inner edge 31a, arranged close to the central longitudinal axis B, and a bead inner edge 31b, arranged remote from the central longitudinal axis B. The chamber 12 has the greatest axial extent close to the central longitudinal axis B, wherein the ratio of inner radius r_{is} of the containment can 10 to spacing A_{sa} of bead outer edge 31b and central longitudinal axis B of the containment can 10 lies in a range from 1.3 to 1.6, and preferably in a range from 1.38 to 1.57.

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The spacing A_{si} of the bead inner edge 31a to the central longitudinal axis B of the containment can 10 is defined by the formula $\frac{1}{7} * \text{containment can inner radius}^Y$, wherein Y preferably lies in a range from approximately 1.14 to 1.17.

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The containment can 10 is produced by deep drawing or by casting, wherein at least one bead 31 is produced in the base 26, which bead is arranged with a radial spacing to the central longitudinal axis B of the containment can 10. In the case of a containment can 10 produced by deep drawing, the beads 31 are stamped into the base 26 during the deep drawing process.

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The beads 31, which are arranged with a radial spacing to the central longitudinal axis B of the containment can 10, extend in a radial direction to a point close to the rim region 30, or even extend as far as the latter.

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As can be seen from figure 2, the bead base 32 runs in a plane which is situated substantially parallel to the plane which corresponds to the transition from the spherical cap region 29 to the rim region 30. In particular, the inner wall 34 of the containment can 10 in the region of the bead base 32 lies substantially in the same imaginary plane, perpendicular to the central longitudinal axis B, as the transition from the

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spherical cap region 29 to the rim region 30. Alternatively, as shown in figure 4, the bead base 32 of the containment can 10 may be formed so as to run parallel to the spherical cap region 29. Here, a part
5 of the bead base 32 extends as far as a plane which runs perpendicular to the central longitudinal axis B and which lies in the rim region 30. As illustrated in figure 1, in the region of the bead base 32, the maximum spacing X of the inner wall 34 of the
10 containment can 10 to a face side 35, facing toward the base 26 of the containment can 10, of the inner rotor 17 is approximately 20 mm. It is preferably the case that, in the region of the bead base 32, the maximum spacing X of the inner wall 34 of the containment can
15 10 to the face side 35 of the inner rotor 17 is approximately 10 mm.

The transitions between the spherical cap region 29 and the bead walls 33 have greater radii than the
20 transitions from the bead walls 33 to the respective bead base 32.

The beads 31 illustrated in figures 1 to 4 have a substantially stadium-shaped geometry. Alternatively,
25 said beads may have any other desired geometry. The beads 31 may for example be of prism-shaped, cuboidal or spherical form or may be formed from similar truncated geometries or combinations thereof or may, as shown in figure 5, have a bead base 32 which is domed
30 in the direction of the inner rotor.

List of reference designations

1	Pump arrangement	33	Bead wall
2	Casing	34	Inner wall
3	Hydraulics casing	35	Face side of the
4	Casing cover		inner rotor
5	Bearing carrier cage		
6	Bearing carrier		
7	Bearing cover	A	Axis of rotation
8	Inlet opening	B	Central longitudinal
9	Outlet opening		axis
10	Containment can	r_{is}	Inner radius r_{is} of
11	Interior space		containment can
12	Chamber	A_{sa}	Spacing between bead
13	Impeller shaft		outer edge and
13a	Shaft section		central longitudinal
13b	Shaft section		axis
14	Flow chamber	A_{si}	Spacing between bead
15	Opening		inner edge and
16	Impeller		central longitudinal
17	Inner rotor		axis
18	Magnet		
19	Bearing arrangement		
20	Drive shaft		
21	Ball bearing		
22	Ball bearing		
23	Magnet		
24	Outer rotor		
25	Main body		
26	Base		
27	Attachment flange		
28	Bore		
29	Spherical cap region		
30	Rim region		
31	Bead		
31a	Bead inner edge		
31b	Bead outer edge		
32	Bead base		

Patent claims

Pump arrangement and method for producing a containment
shell for the pump arrangement

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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
containment can which has a central longitudinal
10 axis and 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 can be driven in
rotation about an axis of rotation, having an
15 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
outer rotor which is arranged on a drive shaft and
which interacts with the inner rotor, wherein the
20 containment can has a base with at least one bead
which projects into the chamber,

characterized in that

- 25 the at least one bead (31) is arranged with a
radial spacing to the central longitudinal axis
(B) of the containment can (10), wherein the ratio
of inner radius (r_{is}) of the containment can (10)
to spacing (A_{sa}) of bead outer edge (31b) and
30 central longitudinal axis (B) of the containment
can (10) lies in a range from 1.3 to 1.6.

2. The pump arrangement as claimed in claim 1,
characterized in that the ratio of inner radius
35 (r_{is}) of the containment can (10) to spacing (A_{sa})
of bead outer edge (31b) and central longitudinal
axis (B) of the containment can (10) lies in a
range from 1.38 to 1.57.

3. The pump arrangement as claimed in claim 1 or 2, characterized in that the spacing of the bead inner edge (31a) to the central longitudinal axis (B) of the containment can (10) is calculated using the formula $\frac{1}{7} * \text{containment can inner radius}^Y$, wherein Y lies in a range from approximately 1.14 to 1.17.
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4. The pump arrangement as claimed in one of claims 1 to 3, characterized in that the base (26) is formed by a substantially spherical-segment-shaped spherical cap region (29) and by a rim region (30) which forms the transition region between main body (25) and spherical cap region (29).
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5. The pump arrangement as claimed in one of claims 1 to 4, characterized in that the at least one bead (31) has a bead base (32) and bead walls (33), wherein the bead base (32) runs in a plane which is situated substantially parallel to the plane in which the transition from the spherical cap region (29) to the rim region (30) is situated.
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6. The pump arrangement as claimed in one of claims 1 to 5, characterized in that the inner wall (34) of the containment can (10) in the region of the bead base (32) lies substantially in the same plane as the transition from the spherical cap region (29) to the rim region (30).
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7. The pump arrangement as claimed in one of claims 1 to 5, characterized in that the bead base (32) is formed so as to run parallel to the spherical cap region (29).
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8. The pump arrangement as claimed in one of claims 1 to 7, characterized in that, in the region of the bead base (32), the maximum spacing (X) of the
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inner wall (34) of the containment can (10) to the face side (35) of the inner rotor (17) is approximately 20 mm.

- 5 9. The pump arrangement as claimed in one of claims 1 to 7, characterized in that, in the region of the bead base (32), the maximum spacing (X) of the inner wall (34) of the containment can (10) to the face side (35) of the inner rotor is approximately
10 10 mm.
10. The pump arrangement as claimed in one of claims 1 to 9, characterized in that the transitions between the spherical cap region (29) and the bead
15 walls (33) have greater radii than the transitions from the bead walls (33) to the respective bead base (32).
11. The pump arrangement as claimed in one of claims 1 to 10, characterized in that the at least one bead
20 (31) extends in a radial direction to a point close to the rim region (30), or extends as far as the latter.
12. A method for producing a containment can of a pump arrangement, in particular magnetic clutch pump arrangement, as claimed in one of claims 1 to 11, characterized in that the containment can (10) is produced by way of a deep drawing process or by
25 way of a casting process, wherein at least one bead (31) is produced in the base (26), which bead is arranged with a radial spacing to the central longitudinal axis (B) of the containment can (10).
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