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(54) SUCTION MUFFLER FOR A REFRIGERANT COMPRESSOR

(57) The invention relates to a suction muffler (600) for an encapsulated refrigerant compressor, comprising
- a suction muffler housing (602) defining a suction muffler volume, wherein the suction muffler housing (602) is made of plastic material, wherein the suction muffler housing (602) has a lower housing part (610) and an upper housing part (620);
wherein the upper housing part (620) includes
- an inlet section (605) to allow refrigerant to enter the suction muffler volume, the inlet section (605) comprising an inlet opening and an inlet tube (622) for directing refrigerant to a first suction muffler chamber (603), the inlet opening being connected to the inlet tube (622) and
- an outlet section (606) to allow refrigerant to escape from the suction muffler volume (601) of the suction muffler (600) towards the cylinder of the refrigerant compressor.

In order to achieve a compact design and to reduce production costs as well as to simplify assembly its it is provided that the suction muffler (600) further comprises an inner housing element (630), which is inserted into the suction muffler housing (602), which inner housing element (630) separates the suction muffler volume into the first suction muffler chamber (603) and a second suction muffler chamber (604).

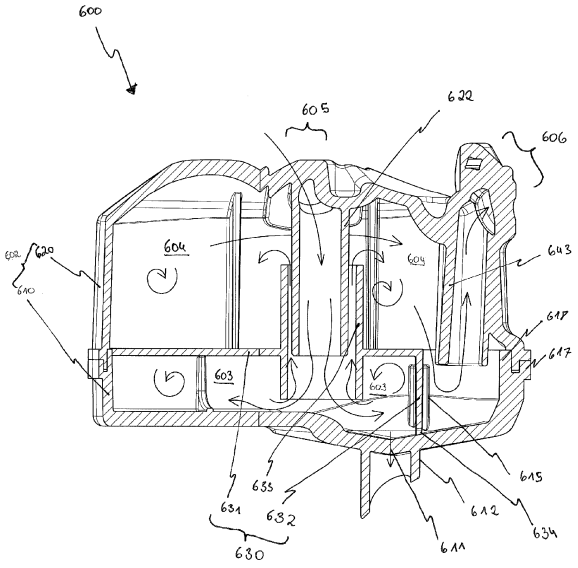

Fig. 11

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Description

FIELD OF THE INVENTION

[0001] The invention relates to a suction muffler for an encapsulated refrigerant compressor, comprising

- a suction muffler housing defining a suction muffler volume, wherein the suction muffler housing is made of plastic material, wherein the suction muffler housing has a lower housing part and an upper housing part;

wherein the upper housing part includes

- an inlet section to allow refrigerant to enter the suction muffler volume, the inlet section comprising an inlet opening and an inlet tube for directing refrigerant to a first suction muffler chamber, the inlet opening being connected to the inlet tube and
- an outlet section to allow refrigerant to escape from the suction muffler volume of the suction muffler towards the cylinder of the refrigerant compressor;

wherein the lower housing part includes an oil drain opening.

PRIOR ART

[0002] Encapsulated, especially hermetically sealed, refrigerant compressors have been known for a long time and are mainly used in refrigeration cabinets, such as refrigerators or refrigerated shelves, but can also be used in mobile appliances. The refrigerant process as such has also been known for a long time. Refrigerant is thereby heated by energy absorption from the space to be cooled in an evaporator and finally superheated and pumped to a higher pressure level using the refrigerant compressor having a cylinder and a reciprocating piston. At this higher pressure level the refrigerant is cooled via a condenser and is conveyed back into the evaporator via a throttle, via which throttle the pressure is reduced and the refrigerant is further cooled down, before the cycle starts anew.

[0003] The path of the (usually gaseous) refrigerant through the compressor can be described as follows: The refrigerant enters a compressor shell of the refrigerant compressor, which compressor shell encapsulates a pump unit of the refrigerant compressor, through a suction pipe, which is in the operating state connected to the evaporator of the refrigerant appliance. During a suction cycle, the refrigerant is sucked through a suction muffler, a suction opening of a valve plate, which suction opening is released by a suction valve spring, into a cylinder of the pump unit of the refrigerant compressor. The suction is caused by linear movement of a piston inside the cylinder. During a compression part of a compression and discharge cycle, the refrigerant is compressed within the cylinder by the linear movement of the piston until a discharge valve spring releases a discharge opening of the valve plate. During a discharge part of the compression and discharge cycle, the so compressed refrigerant then flows through the discharge opening of the valve plate into a discharge muffler and leaves the compressor shell through a discharge pipe, which is connected to the discharge muffler by a discharge connection tube. The discharge tube is in the operating state connected to the condenser of the refrigerant appliance.

[0004] The pump unit comprises a cranktrain, which includes the piston and is causing the linear movement of the piston inside the cylinder, a crankcase, in which a crankshaft of the cranktrain is mounted, the crankcase also having a cylinder housing, an electric drive unit, which comprises a rotor and a stator, and a cylinder head arrangement. The cylinder head arrangement includes the valve plate, the suction valve spring, the discharge valve spring, the suction muffler and the discharge muffler. The pump unit is supported within the compressor shell on a plurality of support spring assemblies, preferably on four support spring assemblies.

[0005] The shell usually comprises a lower shell part and an upper shell part, which are welded together. The discharge pipe and the suction pipe as well as a maintenance pipe (also known as service pipe) are hermetically connected to the shell. As the refrigerant compressor is a stand-alone product, which is integrated into a refrigerant appliance at some stage of the assembly process, the discharge pipe, the suction pipe and the maintenance pipe are also called discharge connector, suction connector and maintenance connector as they are configured to be connected with respective elements with the refrigerant appliance during assembly and/or in the operation state.

[0006] The movement of the piston is caused by rotation of the crankshaft, wherein the piston is connected to a crank-pin of the crankshaft via a connecting rod. The electric drive unit is required to facilitate the rotation of the crankshaft, wherein the rotor is fixed to the crankshaft.

[0007] Usually an electronic control unit is mounted to an outside surface of the compressor shell, wherein the stator is connected to an electric pass through element (also known as "fusite") via an inner harness and the electronic control unit is connected to the electric pass through element via an outer harness. The electronic control unit powers the stator and thereby controls the rotational speed of the pump unit of the refrigerant compressor.

OBJECT OF THE INVENTION

[0008] It is an object of the invention to provide a suction muffler with a compact design, which is relatively cheap to produce and easy to assemble. A further object of the invention is to provide an optimised muffler design with regard to an external oil circulation.

SUMMARY OF THE INVENTION

[0009] In order to achieve at least one of the objects set out above in a suction muffler as defined initially it is suggest according to the invention that the suction muffler further comprises an inner housing element, which is inserted into the suction muffler housing, which inner housing element separates the suction muffler volume into the first suction muffler chamber and a second suction muffler chamber. Due to this specific design, the two muffler chambers, which act as resonators required to reduce the noise level of the suction muffler as well as of a pump unit of the refrigerant compressor in general, can be defined in a very simple way. Further the complexity of the lower housing part and of the upper housing part is reduced as the suction muffler chambers are created by the insertable inner housing element, which can also have a relative simple and straightforward design. As the inner housing element is inserted into the suction muffler housing during assembly, the lower housing part and the upper housing part of the suction muffler housing can be welded together and contain the inner housing part within. Therefore production costs can be lowered and the size of the suction muffler can be reduced with regard to suction mufflers according to the prior art.

[0010] According to a further embodiment variant of the invention, the inner housing element comprises, preferably consists of, a top wall and a side wall, wherein the first suction muffler chamber is bounded by the lower housing part, the top wall of the inner housing element and the side wall of the inner housing element, and wherein the top wall has a protruding tubular section, wherein at least a section of the inlet tube is received by the protruding tubular section of the inner housing element. The inner housing element having a top wall and a side wall, which are preferably forming an L-shaped inner housing element, allows for a comparably easy design of the inner housing element and defining the boundaries of the first suction muffler chamber. The protruding tubular section, which forms an opening in the top wall, allows refrigerant to enter the first suction muffler chamber as a section of the inlet tube is received by the protruding tubular section. In order to close the first suction muffler chamber, the outline of the top wall (as seen from a height direction) resembles the outline of the suction muffler housing, especially of the lower housing part. Accordingly, the outline of the side wall of the inner housing element resembles a cross section of the suction muffler housing, especially of the lower housing part, in a plane being parallel to the height direction.

[0011] A further embodiment variant of the invention provides that two slots are formed at an inner surface of the lower housing part in order to guide the side wall of the inner housing element during mounting and to support opposite edges of the side wall in the lower housing part. Each slot can be formed by a set of two reinforcement ribs protruding from an inner surface of the lower housing part. The reinforcement ribs are preferably running in parallel to a height direction so that the side wall of the inner housing element can be inserted into the slots in a simple way. The slots are used for supporting and positioning the inner housing element inside the suction muffler housing. They are further used to guide the inner housing element into the correct position during assembly and to fix it there, before the lower housing part and the upper housing part of the suction muffler are mated.

[0012] In order to position the inner housing element within the suction muffler housing and to define the first suction muffler chamber, a further embodiment variant of the invention provides that the top wall of the inner housing element is aligned with an upper edge of the lower housing part. The upper edge can be formed as a part of the circumferential fixing groove of the lower housing part.

[0013] According to a further embodiment variant of the invention it is provided that the protruding tubular section of the inner housing element is extending perpendicularly to both sides of the top wall of the inner housing element. Because of this design of the inner housing element, the protruding tubular section extends (in the mounted state of the suction muffler) on one side of the top wall inside the upper housing part (and thus into the second suction muffler chamber) in order to form an overlapping section with the suction pipe. On the other side of the top wall, the protruding tubular section of the inner housing element extends into the lower housing part of the suction muffler and thus into the first suction muffler chamber. Accordingly the flow of the refrigerant can be optimised within the suction muffler as the protruding tubular section distributes the refrigerant to the respective portions of the suction muffler housing.

[0014] In a further embodiment variant it is provided that the protruding tubular section of the inner housing element and the inlet tube of the upper housing part are oriented in parallel, wherein an air gap is formed between the protruding tubular section of the inner housing element and the inlet tube of the upper housing part, through which air gap refrigerant can flow from the first suction muffler chamber to the second suction muffler chamber. Due to the air gap the protruding tubular section of the inner housing element does not only direct the refrigerant coming from the inlet pipe into the first suction muffler chamber, but also acts as a connector of the first suction muffler chamber and the second muffler chamber. Therefore refrigerant can flow from the first suction muffler chamber and the second muffler chamber through the air gap, which further optimises the refrigerant flow and the noise dampening characteristics of the suction muffler.

[0015] In order to further improve the flow characteristics of the refrigerant within the suction muffler a further embodiment variant of the invention provides that the protruding tubular section of the inner housing element and the inlet tube of the upper housing part are arranged eccentrically to each other. Preferably the eccentric cross

section of the air gap resulting from the positioning of inlet tube and protruding tubular section can be used to specifically influence how much refrigerant flows to which specific portion of the second suction muffler chamber.

[0016] As the pump unit of the refrigerant compressor is lubricated during operation via oil as a lubricant, that is conveyed by the pump unit and splashed onto the pump unit, droplets of oil can be contained within the refrigerant that is sucked into the suction muffler. In order to prevent that the oil accumulates within the suction muffler and prevents it from functioning properly, the lower housing part has the oil drain opening through which oil can drain from the suction muffler. However as the suction muffler has two separate chambers oil needs to be drained from both chambers. In order to prevent the requirement of having two separate oil drain openings for each suction muffler chamber, a further embodiment variant of the invention provides that the side wall of the inner housing element has an oil opening for allowing oil from one suction muffler chamber to flow to the oil drain opening located in the other suction muffler chamber. Preferably the oil opening is located in a bottom section of the side wall of the inner housing element and is relatively small compared to the cross section of the protruding tubular section of the inner housing element, so that an oil accumulation formed in a bottom section of the lower housing during operation can clos the oil opening and prevents formation of a second flow path from the first suction muffler chamber into the second suction muffler chamber.

[0017] In order to improve the oil draining efficiency of the suction muffler, even in case the refrigerant compressor is placed on an inclined surface and thus is not oriented correctly, a further embodiment variant of the invention provides that the oil drain opening is located at a lowest point of an inner surface of the lower housing part, wherein the inner surface is declining toward the oil drain opening at least in sections adjacent to the oil drain opening. Due to this design oil flows towards the oil drain opening even in the afore mentioned case and does not accumulate in the chamber not having an oil drain opening. It is, however, not required that the whole lower part of the inner surface needs to incline towards the oil drain opening as there can be relatively flat sections, if they are not in the direct vicinity of the oil drain opening.

[0018] According to a further embodiment variant of the invention the second suction muffler chamber is bounded by the upper housing element, the top wall of the inner housing element, the side wall of the inner housing element and a section of the lower housing part. Thus, both suction muffler chambers are defined and bounded solely by inner surfaces of the lower housing part and the upper housing part as well as by the inner housing element.

[0019] A further embodiment variant of the invention provides that the inlet opening is surrounded by an embossing, which embossing is located on an outer surface of the upper housing part. Preferably the embossing is located at an outer surface of the upper housing part. The embossing prevents oil drops which splash onto the suction muffler during operation from directly entering the suction muffler as they are redirected by the embossing and flow along the embossing around the inlet opening.

[0020] In a further embodiment variant of the invention it is provided that the embossing is chamfered towards the inlet opening and/or that the embossing has at least two tangential extensions. The chamfering improves the flow characteristics of the refrigerant flowing into the suction muffler whereas the tangential extensions, especially if they are oriented parallel to each other, improve the oil drain from the embossing. It is preferred that the tangential extensions are positioned symmetrical to a vertical symmetry plane of the inlet opening.

[0021] Due to the lack of available space within a compressor shell of the refrigerant compressor due to the aim to minimise the size of the refrigerant compressor, it is in some embodiments not possible to place an embossing that projects over the contour of the suction muffler, a further embodiment variant provides that the embossing is located in a recessed area of the outer surface of the upper housing part. Due to the recessed area the available space can be used optimally, while still benefitting from the technical effect of the embossing.

[0022] It is thus especially preferred that the embossing does not project over the contour of the surrounding non-recessed surfaces of the outer surface of the upper housing part.

[0023] A further preferred embodiment variant of the invention provides that the lower housing part has an outer tubular extension which is surrounding the oil drain opening. The outer tubular extension further improves the formation of droplets of oil coming from the oil drain opening and allows the oil to drip off the suction muffler. Preferably the outer tubular extension is spaced apart from the oil drain opening.

[0024] The above described characteristics are further improved in another embodiment variant of the compressor which provides that the outer tubular extension of the lower housing part has a diagonal cut, preferably a 45° cut end section.

[0025] In a further embodiment variant of the suction muffler it is provided that the outlet section is formed by a suction connector head for connecting the suction muffler with a suction valve of a cylinder head assembly of the refrigerant compressor, which suction connector head has a sealing surface for connection with a valve plate of the refrigerant compressor, wherein the suction connector head is connected with an outlet tube, which is located within the upper housing part. The suction connector head allows to easily establish a secure connection of the suction muffler to the valve plate and seal this connection. The outlet tube within the suction muffler housing is used to further improve the flow characteristics of the refrigerant within the muffler volume, especially within the second suction muffler chamber.

[0026] A further embodiment variant of the invention provides that the suction muffler, especially the suction muffler housing, the inner housing element and the suction connector head, is/are made of a polybutylene terephthalate [PBT] based polymer material. Even though other polymer materials having the same material properties can be used for manufacturing suction mufflers, PBT based polymer material based products have been tested to have a superior combination of availability, costs, thermal properties - especially thermal conductivity - and mechanical properties. Furthermore the suction muffler housing is usually produced via injection moulding.

[0027] In a further preferred embodiment variant of the suction muffler it is provided that the polymer material is fibre-reinforced, preferably by glass fibres. Fibre-reinforced polymer materials have even further improved characteristics especially with regard to the mechanical stability. Preferably the polymer material used is PBT GF30, which has a 30% share of glass fibres and can be bought under the commercial name Ultradur® B4300G6 from BASF.

[0028] The invention further relates to an encapsulated refrigerant compressor having

- a compressor shell having a lower shell part and an upper shell part, wherein a discharge pipe, a suction pipe and a maintenance pipe enter the compressor shell,
  wherein an electric pass through element is inserted into the compressor shell;
  - a pump unit comprising:
    -- a cranktrain having a crankshaft, a crank pin, a connecting rod and a piston;
    -- an electric drive unit having an inner harness, a stator and a rotor, the rotor being fixed to the crankshaft, wherein the inner harness is connecting the electric pass through element and the stator;
    -- a crankcase with a cylinder housing,

    wherein a cylinder for reciprocating movement of the piston is located in the cylinder housing, wherein the crankshaft is rotatably mounted in the crankcase,
    wherein the stator is attached to the cylinder crankcase;

    -- a cylinder head assembly mounted to the cylinder housing of the crankcase, the cylinder head assembly comprising a valve plate, a suction valve spring, a discharge valve spring and a discharge muffler, wherein the discharge muffler has a discharge connection tube being connected to the discharge pipe;
  - a plurality of support spring assemblies for supporting the compressor body in the compressor shell,
    wherein the cylinder head assembly comprises the suction muffler according to the invention described above.

BRIEF DESCRIPTION OF THE DRAWINGS

[0029] The invention will now be explained in more detail below with reference to one exemplary embodiment. The drawings are provided by way of example and are intended to explain the concept of the invention, but shall in no way restrict it or even render it conclusively, wherein:

Fig. 1 shows a three dimensional view of a refrigerant compressor from the outside;
Fig. 2 shows an exploded view of the refrigerant compressor;
Fig. 3 shows a three dimensional view of an assembled pump unit of the refrigerant compressor;
Fig. 4 shows a 3D view of a rear side of a suction muffler as well as an exploded view of elements of a cylinder head assembly;
Fig. 5 shows a 3D view of a front side of the suction muffler according to Fig. 4;
Fig. 6 shows a 3D view of the suction muffler according to Fig. 4 with removed upper housing part;
Fig. 7 shows a 3D view of an inner housing element of the suction muffler according to Fig. 4;
Fig. 8 shows a top view of a lower housing part of the suction muffler according to Fig. 4;
Fig. 9 shows a bottom view of an upper housing element of the suction muffler according to Fig. 4;
Fig. 10 shows a first sectional view of the suction muffler according to Fig. 4;
Fig. 11 shows a second sectional view of the suction muffler according to Fig. 4.

DETAILED DESCRIPTION

[0030] Fig. 1 shows an outside view of an, in particular hermetically, encapsulated refrigerant compressor 1 which extends along a length direction x, a width direction y and a height direction z. Length direction x, width direction y and height direction z form an orthogonal reference system. In general the length dimension of the refrigerant compressor measured along the length direction x is greater than the width dimension measured along the width direction y.

[0031] In the following reference will occasionally be made to a (usually gaseous) refrigerant, which flows through the refrigerant compressor 1. It is self evident that these remarks refer to an operating state of the refrigerant compressor 1, but that usually no refrigerant is present in the refrigerant compressor 1 when the refrig-

erant compressor 1 is produced or sold as a stand-alone product.

[0032] The refrigerant compressor 1 comprises a compressor shell 100, which in this embodiment consists of a lower shell part 110 and an upper shell part 120. The upper shell part 120 and the lower shell part 110 are welded together. On both sides of the lower shell part 110, which extend mainly in the length direction x, a supporting base plate 160 is fixed to the compressor shell 100. Each supporting base plate 160 has two openings 164 for mounting support damper assemblies 90 (see Fig. 2).

[0033] A suction pipe 30, which is connectable to a low pressure side of a refrigerant appliance, enters the upper shell part 120 on a lateral side of the refrigerant compressor 1. During operation refrigerant is sucked into the refrigerant compressor 1 through the suction pipe 30, mainly during a suction cycle of a pump unit 10 (see Fig. 3) of the refrigerant compressor 1. Therefore, in an operating state, the suction pipe 30 is connected directly or indirectly, e.g. through piping of the low pressure side of the refrigerant appliance, to an evaporator of the refrigerant appliance. With regard to the compressor shell 100, the suction pipe 30 enters the upper shell part 110 through a second connector element 80, which second connector element 80 is hermetically connected to the upper shell part 120 on the one hand and to the suction pipe 30 on the other hand, for example by welding and/or soldering.

[0034] A discharge pipe 20 as well as a maintenance pipe 40 enters the lower shell part 110 on a front side of the refrigerant compressor 1. The discharge pipe 20 enters the lower shell part 110 through a first connector element 70, which first connector element 70 is hermetically connected to the lower shell part 110 on the one hand and to the discharge pipe 20 or maintenance pipe 40 respectively on the other hand, for example by welding and/or soldering. During operation, refrigerant compressed by the pump unit 10 can escape the refrigerant compressor 1 through the discharge pipe 20, mainly during a compression and discharge cycle of the pump unit 10. Therefore, the discharge pipe 20 is connectable to a high pressure side of the refrigerant appliance to allow compressed refrigerant to be fed to a high pressure side of the refrigerant appliance. In the operation state the discharge pipe 20 is connected directly or indirectly, e.g. through piping of the high pressure side of the refrigerant appliance, to a condenser of the refrigerant appliance.

[0035] The maintenance pipe 40 can be used to insert lubrication oil and/or refrigerant into the refrigerant compressor 1 during assembly of the refrigerant application or during maintenance operations. The maintenance pipe 40 is, similar to the suction pipe 30, connected to the lower shell part 110 by a second connector element 80, which is hermetically connected to the lower shell part 110 on the one hand and to the maintenance pipe 40 on the other hand, for example by welding and/or soldering.

[0036] With regard to Fig. 2 all main components of the refrigerant compressor 1 as well as their functions will be briefly described. The refrigerant compressor 1 comprises the shell 100, an electronic control unit 800, which is detachably mounted to the compressor shell 100, and the pump unit 10 (see Fig. 3), which is located inside the compressor shell 100 and supported by four support spring assemblies 60. The refrigerant compressor 1 is mounted on four support damper assemblies 90, which are connected to the respective openings of the two supporting base plates 160. Each support damper assembly 90 includes a damper pin 92, an outer dampening element 91, a lining disk 93 and a securing element 94.

[0037] As can be seen in Fig. 2, the suction pipe 30 enters the upper shell part 120 through a second connection opening 102, whereas the maintenance pipe 20 enters the lower shell part 110 through a third connection opening 103. Even though not visible in Fig. 2, the discharge pipe 20 enters the lower shell part 110 through a first connection opening.

[0038] The pump unit 10 comprises an electric drive unit 400, a cranktrain 200, a crankcase 300 and a cylinder head assembly 500, which includes a suction muffler 600 and a discharge muffler 700.

[0039] Each support spring assembly 60 comprises a mounting pin 140, which is fixed, preferably welded, to the lower shell part 110, a lower spring pin 61, which is mounted on the respective mounting pin 140, and a support spring 62, which is supported on the lower spring pin 61.

[0040] The electric drive unit 400 comprises a stator 420, a rotor 410 and an inner harness 430. The stator 420 has a lower end element 421 made of plastic, which lower end element 421 comprises four upper spring holders 63 for the respective support springs 62. The stator 420 is fixed to the crankcase 300 via two stator mounting screws 340. The inner harness 430 connects the stator 420 with an electric pass through element 50, which is located in the compressor shell 100. On the outside of the compressor 1 the electronic control unit 800 is connected to the electric pass through element 50 via an outer harness 801, in order to control the rotation speed of the pump unit 10.

[0041] The cranktrain 200 comprises a piston 240 and a crankshaft 210, which is rotatably mounted inside a main bearing 302 of the crankcase 300 on the one hand and axially supported on the crankcase 300 by a ball bearing 201. The crankshaft 210 has a crank pin 220 on which a connecting rod 230 is mounted, which connecting rod 230 connects the crank pin 220 with a piston pin 243 of the piston 240. The piston pin 243 is fixed to the piston 240 via a clamping sleeve 244 that is inserted into a matching axial opening in the piston 240 and the piston pin 243. On a lower end of the crankshaft 210, opposite the end with the crankpin 220, the rotor 410 is mounted to the crankshaft 210, preferably via press fitting. Further an oil pickup 250 for conveying lubricant from a lubricant

sump formed in the lower shell part 110 during operation into a lubricant conveying system of the cranktrain 200 is mounted to the rotor 410 via three mounting rivets 251.

[0042] The crankcase 300 includes a cylinder housing 310, in which a cylinder 320 is formed. The piston 240 reciprocates within the cylinder 320 during operation of the refrigerant compressor 1 in order to suck refrigerant into the cylinder 320 during a suction cycle and to compress and discharge the compressed refrigerant during a compression and discharge cycle. On the crankcase 300 a set of two first protrusions 301 is located on the side opposite of the cylinder housing 310 and a set of two second protrusions 311 is located on the cylinder housing 310 itself. Inner dampening elements 330 are attached to each of the first protrusions 301 and second protrusions 311, which inner dampening elements 330 interact with respective regions of an inner surface of the upper housing part 120 in order to dampen vibrations of the pump unit 10 during operation and to prevent damages during transport.

[0043] In order to establish a suction path and a discharge path for the refrigerant from the suction pipe 30 via the cylinder 320 to the discharge pipe 20, the cylinder head assembly 500 is mounted onto a cylinder head section of the cylinder housing 510. The cylinder head assembly 500 comprises a cylinder gasket 510, a suction valve spring 520, a valve plate 530 and a discharge valve spring 540, wherein the valve plate 530 has a suction opening 531 and a discharge opening 532. The cylinder gasket 510 and the suction valve spring 520 are located on a suction side 530a of the valve plate 530, which suction side 530a faces towards the piston 240. The discharge valve spring 540 is located on a discharge side 530b of the valve plate 530, which faces in the opposite direction of the piston 240. When assembled, the valve plate 530, the suction valve spring 520 and the cylinder gasket 510 are pressed into a valve plate seat 312 of the cylinder housing 310, as will be described below in detail.

[0044] A suction connector head 640 of the suction muffler 600 and a discharge connector head 730 of the discharge muffler 700 are pressed onto the discharge side 530b of the valve plate 530, wherein a first sealing element 550 is placed between the valve plate 530 and the suction connector head 640 as well as the discharge connector head 730 respectively.

[0045] During the suction cycle of the pump unit 10, the piston 240 inside the cylinder 320 moves away from the valve plate 530, so that a negative pressure builds up in the cylinder 320, because the suction valve spring 520 keeps the suction opening 531 of the valve plate 530 closed due to its spring force, while the discharge valve spring 540 closes the discharge opening 532 of the valve plate 530. When the negative pressure exceeds a certain threshold, the suction valve spring 520, which at least has a section configured as a reed valve, opens the suction opening 531 to allow refrigerant to flow from the suction pipe 30 through the suction muffler 600 into the cylinder 320.

[0046] During the compression cycle of the pump unit 10, the piston 240 inside the cylinder 320 moves in the direction of the valve plate 530, so that the refrigerant in the cylinder 320 is compressed, because the discharge valve spring 540 keeps the discharge opening 532 of the valve plate 530 closed due to its spring force, while the suction valve spring 520 keeps the suction opening 531 of the valve plate 530 closed. Once the pressure of the compressed refrigerant exceeds a predefined threshold, the discharge valve spring 540, which is configured as a reed valve, opens the discharge opening 532 of the valve plate 530 to allow refrigerant to flow from the cylinder 320 through the discharge muffler 700 to the discharge tube 20.

[0047] The suction muffler 600 includes a lower housing part 610, an upper housing part 620 and an inner housing element 630, which is inserted into a suction muffler volume 601 defined by the lower housing part 610 and the upper housing part 620 of the suction muffler 600. Refrigerant is sucked into the suction muffler 600 via an inlet opening 621 located in the upper housing part 620 mainly during the suction cycle of the pump unit 10. The suction muffler 600 dampens sound based on the well-known Helmholtz principle when refrigerant flows through it, i.e. by chambers formed within the suction muffler 600 which act as resonators that absorb sound. The refrigerant escapes the suction muffler 600 through the suction connector head 640, which is placed above the suction opening 531 of the valve plate 530 and is located on the upper housing part 620 of the suction muffler 600.

[0048] The discharge muffler 700 includes a lower housing part 710, an upper housing part 720 and the discharge connector head 730, which is connected to the upper housing part 720 of the discharge muffler 700. During the discharge cycle of the pump unit 10, compressed refrigerant coming from the discharge opening 532 of the valve plate 530 enters the discharge muffler 700 though the discharge connector head 730. The discharge muffler 700 dampens sound based on the well-known Helmholtz principle when refrigerant flows through it, i.e. by chambers formed within the discharge muffler 700 which chambers act as resonators that absorb sound and or by pulsation filtering. The compressed refrigerant escapes the discharge muffler 700 through a discharge connection tube 750, which is connected to the discharge tube 20 via connection sleeve 760 and an O-ring seal 762.

[0049] The mounting of the cylinder head assembly 500 to the cylinder housing 310 is facilitated by a mounting assembly 580 (see Fig. 3), which comprises a clamping element 560 for clamping the valve plate 530 to the valve plate seat 312 and a fixing element 570, which presses the suction connector head 640 and the discharge connector head 730 onto the valve plate 530. The fixing element 570 is latched onto the clamping element 560. The clamping element 560 further comprises two positioning pins 565 (see Fig. 2), which are used for aligning the discharge connector head 730 with the discharge

opening 532 and the suction connector head 640 with the suction opening 531 respectively.

[0050] Fig. 3 shows the pump unit 10 of the refrigerant compressor 1 in an assembled state. The suction muffler 600 and the discharge muffler 700 are fixed to the cylinder housing 210 via the clamping element 560 and the fixing element 570 of the mounting assembly 580, while the crankshaft 210 is inserted into the crankcase 300 and the stator 420 is surrounding the rotor 410.

[0051] Fig. 4 shows a schematic rear view of an embodiment of the suction muffler 600 according to the invention from an angled top view, in which other main components of the cylinder head assembly 500 for connecting the suction muffler 600 with the cylinder housing 310 are presented in an exploded view. The suction muffler 600 comprises the lower housing part 610 having an outer surface 610b and the upper housing part 620 having an outer surface 620b. The lower housing part 610 has an outer tubular extension 612 with a diagonal cut at the bottom, which outer tubular extension 612 is surrounding an oil drain opening 611 (see Fig. 8), which will be described in more detail below.

[0052] When assembled, a sealing surface 640a of the suction connector head 640 is pressed onto the discharge side 530b of the valve plate 530, which faces in the opposite direction of the piston 240 (see Fig. 2). The first sealing element 550 is placed between the valve plate 530 and the suction connector head 640. The discharge valve spring 540 is located on a discharge side 530b of the valve plate 530. On the suction side 530a of the valve plate 530, which suction side 530a faces towards the piston 240 (see Fig. 2), the cylinder gasket 510 and the suction valve spring 520 of the cylinder head assembly 500 are located.

[0053] As can be seen in detail in Fig. 4, the valve plate 530 features the suction opening 531 for letting refrigerant flow from the suction muffler 600 into the cylinder 320, when the suction valve spring 520 is opening the suction opening 531. The valve plate 530 further features the discharge opening 532 for letting compressed refrigerant flow from the cylinder through the discharge muffler 700 to the discharge tube 20, when the discharge valve spring 540 opens the discharge opening 532. The suction opening 531 can be closed by a suction reed valve section 521 of the suction valve spring 520.

[0054] The first sealing element 550 comprises a first sealing section 550a and a second sealing section 550b, wherein the first section 550a is essentially shaped as a flat gasket and the second section 550b has characteristics and a cross section similar to an O-ring seal. The first sealing element 550 further comprises a suction opening 551 in the first section 550a and a discharge opening 552 in the second section 550b. The suction opening 551 of the first sealing element 550 is arranged to essentially match with the suction opening 531 of the valve plate 530, so that refrigerant can also pass the first sealing element 550, when refrigerant is sucked through the suction muffler 600 into the cylinder 320. When mounted, the fixing element 570 (see Fig. 3) compresses the first sealing section 550a between the sealing surface 640a of the suction connector head 640 and the discharge side of the valve plate 530 in order to seal the low-pressure connection between the valve plate 530 and the suction connector head 640 in the region of the suction opening 531. The second sealing section 550b is configured to be inserted into a circumferential groove of a sealing surface of the discharge connector head 730. Accordingly the second sealing section 550b is designed to seal the high-pressure connection between the valve plate 530 and the discharge connector head 730 of the discharge muffler 700 in the region of the discharge opening 532, when the fixing element 570 presses the discharge connector head 730 onto the valve plate 530.

[0055] The suction connector head 640 has an outlet opening 641, so that refrigerant can flow from the suction muffler 600 into the cylinder 320 during the suction cycle. The dimensions of the outlet opening 641 of the suction connector head 640 match those of the suction opening 551 of the first sealing element 550, so that the sealing surface 640a presses the first sealing section 550a against the valve plate 530.

[0056] As can be seen in Fig. 4 the suction connector head 640 has two first positioning openings 642, with which the suction muffler 600 is positioned on the positioning pins 565 of the clamping element 560, when assembled (see Fig. 2).

[0057] Fig. 5 shows a schematic front view of the suction muffler 600 from an angled top view.

[0058] In this front view the inlet opening 621, which is located in the upper housing part 620 and connected to the interior inlet tube 622, is visible. Through the inlet opening 621 refrigerant is sucked into the suction muffler 600 mainly during the suction cycle of the pump unit 10. The inlet opening 621 is surrounded by an embossing 623, which embossing 623 is also located in a recessed area 624 on the outer surface 620b of the upper housing part 620. As the inlet opening 621 is located in this recessed area 624 it is made possible that the embossing 623 does not extend over an enveloping surface of the suction muffler 600, wherein the embossing 623 simultaneously can extend from the outer surface 620b of the upper housing part 620.

[0059] The purpose of this embossing 623 is to prevent oil drops or droplets, which splash onto the suction muffler 600 during operation, from entering the suction muffler 600 through the inlet opening 621. In case oil drops or droplets are formed in the area surrounding the inlet opening 621, the embossing 623 forms an obstacle so that the fluid oil cannot enter the suction muffler 600, and on the other hand the embossing 623 serves to make the oil flow down along the embossing 623 by gravitational force and/or vibration of the pump unit 10. To better direct the oil downwards, two tangential extensions 623a are provided. The tangential extensions 623a are positioned symmetrical to a vertical symmetry plane of the inlet opening 620 and are originating from the outmost

points of the inlet opening 620 in relation to said vertical symmetry plane.

[0060] In Fig. 6 the lower housing part 610 of the suction muffler 600 of Fig. 4 and the inner housing element 632 arranged therein is presented.

[0061] The lower housing part 610 has a circumferential fixing groove 616 to receive a circumferential fixing protrusion 625 of the upper housing part 620 of the suction muffler 600 (see e.g. Fig. 10). The circumferential fixing protrusion 625 and the circumferential fixing groove 616 are welded together during production of the suction muffler 600. The circumferential fixing groove 616 is formed by a first wall section 617 and a second wall section 618 of the lower housing part 610 spaced apart from the first wall section 617 (compare Fig. 11). The second wall section 618 projects over the first wall section 617 and thereby forms an upper edge 613 of the lower housing part 610. Further, the outer tubular extension 612 protrudes from a bottom section of the lower housing part 610 downwards in the direction opposite of the inlet opening 621.

[0062] The inner housing element 630 divides the suction muffler volume 601 (see Fig. 10) into a first suction muffler chamber 603 and a second suction muffler chamber 604 (see also Fig. 10). The first suction muffler chamber 603 is bounded by the lower housing part 610, a top wall 631 of the inner housing element 630 and a side wall 632 of the inner housing element 630 (compare Fig. 7). The inner housing element 630 is arranged in the lower housing part 610 in such a way that the top wall 631 of the inner housing element 630 is aligned with the upper edge 613 of the lower housing part 610 and is preferably oriented horizontally.

[0063] In order to be able to fix the inner housing element 630 in a stable manner inside the suction muffler 600 a plurality of reinforcement ribs 615 is provided, and one of which reinforcement ribs 615 can be seen in Fig. 6 (compare Figs. 8 and 11).

[0064] The inner housing element 630 has a protruding tubular section 633 for fluidly connecting the first suction muffler chamber 603 with the second suction muffler chamber 604, which tubular section 633 extends perpendicularly to both sides of the top wall 631 of the inner housing element 630 (see Fig. 7). The protruding tubular section 633 has an annular cross section with a cylindrical inner surface and a cylindrical outer surface.

[0065] Fig. 7 shows a detailed view of the inner housing element 630 from the embodiment of Fig. 6. The inner housing element 630 comprises the top wall 631 and the side wall 632 for dividing the muffler volume 601 into the first suction muffler chamber 603 and the second suction muffler chamber 604 (compare Figs. 10 and 11). The side wall 632 has an oil opening 634 for allowing oil flow from one suction muffler chamber 604 to the other suction muffler chamber 603, when assembled. The side wall 632 extends perpendicularly from the top wall 631. Further, the contour of the top wall 631 corresponds with the contour of the second wall section 618 of the lower housing part 610 so that an edge portion of the top wall 631 abuts against the second wall section 618 of the lower housing part 610, when assembled (see Fig. 6).

[0066] Further the inner housing element 630 comprises the protruding tubular section 633, which perpendicularly extends to both sides of the top wall 631 of the inner housing element 630. Thereby the protruding tubular section 633 in other words forms a cylindrical tube, which penetrates the top wall 631.

[0067] Fig. 8 shows a top view of the lower housing 610 of the suction muffler 600 according to the embodiments of Fig. 4-6.

[0068] The lower housing part 610 has an inner surface 610a, which acts as a boundary for the first suction muffler chamber 603 and the second suction muffler chamber 604. Furthermore, the outer surface 610b of the lower housing part 610 forming an outer contour of the can be seen. For fixing the lower housing part 610 to the upper housing part 620, the lower housing part 610 has the circumferential fixing groove 616 as described previously.

[0069] Inside the lower housing part 610 of the suction muffler 600 the oil drain opening 611 is located, so that oil collecting on a bottom section of the inner surface 610a can drain from the suction muffler volume 601.

[0070] Further, two sets of reinforcement ribs 615 are provided in the inside of the housing part 610, which reinforcement ribs 615 protrude from the inner surface 610b of the lower housing part 610 an run parallel to the height direction. In each set, two reinforcement ribs 615 are spaced apart from each other in order to form a slot 614. Further, the two sets of reinforcement ribs 615 are arranged opposite each other in such a manner, that the side wall 632 of the inner housing element 630 can be guided into the slots 614. The slots 614 are designed to support opposite edges of the side wall 632 of the inner housing element 630.

[0071] Fig. 9 shows a bottom view of the upper housing element 620 of the suction muffler 600.

[0072] The upper housing part 620 has an inner surface 620a, which acts as a boundary for the first suction muffler chamber 603 and the second suction muffler chamber 604. Furthermore, the outer surface 620b forming an outer contour of the upper housing part 620 can be seen. For fixing the upper housing part 620 to the lower housing part 610, the upper housing part 610 has the circumferential fixing protrusion 625 described before. The circumferential fixing protrusion 625 perfectly fits into the circumferential fixing groove 616 of the lower housing part 610, when assembled. Inside the upper housing part 620 the inlet tube 622 for directing refrigerant to the first suction muffler chamber is provided, which is connected to the inlet opening 621 (see Fig. 5). Further, an outlet tube 643 is located within the upper housing part 620, which connects the second suction muffler chamber 604 with the outlet opening 641 of the suction connector head 640.

[0073] Fig. 10 shows a sectional view of a side view of

the suction muffler 600, wherein the sectional plane is the vertical symmetry plane of the inlet opening 621.

[0074] The suction muffler 600 according to the present embodiment consists of the lower housing part 610 and the upper housing part 620, which together form the suction muffler housing 602. As can be seen in detail, the circumferential fixing protrusion 625 of the upper housing part 620 fits into the circumferential fixing groove 616 of the lower housing part 610 to adjoin the muffler housing 602, wherein the upper housing part 620 and the lower housing part 610 are welded together.

[0075] The inner housing element 630, which is inserted into the muffler volume 601 enclosed by the muffler housing 602, divides the suction muffler volume 601 into the first suction muffler chamber 603 and the second suction muffler housing 604 by means of the top wall 631 and the side wall 632 as described before.

[0076] Inside the suction muffler 600 the inlet tube 622 is provided, which is connected to the inlet opening 621 located in the upper housing part 620. An end section of the inlet tube 622 is extends into the protruding tubular extension 633 of the inner housing element 630 in such a manner that an air gap 607 is formed. Refrigerant can flow from the inlet opening 621 through the inlet tube 622 into the first suction muffler chamber 603. The tubular section 633 of the inner housing element 630 and the inlet tube have longitudinal axes which are oriented in parallel.

[0077] Refrigerant can therefore enter the suction muffler 600 via the inlet opening 621 and is directed into the first suction muffler chamber 603 by the inlet tube 622. Afterwards the refrigerant can flow from the first suction muffler chamber 603 into the second suction muffler chamber 604 via the air gap 607 formed between an outer surface of the inlet tube 622 and an inner surface of the protruding tubular section 633. Furthermore, it can be seen that the inner housing element 630, the inlet tube 622 and the outlet tube 643 are surrounded by the muffler housing 602 and contained within the suction muffler volume 601.

[0078] Fig. 11 shows a further, partially offset sectional view the suction muffler 600. The first sectional plate incorporates a first longitudinal axis of the protruding tubular section 633 of the inner housing element 630 and a second longitudinal axis of the outlet tube 643. The second sectional plane is intersecting with the first sectional plane and runs in direction of a lateral end section of the suction muffler housing 601.

[0079] An inlet section 605 of the suction muffler 600 comprises the inlet opening 621, which is connected to the inlet tube 622.

[0080] Preferably the inlet tube 622 is integrally formed with the upper housing part 620. Via the inlet section 605 refrigerant can enter the suction muffler 600 as described in detail before.

[0081] An outlet section 606 of the suction muffler 600 comprises the suction connector head 640, the outlet opening 641 and the outlet tube 643. Via outlet section 606 refrigerant can leave the suction muffler 600 as described in detail before.

[0082] It is apparent from synopsis of Fig. 10 and Fig. 11 with the previously discussed figures that the inner housing element 630 divides the suction muffler volume 601 into the first suction muffler chamber 603 and the second suction muffler chamber 604 by means of the top wall 631 and the side wall 632. Lateral edge portions of the side wall 632 of the inner housing element 630 are arranged in the slots 614 between two reinforcement ribs 615 and are supported the reinforcement ribs 615 forming the slots. The side wall 632 comprises the oil opening 634 for allowing oil from the second suction muffler chamber 604, which has not oil drain opening, to flow to the oil drain opening 611 located in the first suction muffler chamber 603. Thus, the first suction muffler chamber 603 and the second suction muffler chamber 604 are also connected via oil opening 634. However, oil that accumulates within the first suction muffler chamber 603 within the region of the oil drain opening 611 during operation will close the oil opening 634 in the side wall as well as the oil drain opening 611.

[0083] As can be seen, the oil drain opening 611 is located on the bottom of the lower housing part 610, wherein the inner surface 610a is declining towards the oil drain opening 611 at least in sections adjacent to the oil drain opening 611. As a result of this design the oil drain opening 611 is located at the lowest point of the lower housing part 610. Oil can drain through the oil drain opening 611 and drips from the oil drain opening 611 by trickling along an inner surface of the outer tubular extension 612. On the diagonal cut end section, preferably a 45° angled diagonal cut, of the outer tubular extension 612, droplets are forming from the oil draining from the oil drain opening 611.

[0084] In Fig. 11 also a flow path of the refrigerant is indicated by arrows: Refrigerant enters the suction muffler 600 via the inlet section 605, whereby it is guided by the inlet tube 633 through the tubular section 633 of the inner housing element 630 into the first suction muffler chamber 603. Within the first suction muffler chamber 603 the refrigerant stream forms eddies as the stream hits the respective bounding surfaces of the first muffler chamber 603. Via the airgap 607 formed between an inner surface of the tubular section 633 of the inner housing element 630 and an outer surface of the inlet tube 622 the refrigerant is then guided into the second suction muffler chamber 604. In the present embodiment, the volume of the second suction muffler chamber 604 is larger than the volume of the first suction muffler chamber 603. Within the second suction muffler chamber 604 the refrigerant flow is again reflected by the bounding surfaces and forms swirls or eddies respectively. From the second suction muffler chamber 604 the refrigerant is guided to the outlet tube 643 via which outlet tube 643 the refrigerant is directed to the outlet section 606, where the refrigerant exits the suction muffler 600 through the suction connector head 640. Due to the geometry of the

inner surface 610a of the lower housing part 610, the inner surface 620a of the upper housing part 620 and the design of the inner housing element 630, noise and vibration are damped by making use of the Helmholtz principle.

Reference Numerals

[0085]

1	Refrigerant Compressor
10	Pump Unit
20	Discharge Pipe
30	Suction Pipe
40	Maintenance Pipe
50	Electric Pass Through Element
60	Support Spring Assembly
61	Lower Spring Pin
62	Support Spring
63	Upper Spring Holder
70	First Connector Element
80	Second Connector Element
90	Support Damper Assembly
91	Outer Dampening Element
92	Damper Pin
93	Lining Disk
94	Securing Element
100	Compressor Shell
102	Second Connection Opening
103	Third Connection Opening
110	Lower Shell Part
120	Upper Shell Part
160	Supporting Base Plate
164	Opening of the Supporting Base Plate
200	Cranktrain
201	Ball Bearing
210	Crankshaft
220	Crankpin
230	Connecting Rod
240	Piston
243	Piston Pin
244	Clamping Sleeve
250	Oil Pickup
251	Mounting Rivet
300	Crankcase
301	First Protrusion
302	Main Bearing
310	Cylinder Housing
311	Second Protrusion
312	Valve Plate Seat
320	Cylinder
330	Inner Dampening Elements
340	Stator Mounting Screw
400	Electric Drive Unit
410	Rotor
420	Stator
421	Lower End Element
430	Inner Harness
500	Cylinder Head Assembly
510	Cylinder Gasket
520	Suction Valve Spring
530	Valve Plate
530a	Suction Side of the Valve Plate
530b	Discharge Side of the Valve Plate
531	Suction Opening
532	Discharge Opening
540	Discharge Valve Spring
550	First Sealing Element
550a	First Sealing Section of the First Sealing Element
550b	Second Sealing Section of the First Sealing Element
551	Suction Opening of the First Sealing Element
552	Discharge Opening of the First Sealing Element
560	Clamping Element
565	Positioning Pins
570	Fixing Element
580	Mounting Assembly
600	Suction Muffler
601	Suction Muffler Volume
602	Suction Muffler Housing
603	First Suction Muffler Chamber
604	Second Suction Muffler Chamber
605	Inlet Section of the Suction Muffler
606	Outlet Section of the Suction Muffler
607	Air Gap
610	Lower Housing Part of the Suction Muffler
610a	Inner Surface of the Lower Housing Part
610b	Outer Surface of the Lower Housing Part
611	Oil Drain Opening
612	Outer Tubular Extension
613	Upper Edge
614	Slot
615	Reinforcement rib
616	Circumferential Fixing Groove
617	First Wall Section
618	Second Wall Section
620	Upper Housing Part of the Suction Muffler
620a	Inner Surface of the Upper Housing Part
620b	Outer Surface of the Upper Housing Part
621	Inlet Opening
622	Inlet Tube
623	Embossing
623a	Tangential Extension
624	Recessed Area
625	Circumferential Fixing Protrusion
630	Inner Housing Element
631	Top Wall
632	Side Wall
633	Tubular Section
634	Oil Opening
640	Suction Connector Head
640a	Sealing Surface of the Suction Connector Head
641	Outlet Opening
642	First Positioning Opening
643	Outlet Tube

700	Discharge Muffler
710	Lower Housing Part of the Discharge Muffler
720	Upper Housing Part of the Discharge Muffler
730	Discharge Connector Head
750	Discharge Connection Tube
760	Connection Sleeve
800	Electronic Control Unit
x	Length Direction
y	Width Direction
z	Height Direction

Claims

1. A suction muffler (600) for an encapsulated refrigerant compressor (1), comprising

- a suction muffler housing (602) defining a suction muffler volume (601), wherein the suction muffler housing (602) is made of plastic material, wherein the suction muffler housing (602) has a lower housing part (610) and an upper housing part (620);

wherein the upper housing part (620) includes

- an inlet section (605) to allow refrigerant to enter the suction muffler volume (601), the inlet section (605) comprising an inlet opening (621) and an inlet tube (622) for directing refrigerant to a first suction muffler chamber (603), the inlet opening (621) being connected to the inlet tube (622) and
- an outlet section (606) to allow refrigerant to escape from the suction muffler volume (601) of the suction muffler (600) towards the cylinder (320) of the refrigerant compressor (1);

wherein the lower housing part (610) includes an oil drain opening (611);
characterized in that
the suction muffler (600) further comprises an inner housing element (630), which is inserted into the suction muffler housing (602), which inner housing element (630) separates the suction muffler volume (601) into the first suction muffler chamber (603) and a second suction muffler chamber (604).

2. The suction muffler (600) according to claim 1, **characterized in that** the inner housing element (630) comprises a top wall (631) and a side wall (632), wherein the first suction muffler chamber (603) is bounded by the lower housing part (610), the top wall (631) of the inner housing element (630) and the side wall (632) of the inner housing element (630),
and wherein the top wall (631) has a protruding tubular section (633), wherein at least a section of the inlet tube (622) is received by the protruding tubular section (633) of the inner housing element (630), wherein the top wall (631) of the inner housing element (630) is preferably aligned with an upper edge (613) of the lower housing part (610).

3. The suction muffler (600) according to claim 2, **characterized in that** two slots (614) are formed at an inner surface (610a) of the lower housing part (610) in order to guide the side wall (632) of the inner housing element (630) during mounting and to support opposite edges of the side wall (632) in the lower housing part (610).

4. The suction muffler (600) according to any one of claims 2 to 3, **characterized in that** the protruding tubular section (633) of the inner housing element (630) is extending perpendicularly to both sides of the top wall (631) of the inner housing element (630).

5. The suction muffler (600) according to claim 4, **characterized in that** the protruding tubular section (633) of the inner housing element (630) and the inlet tube (622) of the upper housing part (620) are oriented in parallel
and wherein an air gap (607) is formed between the protruding tubular section (633) of the inner housing element (630) and the inlet tube (622) of the upper housing part (620), through which air gap (607) refrigerant can flow from the first suction muffler chamber (603) to the second suction muffler chamber (604).

6. The suction muffler (600) according to claim 5, **characterized in that** the protruding tubular section (633) of the inner housing element (630) and the inlet tube (622) of the upper housing part (620) are arranged eccentrically to each other.

7. The suction muffler (600) according to any one of claims 2 to 6, **characterized in that** the side wall (632) of the inner housing element (630) has an oil opening (634) for allowing oil from one suction muffler chamber (604) to flow to the oil drain opening (611) located in the other suction muffler chamber (603).

8. The suction muffler (600) according to claim 7, **characterized in that** the oil drain opening (611) is located at a lowest point of an inner surface (610a) of the lower housing part (610), wherein the inner surface (610a) is declining toward the oil drain opening (611) at least in sections adjacent to the oil drain opening (611).

9. The suction muffler (600) according to any one of

claims 2 to 8, **characterized in that** the second suction muffler chamber (604) is bounded by the upper housing element (620), the top wall (631) of the inner housing element (630), the side wall (632) of the inner housing element (630) and a section of the lower housing part (610).

10. The suction muffler (600) according to any one of claims 1 to 9, **characterized in that** the inlet opening (621) is surrounded by an embossing (624), which embossing (623) is located on an outer surface (620b) of the upper housing part (620).

11. The suction muffler (600) according to claim 10, **characterized in that** the embossing (623) is chamfered towards the inlet opening (621)

and/or that the embossing (623) has at least two tangential extensions (623a)
and/or that the embossing (623) is located in a recessed area (624) of the outer surface (620b) of the upper housing part (620).

12. The suction muffler (600) according to any one of claims 1 to 9, **characterized in that** the lower housing part (610) has an outer tubular extension (612) which is surrounding the oil drain opening (611), wherein the outer tubular extension (612) of the lower housing part (610) preferably has a diagonal cut.

13. The suction muffler (600) according to any one of claims 1 to 12, **characterized in that** the outlet section (606) is formed by a suction connector head (640) for connecting the suction muffler (600) with a suction valve of a cylinder head assembly (500) of the refrigerant compressor (1), which suction connector head (640) has a sealing surface (640a) for connection with a valve plate (530) of the refrigerant compressor (1),
wherein the suction connector head (640) is connected with an outlet tube (643), which is located within the upper housing part (620).

14. The suction muffler (600) according to any one of the claims 1 to 13, **characterized in that** the suction muffler (600) is made of a polybutylene terephthalate [PBT] based polymer material, wherein the polymer material is preferably fibre-reinforced.

15. An encapsulated refrigerant compressor (1) having

- a compressor shell (100) having a lower shell part (110) and an upper shell part (120), wherein a discharge pipe (20), a suction pipe (30) and a maintenance pipe (40) enter the compressor shell (100), wherein an electric pass through element (50) is inserted into the compressor shell (100);
- a pump unit (10) comprising:
  -- a cranktrain (200) having a crankshaft (210), a crank pin (220), a connecting rod (230) and a piston (240);
  -- an electric drive unit (400) having an inner harness (430), a stator (420) and a rotor (410), the rotor (410) being fixed to the crankshaft (210), wherein the inner harness (430) is connecting the electric pass through element (50) and the stator (420);
  -- a crankcase (300) with a cylinder housing (310), wherein a cylinder (320) for reciprocating movement of the piston (240) is located in the cylinder housing (310), wherein the crankshaft (210) is rotatably mounted in the crankcase (300),
  wherein the stator (420) is attached to the cylinder crankcase (300);
  -- a cylinder head assembly (500) mounted to the cylinder housing (310) of the crankcase (300), the cylinder head assembly (500) comprising a valve plate (530), a suction valve spring (520), a discharge valve spring (540) and a discharge muffler (700), wherein the discharge muffler (700) has a discharge connection tube (750) being connected to the discharge pipe (20);
- a plurality of support spring assemblies (60) for supporting the compressor body (10) in the compressor shell (100),
wherein the cylinder head assembly (500) comprises the suction muffler (600) according to any one of claims 1 to 14.

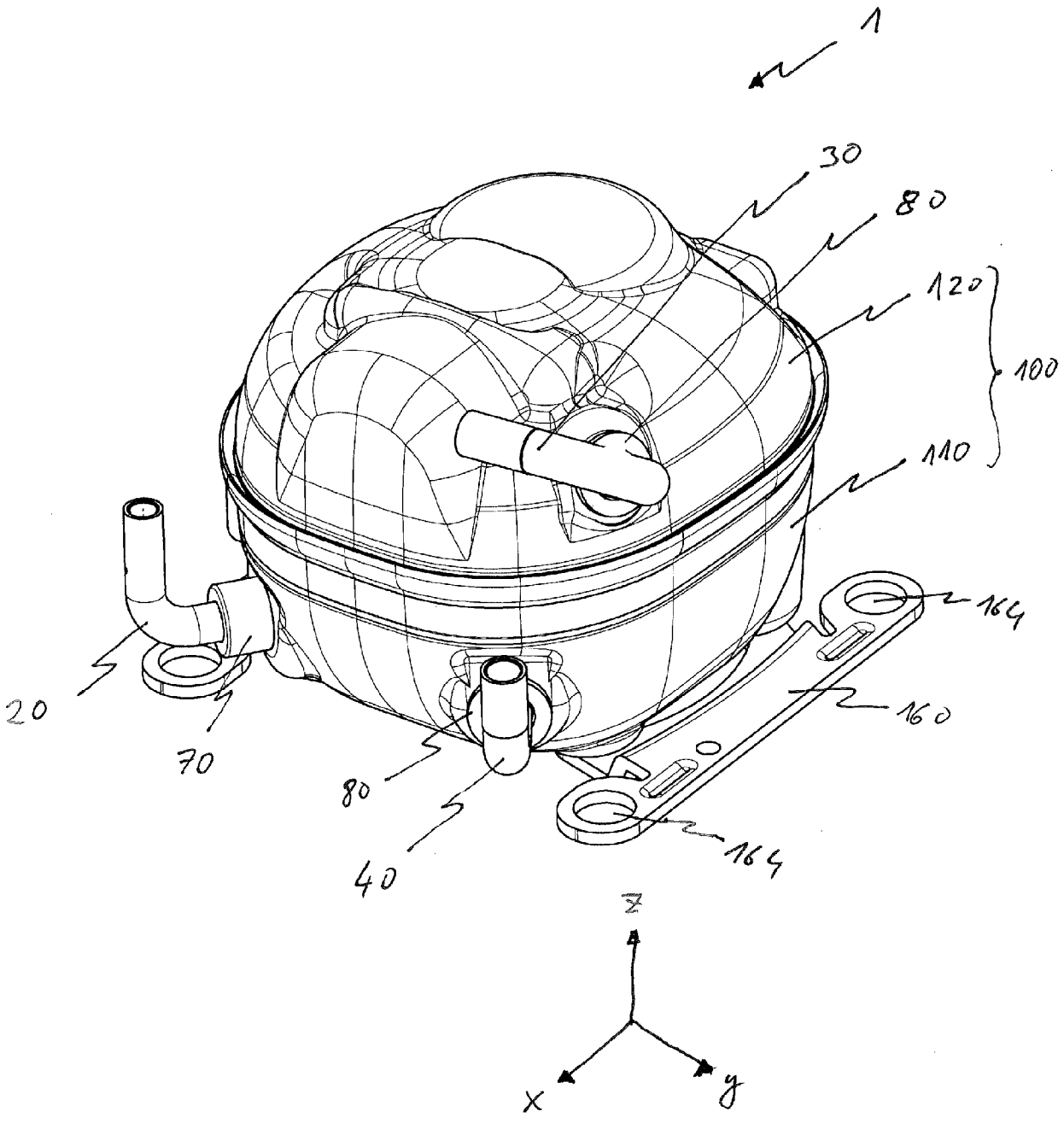

Fig. 1

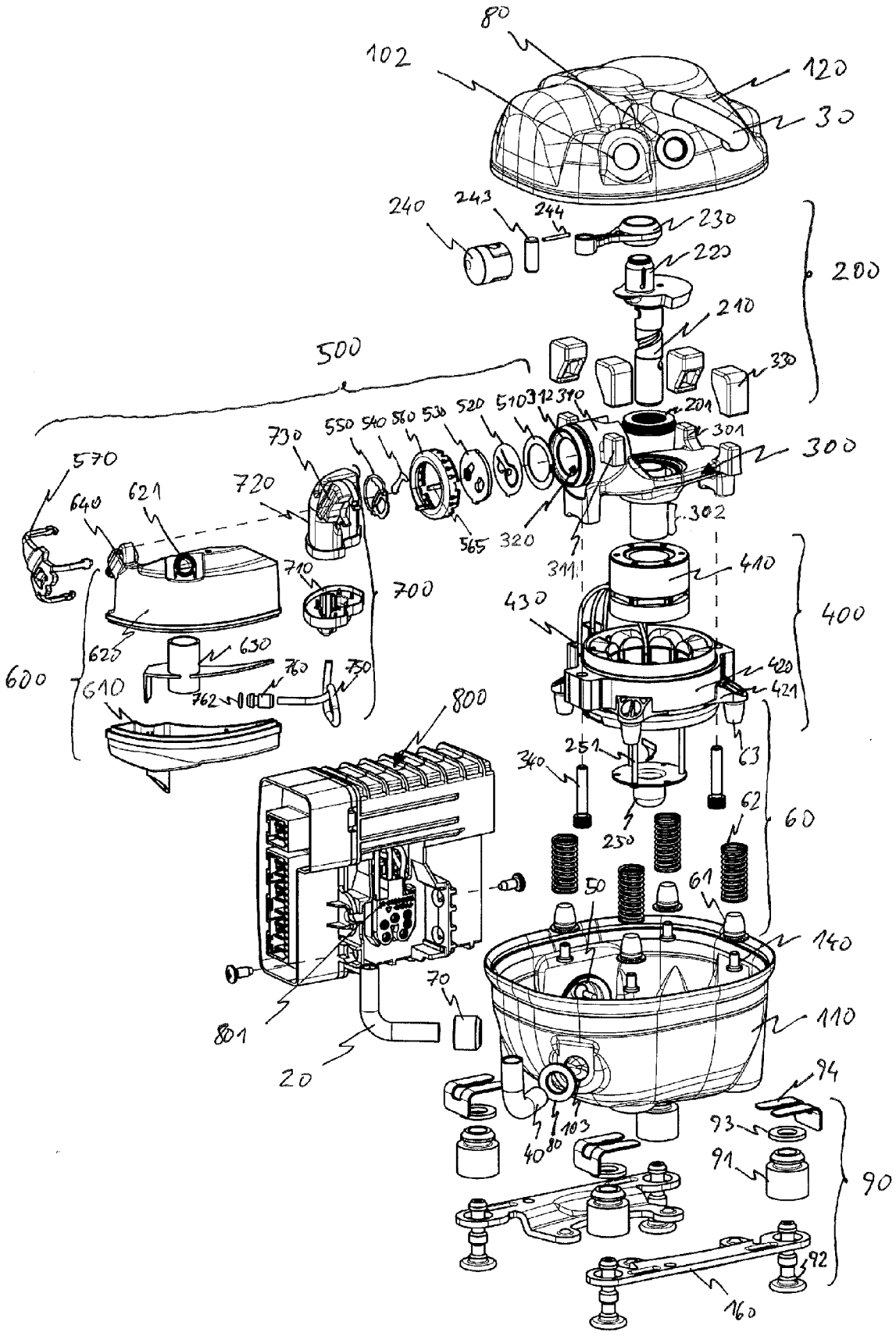
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Fig. 2

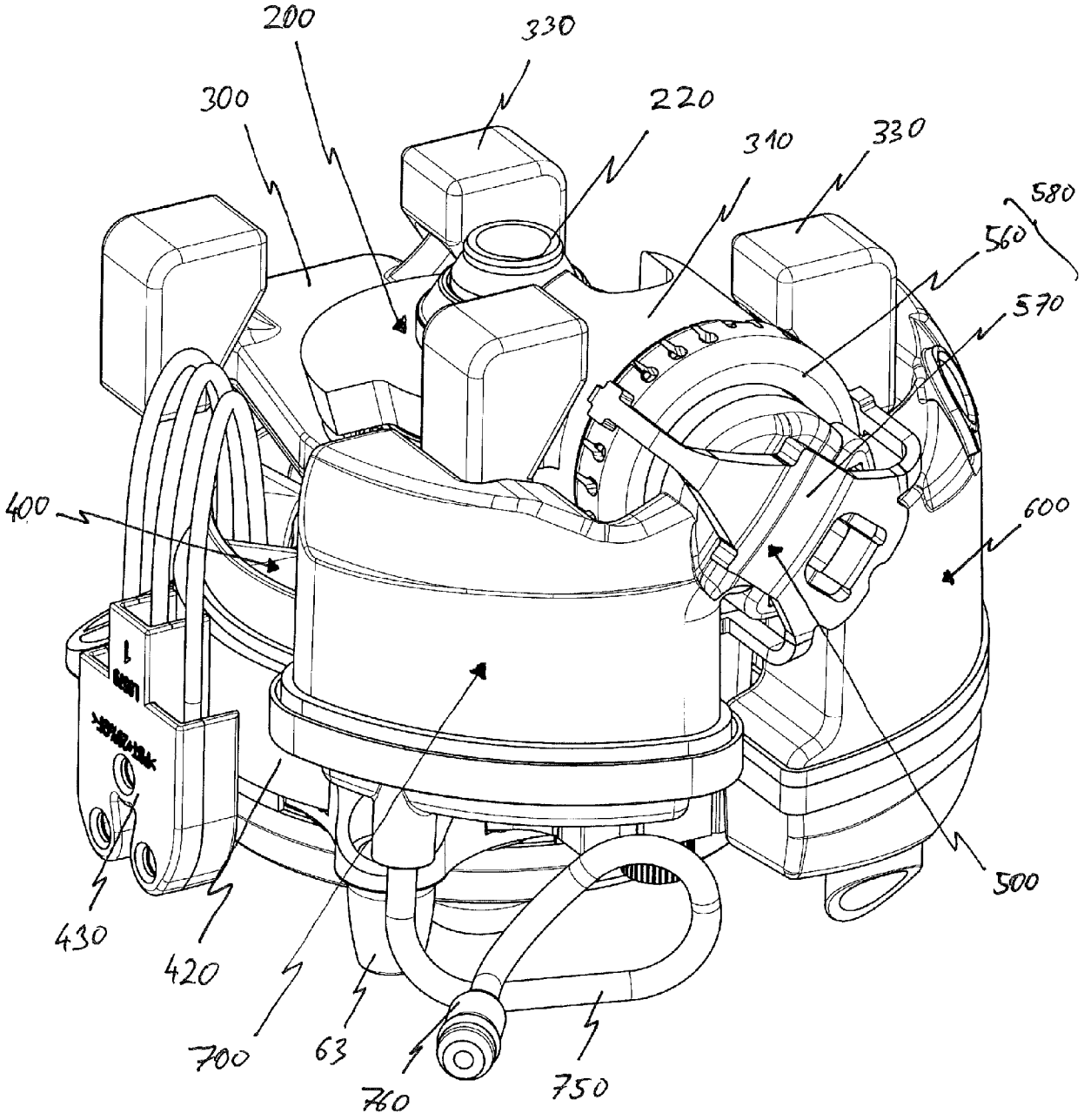
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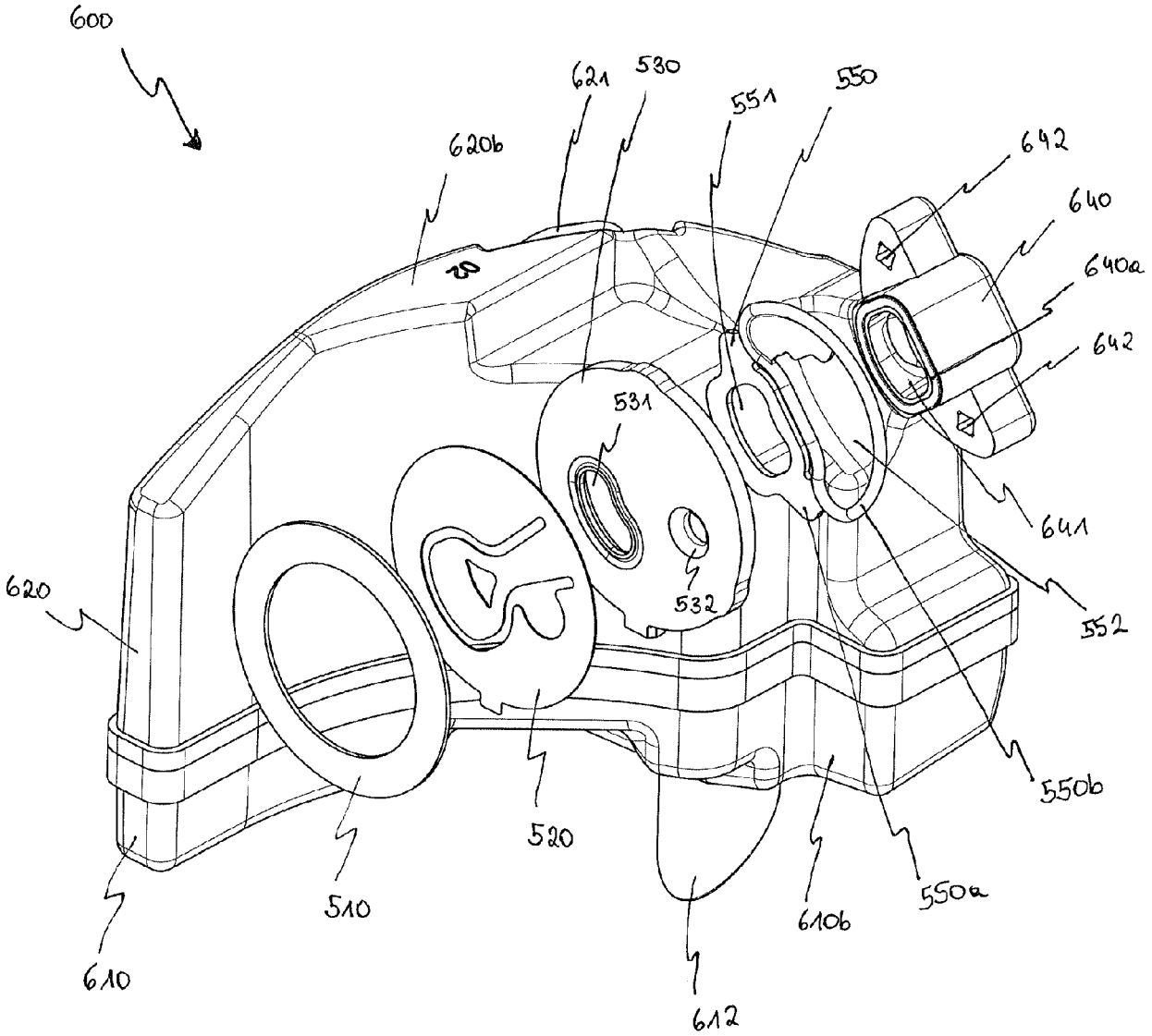
Fig. 3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612

Fig. 4

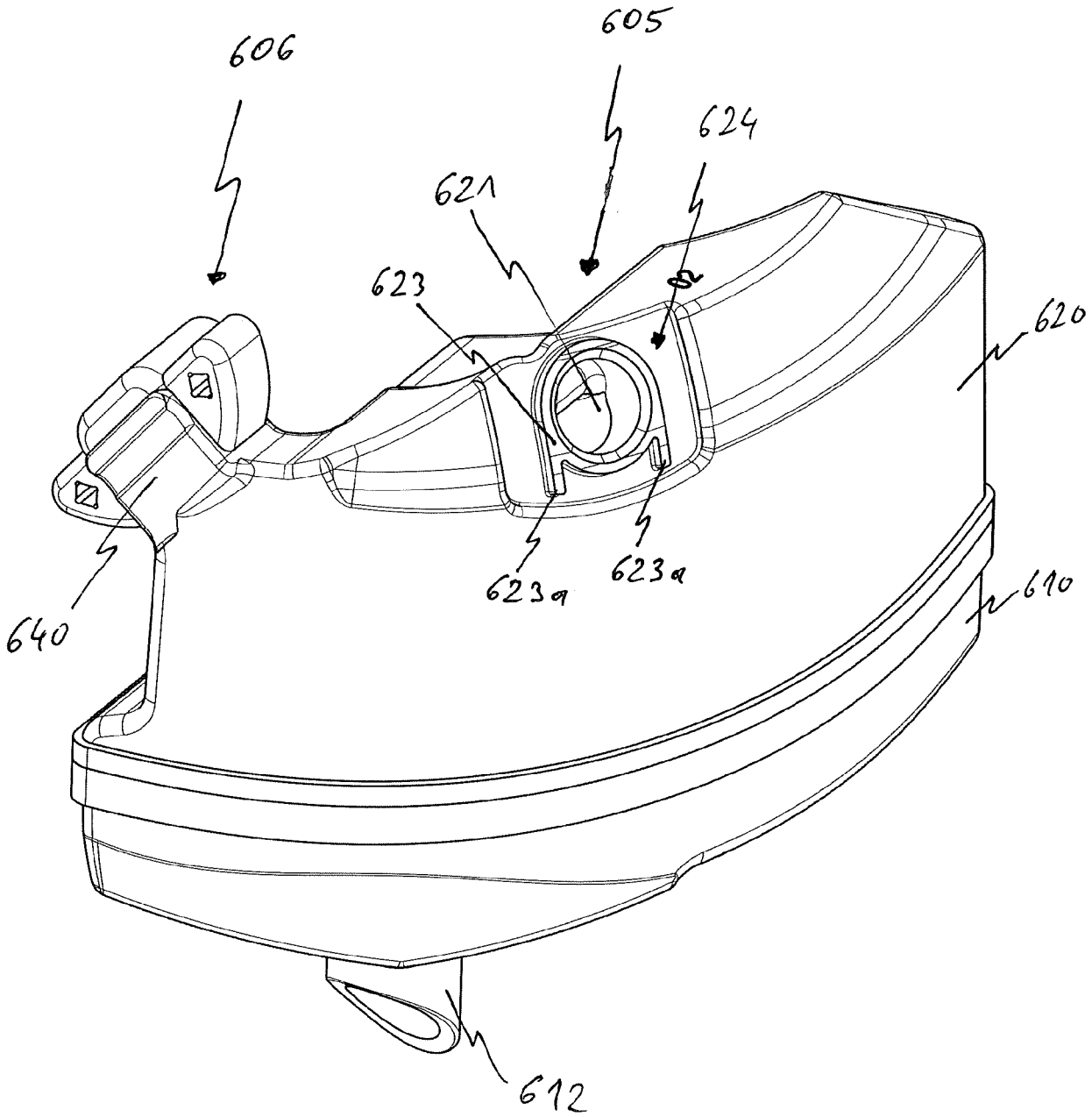

Fig. 5

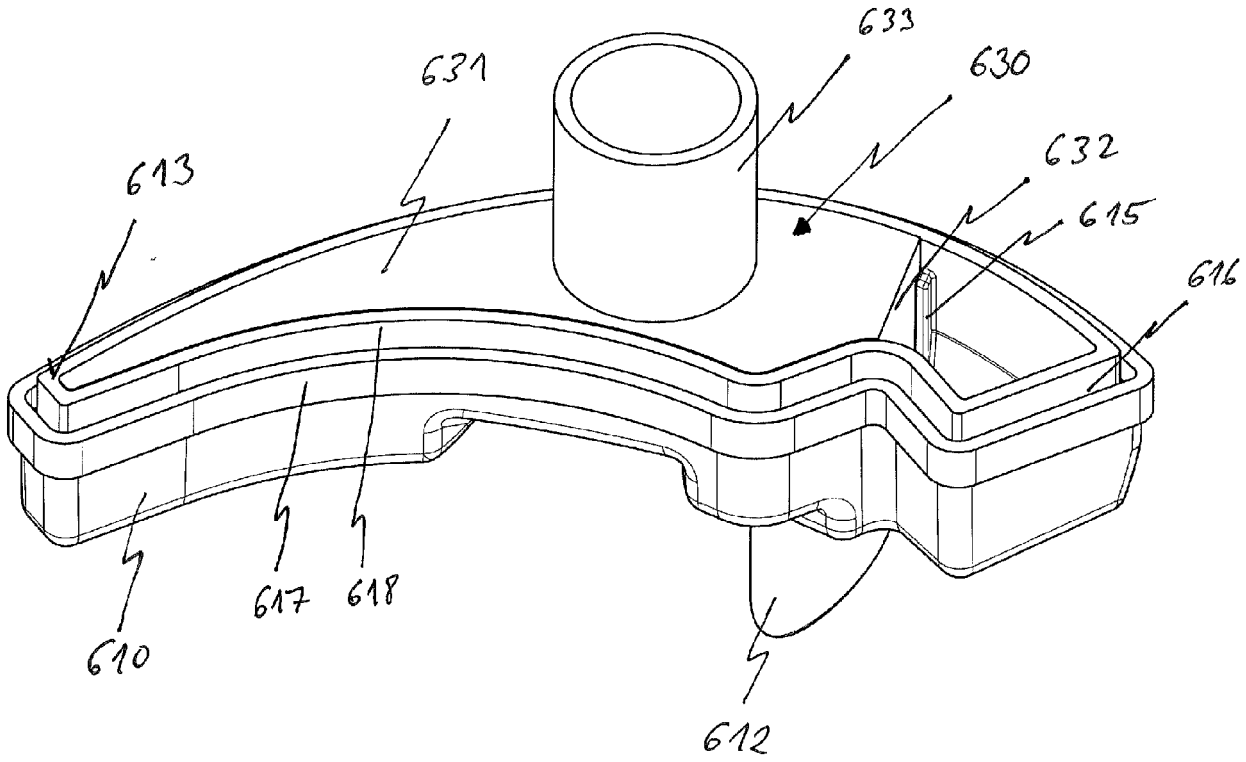

Fig.6

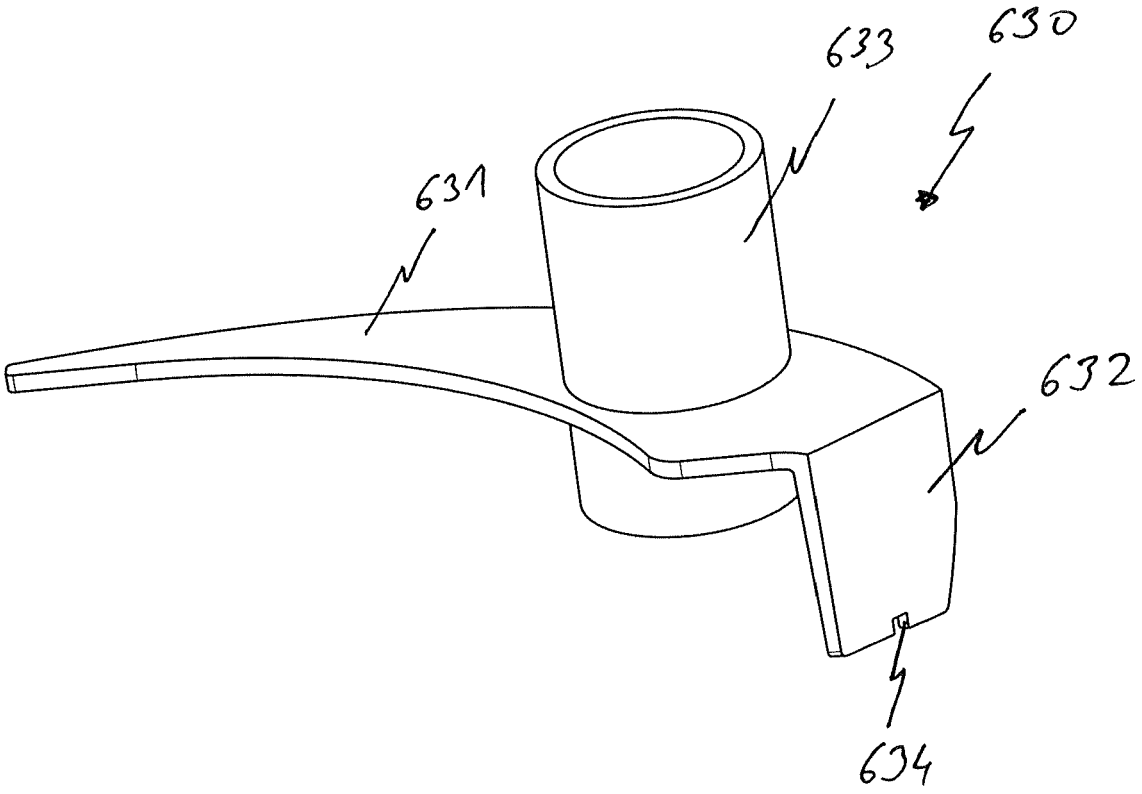

Fig. 7

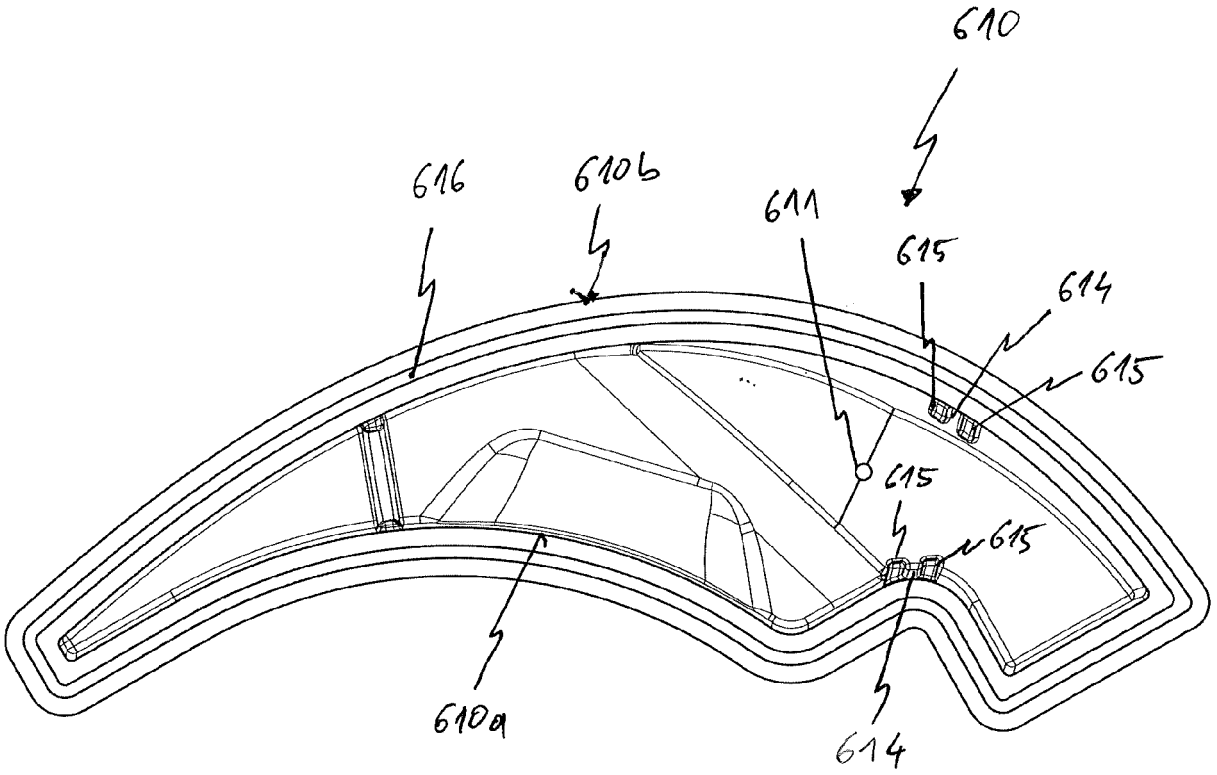

Fig. 8

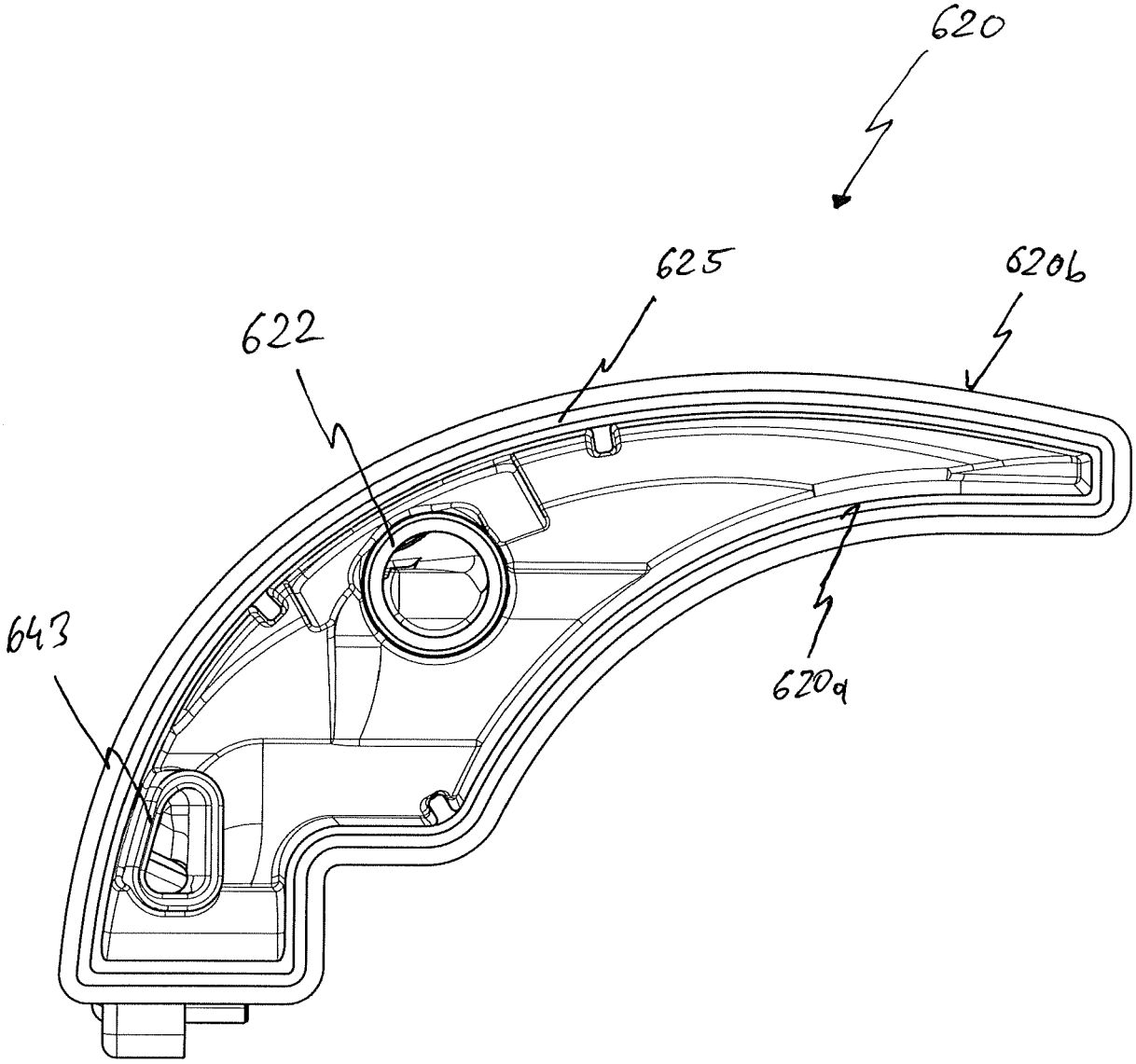

Fig. 9

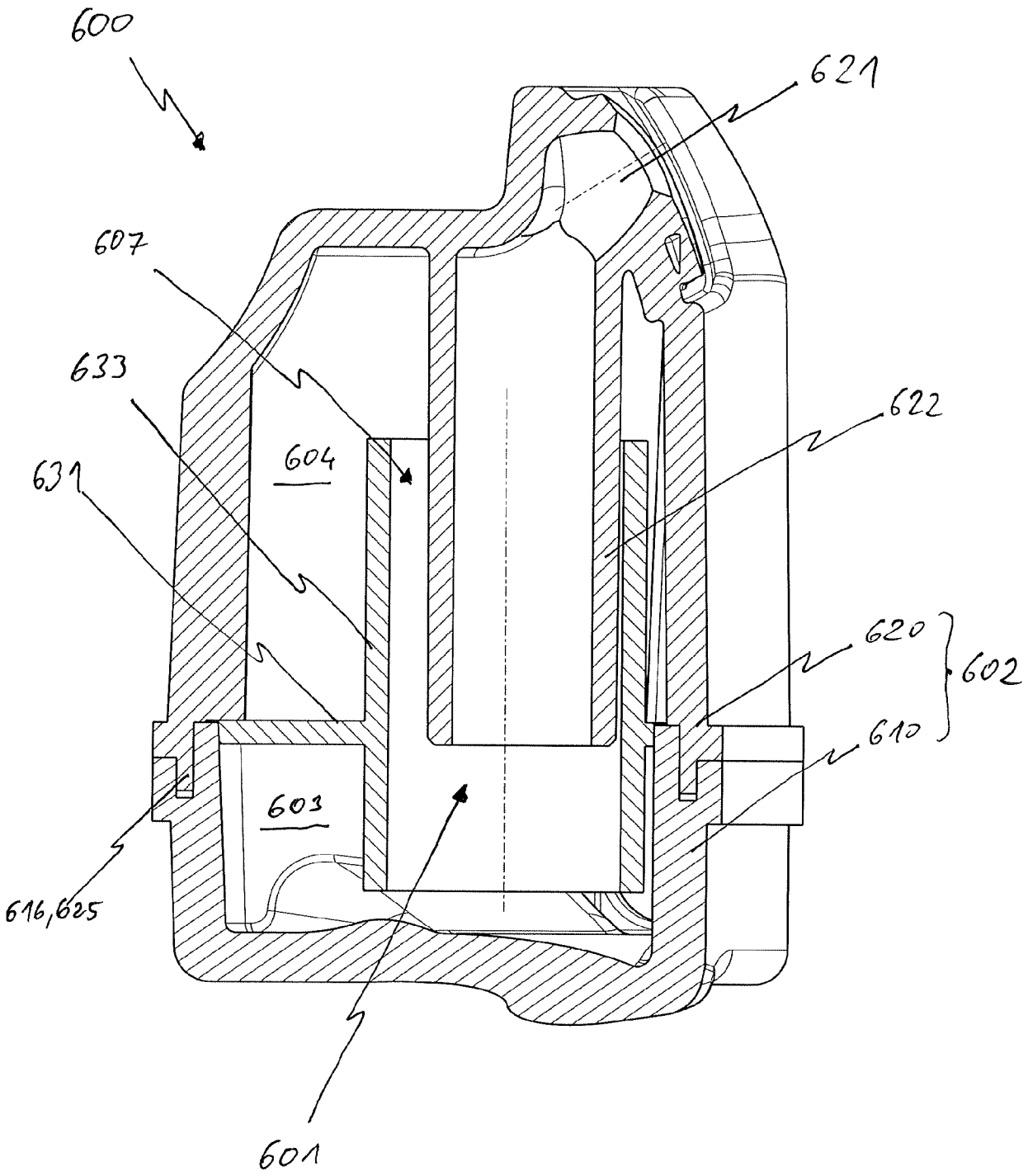

Fig. 10

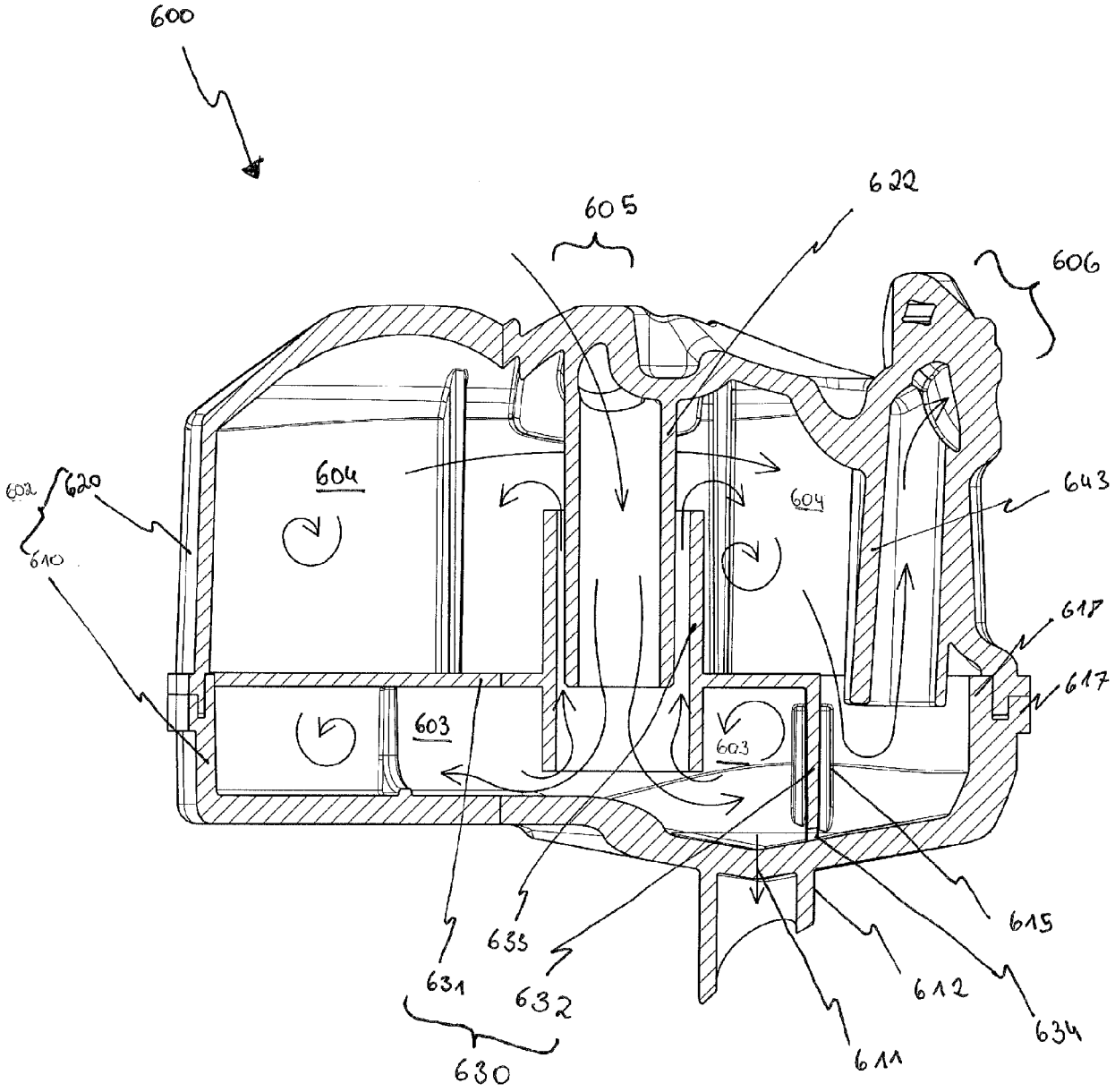
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Fig. 11

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EUROPEAN SEARCH REPORT

Application Number
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Place of search	Date of completion of the search	Examiner
Munich	13 March 2023	Gnüchtel, Frank

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