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(54) DISCHARGE MUFFLER FOR A REFRIGERANT COMPRESSOR

(57) The invention relates to a discharge muffler (700) for an encapsulated refrigerant compressor, comprising
- an inlet section (704) formed by a discharge connector head (730), the discharge connector head (730) defining a first discharge muffler volume (701),
- a discharge muffler housing enclosing an inner housing volume,
- an outlet section (705),

wherein the inner housing volume is divided into a second discharge muffler volume (702) and a third discharge muffler volume (703) by a separation arrangement (740);
wherein the first discharge muffler volume (701) and the second discharge muffler volume (702) are connected by an inlet tube (731),
wherein the second discharge muffler volume (702) and the third discharge muffler volume (703) are connected by a tubelike connection passage (741) formed by the separation arrangement (740),
and wherein the outlet section (705) is connected to the third discharge muffler volume (703).

In order to provide a discharge muffler with a compact design, with which a discharge pulsation can be controlled in an efficient way, it is provided that the second discharge muffler volume (702) has a first plurality of first chambers (708) and the third discharge muffler volume (703) has a second plurality of second chambers (709).

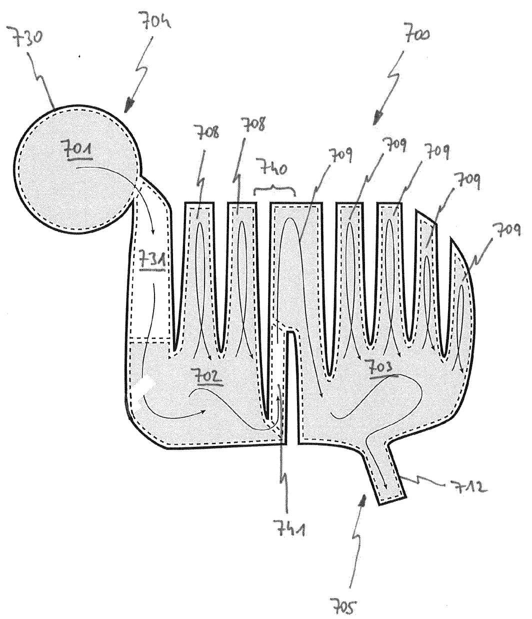

Fig. 8

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Description

FIELD OF THE INVENTION

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

- an inlet section formed by a discharge connector head for connecting the discharge muffler to a discharge valve of a cylinder head assembly of the refrigerant compressor to allow compressed refrigerant coming from a cylinder of the refrigerant compressor to enter the discharge muffler, the discharge connector head defining a first discharge muffler volume,
- a discharge muffler housing enclosing an inner housing volume,

  wherein the discharge muffler housing is made of plastic material, wherein the discharge muffler housing has a lower housing part and an upper housing part,
  wherein the upper housing part and the lower housing part are welded together,

  - an outlet section to allow the compressed refrigerant to escape from the inner housing volume of the discharge muffler toward a discharge pipe of the refrigerant compressor, wherein the discharge connector head is located on the upper housing part and the outlet section is located on the lower housing part;

  wherein the inner housing volume is divided into a second discharge muffler volume and a third discharge muffler volume by a separation arrangement; wherein the first discharge muffler volume and the second discharge muffler volume are connected by an inlet tube, wherein the second discharge muffler volume and the third discharge muffler volume are connected by a tube-like connection passage, which tube-like connection passage is formed by the separation arrangement,
  and wherein the outlet section is connected to the third discharge muffler volume.

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 assembly . The cylinder head assembly 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 discharge muffler with a compact design, with which a discharge pulsation can be controlled in an efficient way. A further object of the invention is to provide an optimised muffler design in order to increase the overall efficiency of the refrigerant compressor.

SUMMARY OF THE INVENTION

[0009] In order to achieve at least one of the objects set out above in a discharge muffler as defined initially, it is provided according to the invention that the second discharge muffler volume has a first plurality of first chambers and the third discharge muffler volume has a second plurality of second chambers.

[0010] Due to this specific design of the discharge muffler, the pulsation caused by the refrigerant flowing through the discharge muffler during the discharge cycle of the pump unit of the refrigerant compressor can controlled and by following principle: the discharge muffler is divided into three discharge muffler volumes, which are fluidly connected in series by two tubes. The first discharge muffler volume, which is defined by the discharge connector head, is connected to the second discharge muffler volume by a first tube, namely by the inlet tube. The muffler housing encloses the inner muffler volume, which is further divided into the second discharge muffler volume and the third discharge muffler volume by the separation arrangement. The second discharge muffler volume and the third discharge muffler volume are interconnected by a second tube, namely the tube-like connection passage formed by the separation arrangement. From the third discharge muffler volume the refrigerant leaves the discharge muffler housing through the outlet section.

[0011] While the global structure of the refrigerant flow path is defined by the above described elements, the discharge pulsation can be further reduced by further dividing the second discharge muffler volume and the third discharge muffler volume into smaller chambers, which act as additional pulsation filters. Therefore the second discharge muffler volume is divided into at least two first chambers, which form the first plurality of first chambers, and the third discharge muffler volume is divided into at least two second chambers, which form the second plurality of second chambers. It is conceivable that the quantity of first chambers can be smaller, greater or equal to the quantity of second chambers.

[0012] According to a further embodiment variant of the invention it is provided that the upper housing part comprises a plurality of chamber walls extending in the direction of the lower housing part, wherein each of the first chambers and each of the second chambers is bounded by at least one chamber wall. Preferably the upper housing part of the discharge muffler encloses a larger part of the inner housing volume of the muffler housing. A main refrigerant flow during operation of the refrigerant compressor is directed by the inlet tube towards the lower housing part of the discharge muffler while the upper housing part is responsible for the additional pulsation filtering. Therefore the chamber walls which are defining the first chambers and second chambers are part of the upper housing part. As on the one hand also the separation arrangement, preferably an upper separation wall, acts as a boundary to the adjacent first chamber as well as to the adjacent second chamber and on the other hand an inner surface of the upper housing part acts as a boundary surface, the chamber walls do not act as a sole boundary to the chambers. The connection of upper housing part and lower housing part via welding ensures an essentially leak tight connection. Preferably the lower housing part is made of a material which allows light of a certain wave length to pass through in order to facilitate laser welding of the discharge muffler housing. E.g. the lower housing part can be at least partly, preferably uniformly, transparent.

[0013] In order to further improve the flow characteristic of the refrigerant stream as well as to further improve the pulsation filtering, a further embodiment variant of the invention provides that each chamber wall has an end section facing towards the lower housing part and each end section has an arc shaped opening. By improving the pulsation filtering the pulsation of the refrigerant is reduced.

[0014] As the discharge muffler is part of a high-pressure side of a gas line of the refrigerant compressor, it is subject to increased structural load and stress. Furthermore, the temperature of the compressed refrigerant is increased by the compression process, which also leads to an increased temperature of the discharge muffler during operation. In order to reduce the overall size of the discharge muffler despite these loads further internal reinforcement is provided in a further embodiment variant of the discharge muffler, which provides that the upper housing part comprises a reinforcement rib which extends laterally to the chamber walls. The reinforcement rib reinforces the external strength of the upper housing as well as the internal strength with regard to the chamber walls.

[0015] According to a further embodiment variant of the invention it is provided that the first plurality of first chambers comprises at least two first chambers and the second plurality of second chambers comprises at least three second chambers, preferably at least four chambers. A preferred embodiment has two first chambers and five second chambers. This design provides a preferred combination of the quantity of chambers with respect of the reduced size of the discharge muffler housing.

[0016] In a further embodiment variant of the invention it is provided that the separation arrangement comprises

- an upper separation wall being located in the upper housing part, the upper separation wall having an end section projecting into the lower housing part and
- a lower separation wall being located in the lower housing part, the lower separation wall having an end section projecting into the upper housing part,

wherein the tube-like connection passage is formed between overlapping sections of the upper separation wall and the lower separation wall. Due to this specific design of the separation arrangement, the refrigerant stream coming from the inlet tube is redirected by the respective parts of the upper separation wall and the lower separation wall into the first chambers. This redirection is improved by the upper separation wall protruding into the lower housing part and the lower separation wall protruding into the upper housing part. Only after the pulsation filtering within the first chambers, the main portion of the refrigerant stream is guided into the third discharge muffler volume through the tube-like passage. Preferably the upper separation wall is positioned closer to the inlet section and the lower separation wall is positioned closer to the outlet section than the respective other separation wall.

[0017] To define the tube-like passage between the second discharge muffler volume and the third discharge muffler volume with a straightforward design, a further embodiment variant of the invention provides that at least a section of the lower separation wall has an essentially U-shaped cross section. Preferably the U-shaped section of the lower separation wall overlaps with an essentially flat surface of the upper separation wall in order to form an essentially vertical tube-like passage. Further it is preferred that the lower separation wall extends along a height direction.

[0018] In order to connect the discharge muffler with a discharge pipe of the refrigerant compressor, which discharge pipe is in an operating state of the refrigerant compressor connected to a high-pressure side of the refrigerant appliance, a further embodiment variant of the invention provides that the discharge muffler further comprises a discharge connection tube having a first end section being connected to the outlet section and a second end section for connection with the discharge pipe of the refrigerant compressor, wherein the discharge connection tube is made of a plastic material. As the discharge connection tube connects the discharge muffler, which is attached to the pump unit as part of the cylinder head assembly, with the discharge pipe, which is fixed to the compressor shell, the discharge connection tube has to be flexible or bendable respectively, in order to compensate relative movements from the pump unit, which is supported in the compressor shell using support spring assemblies, with regard to the compressor shell. Therefore the discharge connection pipe is made of a plastic (in other words polymer) material, which allows for a weight reduction but also ensures the required flexibility.

[0019] A further preferred embodiment variant of the invention provides that the discharge connection tube is made of a polyamide [PA] based polymer material. Even though other polymer materials having the same material properties can be used for manufacturing suction mufflers, PA based polymer material based products have been tested to have a superior combination of availability, costs, thermal properties - especially thermal conductivity - and mechanical properties.

[0020] The connection of the discharge connection tube to the discharge muffler housing, especially to the lower housing part, can in a further preferred embodiment variant achieved, which provides that the outlet section of the discharge muffler includes a tubular discharge connecting extension projecting from an outer surface of the lower housing part, wherein the first end section of the discharge connection tube is inserted into the tubular extension. As both the discharge muffler housing as well as the discharge connection tube are made of a plastic material, the connection can be further strengthened by plastic welding. Plastic welding also ensures that the connection between discharge muffler housing and discharge connection tube is sealed.

[0021] In order to seal the connection between the discharge connection tube and the discharge tube of the refrigerant compressor, a further embodiment variant of the invention provides that the second end section of the discharge connection tube is inserted into a connection sleeve having a groove for receiving an O-ring seal. In an operation state of the refrigerant compressor the sleeve is inserted into the discharge tube and an O-ring seal is sealing the space between the outer circumferential surface of the connection sleeve and the inner surface of the discharge tube. Preferably the connection sleeve is also made of a plastic material so it can be plastic welded to the discharge connection tube. Furthermore the discharge pipe can be crimped once the connection sleeve is inserted in order to keep the connection sleeve in place during operation and to prevent slipping out of the connection sleeve from the discharge pipe.

[0022] For establishing a tightly sealed connection between the discharge side of the valve plate, especially with regard to its discharge opening, and the discharge connector head, a further embodiment variant of the invention provides that the discharge connector head has a sealing surface for connection with a valve plate of the refrigerant compressor having a circumferential groove for receiving a first sealing element. By improving the sealing between the discharge connector head and the valve plate, the overall coefficient of performance [COP] of the refrigerant compressor can be increased as the losses along the discharge line are minimised.

[0023] During the discharge cycle the discharge valve spring, which is usually configured as a reed valve, opens the discharge valve by elastic deformation, when the pressure in the cylinder reaches a certain threshold. When the threshold is undershot, the discharge valve spring elastically returns into the closed initial state. In order to ensure that the discharge valve spring is closed at the beginning of the suction cycle, an "over-opening" of the discharge valve spring has to be avoided, as the returning into the initial state would otherwise take too long. Therefore a further embodiment variant of the invention provides that the discharge connector head has a protruding element which acts as a stopping element for a discharge valve spring of the discharge valve. Once the discharge valve spring makes contact with the protruding element, the deformation is interrupted and further deformation can be prevented in order to avoid over-opening. As the stopper element is integrated into the discharge connector head, no separate element is required and the overall size of the cylinder head assembly can be reduced.

[0024] A further embodiment variant of the invention provides that the discharge muffler, especially the discharge connector head and/or the discharge muffler housing, is/are made of a polyamide [PA] based polymer material. Even though other polymer materials having the same material properties can be used for manufacturing suction mufflers, polyamide 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 discharge muffler housing, including the discharge connector head, is usually produced via injection moulding. Typically the lower housing part of the discharge muffler, the upper housing part of the discharge muffler and the discharge connector head, which discharge connector head is integrally formed with the upper housing part, are made of a polyamide [PA] based polymer material.

[0025] In a further preferred embodiment variant of the discharge 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 PA66 GF30, which has a 30% share of glass fibres and can be bought under the commercial name TECAMID 66 GF30 from Ensinger. Typically the lower housing part of the discharge muffler, the upper housing part of the discharge muffler and the discharge connector head, are made of a fibre reinforced polymer material, preferably a reinforced polyamide based polymer material.

[0026] 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 suction muffler;

- a plurality of support spring assemblies for supporting the compressor body in the compressor shell,

wherein the cylinder head assembly comprises the discharge muffler according to the invention described above, wherein the discharge muffler has a discharge connection tube, preferably as described in more detail above, being connected to the discharge pipe.

BRIEF DESCRIPTION OF THE DRAWINGS

[0027] 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 an exploded view of a discharge muffler as well as of elements of a cylinder head assembly;

Fig. 5 shows a three dimensional view of the discharge muffler;

Fig. 6 shows a bottom view of an upper housing part of the discharge muffler;

Fig. 7 shows a three dimensional view of a lower housing part of the discharge muffler;

Fig. 8 shows a schematic sectional view of the discharge muffler according to Fig. 5;

Fig. 9 shows a sectional view of the discharge muffler according to Fig. 5.

DETAILED DESCRIPTION

[0028] 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.

[0029] 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 refrigerant compressor 1 is produced or sold as a stand-alone product.

[0030] 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).

[0031] 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.

[0032] 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.

[0033] 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.

[0034] 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.

[0035] 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.

[0036] 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.

[0037] 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.

[0038] 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.

[0039] 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.

[0040] The cranktrain 200 comprises a piston 240 and a crankshaft 210, which is rotatably mounted inside a main bearing section 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.

[0041] 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.

[0042] 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 310. 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.

[0043] 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.

[0044] 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.

[0045] 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.

[0046] 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 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.

[0047] 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 having a groove 761 and an O-ring seal 762.

[0048] 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.

[0049] 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 310 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.

[0050] Fig. 4 shows a schematic exploded view of an embodiment of the discharge muffler 700 according to the invention from an angled side view, in which also other main components the cylinder head assembly 500 for connecting the discharge muffler 700 with cylinder housing 310 are presented. The discharge muffler 700 comprises a discharge muffler housing 706 enclosing an inner housing volume 707, wherein the discharge muffler housing 706 has a lower housing part 710 having an inner surface 710a and an outer surface 710b as well as an upper housing part 720 having an inner surface 720a and an outer surface 720b (see Figs 6 and 7). The lower housing part 710 and the upper housing part 720 are welded together.

[0051] Furthermore, the discharge muffler 700 comprises an outlet section 705 to allow the compressed refrigerant to escape from the inner housing volume 707 toward the discharge pipe 20, which outlet section 705 is located on the lower housing part 710. The outlet section 705 includes a tubular discharge connecting extension 712 projecting from the outer surface 710b of the lower housing part 710.

[0052] The discharge connection tube 750, which is made of a polyamide based polymer material in this embodiment of the invention, has a first end section 751 for connection with the outlet section 705 of the lower housing part 710 and a second end section 752 for establishing a connection with the discharge pipe 20. In detail the first end section 751 of the discharge connection tube 750 is inserted into the tubular discharge connection extension 712 of the outlet section 705 of the lower housing part 710 and the second end section 752 of the discharge connection tube 750 is inserted into the connection sleeve 760, which connection sleeve 760 is inserted into the discharge pipe 20 as already described with regard to Fig. 2.

[0053] When assembled, a sealing surface 730a of the inlet section 704 formed by a discharge connector head 730, which is located on the upper housing part 720 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 sealing surface 730a has a circumferential groove 732 for receiving a first sealing element 550 (see Fig. 5).

[0054] The first sealing element 550 is placed between the valve plate 530 and the discharge connector head 730. 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.

[0055] 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 320 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.

[0056] 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 550 and the discharge connector head 730 in the region of the discharge opening 532, when the fixing element 570 presses the discharge connector head 730 onto the valve plate 550.

[0057] The discharge connector head 730, which defines a first discharge muffler volume 701, has an opening which is connected to an inlet tube 731, so that refrigerant can flow from the cylinder 320 into the discharge muffler 700 during the discharge cycle; see Fig. 5, which shows a three dimensional view of the discharge muffler 700. The dimensions of the opening and the inlet tube 731 of the discharge connector head 730 match those of the discharge opening 532 of the first sealing element 550, so that the sealing surface 730a of the discharge connector head 730 presses the second sealing section 550b against the valve plate 530.

[0058] As can be seen in Fig. 5 the discharge connector head 730 has two second positioning openings 734, with which the discharge muffler 700 is positioned on the positioning pins 565 of the clamping element 560, when assembled (see Fig. 2). Furthermore the discharge connector head 730 comprises a protruding element 733 which acts as a stopping element for the discharge valve spring 540.

[0059] In this embodiment of the invention both the discharge connector head 730 and the discharge muffler housing 706 are made if a polyamide based polymer material, which is fibre reinforced.

[0060] The inner housing volume 707 is divided into a second discharge muffler volume 702 and a third discharge muffler volume 703 by a separation arrangement 740, wherein the second and third discharge muffler volume 702,703 are connected by a tube-like connection passage 741, which is formed by the separation arrangement 740 (see Figs. 8 and 9). Fig. 8 shows a schematic sectional view of the discharge muffler 700 according to Fig. 5, while Fig. 9, whose sectional line runs in such a way that a last second chamber 709, which is visible in Fig. 8, is not seen in Fig. 9, shows a sectional view of the discharge muffler according to Fig. 5. The second discharge muffler volume 702 has in this embodiment two first chambers 708 and the third muffler volume 703 has five second chambers 709.

[0061] Furthermore Fig. 8 shows the overall structure of the discharge muffler 700 and its different volumes 702,703 and tubes 731,740: the first discharge muffler volume 701 formed within the discharge connector head 730, the second discharge muffler volume 702 formed within the muffler housing 706 and separated from the third discharge muffler volume 703 by the separation arrangement 740. The first discharge muffler volume 701 is connected to the second discharge muffler volume 702 by the inlet tube 731 and the second discharge muffler volume 702 is connected to the third discharge muffler volume 703 by the tube-like connection passage 740 formed by the separation arrangement 740.

[0062] In Fig. 6, which shows a bottom view of the upper housing part 720 of the discharge muffler 700, is visible that the upper housing part 720 comprises a first plurality of first walls 721 extending in the direction of the lower housing part 710, wherein each of the first chambers 708 and each of the second chambers 709 is bounded by at least one chamber wall 721. Each chamber wall 721 has an end section 721a facing towards the lower housing part 710 and each end section 721a has an arc shaped opening 724. Furthermore, the upper housing part 720 comprises a reinforcement rib 722 which extends laterally to the chamber walls 721.

[0063] The separation arrangement 740 comprises an upper separation wall 723 being located in the upper housing part 720, which upper separation wall 723 has an end section 723a projecting into the lower housing part 710 (see Fig. 6). In addition, the separation arrangement 740 comprises a lower separation wall 711 being located in the lower housing part 710, which is visible in Fig. 7, which shows a three dimensional view of the lower housing part 710 of the discharge muffler 700. The lower separation wall 711 has an end section 711a projecting into the upper housing part 720, wherein the tube-like passage 741 is formed between overlapping sections of the upper separation wall 723 and the lower separation wall 711, wherein the lower separation wall 711 has an essentially U-shaped cross section. Fig. 9 shows how the tube-like passage 741 and the separation arrangement 740 in more detail.

[0064] Furthermore the lower housing part 710 comprises multiple centring pins 713 for centring the upper housing part 720 on the lower housing part 710. During assembly, the upper housing part 720 is placed on the lower housing part 710 in such a way that all centring pins 713 are arranged within the inner surface 720a of the upper housing part 720, resulting in a fully uniform distance between the outer surface 720b of the upper housing part 720 and a collar section 714 of the lower housing part 710.

[0065] Figures 8 and 9 further depict the gas flow of the refrigerant through the discharge muffler 700 by arrows: refrigerant flows into the first discharge muffler volume 701 formed in the discharge connector head 730 essentially exclusively during the discharge cycle. From the first discharge muffler volume 701 the refrigerant is guided into the second discharge muffler volume 702 via the inlet tube 731. Within the second discharge muffler volume 702 a main portion of the refrigerant flow is deflected by the separation arrangement 740, mainly by the upper separation wall 723, into the first plurality of first chambers 708, where the refrigerant is reflected and pulsation is thereby reduced. The refrigerant reflected in from the first chambers 708 as well as the portion of the refrigerant flow, which is not reflected by the separation arrangement 740, then flows through the tube-like passage 741 of the separation arrangement 740 into the third discharge muffler volume 703, where the main portion of the refrigerant flow is directed into the second plurality of second chambers 709, which act similar to the first chambers 708. From the third discharge muffler volume 703 the refrigerant flows through the outlet section 705, in detail through the tubular connection extension 725, into the discharge connection tube 750.

[0066] The lower housing part 710 is made in a transparent colour to allow a laser to go through it for welding the upper housing part 720 and the lower housing part 710 together. The collar section 714 of the lower housing part 710 forms a protrusion and allows an accommodation of melted material of the upper housing part 720 and/or the lower housing part 710, which is advantageous for a good connection.

Reference Numerals

[0067]

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
140	Mounting Pin
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 Section of the Crankcase
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
610	Lower Housing Part of the Suction Muffler
620	Upper Housing Part of the Suction Muffler
621	Inlet Opening
630	Inner Housing Element
640	Suction Connector Head
640a	Sealing Surface of the Suction Connector Head
700	Discharge Muffler
701	First Discharge Muffler Volume
702	Second Discharge Muffler Volume
703	Third Discharge Muffler Volume
704	Inlet Section of the Discharge Muffler
705	Outlet Section of the Discharge Muffler
706	Discharge Muffler Housing
707	Inner Housing Volume

708	First Chamber
709	Second Chamber
710	Lower Housing Part of the Discharge Muffler
710a	Inner Surface of the Lower Housing Part
710b	Outer Surface of the Lower Housing Part
711	Lower Separation Wall
711a	End Section of the Lower Separation Wall
712	Tubular Discharge Connecting Extension
713	Centring Pins
714	Collar Section
720	Upper Housing Part of the Discharge Muffler
720a	Inner Surface of the Upper Housing Part
720b	Outer Surface of the Upper Housing Part
721	Chamber Wall
721a	End Section of the Chamber Wall
722	Reinforcement Rib
723	Upper Separation Wall
723a	End Section of the Upper Separation Wall
724	Arc Shaped Opening
730	Discharge Connector Head
730a	Sealing Surface of the Discharge Connector Head
731	Inlet Tube
732	Circumferential Groove
733	Protruding Element
734	Second Positioning Opening
740	Separation Arrangement
741	Tube-Like Connection Passage
750	Discharge Connection Tube
751	First End Section of the Discharge Connection Tube
752	Second End Section of the Discharge Connection Tube
760	Connection Sleeve
761	Groove of the Connection Sleeve
762	O-Ring Seal
800	Electronic Control Unit
x	Length Direction
y	Width Direction
z	Height Direction

Claims

1. A discharge muffler (700) for an encapsulated refrigerant compressor (1), comprising

- an inlet section (704) formed by a discharge connector head (730) for connecting the discharge muffler (700) to a discharge valve of a cylinder head assembly (500) of the refrigerant compressor (1) to allow compressed refrigerant coming from a cylinder (320) of the refrigerant compressor (1) to enter the discharge muffler (700), the discharge connector head (730) defining a first discharge muffler volume (701),
- a discharge muffler housing (706) enclosing an inner housing volume (707),

wherein the discharge muffler housing (706) is made of plastic material, wherein the discharge muffler housing (706) has a lower housing part (710) and an upper housing part (720), wherein the upper housing part (720) and the lower housing part (710) are welded together,

- an outlet section (705) to allow the compressed refrigerant to escape from the inner housing volume (707) of the discharge muffler (700) toward a discharge pipe (20) of the refrigerant compressor (1),

wherein the discharge connector head (730) is located on the upper housing part (720) and the outlet section (705) is located on the lower housing part (710);
wherein the inner housing volume (707) is divided into a second discharge muffler volume (702) and a third discharge muffler volume (703) by a separation arrangement (740);
wherein the first discharge muffler volume (701) and the second discharge muffler volume (702) are connected by an inlet tube (731),
wherein the second discharge muffler volume (702) and the third discharge muffler volume (703) are connected by a tube-like connection passage (741), which tube-like connection passage (741) is formed by the separation arrangement (740),
and wherein the outlet section (705) is connected to the third discharge muffler volume (703),
characterized in that
the second discharge muffler volume (702) has a first plurality of first chambers (708) and the third discharge muffler volume (703) has a second plurality of second chambers (709).

2. The discharge muffler (700) according to claim 1, **characterized in that** the upper housing part (720) comprises a plurality of chamber walls (721) extending in the direction of the lower housing part (710), wherein each of the first chambers (708) and each of the second chambers (709) is bounded by at least one chamber wall (721).

3. The discharge muffler (700) according to claim 2, **characterized in that** each chamber wall (721) has an end section (721a) facing towards the lower housing part (710) and each end section (721a) has an arc shaped opening (724).

4. The discharge muffler (700) according to any one of claims 2 to 3, **characterized in that** the upper housing part (720) comprises a reinforcement rib (722) which extends laterally to the chamber walls (721).

5. The discharge muffler (700) according to any one of claims 2 to 4, **characterized in that** the first plurality of first chambers comprises at least two first chambers (708) and the second plurality of second chambers comprises at least three second chambers (709).

6. The discharge muffler (700) according to any one of claims 1 to 5, **characterized in that** the separation arrangement (740) comprises

   - an upper separation wall (723) being located in the upper housing part (720), the upper separation wall (723) having an end section (723a) projecting into the lower housing part (710) and
   - a lower separation wall (711) being located in the lower housing part (710), the lower separation wall (711) having an end section (711a) projecting into the upper housing part (720),

   wherein the tube-like connection passage (741) is formed between overlapping sections of the upper separation wall (723) and the lower separation wall (711).

7. The discharge muffler (700) according to claim 6, **characterized in that** at least a section of the lower separation wall (711) has an essentially U-shaped cross section.

8. The discharge muffler (700) according to any one of claims 1 to 7, **characterized in that** the discharge muffler (700) further comprises a discharge connection tube (750) having a first end section (751) being connected to the outlet section (705) and a second end section (752) for connection with the discharge pipe (20) of the refrigerant compressor (1), wherein the discharge connection tube (750) is made of a plastic material.

9. The discharge muffler (700) according to claim 8, **characterized in that** the discharge connection tube (750) is made of a polyamide [PA] based polymer material.

10. The discharge muffler (700) according to claim 8 or 9, **characterized in that** the outlet section (705) of the discharge muffler (700) includes a tubular discharge connecting extension (712) projecting from an outer surface (710b) of the lower housing part (710), wherein the first end section (751) of the discharge connection tube (750) is inserted into the tubular discharge connecting extension (712).

11. The discharge muffler (700) according to any one of claims 8 to 10, **characterized in that** the second end section (752) of the discharge connection tube (750) is inserted into a connection sleeve (760) having a groove (761) for receiving an O-ring seal (762).

12. The discharge muffler (700) according to any one of claims 1 to 11, **characterized in that** the discharge connector head (730) has a sealing surface (730a) for connection with a valve plate (530) of the refrigerant compressor (1) having a circumferential groove (732) for receiving a first sealing element (550).

13. The discharge muffler (700) according to any one of claims 1 to 12, **characterized in that** the discharge connector head (730) has a protruding element (733) which acts as a stopping element for a discharge valve spring (540) of the discharge valve.

14. The discharge muffler (700) according to any one of claims 1 to 13, **characterized in that** the discharge connector head (730) and/or the discharge muffler housing (706) is made of a polyamide [PA] 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 suction muffler (600);
     - 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 discharge muffler (700) according to any one of claims 1 to 14, wherein the discharge muffler (700) has a discharge connection tube (750) being connected to the discharge pipe (20).

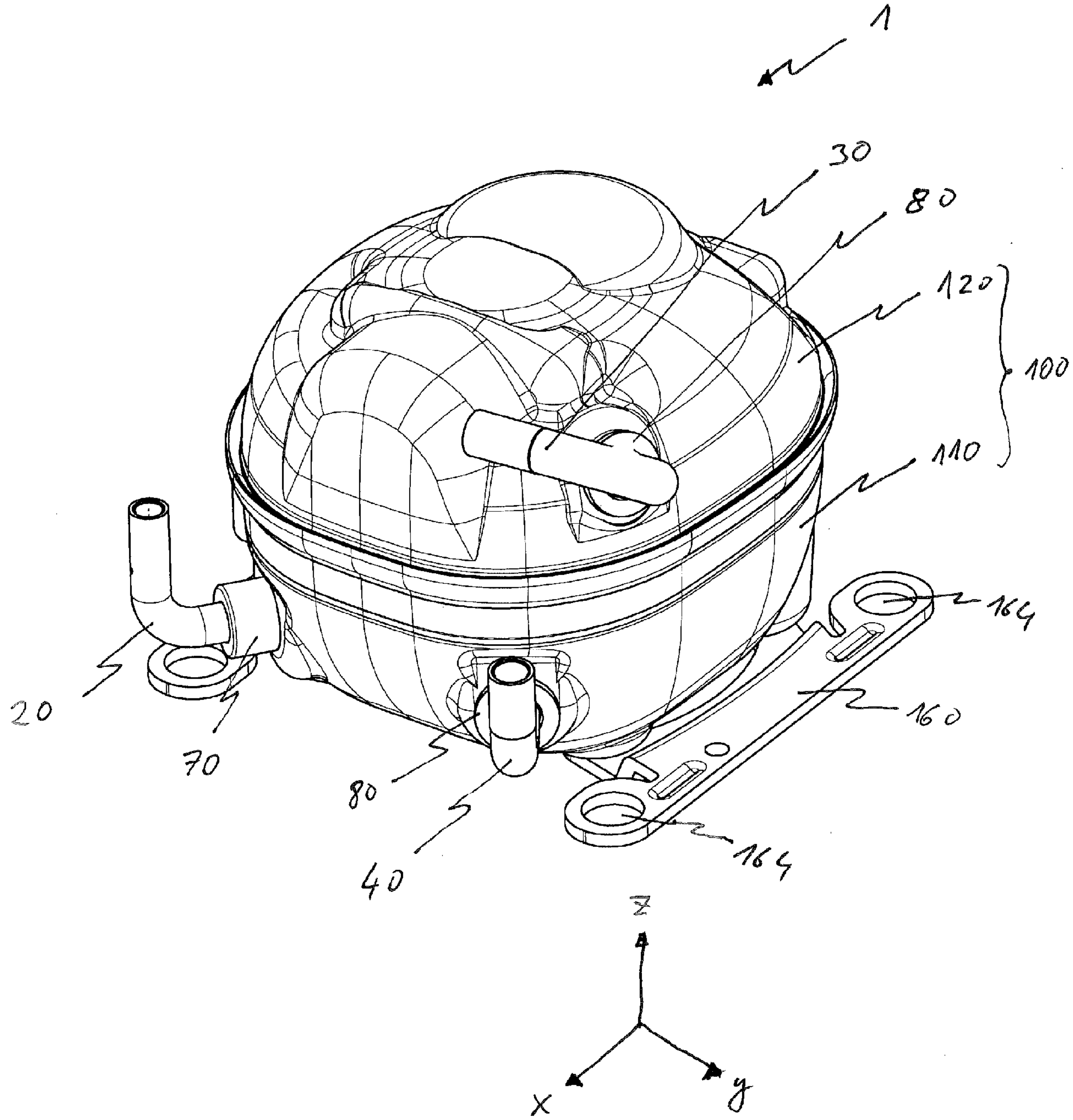


Fig. 1

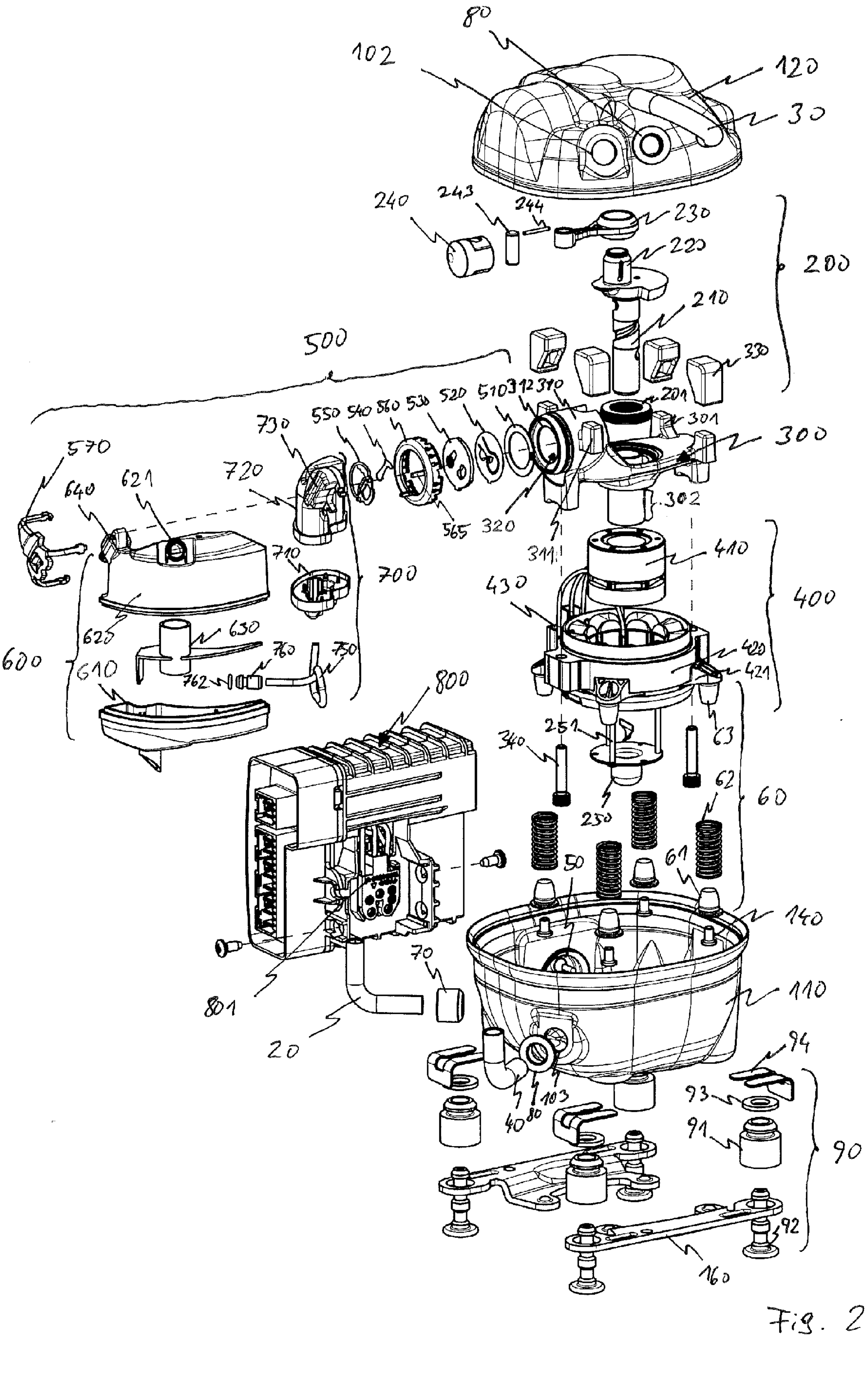
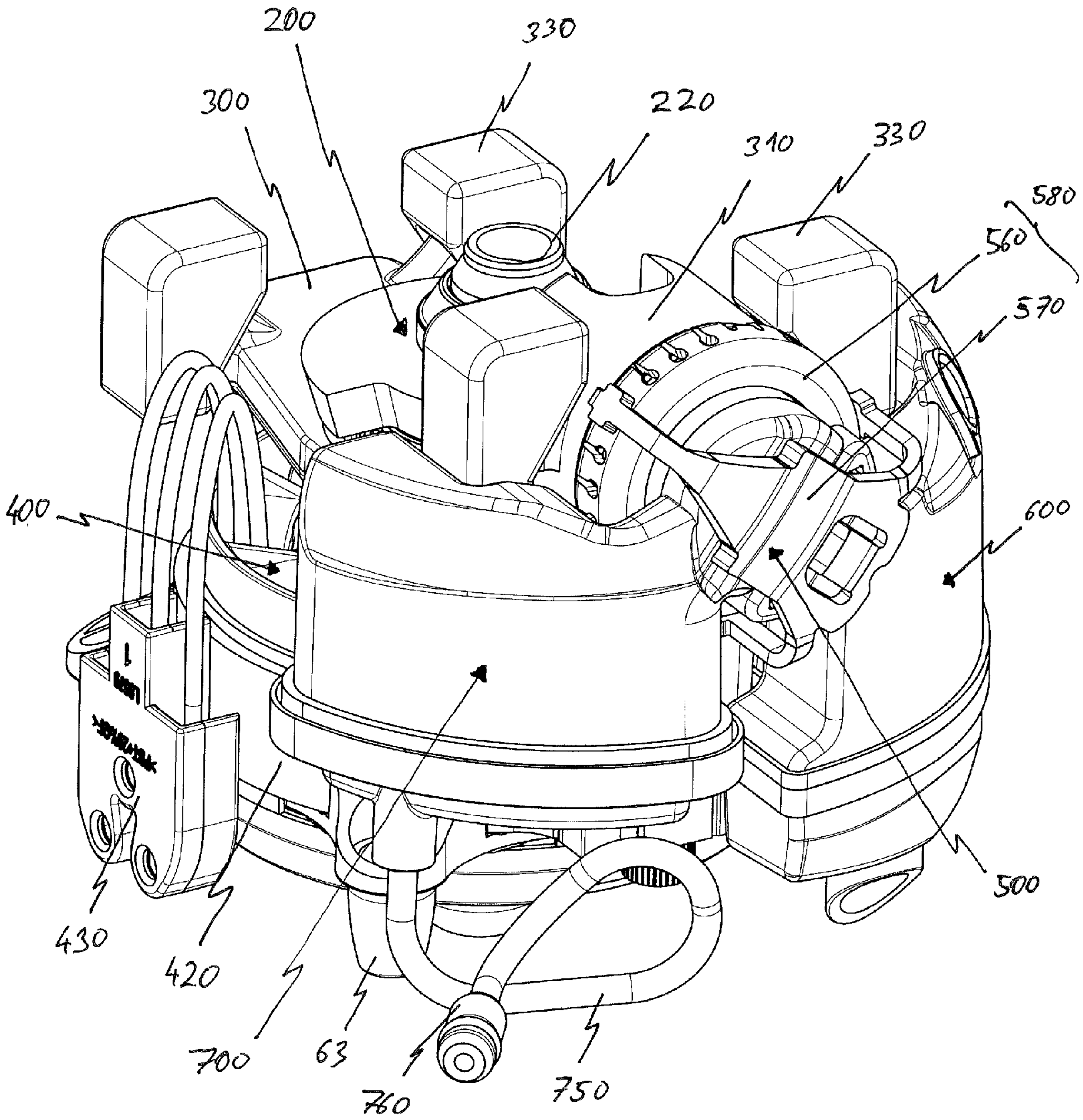


Fig. 2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310
330
580
560
570
400
600
430
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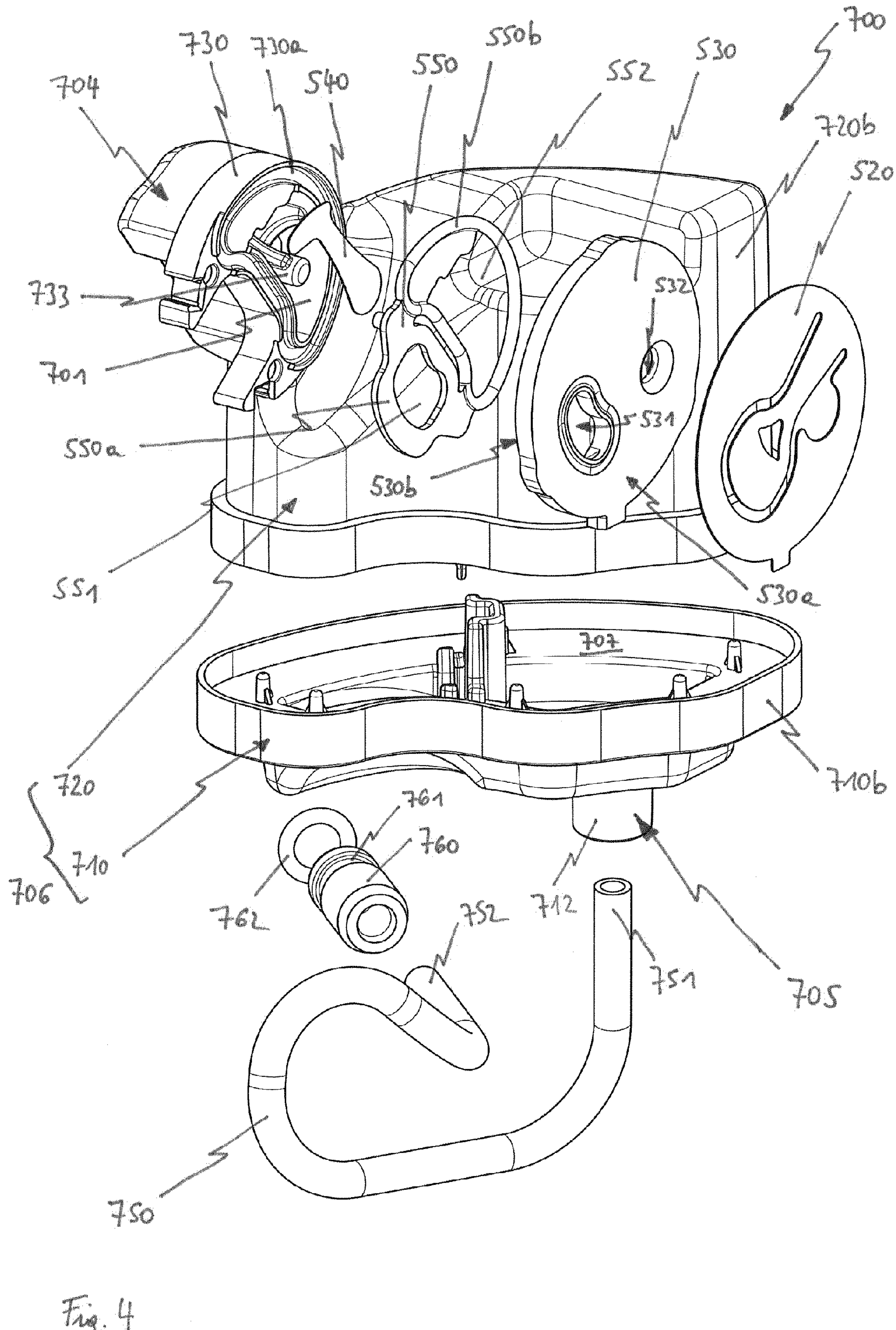
500
700
63
760
750

Fig. 3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704
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730a
540
550
550b
552
530
720b
520
733
701
532
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550a
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712
751
705
750

Fig. 4

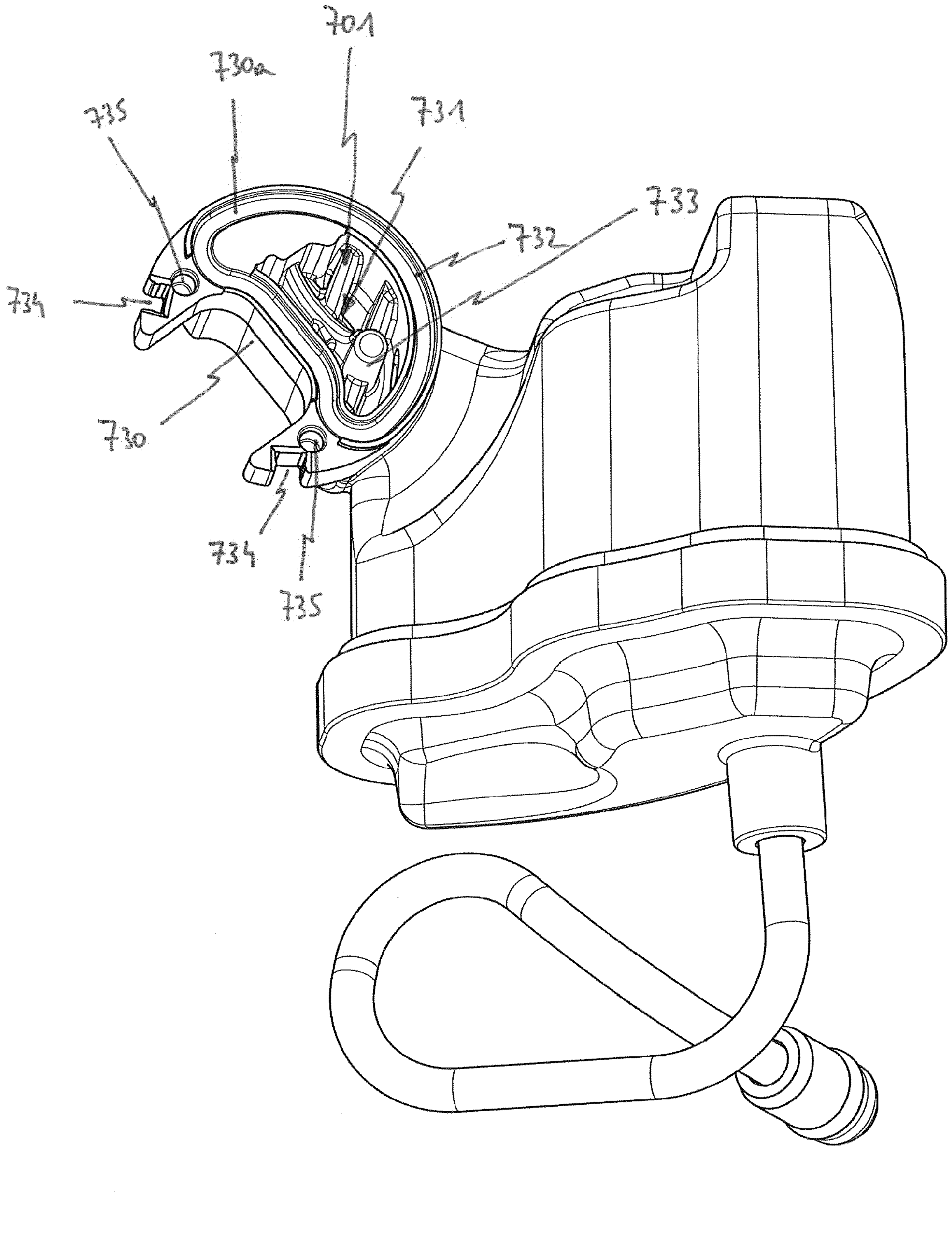
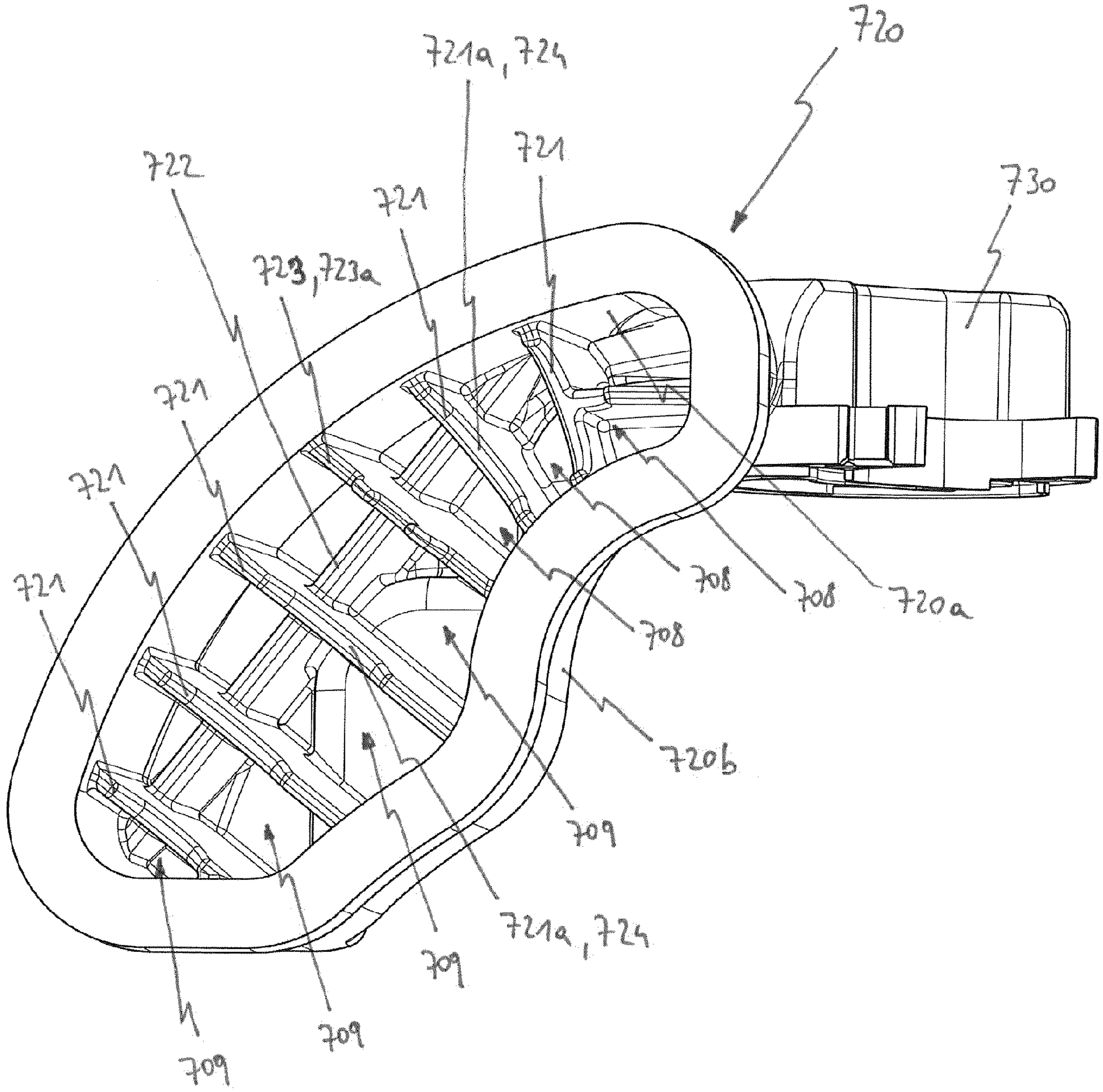


Fig. 5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721a, 724
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722
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Fig. 6

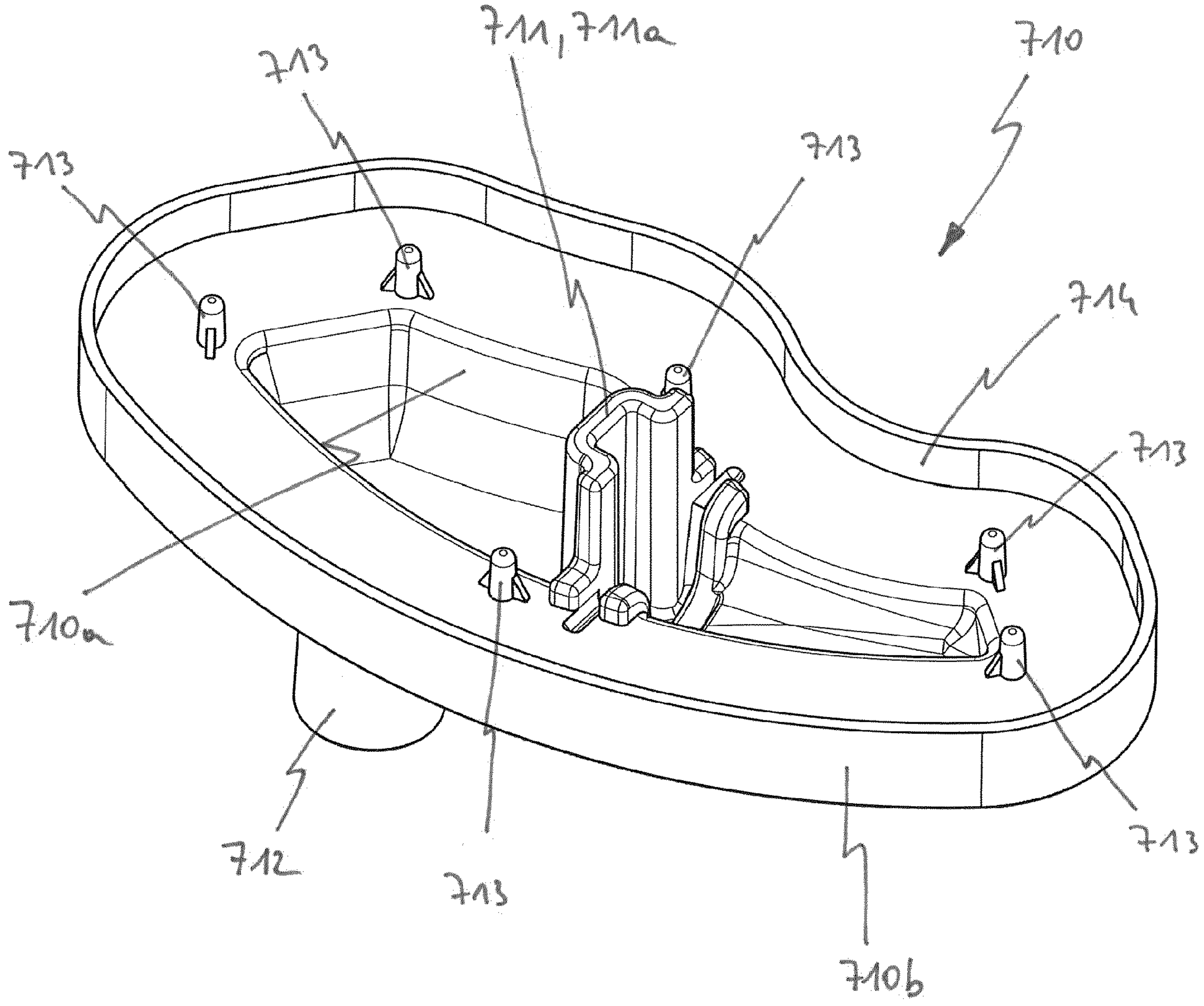
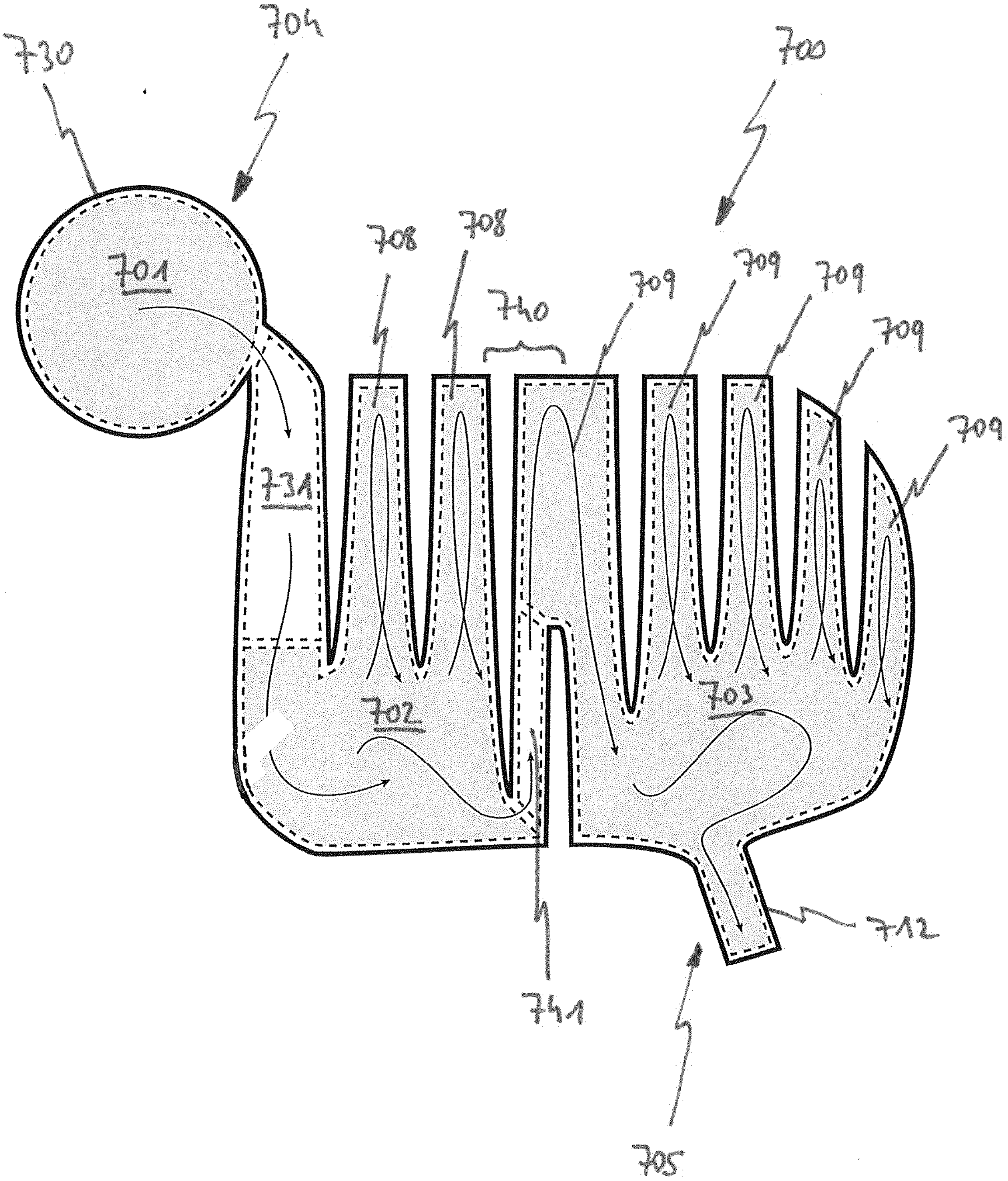


Fig. 7


730
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740
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731
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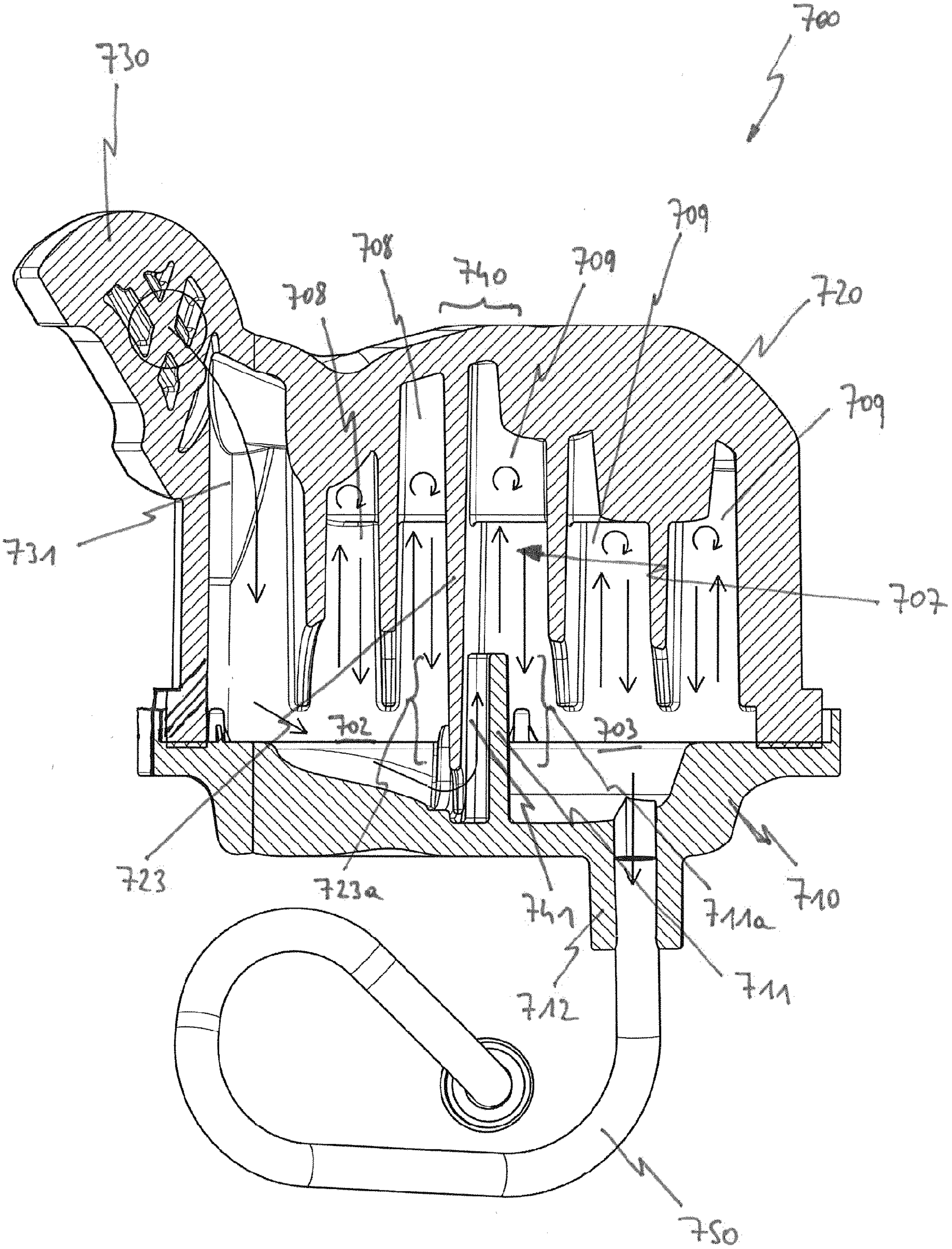
703
741
712
705

Fig. 8


700
730
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720
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707
702
703
723
723a
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711a
710
712
711
750

Fig. 9

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EUROPEAN SEARCH REPORT

Application Number
EP 22 20 3372

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
Y A	WO 2011/137474 A2 (ACC AUSTRIA GMBH [AT]) 10 November 2011 (2011-11-10) * figures 3-5, 7 * * page 6, line 19 - page 10, line 14 *	1-5,8-15 6,7	INV. F04B39/00 F04B39/12
Y A	CN 111 287 939 A (ANHUI MEIZHI COMPRESSOR CO., LTD. [CN]) 16 June 2020 (2020-06-16) * figures 1, 2 * * claim 14 * * paragraph [0051] - paragraph [0070] *	1-5,8-15 6,7	
A	WO 2014/053040 A1 (WHIRLPOOL S.A. [BR]) 10 April 2014 (2014-04-10) * figure 4 * * page 6, line 10 - page 11, line 4 *	1-15	
A	EP 3 217 012 A1 (WHIRLPOOL S.A. [BR]) 13 September 2017 (2017-09-13) * figures 1, 3 * * paragraph [0019] - paragraph [0031] *	1-15	TECHNICAL FIELDS SEARCHED (IPC)
A	JP S59 43990 A (SANYO ELECTRIC CO. [JP]) 12 March 1984 (1984-03-12) * figures 1, 2 * * abstract *	1-15	F04B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	10 March 2023	Gnüchtel, Frank

2

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 22 20 3372

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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10-03-2023

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2011137474 A2	10-11-2011	AT 12789 U1	15-11-2012
		CN 102971533 A	13-03-2013
		EP 2567093 A2	13-03-2013
		US 2013330214 A1	12-12-2013
		WO 2011137474 A2	10-11-2011
CN 111287939 A	16-06-2020	NONE	
WO 2014053040 A1	10-04-2014	AU 2013327353 A1	16-04-2015
		BR 102012025273 A2	26-08-2014
		CN 104797820 A	22-07-2015
		EP 2912315 A1	02-09-2015
		ES 2692655 T3	04-12-2018
		JP 6225191 B2	01-11-2017
		JP 2015530520 A	15-10-2015
		MX 355382 B	17-04-2018
		NZ 706406 A	24-11-2017
		US 2015275883 A1	01-10-2015
		WO 2014053040 A1	10-04-2014
EP 3217012 A1	13-09-2017	BR 102016005387 A2	19-09-2017
		CN 107178483 A	19-09-2017
		EP 3217012 A1	13-09-2017
		JP 2017160908 A	14-09-2017
		US 2017260974 A1	14-09-2017
JP S5943990 A	12-03-1984	JP H0448944 B2	10-08-1992
		JP S5943990 A	12-03-1984

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82