housing. Due to these tensions, the connections of the holder to the pump housing deteriorate over time. In addition, it is extremely important for space to be saved, especially for very small pumps. This applies particularly to pumps which are to be implanted in a body. This is more difficult to realize in the case of pumps having a plurality of individual parts than in the case of a pump having a smaller number of individual parts.

In general, ~~it is an object~~ embodiments of the present invention seek to at least partly overcome the disadvantages of the prior art.

~~A further object is~~ Further, embodiments of the present invention seek to provide a pump device whose materials are as biocompatible as possible, as easily processible as possible, as corrosion resistant as possible and can be durably connected to one another.

~~A further object is~~ Further, embodiments of the present invention seek to provide a pump device which is designed to be as space-saving as possible.

Furthermore, ~~it is an object~~ embodiments of the invention seek to provide pump device being as tension-free as possible, in particular having a housing or pump housing being as tension-free as possible, and in particular to provide a passage from the pump housing to the remaining part of the pump device being as tension-free as possible.

~~An additional object is~~ Further, embodiments of the present invention seek to provide a pump device which has, during use, an abrasion of the movable parts and the mountings thereof as low as possible.

In addition, ~~it is an object~~ embodiments of the invention seek to provide a pump housing for a pump device which can be integrated in an as simply and as space-saving manner as possible into other components, e.g. a component housing of the pump device.

In addition, ~~it is an object~~ embodiments of the invention seek to provide a pump housing for a pump device which can be connected to a component housing of the pump device in a hermetically sealed manner.

Furthermore, ~~it is an object~~ embodiments of the invention seek to provide a housing or pump housing which is as free as possible of internal and/or external tensions.

Furthermore, ~~it is an object~~embodiments of the invention seek to provide a process by means of which a pump housing can be produced in a manner being as cost-saving and as time-saving as possible.

~~It is also an object~~ Embodiments of the invention seek to provide a component housing which is designed to be as space-saving as possible.

~~A further object is~~ Further, embodiments of the present invention seek to provide a housing which can be joined in a hermetically sealed manner to other components.

A first ~~object~~aspect of the present invention ~~is~~provides a pump device (10) comprising:

i. an impeller;

ii. a pump housing which at least partly surrounds an interior region and has an inlet and an outlet,

wherein the impeller is provided in the interior region of the pump housing;

wherein the pump housing comprises a composite of a first hollow body and a further hollow body which at least partly surrounds the first hollow body on the side facing away from the interior region;

wherein at least 60% of the surface area of the side of the first hollow body facing away from the interior space is connected to the further hollow body, based on the surface area of the side of the first hollow body facing away from the interior space,

wherein a further surface of the first hollow body of the pump housing faces the interior region ~~with a further surface of the first hollow body~~;

wherein the further surface of the first hollow body facing the interior region of the pump housing has a hardness of at least 330 HV,

wherein the further hollow body has a metal content of at least 50% by weight, based on the total mass of the further hollow body.

The pump device of the invention is preferably suitable for being introduced into the body of a human being or an animal. The pump device of the invention is also preferably designed for conveying body fluids such as blood, serum, plasma, interstitial liquid, saliva or urine. In particular, the pump device of the invention is preferably introduced into the blood stream of a human being or animal in order to pump blood. The introduction of the pump device of the invention

in a living body. The biocompatibility of the surfaces which come into contact with body fluid contributes to the body not being damaged on contact with these areas.

~~The~~A second aspect of the present invention further provides a process for producing a pump housing for a pump device, which comprises the steps:

a. Provision of a first hollow body;
b. Provision of a further hollow body;

wherein at least the first hollow body is configured as a cylindrical hollow body;

c. Contacting of the first hollow body with the further hollow body
to form a composite,
wherein the contacting is performed as a force-fitting or material-fitting connection of the first hollow body and the further hollow body.

The provision of the first hollow body in step a. and of the further hollow body in step b. can be carried out in any way which a person skilled in the art would select for this purpose.

The contacting in step c. can be any contacting which a person skilled in the art would use for a force-fitting or material-fitting connection between the first hollow body and the further hollow body.

In a preferred embodiment of the process for producing a pump housing according to the invention, the contacting in step c. is selected from the group consisting of adhesive bonding, pressing, sintering and a combination of at least two thereof. The contacting is preferably selected from the group consisting of pressing with hot contacting, sintering and adhesive bonding and a combination of at least two thereof. According to the invention, a composite of the first hollow body and the further hollow body is produced in step c. This composite of the two hollow bodies forms a stable pump housing. The bond between the two hollow bodies is preferably so strong that an attempt to separate the two hollow bodies would lead to destruction of the pump housing.

Hot contacting is preferably carried out by means of heating of one of the two hollow bodies. The further hollow body is preferably heated to a temperature which is below the melting point of the further hollow body but results in expansion of the hollow body. The further hollow body likewise preferably has a cylindrical shape. Furthermore, the further hollow body preferably has an internal diameter which is identical to the external diameter of the first hollow body. The hol-

The present invention further provides a pump housing for a pump device obtainable by the above-described process of the invention.

~~The~~A third aspect of the present invention further provides a housing which at least partly surrounds an interior region and has ~~a first end and a second end,~~an inlet and an outlet;

wherein the housing comprises a composite of a first hollow body and a further hollow body which at least partly surrounds the first hollow body on the side facing away from the interior region;

wherein at least 60% of the surface area of the side of the first hollow body facing away from the interior space is connected to the further hollow body, based on the surface area of the side of the first hollow body facing away from the interior space;

wherein a further surface of the first hollow body of the housing faces the interior region ~~with a further surface of the first hollow body~~;

wherein the further surface of the first hollow body facing the interior region of the housing has a hardness of at least 330 HV,

wherein the further hollow body has a metal content of at least 50% by weight, based on the total mass of the further hollow body.

The housing corresponds in terms of its shape, its composition and its further configuration to the pump housing which has been described above in connection with the pump device.

In a preferred embodiment of the housing, a shiftable element is provided in the component housing at least in part of the component housing. Further preferred embodiments correspond to the above-described embodiments of the pump device.

The shiftable element can be selected from the group consisting of a sphere, a cylinder, an air bubble and a combination of at least two thereof. The shiftable element preferably has a shape which corresponds to the diameter of the pump housing. The material of the shiftable element can be any material which a person skilled in the art would use for this purpose. The shiftable element preferably comprises a metal, a polymer, a ceramic or a mixture thereof. The metal or the polymer can be selected from among a metal, a polymer and a ceramic as have been described for the first hollow body for the pump housing. The shiftable element can, for example, serve to be shifted in terms of its position in the component housing by means of a change in

Patent claims

1. A pump device ~~(10)~~ comprising:

   i. an impeller ~~(80)~~;

   ii. a pump housing ~~(20)~~ which at least partly surrounds an interior region ~~(50)~~ and has an inlet ~~(22)~~ and an outlet ~~(24)~~;

   wherein the impeller ~~(80)~~ is provided in the interior region ~~(50)~~ of the pump housing ~~(20)~~,

   wherein the pump housing ~~(20)~~ comprises a composite ~~(142)~~ of a first hollow body ~~(26)~~ and a further hollow body ~~(28, 28')~~ which at least partly surrounds the first hollow body ~~(26)~~ on the side facing away from the interior region ~~(50)~~;

   wherein at least 60% of the surface area of the side of the first hollow body ~~(26)~~ facing away from the interior space ~~(50)~~ is connected to the further hollow body ~~(28, 28')~~, based on the surface area of the side of the first hollow body ~~(26)~~ facing away from the interior space ~~(50)~~,

   wherein a further surface ~~(140)~~ of the first hollow body ~~(26)~~ of the pump housing ~~(20)~~ faces the interior region ~~(50)~~;

   wherein the further surface ~~(140)~~ of the first hollow body ~~(26)~~ facing the interior region ~~(50)~~ of the pump housing ~~(20)~~ has a hardness of at least 330 HV,

   wherein the further hollow body ~~(28, 28')~~ has a metal content of at least 50% by weight, based on the total mass of the further hollow body ~~(28)~~.

2. The pump device ~~(10)~~ as claimed in claim 1, wherein the first hollow body ~~(26)~~ and the further hollow body ~~(28, 28')~~ are connected in a force-fitting manner.

3. The pump device ~~(10)~~ as claimed in claim 1 or 2, wherein the first hollow body ~~(26)~~ or the further hollow body ~~(28, 28')~~ or both hollow bodies ~~(26, 28)~~ in each case form a cylindrical hollow body.

4. The pump device ~~(10)~~ as claimed in any of the preceding claims, wherein the material of the first hollow body ~~(26)~~ is a ceramic, preferably selected from the group consisting of aluminum oxide (Al_2O_3), zirconium dioxide (ZrO_2), aluminum oxide-reinforced zirconium oxide (ATZ), zirconium oxide-reinforced aluminum oxide (ZTA), yttrium-reinforced

zirconium oxide (Y-TZP), aluminum nitride (AlN), magnesium oxide (MgO), piezoceramic, barium (Zr, Ti) oxide, barium (Ce, Ti) oxide, titanium nitride (TiN), silicon dioxide (SiO_2) and sodium potassium niobate and a mixture of at least two thereof.

5. The pump device ~~(10)~~ as claimed in any of the preceding claims, wherein the metal of the further hollow body ~~(28, 28')~~ is selected from the group consisting of platinum (Pt), iron (Fe), stainless steel, iridium (Ir), niobium (Nb), a niobium alloy, molybdenum (Mo), tungsten (W), titanium (Ti), a titanium alloy, cobalt (Co), chromium (Cr), a cobalt-chromium alloy, tantalum (Ta) and zirconium (Zr) and a mixture of at least two thereof.

6. The pump device ~~(10)~~ as claimed in any of the preceding claims, wherein the first hollow body ~~(26)~~ comprises less than 10% by weight, based on the total mass of the first hollow body ~~(26)~~, of metal.

7. The pump device ~~(10)~~ as claimed in any of the preceding claims, wherein the pump device is at least partly surrounded by a component housing ~~(40)~~, wherein the composite ~~(142)~~ of the pump device ~~(10)~~ is joined to the component housing ~~(40)~~.

8. The pump device ~~(10)~~ as claimed in any of the preceding claims, wherein the pump housing ~~(20)~~ has a volume in the range from 0.1 cm^3 to 10 cm^3.

9. The pump device ~~(10)~~ as claimed in either of the two preceding claims, wherein the component housing ~~(40)~~ comprises at least 30% by weight, based on the total mass of the component housing ~~(40)~~, of titanium.

10. The pump device ~~(10)~~ as claimed in any of the preceding claims, wherein the first hollow body ~~(26)~~ has a magnetic permeability of less than 2 µ.

11. A process for producing a pump housing ~~(20)~~ for a pump device ~~(10)~~, which comprises the steps:
    a. Provision of a first hollow body ~~(26)~~;
    b. Provision of a further hollow body ~~(28, 28')~~;
       wherein at least the first hollow body ~~(26)~~ is configured as a cylindrical hollow body ~~(20)~~;
    c. Contacting of the first hollow body ~~(26)~~ with the further hollow body ~~(28, 28')~~

to form a composite (142),

wherein the contacting is performed as a force-fitting or material-fitting connection of the first hollow body (26) and the further hollow body (28, 28').

12. The process as claimed in the preceding claim, wherein the contacting in step c. is selected from the group consisting of adhesive bonding, pressing, sintering and a combination of at least two thereof.

13. A pump housing obtainable by a process as claimed in claim 11 or 12.

14. A housing (20) which at least partly surrounds an interior region (50) and has an inlet (22) and an outlet (24);

wherein the housing (20) comprises a composite (142) of a first hollow body (26) and a further hollow body (28, 28') which at least partly surrounds the first hollow body (26) on the side facing away from the interior region (50);

wherein at least 60% of the surface area of the side of the first hollow body (26) facing away from the interior space (50) is connected to the further hollow body (28, 28'), based on the surface area of the side of the first hollow body (26) facing away from the interior space (50),

wherein a further surface (140) of the first hollow body (26) of the housing (20) faces the interior region (50);

wherein the further surface (140) of the first hollow body (26) facing the interior region (50) of the housing (20) has a hardness of at least 330 HV,

wherein the further hollow body (28, 28') has a metal content of at least 50% by weight, based on the total mass of the further hollow body (28).

15. A pump device (10) comprising at least one housing (20) as claimed in claim 14 or a housing (20) obtainable by a process as claimed in at least one of claims 11 or 12.