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The invention relates to a sound head for installation into a measurement tube of a flow meter for sound-based detection of a flow rate of a medium.

Flow meters based on ultra(sound) measurement technology are known. Pulse-like (ultra)sound signals are generated by means of (ultra)sound transducers and are transmitted through the medium in the flow direction and counter to the flow direction. The difference in the propagation times of the sound signals in both directions of propagation is evaluated for the purpose of determining the flow rate of the medium. Such ultrasound-based flow meters work according to the propagation time difference principle.

Various configurations exist. Firstly, devices which constitute flow meters in the actual sense and determine exclusively the flow rate of the medium are known. Secondly, there are also energy meters, for example in the form of heat meters and cold meters, in the case of which the flow rate determined according to the previously explained principle is associated with at least one additional temperature measurement value in order, in this way, to determine the (heat or cold) energy supplied via the medium. Said energy meters are also to be understood here as - specially configured - flow meters.

The sound transducers used for sound generation and for sound reception may, depending on the design of the flow meter, also be installed in separate components. In this regard, the sound transducer may be situated for example in a separate housing. Such a unit composed of a housing with a sound transducer placed therein is also referred to here as a sound head. In known sound head designs, the housing may be designed to be very stable, for example as a brass component. Although the sound head is then able to withstand very high pressure loads exerted by the medium to be detected, relatively high production costs and a high weight also result.

Other designs of sound heads, in which the housing accommodating the respective sound transducer is open on its side facing the medium to be subjected to sound and is covered or closed off merely by a sealing film, are described in DE

10 2009 046 147 A1, DE 10 2009 046 148 A1 and DE 10 2010 000 967 A1. These sound heads are intended especially for use in gaseous media, in particular in the ambient air. At any rate, these sound heads are not subjected to any high pressure loads which the sealing films used would otherwise not be able to withstand.

EP 3 178 570 A1 describes a sound head comprising a metallic pot, which has a pot side wall, a pot base through which sound is to be passed and a pot opening which is opposite the pot base. A piezo element is adhesively bonded to the inner side of the pot base by means of an acoustic coupling layer. An elastically deformable connecting band is provided for the electrical contacting of the piezo element. Furthermore, a housing is inserted into the pot and closes off the pot opening. Said housing has on its top side a protective collar which projects beyond the closed pot opening, which surrounds the connecting band and which is provided with an undercut.

EP 1 315 144 A2 describes a further sound head, which has a pot-like connection electrode, wherein a piezoelectric body is placed on the inner side of the pot base. A housing is inserted into the pot-like first connection electrode and closes off the pot opening. The housing has a protective collar which projects beyond the closed pot opening and which surrounds electrical feed lines of the piezoelectric body.

Although many designs of sound heads are already known, there continues to be a need for improved solutions with regard to the handling, operational safety, suitability for automated mass production and/or production costs of such components.

The object of the invention is to specify a sound head for installation into a flow meter, which is further improved in comparison with the known configurations.

To achieve said object, a sound head according to the features of patent claim 1 is specified. The sound head according to the invention has a pot composed of a

metallic pot material, having a pot side wall, a pot base through which sound is to be passed and a pot opening opposite the pot base, has an electromechanical sound transducer element, adhesively bonded to an inner side of the pot base, has two electrical feed lines, leading out of the pot opening and serving for the electrical contacting of the electromechanical sound transducer element, and has a closure part, inserted into the pot and closing off the pot opening. Here, the closure part has on a side facing away from the electromechanical sound transducer element a protective collar which projects beyond the closed pot opening and which surrounds the electrical feed lines, wherein the protective collar is provided with pull-out means. Furthermore, the electrical lines have exposed end portions, and the protective collar extends in the axial direction at least exactly as far as the exposed end portions of the electrical feed lines. Moreover, the pull-out means are formed as at least one passage opening which is present in a collar wall of the protective collar.

The pot is in particular a deep-drawn component and can accordingly be manufactured inexpensively. The pot material is moreover preferably electrically conductive. It is in particular a metal and consists for example of a high-grade steel or has a high-grade steel portion. The pot is furthermore in particular integrally formed. Thus, it is especially the case that the pot side wall and the pot base are integrally connected to one another. They consist of the same material. There is accordingly a material connection between them. The pot is furthermore closed off on its bottom side by the pot base, which bottom side, when the sound head is installed into a measurement tube, faces the medium to be detected and in particular also comes into direct contact with the medium. In the installed state, the pot encapsulates the inner side of the pot and the components situated therein, in particular – but not only – the electromechanical sound transducer element, safely with respect to the medium to be detected or subjected to sound.

The electromechanical sound transducer element is preferably adhesively bonded to the inner side of the pot base. In this way, it is achieved in particular that the pot base vibrates substantially jointly with the electromechanical sound transducer element and that sound energy is thereby radiated via the pot base

into the medium and conversely also transmitted from the medium to the sound transducer element. The pot base and the electromechanical sound transducer element adhesively bonded therein or thereon form in this respect an expedient sound combination unit.

The medium whose flow rate is to be detected by means of the sound head is in particular a liquid medium, preferably water. For the purpose of detecting the flow rate of the medium, the sound head is designed in particular to subject said medium to sound.

The protective collar advantageously protects those end portions of the electrical feed lines which it surrounds. In particular, the protective collar extends in the axial direction, that is to say in the direction of the longitudinal axis of the sound head, at least approximately exactly as far as the exposed ends of the electrical feed lines, which consequently are substantially completely surrounded by the protective collar. The protective collar prevents in particular mechanical damage to the exposed ends of the electrical feed lines and in the process ensures that the free ends, intended for the signal connection, of the electrical feed lines are at all times at the correct position and also remain there, said position also being set originally during production. In this way, the sound head can be installed preferably in an automated manner into a measurement system. Furthermore, the pull-out means present in the protective collar facilitate dismounting of the sound head from its installation position in a measurement tube. Such dismounting can, in particular after a relatively long operating period of the sound head, be difficult since crusting deposits can form on the bottom side of the pot base and on the adjoining inner wall of the measurement tube, which can make removal of the sound head, be it for inspection purposes or be it for replacement owing to a defect, more difficult. The pull-out means facilitate the removal of the sound head also under such adverse installation conditions.

It is possible to insert into the passage opening present in the collar wall of the protective collar in particular a correspondingly designed pull-out tool, in order for

the sound head then to be pulled out of its installation position advantageously without relatively great effort.

Advantageous configurations of the sound head according to the invention will emerge from the features of the claims which are dependent on Claim 1.

According to one expedient configuration, the pull-out means are formed as two passage openings which are present in a collar wall of the protective collar and which are aligned with one another. This simplifies the removal of the sound head from its installation position. If the pull-out tool engages into both passage openings, which are aligned with one another, a pull-out force acting substantially parallel to the longitudinal axis of the sound head is applied, with the result that, during the pulling-out of the sound head, no tilting of the sound head occurs, which would otherwise make the removal from the installation position more difficult.

According to a further expedient configuration, the closure part is placed within the pot such that said closure part exerts pressure on the electromechanical sound transducer element. This exertion of pressure may be realized in particular directly or indirectly, for example by means of an in particular compressible damping body. This results in a permanently stable construction, which ensures a consistently good functionality of the sound head over a long period of time. The application of pressure also provides for constant damping and a controlled manufacturing process.

According to a further expedient configuration, the closure part has a laterally projecting and fully encircling connecting collar which is connected fixedly to an in particular deformed or bent-over edge region of the pot side wall. Preferably, the connection between the connecting collar and the edge region of the pot side wall is an adhesive connection or a welded connection. In this way, very good protection against external disruptive influences is achieved. In particular, the connection is very tight in relation to infiltration of dust, dirt and/or water or other liquids.

According to a further expedient configuration, the closure part has a plastic main body and a reinforcement plate, wherein the reinforcement plate is at least partly embedded in the plastic main body. The protective collar is in particular a constituent part of the plastic main body and is preferably arranged on a side of the reinforcement plate that faces away from the electromechanical sound transducer element. Furthermore, the pot has in particular a pot wall thickness in the range between 0.1 mm and 1 mm, preferably between 0.2 mm and 0.5 mm. These thickness values apply in particular both to the pot side wall and to the pot base. At any rate, a particularly large pot wall thickness is not involved. In this respect, it is also the case that the pot is able to be loaded mechanically only to a limited extent. This applies in particular in the case of the embodiment as a deep-drawn component. The reinforcement plate of the closure part leads in this respect to an advantageous mechanical load relief for the pot, in particular for the pot side wall thereof and/or for the pot base thereof. The reinforcement plate has a plate thickness preferably in the range between 0.5 mm and 5 mm, in particular in the range between 0.75 mm and 3 mm. This results in highly effectively mechanical reinforcement both of the pot and of the entire construction of the sound head. The latter is advantageous in particular if the medium to be detected or subjected to sound by means of the sound head is highly pressurized, for example is at a pressure of more than 10 bar, preferably in the range between approximately 16 bar and approximately 25 bar, during normal operation. In cases of special operation, it is also possible for pressure peaks with even higher pressure values of in particular up to 50 bar to occur with flow meters. The plastic main body of the closure part is – in contrast to the reinforcement plate – not provided primarily for increasing the mechanical stability, although it does in principle also contribute thereto to a certain extent. The plastic main body serves primarily for closing off the pot opening, but also for guiding the electrical feed lines and in particular also for protecting the exposed end portions of the electrical feed lines. In this respect, the reinforcement plate and the plastic main body perform, as the two components of the closure part, in particular in each case specific and different tasks, according to those tasks for which they are preferably specifically designed. The plastic main body is in this case used in particular also for saving weight, in comparison with a purely metallic embodiment. The closure part

composed of two components therefore offers advantages in particular in comparison with a single-part embodiment having only one component.

According to a further expedient configuration, the reinforcement plate extends as far as the connecting collar and, there, forms a closure part connecting surface which is connected to a corresponding pot connecting surface which is present in the edge region of the pot side wall. This advantageously results in a metal-to-metal connection, which is highly stable and resistant. In particular, the connecting collar is formed substantially by the reinforcement plate. In particular, the closure part connecting surface is an exposed part of the surface of the reinforcement plate which, in this region, is uncovered, that is to say not embedded into the plastic material of the plastic main body.

According to a further expedient configuration, the pot side wall has a pot step, and the closure part has in a closure part side wall a closure part step which corresponds to the pot step, wherein the pot step and the closure part step bear directly against one another. The advantageously stepped pot side wall offers, in interaction with the likewise advantageously stepped closure part side wall, particularly high resistance to applications of high pressure which may, on account of the contact with the medium, occur during operation. The medium is in particular a liquid transported in a tube system, as a result of which the transmission of quite considerable pressure loads by the medium to the sound head is possible. The sound head is preferably designed for use in such a (possibly highly pressurized) liquid medium. The steps bearing against one another, that is to say the pot step and the corresponding closure part step, expediently receive the pressure loads and dissipate them, with the result that the electromechanical sound transducer element placed on the pot base is protected against mechanical damage. Furthermore, the steps bearing against one another, during the production of the sound head, advantageously serve as an end stop for defining the depth of insertion of the closure part into the pot. In this way, the design specifications can be adhered to in a very simple and, in particular, very reliable manner. In particular, it is thereby ensured without any problem that the closure part (directly or indirectly) exerts the exactly desired pressure on the electromechanical sound

transducer element, and/or that a first adhesive layer between the electromechanical sound transducer element and the pot base has the desired layer thickness. Moreover, the outer side of the pot step may be used for the mounting of the holding webs of a sound reflector, which deflects a sound signal emanating from the sound head or an incoming sound signal to the sound head, onto the step edge. The pot step is therefore in particular also an attachment or fastening point for such a sound reflector.

According to a further expedient configuration, an electrically insulating first adhesive layer is present for the adhesive bond between the electromechanical sound transducer element and the pot base. The first adhesive layer in particular forms the adhesive bond between the electromechanical sound transducer element and the pot base. During the use of the sound head in a flow meter, there is then advantageously no electrically conductive connection between the medium flowing past the outer side of the in particular electrically conductive pot base and the electromechanical sound transducer element adhesively bonded to the pot base on the inside. In this way, the susceptibility to faults of the measurement system is reduced overall. It is possible to generate a stronger useful signal for evaluation. Moreover, the galvanic separation, provided inherently on account of the preferably electrically insulating first adhesive layer, between the electromechanical sound transducer element, including the electrical feed lines thereof, on the one hand, and the in particular metallic and thus electrically conductive pot on the other hand, facilitates the electrical connection of the sound head to an energy supply and/or to an actuation/evaluation unit. The additional component for galvanic separation otherwise present in such an electrical connection, for example an optocoupler, can be dispensed with, which offers cost advantages for an overall measurement system realized with the sound head.

According to a further expedient configuration, the electrically insulating first adhesive layer has mechanically stable spacing elements, in particular in the form of small glass balls. Said small glass balls are in particular likewise electrically insulating. They ensure that a desired minimum insulation spacing between the electromechanical sound transducer element and the pot base is provided pre-

ferably everywhere. The spacing elements may in particular also be referred to as “spacers”.

According to a further expedient configuration, the electrically insulating first adhesive layer has a layer thickness in the range between 5 µm and 300 µm, in particular between 10 µm and 200 µm, everywhere. In this way, a very good compromise between two opposing tendencies is achieved. The larger the layer thickness of the first adhesive layer, the more stable the mechanical properties are. On the other hand, an excessively thick first adhesive layer makes more difficult or prevents a vibrating capability, essential to the noise-generating and receiving main function of the sound head, of the electromechanical sound transducer element or of the adhesively bonded assembly composed of the electromechanical sound transducer element and the pot base. Layer thicknesses from the above-stated value ranges equally satisfy both aspects very well.

According to a further expedient configuration, the closure part and the pot side wall are connected to one another by means of a second adhesive layer. Said second adhesive layer serves for protecting against infiltration of dust, other dirt, water, other liquids and/or gases into the pot interior, in which the essential components of the sound head are situated. Moreover, the sound head, on account of the adhesive bond between the closure part and the pot side wall by means of the second adhesive layer, is a combination part which is in particular unable to be disassembled. The latter can, more easily and with a lower susceptibility to faults, be handled and used for further installation.

According to a further expedient configuration, the first and second adhesive layers have the same curing conditions, in particular the same curing time, the same curing temperature and the same curing pressure. Both adhesive layers can then advantageously be cured simultaneously, which shortens the production time. The first and second adhesive layers may, for example, consist of an epoxy adhesive or comprise such a material component. It is possible, but not absolutely necessary, for both adhesive layers to consist of the same adhesive or at least to be based on the same adhesive. A conceivable difference is that the second

adhesive layer, in contrast to the first adhesive layer, comprises no additional component in the form of the spacing elements. Although the second adhesive layer may likewise be formed to be electrically insulating, this is not absolutely necessary and offers no advantages comparable to those for the first adhesive layer.

According to a further expedient configuration, the pot has a pot wall thickness between 0.1 mm and 1 mm, preferably between 0.2 mm and 0.5 mm. These thickness values apply in particular both to the pot side wall and to the pot base. At any rate, a particularly large pot wall thickness is not involved. In this respect, it is also the case that the pot is able to be loaded mechanically only to a limited extent. Nevertheless, the sound head is mechanically stable overall, the reinforcement plate contributing in particular thereto. The relatively small pot wall thickness saves material and thus costs. Moreover, also because of this, a preferably relatively low overall weight of the sound head results.

According to a further expedient configuration, the reinforcement plate has a reinforcement plate thickness (=plate thickness) of between 0.5 mm and 5 mm, in particular between 0.75 mm and 3 mm. This brings about very good mechanical reinforcement, which is advantageous in particular if the medium to be detected is highly pressurized. A reinforcement plate having a plate thickness from the above-stated, particularly expedient value ranges relieves load on the pot preferably highly efficiently.

According to a further expedient configuration, the reinforcement plate is a punched metal disc. This can be produced very easily, quickly and inexpensively.

According to a further expedient configuration, the reinforcement plate has a central passage opening through which the plastic main body and the electrical feed lines extend. This geometry of the reinforcement plate is expedient since it permits the passage of the electrical feed lines on the one hand without significantly diminishing the mechanical stabilization effect of the reinforcement plate on the other hand.

According to a further expedient configuration, the reinforcement plate has multiple decentralized passage openings which are filled with the plastic material of the plastic main body. This results in a particularly stable and intimate connection between the reinforcement plate and the plastic main body.

According to a further expedient configuration, the reinforcement plate is encapsulated by injection moulding with the plastic material of the plastic main body, with the result that a combined structural unit composed of the plastic main body and the reinforcement plate is formed. Such encapsulation by injection moulding or injection moulding of the reinforcement plate with the plastic of the plastic main body is realized in particular by means of an advantageously automated injection moulding process. The closure part can in this way be produced in a very simple and efficient manner as a composite component (=combined structural unit).

According to a further expedient configuration, the reinforcement place is arranged parallel to the electromechanical sound transducer element. The reinforcement plate then contributes particularly well to the protection of the electromechanical sound transducer element as the key component of the sound head and to the mechanical stability of the sound head overall. The construction of the sound head is in this way very securely protected against damage.

Further features, advantages and details of the invention are obtained from the following description of exemplary embodiments based on the drawing.

Fig. 1 shows an exemplary embodiment of a sound head according to the invention for a flow meter in a first longitudinal sectional representation,

Fig. 2 shows the sound head according to Fig. 1 in a perspective view,

Fig. 3 shows the sound head according to Fig. 1 and 2 in a second longitudinal sectional representation that is perpendicular to the first longitudinal sectional representation according to Fig. 1,

Fig. 4 shows the sound head according to Fig. 1 to 3 in an exploded representation,

Fig. 5 shows the sound head according to Fig. 1 to 4 in a plan view from above,

Fig. 6 shows a plan view of a reinforcement plate of the sound head according to Fig. 1 to 5, and

Fig. 7 shows an enlarged detail view of the extract marked VII in Fig. 1.

Parts corresponding to one another are marked with the same reference numbers in Fig. 1 to 7. Details of the exemplary embodiments explained in more detail in the following can, taken by themselves, constitute an invention or be part of a subject of an invention.

In Fig. 1 to 5, an exemplary embodiment of a sound head 1 is shown, which is intended for an installation in a measurement tube of a flow meter for the sound-based detection of a flow rate of a medium. The measurement tube can be for example a valve housing. The sound head 1 is characterized by a simple installation which advantageously makes possible a highly assembly-friendly, in particular fully automated manufacturing process. In this way, large numbers of the sound head 1 can be produced with comparatively low costs and with a comparatively short manufacturing duration.

The sound head 1 has a longitudinal axis 2. In a possible embodiment, the sound head 1 is substantially embodied rotation-symmetrically with respect to the longitudinal axis 2. However, this is not mandatorily necessary. Other cross-sectional geometries, for example a substantially square or rectangular cross-sectional geometry with respect to the longitudinal axis 2 are likewise possible.

The sound head 1 comprises multiple partial components, among these a pot 3 of a metallic, electrically conductive pot material, for example of a stainless steel. The pot 3 in the shown exemplary embodiment is in particular a deep-drawn

component. It comprises an in particular stepped pot side wall 4 and a pot base 5. A pot opening 6 is located opposite the pot base 5. The pot side wall 4 has a top step 7. In addition, the pot side wall 4, at the height of the pot opening 6, opens into a pot edge region 8 that is reshaped in particular during the deep-drawing process, which extends laterally away from the longitudinal axis 2. A surface normal of the pot edge region 8 is substantially parallel to the longitudinal axis 2. With a rotation-symmetrical geometry of the sound head 1, the pot edge region 8 projects radially. Independently of the outer geometrical shape of the sound head 1, the pot edge region 8 surrounds the pot opening 6 in particular fully.

As a further component, the sound head 1 comprises an electromechanical sound transducer element 9. The latter is the key component for the sound-receiving and/or sound-sending function of the sound head 1. The electromechanical sound transducer element 9 is adhesively bonded to the inner side of the pot base 5. It has a flat piezoelectrical plate 10 with a planar top and bottom side, both of which are oriented substantially perpendicularly to the longitudinal axis 2. On the top and bottom side, the piezoelectrical plate 10 is provided in each case with an electrode 11 and 12 respectively, wherein the electrode 12 arranged on the bottom side is extracted upwards in the region of a lateral recess 13 of the piezoelectrical plate 10 over the edge of the piezoelectrical plate 10 as far as to the top side (see Fig. 4 in this regard). The electrode 11 provided on the top side has a recess in this region and does not extend as far as to that location, so that between the component of the electrode 12 that is extracted upwards from the lower side and the electrode 11 on the top side there is an insulation gap. The lateral recess 13 also serves for the position-correct placing of the electromechanical sound transducer element 9 on the pot base 5 carried out in particular in an automated manner.

The pot 3 is a unitary deep-drawn component. In particular, the top side wall 4 and pot base 5 are thus unitarily connected to one another. They consist of the same material. Accordingly, a composition of matter is present between them. On its lower side facing the medium to be detected upon its installation in the

measurement tube, the pot 3 is closed, furthermore, by the pot base 5. In the installed state, the pot 3 encapsulates the inner side of the pot 3 and the components located therein securely from the medium to be detected, wherein the medium flows directly past the bottom side of the pot base 5 located outside. Namely the sound head 1 is to be inserted in particular into a passage opening of the measurement tube and thus comes into contact with the medium to be detected on its lower side.

Furthermore, the sound head 1 comprises two electrical feed lines 14 and 15, by means of which the two electrodes 11 and 12 are electrically contacted. The electrical feed lines 14 and 15 in the shown exemplary embodiment are embodied as spring contact pins. Their feed portions extending in the direction of the longitudinal axis 2 are passed through a damping element 16 (= backing) fitted to the back of the electromechanical sound transducer element 9. The damping element 16 consists of an elastomer, for example of Viton. It is compressible to a certain degree and in the compressed state exerts a pressure force on the electromechanical sound transducer element 9 and on the bent-over portions of the spring contact pins of the electrical feed lines 14 and 15, which because of this are pressed against the respective electrical contact points on the electrodes 11 and 12. The damping element 16 is likewise a component of the sound head 1.

A further component of the sound head 1 is a closure part 17 which is inserted in the pot 3 and closes off the top opening 6. The closure part 17 is the load-bearing component which, apart from the closing off of the top opening 6, above all also serves for ensuring the mechanical stability of the sound head 1 as a whole. It is a composite component composed of a plastic main body 18 and a reinforcement plate 19. The in particular metallic reinforcement plate 19 is partly embedded in the plastic main body 18. In a part it is overmoulded with the plastic of the plastic main body 18. This overmoulding or injection-moulding of the reinforcement plate 19 with the plastic of the plastic main body 18 takes place in particular by means of an advantageously automated injection moulding process. At the end of this

injection moulding process the closure part 17 is available as composite component.

A plan view of the reinforcement plate 19 (not yet overmoulded with plastic) is shown in Fig. 6. It contains a central passage opening 20 and three further edge openings 21, 22, 23 that are each evenly distributed in the circumferential direction, which can also be understood as decentralized passage openings. The latter are filled out with the plastic of the plastic main body 18, so that it results in a closed connection between these two partial components. In the region of the central passage opening 20, the electrical feed lines 14, 15 with their feed portions, are passed through the reinforcement plate 19. Otherwise, the plastic of the plastic main body 18 also extends through the central passage opening 20, which further increases the composite strength.

The closure part 17 with an inner part 24 of the plastic main body 18 is inserted in the pot 3. The inner part 24 laterally surrounds the damping element 16 and at least partly also the electromechanical sound transducer element 9. From the top, the inserted closure part 17 exerts pressure on the damping element 16 so that the latter is compressed. In the region of its inner part 24, the closure part 17 has a closure part side wall 25 which is provided with a closure part step 26 corresponding to the top step 7. The top step 7 and the closure part step 26 directly abut on one another in the final assembly state of the sound head 1.

Above the inner part 24 with its closure part side wall 25, the reinforcement plate 19 is arranged. It forms a laterally projecting and fully encircling connecting collar 27 of the closure part 17 and is firmly connected to the pot edge region 8, in the shown exemplary embodiment adhesively bonded. The connecting collar 27 laterally projects over the closure part side wall 25. In the region of the connecting collar 27, the reinforcement plate 19 has a closure part connecting surface 28, which is connected to a corresponding pot connecting surface 29 present in the pot edge region 8, in particular adhesively bonded. The connection in each case is effected between two metal components and is therefore particularly stable and durable.

The reinforcement plate 19 of the closure part 17 serves for the mechanical reinforcement, which is advantageous in particular when the medium to be detected by means of the sound head 1 is under high pressure. In practice, pressure values in the range between approximately 16 bar to approximately 25 bar can occur when used in a liquid medium during normal operation. Pressure peaks in the range between approximately 24 bar to approximately 50 bar can even occur briefly. Then, the reinforcement plate 19 prevents an undesirable bending of the sound head 1 and in particular of the electromechanical sound transducer element 9 contained therein, so that the full functionality is retained even with such high pressure values although the pot 3 representing the outer sleeve is only a deep-drawn component with comparatively thin pot wall thickness. The pot wall thickness of the pot 3 is for example merely around approximately 0.25mm and 0.45 mm. Nevertheless, the mechanical stability remains ensured which is achieved in particular because of the reinforcement plate 19. Apart from damage to the sound head 1, the reinforcement plate 19 also prevents that for example because of a deformation of the outer contour of the sound head 1 that is otherwise possible upon high pressure impingements a leakage occurs in the place in the pipeline system conducting the medium, into which the sound head 1 is inserted.

The closure part step 26 abutting on the pot step 7 also serves for stabilization. It absorbs a part of the pressure exerted by the medium, passing it on to the reinforcement plate 19. A further advantageous function of the pot step 7 and the closure part step 26 abutting on the same consists in that by way of this an end stop during the fixing with adhesive is formed. In addition, a sound reflector that may be required during the operation of the sound head 1 can be attached to the outside of the pot step 7 during the installation in the measurement tube. This is also advantageous.

In the shown exemplary embodiment, the reinforcement plate 19 has a thickness of approximately 1 mm. Because of this it is able to absorb the pressure forces that occur during the operation. The reinforcement plate 19 is a punched metal disc. It is at least partly overmoulded with the plastic material of the plastic main

body 18, so that altogether a combined unit of the plastic main body 18 and the reinforcement plate 19 is formed. In the mounted state, the reinforcement plate 19 is arranged substantially parallel to the plate-like electromechanical sound transducer element, so that the reinforcement plate 19 can very favourably contribute to the protection of this key component and for the mechanical stability of the sound head 1 as a whole. Forces which would otherwise lead to a bending of the pot base 5 and of the electromechanical sound transducer element 9 arranged on its inner side are absorbed by the reinforcement plate 19. The construction of the sound head 1 retains its original form and is securely protected from damage.

Between the electromechanical sound transducer element 9 and the inner side of the pot base 5 a first adhesive layer is located, which brings about the fixed connection between these two components. This first adhesive layer is electrically insulating. In the shown exemplary embodiment, it contains an epoxy adhesive as main component, which is in particular additionally provided with mechanically stable spacer elements 31 in the form of small glass spherules. These spacer elements 31 evident in the enlarged extract representation according to Fig. 7 ensure that a gap d between the electromechanical sound transducer element 9 and the pot base 5 amounts to approximately 100 µm in any place. The gap d is the layer thickness of the first adhesive layer 30 which, because of its composition of the matrix of the actual adhesive, here the epoxy adhesive, and the spacer elements 31 embedded therein can also be understood to be a composite layer. Both the actual adhesive and also the spacer elements 31 are electrically insulating, so that the first adhesive layer 30 on the whole also has this property. Insofar, there is no electrically conductive connection between the medium flowing past the outside of the electrically conductive pot base 5 and the electromechanical sound transducer element 9 fastened on the inner side of the pot base 5 by means of the electrically insulating first adhesive layer 30 when employing the sound head 1. Because of this, the susceptibility to error of the measurement system as a whole is reduced. A stronger useful signal for evaluation can be generated.

In addition, the energy supply connection of the control unit, to which the sound head 1 is connected for the operation, is also simplified through this measure. Because of the first adhesive layer 30 embodied in an electrically insulating manner there is no electrically conductive connection between the electromechanical sound transducer element 9 and the metallic pot 3. Thus, the electromechanical sound transducer element 9 including its electrical feed lines 14, 15 is also galvanically separated from the medium to be detected flowing past the outside of the pot base 5 during the operation of the sound head 1. This galvanic separation is achieved solely through the favourable internal construction of the sound head 1, in particular through the electrically insulating first adhesive layer 30. Insofar, an additional component, for example in the form of an optocoupler, that would otherwise be necessary for the galvanic separation can be omitted in the energy supply connection of the control unit of the sound head 1. This contributes to the cost reduction of the measurement system as a whole.

In addition to this, the pot side wall 4 and the inner part 24 of the closure part 17 inserted in the pot 3 are connected fixedly to one another by means of a second adhesive layer 32. This second adhesive layer 32 is situated in particular between the closure part connecting surface 28 on the connecting collar 27 of the closure part 17 and the pot connecting surface 29 on the pot edge region 8. There, it ensures a durable and tight connection between the pot 3 and the closure part 17. The remaining components arranged within the pot 3 are thus very well shielded against adverse external environmental influences. Thus, the second adhesive layer 32 also has in particular a sealing function. In particular, this thereby provides protection against the entering of dust, other dirt and water.

The second adhesive layer 32 can also be embodied as epoxy adhesive. The adhesives of the first adhesive layer 30 and of the second adhesive layer 32 however can be embodied differently. However, they advantageously nevertheless have the same curing conditions, i.e. in particular the same curing times, same curing temperatures and same curing pressure. Insofar, the first and the second adhesive layer 30 and 32 respectively can be cured simultaneously during the production, as a result of which the production time is shortened.

Because of the fixed adhesive connection between the pot 3 and the closure part 17 the sound head 1 is a non-demountable combination component, the individual components of which always stay in the desired position during the manufacturing process but above all even thereafter. This facilitates the installation of the sound head 1 in a measurement system. Incorrect assemblies can be excluded in this way. Compared with this, it can occur in the case of an only loosely assembled and re-demountable construction that components are (subsequently) dislodged and are no longer in the correct position, as a result of which defects can occur.

The closure part 17 continues on the side of the reinforcement plate 19 facing away from the inner part 34 inserted in the pot 3. In this outer region situated outside of the pot 3, the closure part 17 has a protective collar 33 which projects over the closed pot opening 6 and surrounds the electrical feed lines 14 and 15 in this outer region. A collar wall of the protective collar 33 comprises two passage openings 34, 35 that are aligned with one another. These two passage openings 34, 35 are extraction means which facilitate the removing of the sound head from its installation position in the measurement tube. Such a removal can be difficult in particular after an extended operating time of the sound head 1, since crusting deposits can form on the lower side of the pot base 5 and on the inner wall of the measurement tube adjoining thereon, which render removing the sound head 1, be it for inspection purposes or for the replacement because of a defect, more difficult. The passage openings 34, 35 make possible removing the sound head 1 even under such unfavourable installation conditions in that a suitable extracting tool is inserted in both passage openings 34, 35.

Otherwise, the protective collar 33 serves for protecting the end portions of the electrical feed lines 14, 15 arranged therein. In this way it is prevented that the exposed ends of the electrical feed lines 14, 15 are damaged or even merely bent over, which would otherwise render the installation of the sound head 1 in a measurement system difficult or in the most unfavourable case even impossible. The protective collar 33 by contrast ensures that the free ends of the electrical feed lines 14, 15 provided for the signal connection are always in their intended

position. By way of this, automated assembly of the sound head 1 in a measurement system is in particular also made possible.

As is evident from Fig. 3 and 5, the closure part 17 also has a ventilation bore 36. This ventilation bore 36 runs within the plastic main body 18 in the region which penetrates the central passage opening 20 of the reinforcement plate 19. This ventilation bore 36 serves in particular for air and/or gases, which are present or form in the interior of the pot 3 during the manufacture and also later during the operation of the sound head 1, to escape. This applies in particular for the period of the adhesive bonding process for producing the durable connection between the pot 3 and the closure part 17. Excess air and gases, which form during the course of establishing the adhesive connection, can escape in this way and do not then result in an undesirable air or gas inclusion in the interior of the pot 3, as a result of which the function could otherwise be negatively affected. If required, the damping element 16 can also be equipped with at least one such ventilation bore in an alternative embodiment which is not shown.

Altogether, the sound head 1 can be advantageously produced in a fully automated manner and thus highly cost-efficiently and also in large quantities. The pot 3 embodied as deep-drawn component and the closure part 17 embodied as plastic injection moulding component are components the manufacture of which can be carried out in the known automated manner. The resulting sound head 1 has all acoustic and mechanical properties necessary for its application purpose, although, compared with earlier designs, which for example have a very high brass housing, has a significantly lower weight.

Patentkrav

1. Lydhoved til indbygning i en gennemstrømningsmålers målerør til lydbaseret registrering af en gennemstrømningsmængde af et medium omfattende

a) en potte (3) af et metallisk pottemateriale med en pottesidevæg (4), en pottebund (5), som skal lade lyd passere igennem, og en modsat pottebunden (5) beliggende potteåbning (6),

b) et elektromekanisk lydomdannelseselement (9), som er klæbet på indersiden af pottebunden (5),

c) to ud af potteåbningen (6) førende elektriske tilføringsledninger (14, 15) til at gå i elektrisk kontakt med det elektromekaniske lydomdannelseselement (9),

d) en lukkedel (17), som er indsat i potten (3) og aflukker potteåbningen (6), hvorved

e) lukkedelen (17) på en væk fra det elektromekaniske lydomdannelseselement (9) vendende side har en beskyttelseskrave (33), som rager op over den aflukkede potteåbning (6) og omslutter de elektriske tilføringsledninger (14, 15), hvorved beskyttelseskraven (33) er udstyret med udtræksmidler (34, 35), som letter en demontering af lydhovedet fra en indbygningsposition, **kendetegnet ved,** at

f) de elektriske tilføringsledninger (14, 15) har fritliggende endeafsnit, og at beskyttelseskraven (33) strækker sig i det mindste nøjagtigt lige så langt i aksial retning som de fritliggende endeafsnit af de elektriske tilføringsledninger (14, 15), og

g) udtræksmidlerne er tildannet som mindst en i en kravevæg på beskyttelseskraven (33) værende gennemgangsåbning (34, 35).

2. Lydhoved ifølge krav 1, **kendetegnet ved,** at udtræksmidlerne er tildannet som to gennemgangsåbninger (34, 35), som findes i en kravevæg på beskyttelseskraven (33) og flugter med hinanden.

3. Lydhoved ifølge et af de foregående krav, **kendetegnet ved,** at lukkedelen (17) er placeret således inden i potten (3), at den påvirker det elektromekaniske lydomdannelseselement (9) med et tryk.

4. Lydhoved ifølge et af de foregående krav, **kendetegnet ved,** at lukkedelen (17) har en ud til siden ragende og fuldstændigt rundtgående forbindelseskrave (27), som er fast forbundet med et randområde (8) på pottesidevæggen (4).

5. Lydhoved ifølge krav 4, **kendetegnet ved,** at forbindelsen imellem forbindelseskravens (27) og pottesidevæggens (4) randområde (8) er en klæbeforbindelse eller en svejseforbindelse.

6. Lydhoved ifølge et af de foregående krav, **kendetegnet ved,** at lukkedelen (17) har et plast-hovedlegeme (18) og en forstærkningsplade (19), hvorved forstærkningspladen (19) i det mindste delvis er indlejret i plast-hovedlegemet (18).

7. Lydhoved ifølge krav 4 og 6, **kendetegnet ved,** at forstærkningspladen (19) strækker sig ind i forbindelseskraven (27) og der danner en lukkedel-forbindelsesflade (28), som er forbundet med en i pottesidevæggens (4) randområde (8) værende korresponderende potteforbindelsesflade (29).

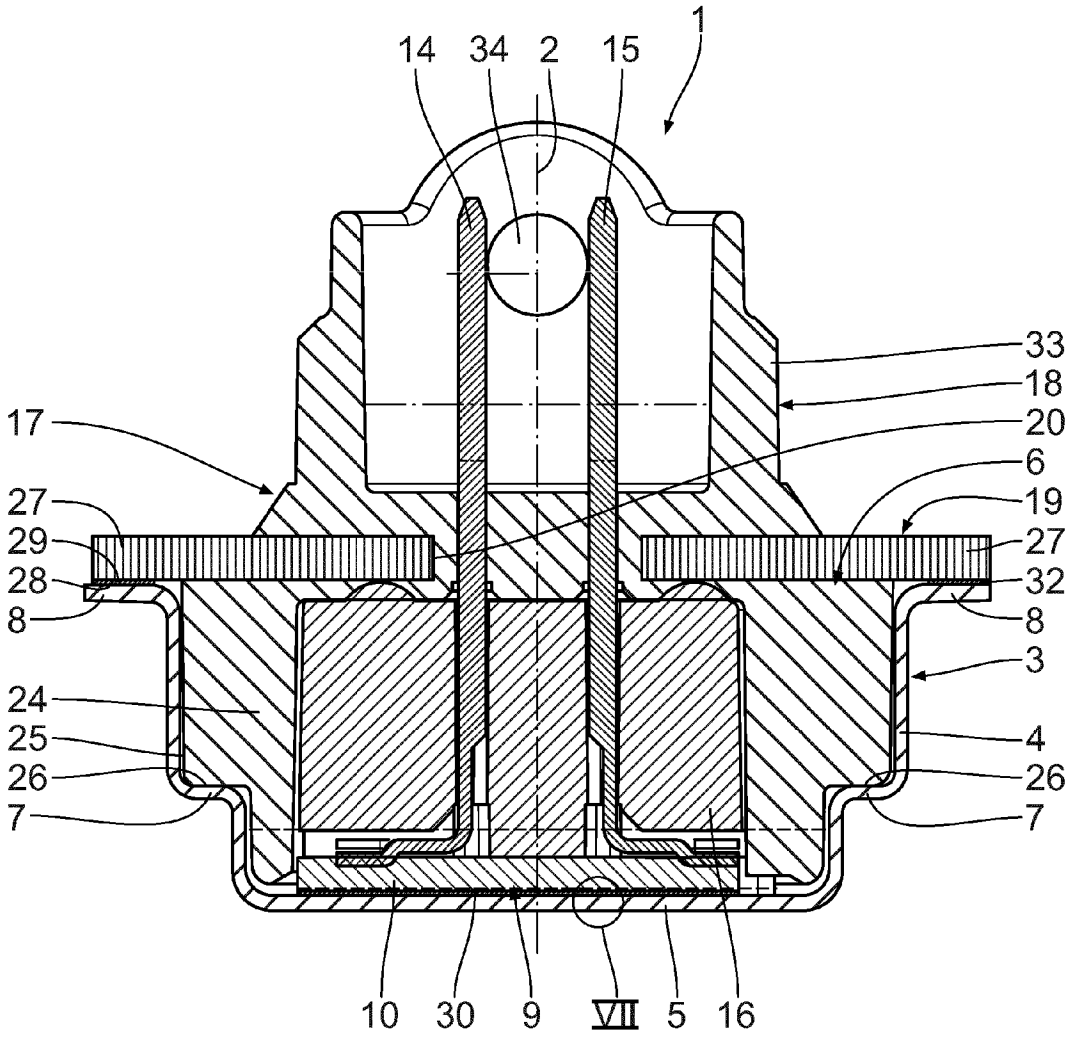
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Fig. 1

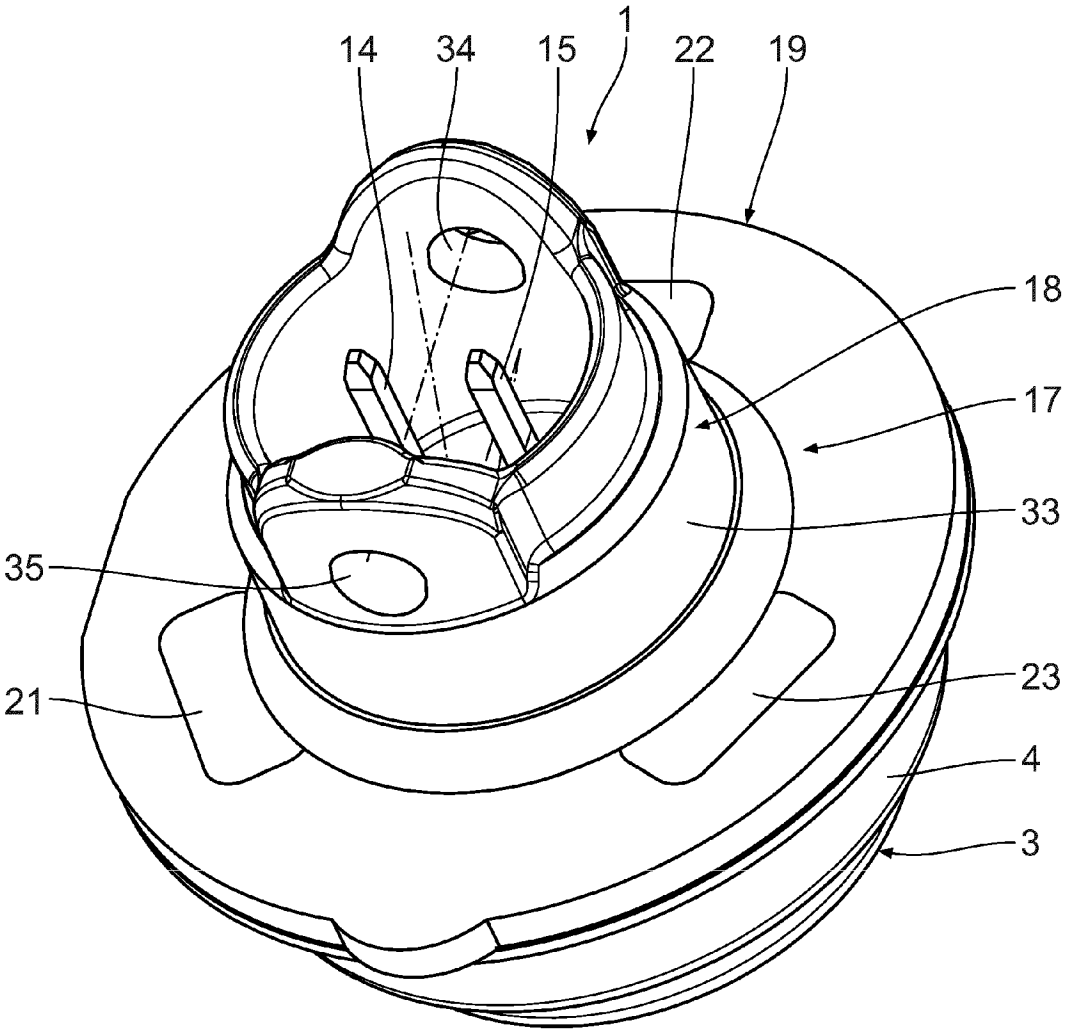

Fig. 2

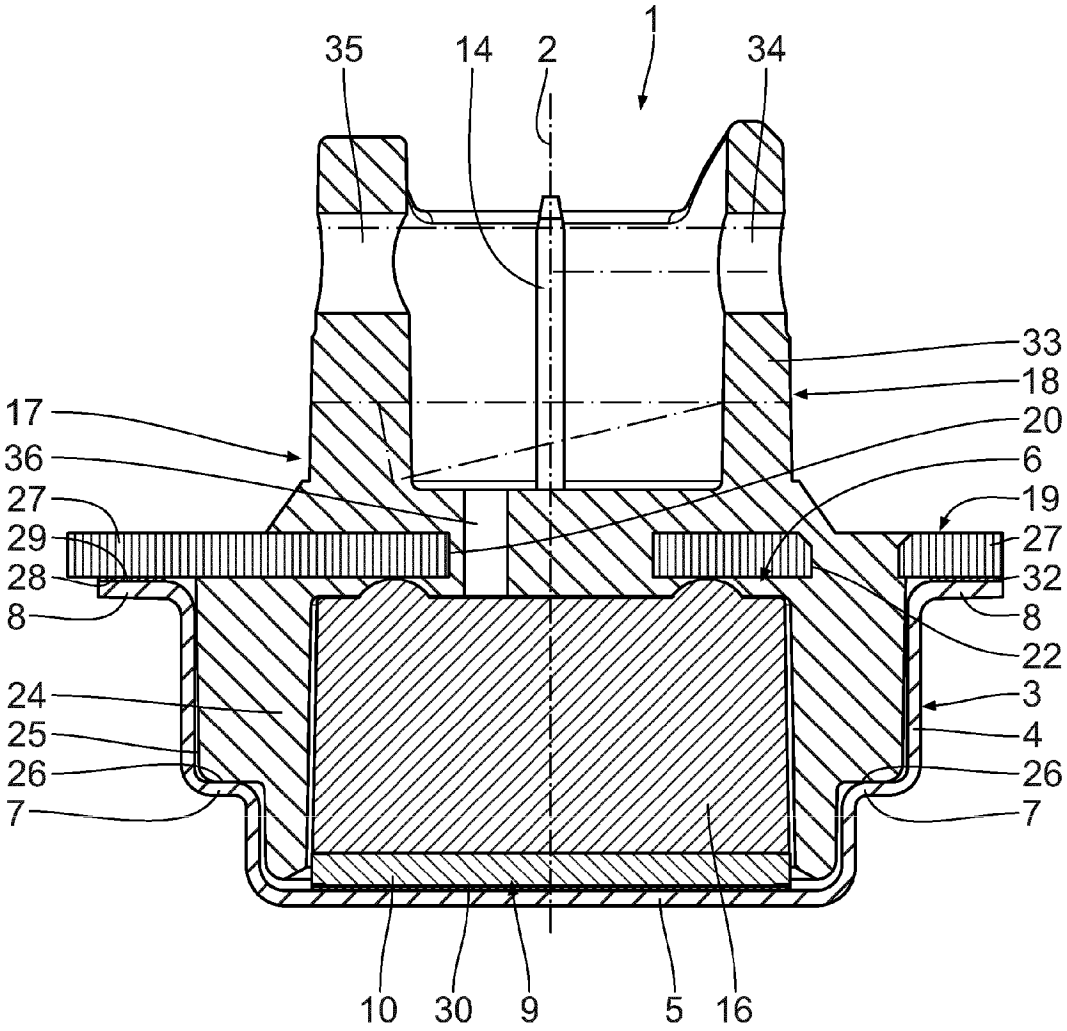
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Fig. 3

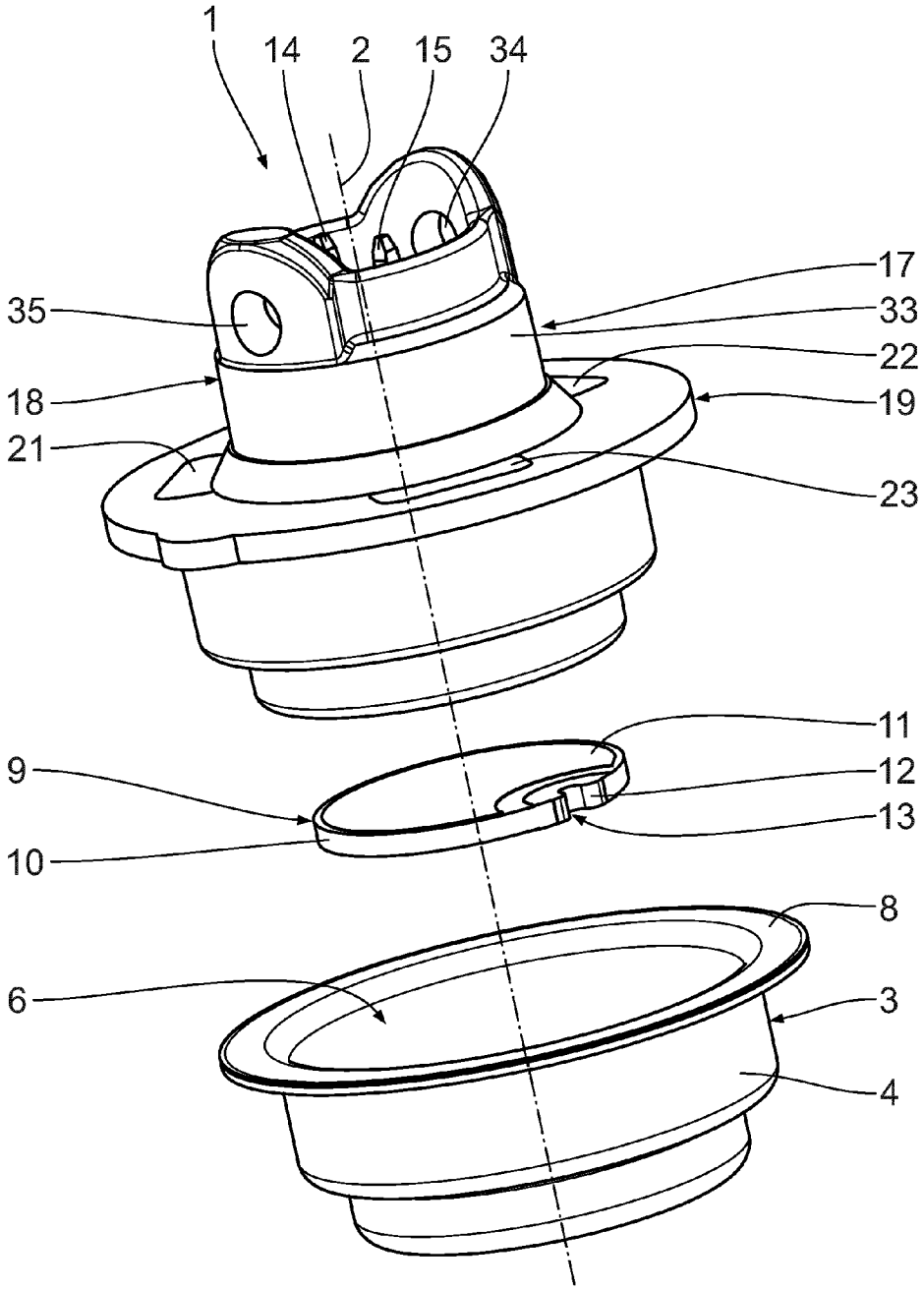

Fig. 4

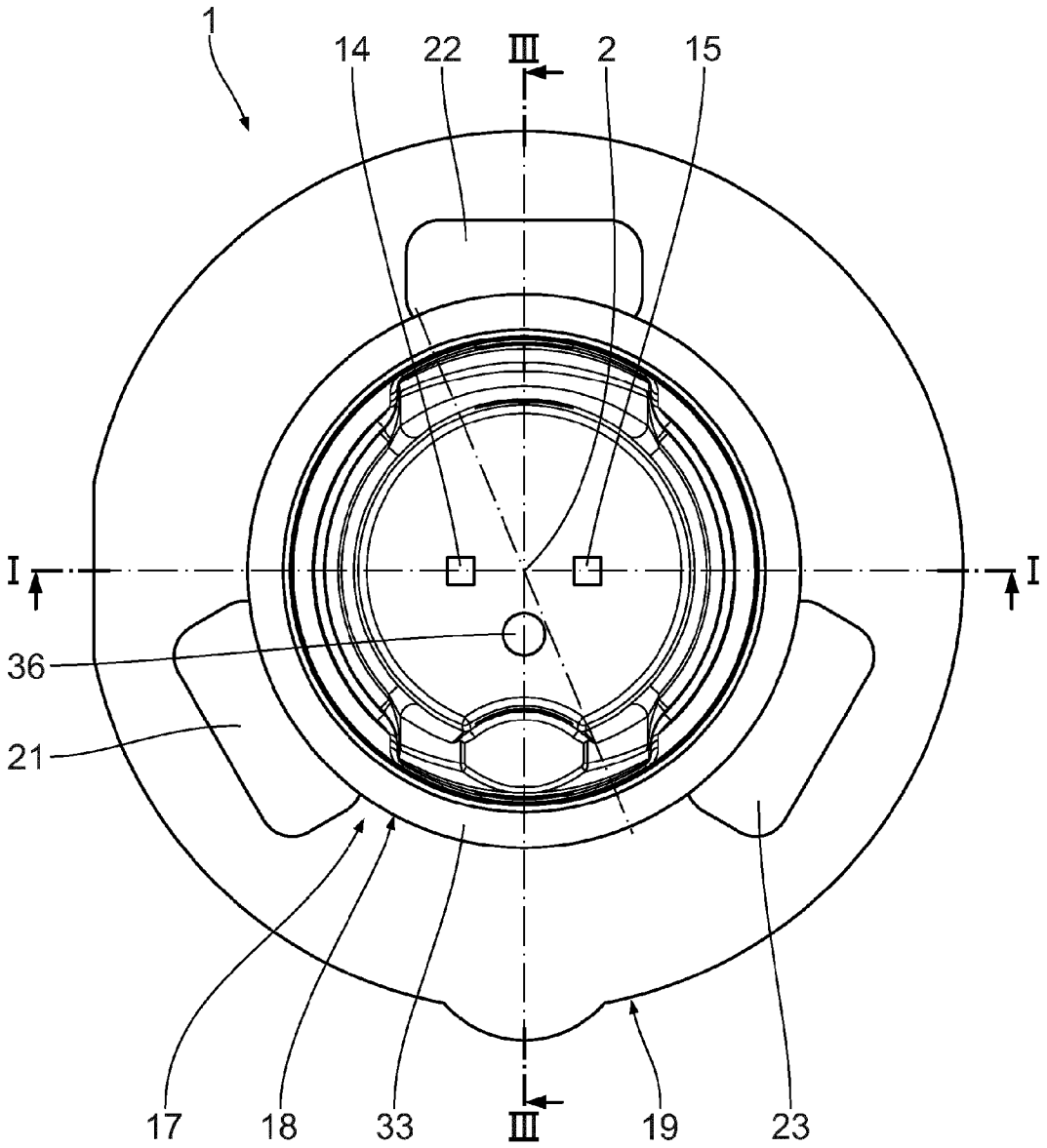

Fig. 5

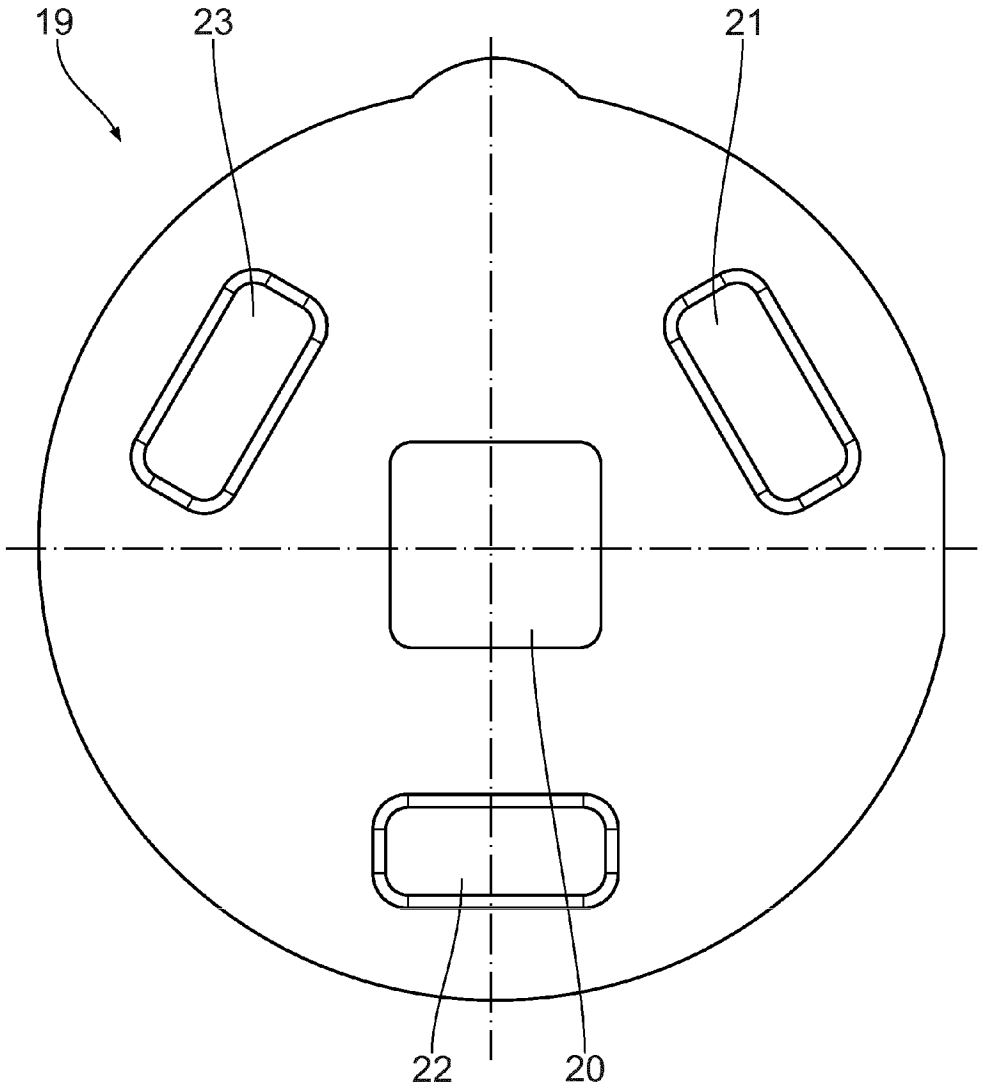

Fig. 6

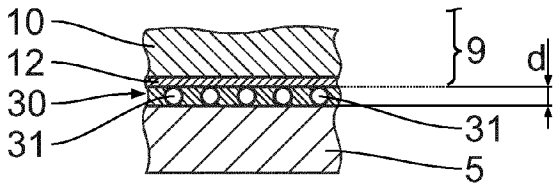

Fig. 7