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Brabek et al.(10) **Pub. No.: US 2009/0214367 A1**(43) **Pub. Date: Aug. 27, 2009**(54) **REFRIGERANT COMPRESSOR**(30) **Foreign Application Priority Data**(75) Inventors: **Walter Brabek**, Fuerstenfeld (AT);
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(52) **U.S. Cl.** **417/559**(57) **ABSTRACT**

A hermetically encapsulated refrigerant compressor having a hermetically sealed compressor housing, in whose interior a piston-cylinder unit operates, whose cylinder housing (1) is closed using a valve plate (2) having a pressure hole (10) and a suction hole (16), and a suction channel and a pressure channel are provided. Preferably V-shaped sealing beads (23) or sealing projections (22) are provided in the valve plate (2) and the front face of the component (9) forming the suction channel is equipped along its suction contact edge (17) with sealing projections (22) or sealing beads (23) essentially corresponding to the V-shaped sealing beads (23) or sealing projections (22), the sealing projections (22) being implemented differently from the sealing beads (23) in their geometrical design and/or having a different volume.

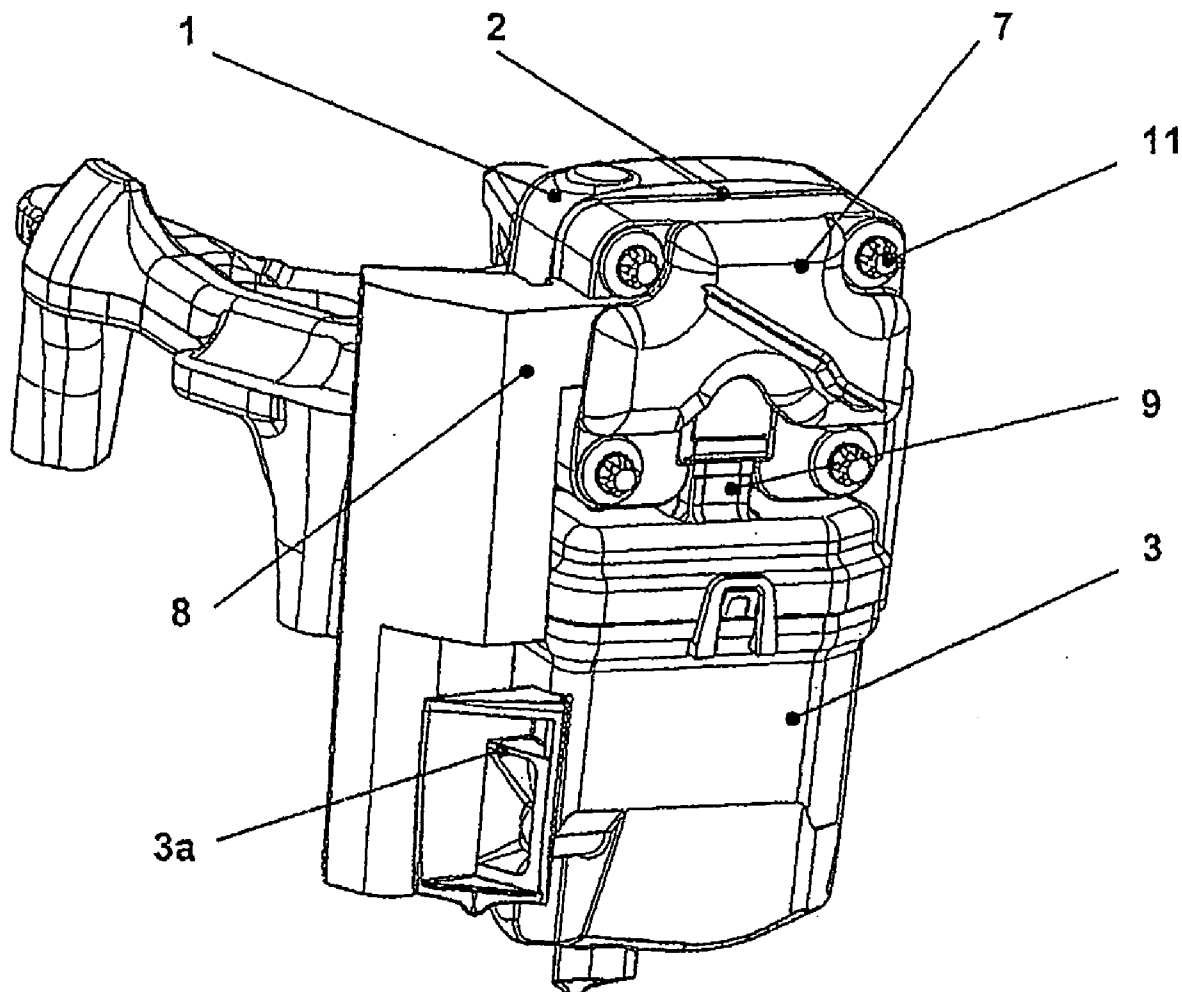
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Fuerstenfeld (AT)(21) Appl. No.: **11/918,285**(22) PCT Filed: **Mar. 30, 2006**(86) PCT No.: **PCT/EP2006/061196**§ 371 (c)(1),
(2), (4) Date: **Jan. 5, 2009**

Fig. 1

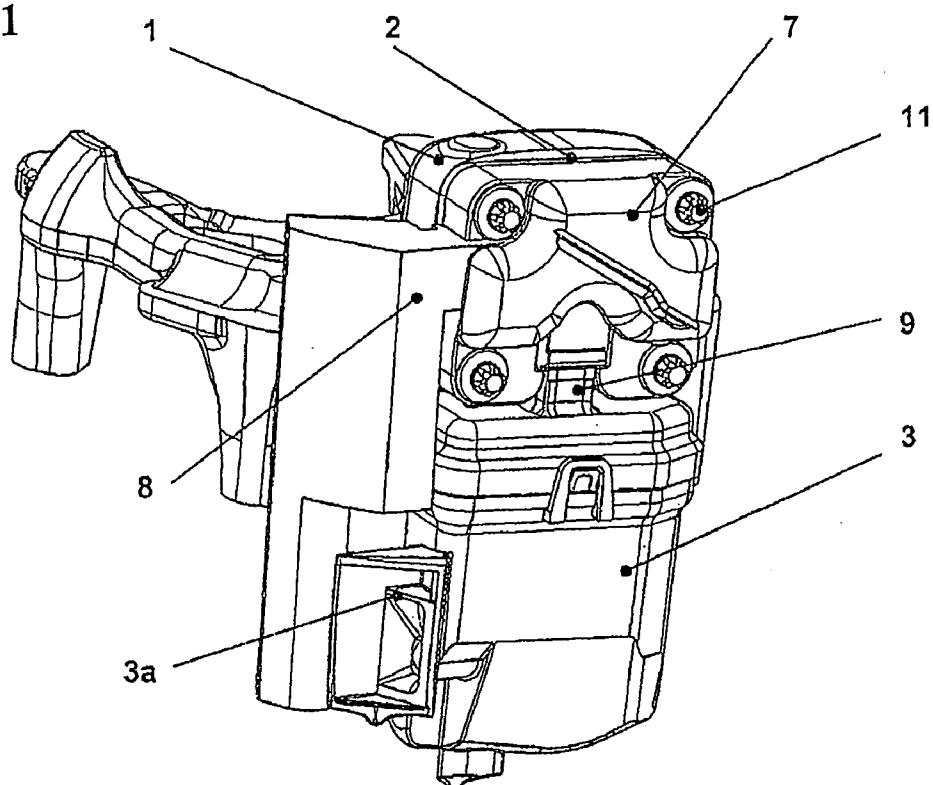


Fig. 2

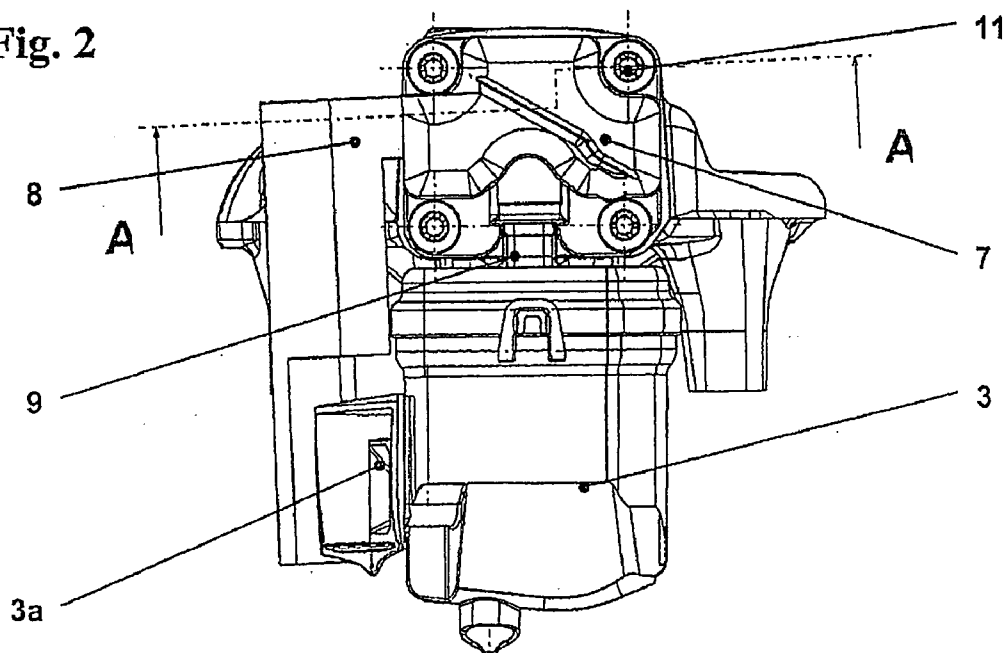


Fig. 3

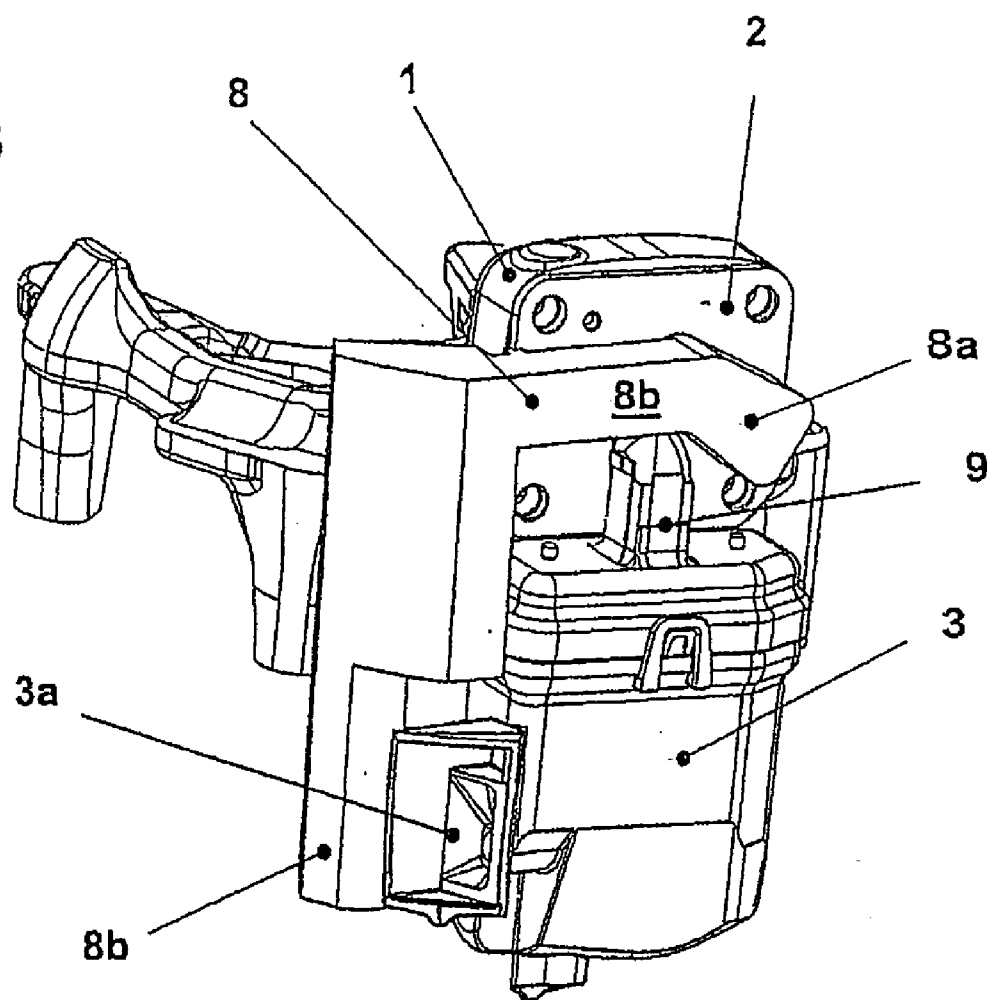


Fig. 4

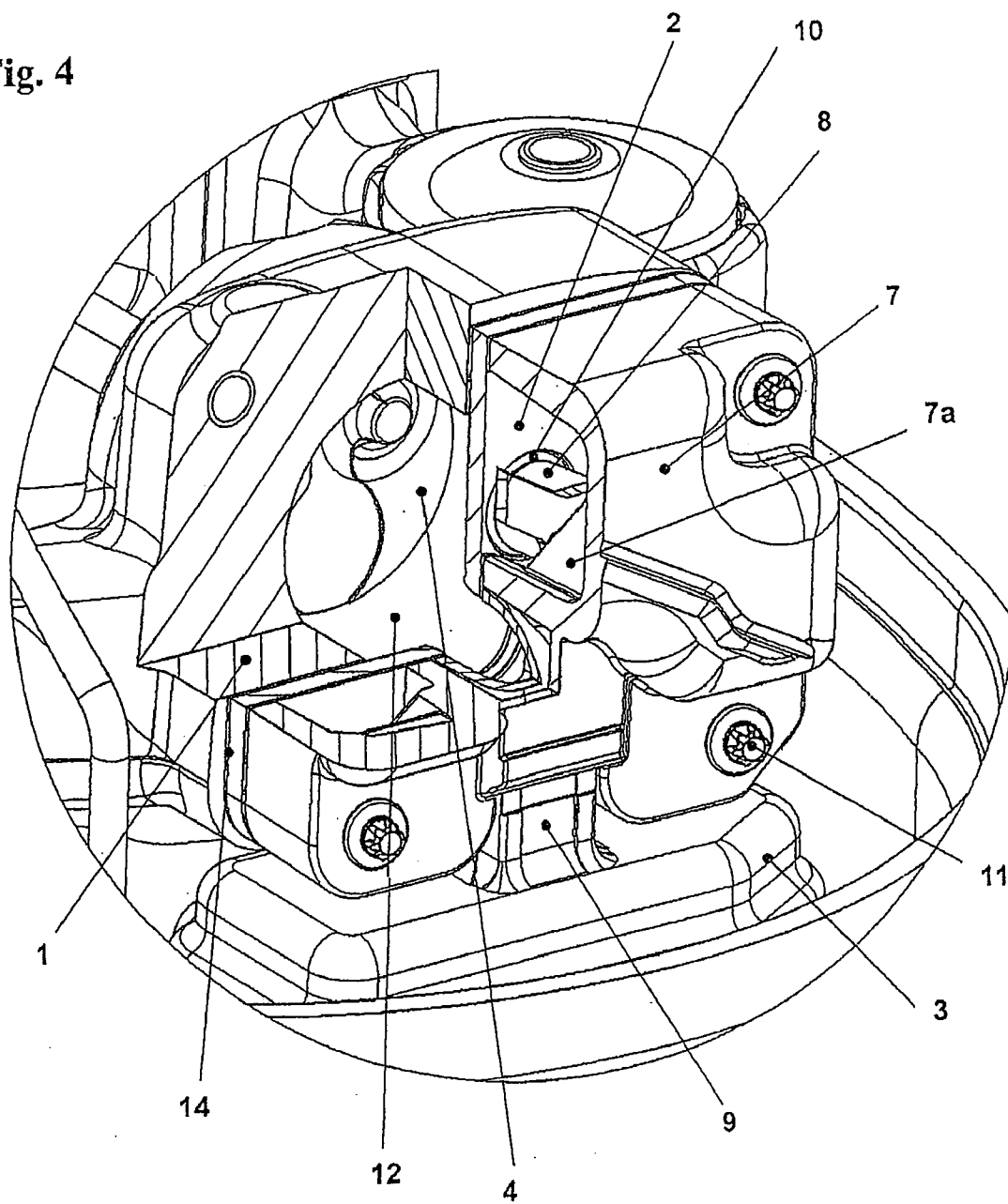


Fig. 5

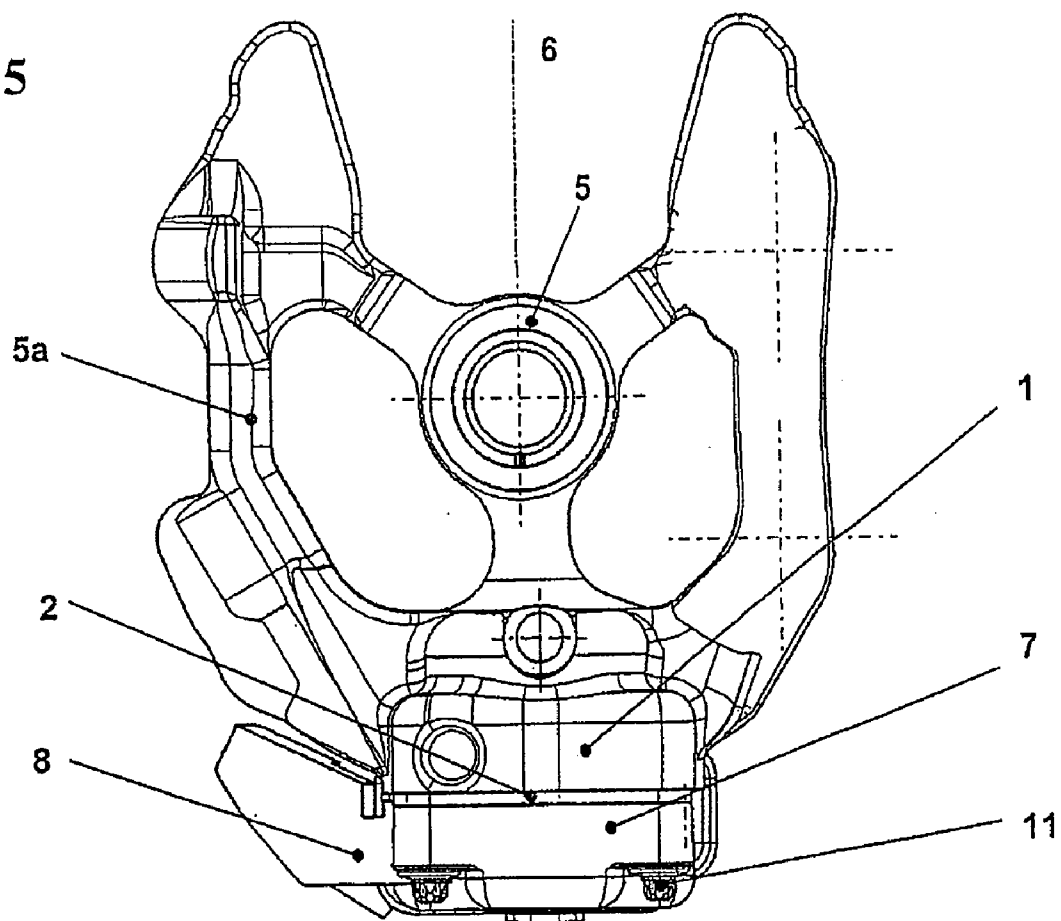


Fig. 6

CROSS SECTION A-A

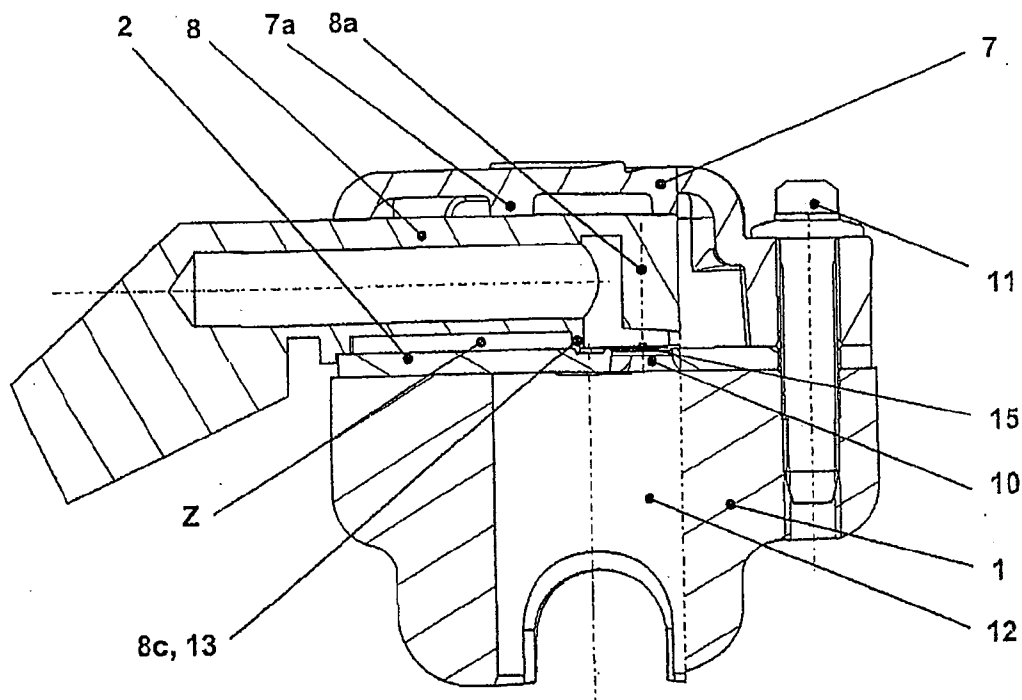


Fig. 7

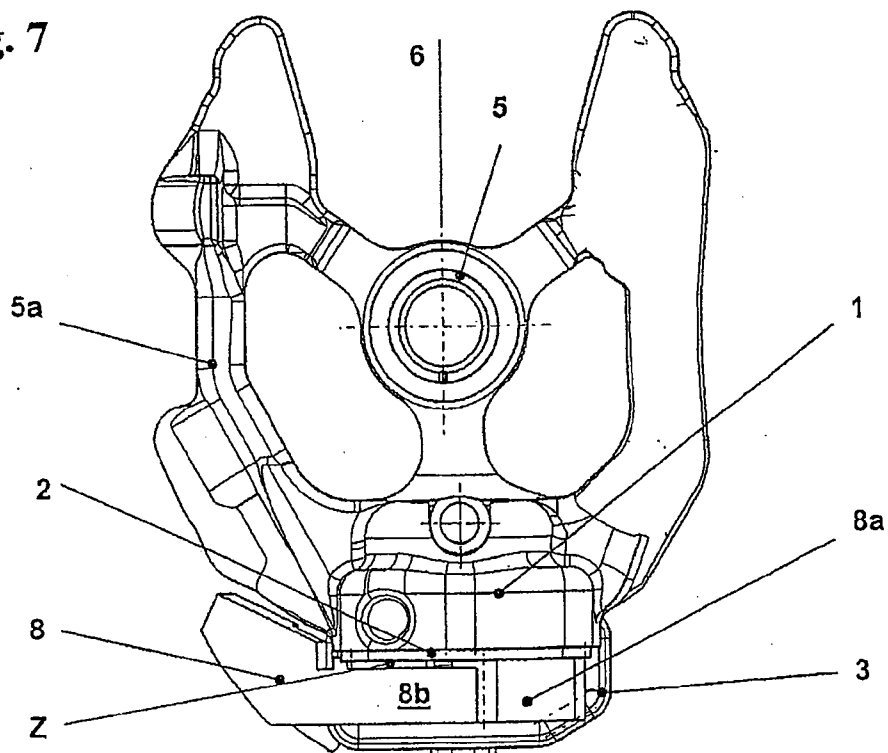


Fig. 8

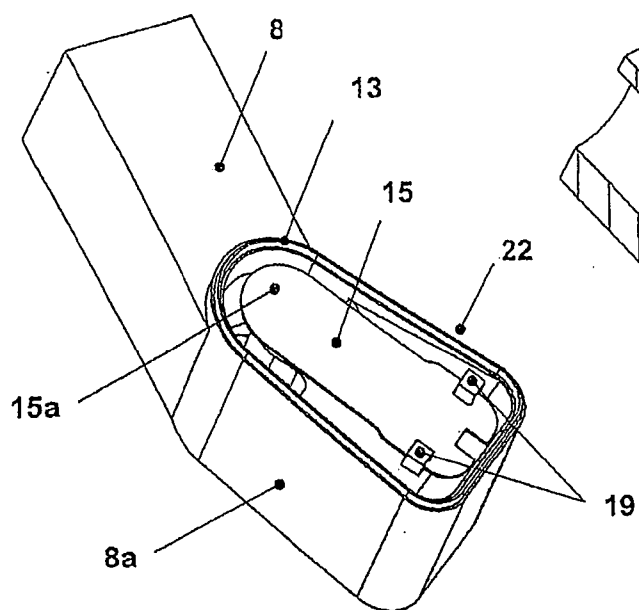


Fig. 8a

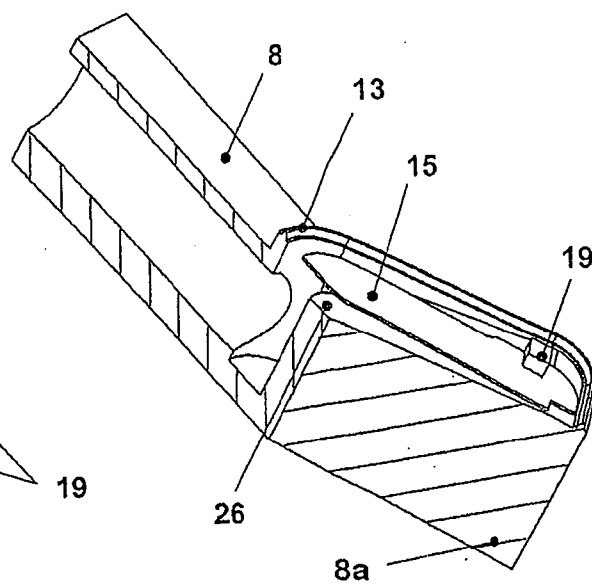


Fig. 9

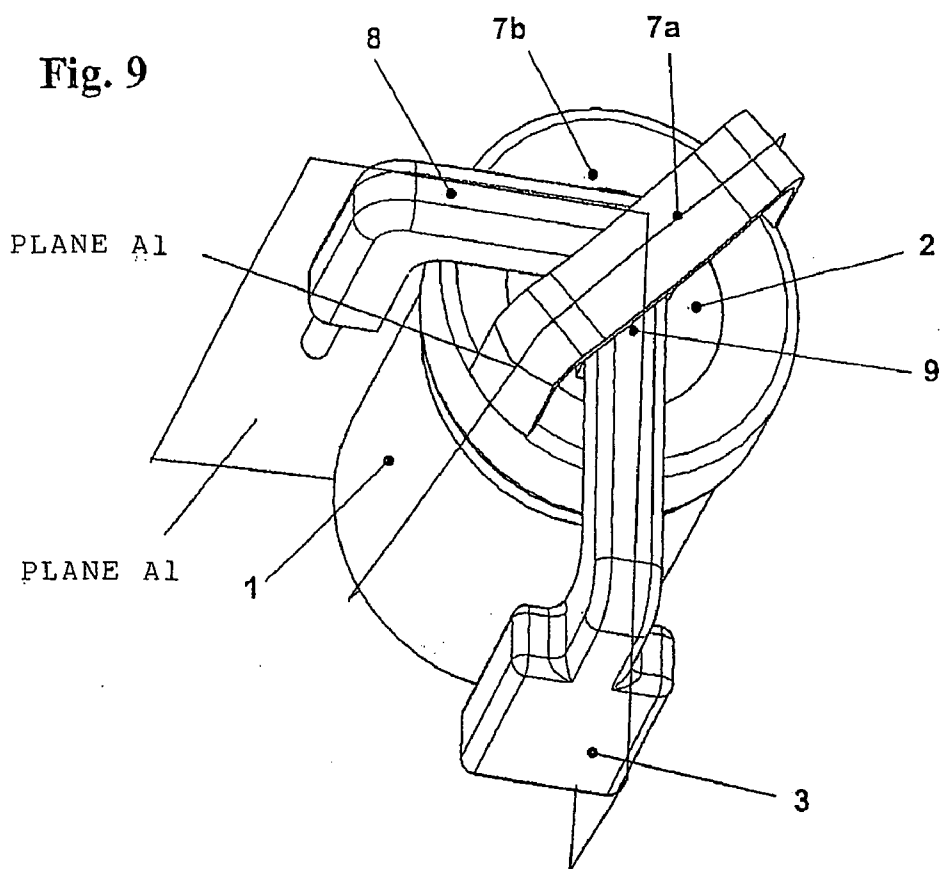


Fig. 10

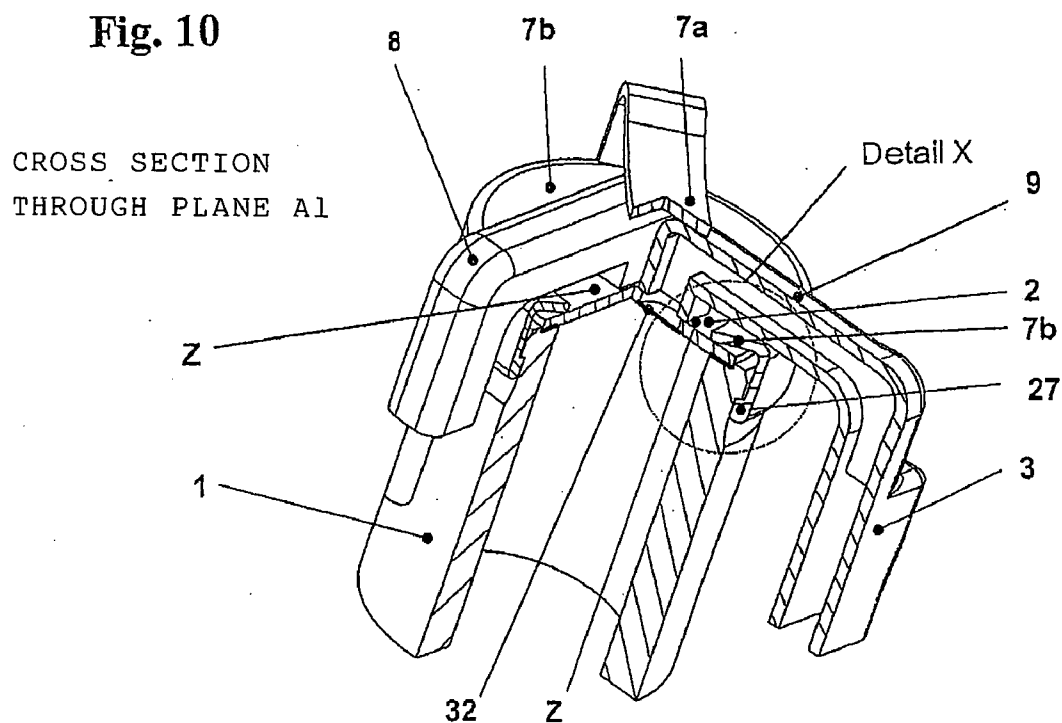


Fig. 11

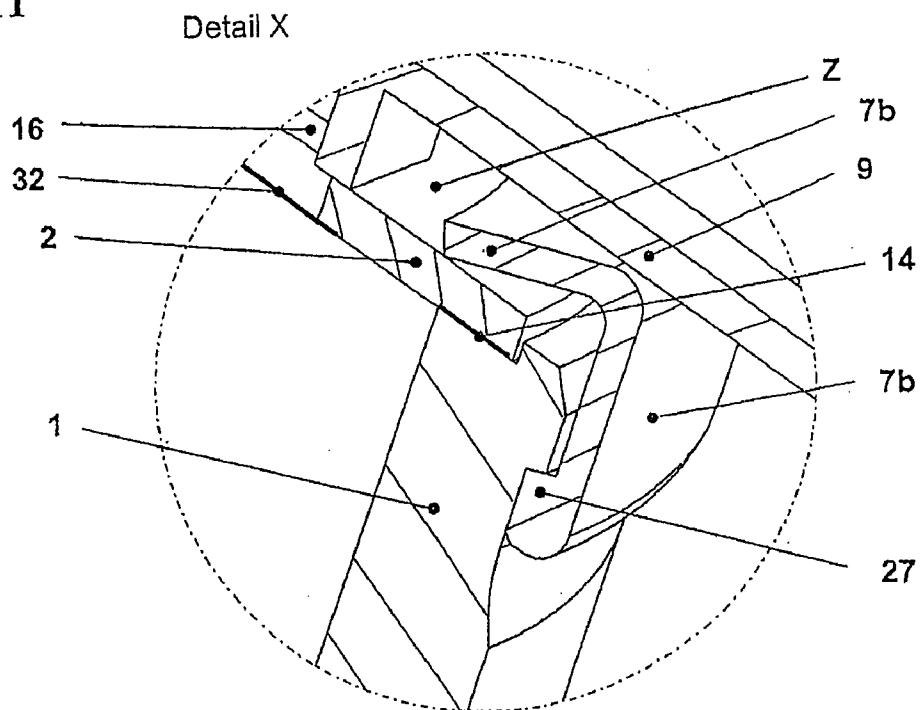


Fig. 12

CROSS SECTION THROUGH PLANE A

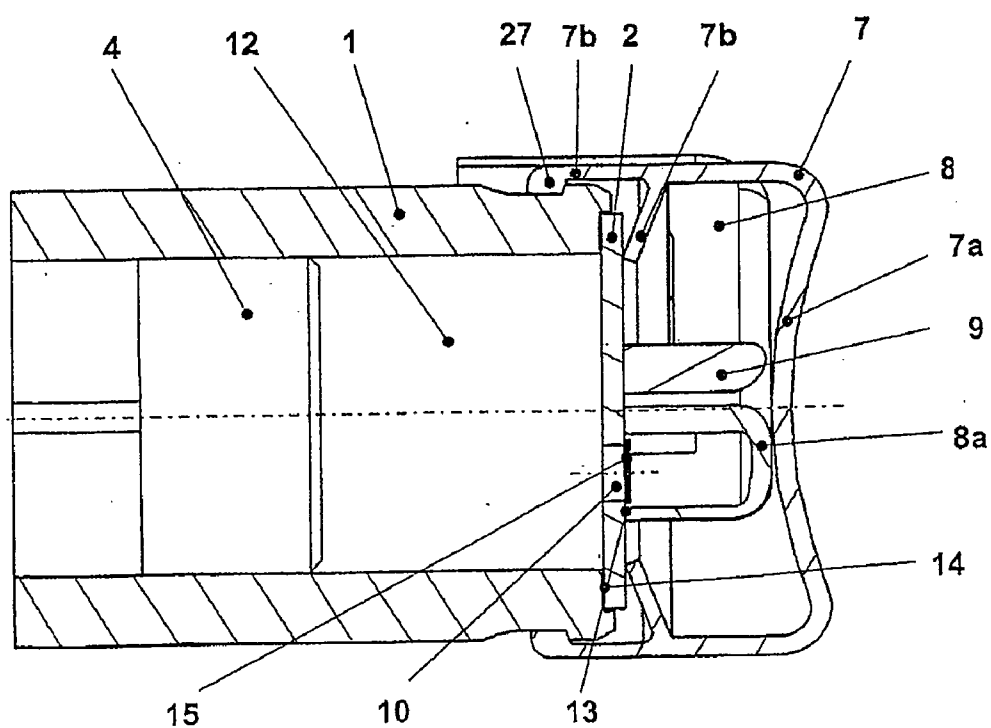


Fig. 13

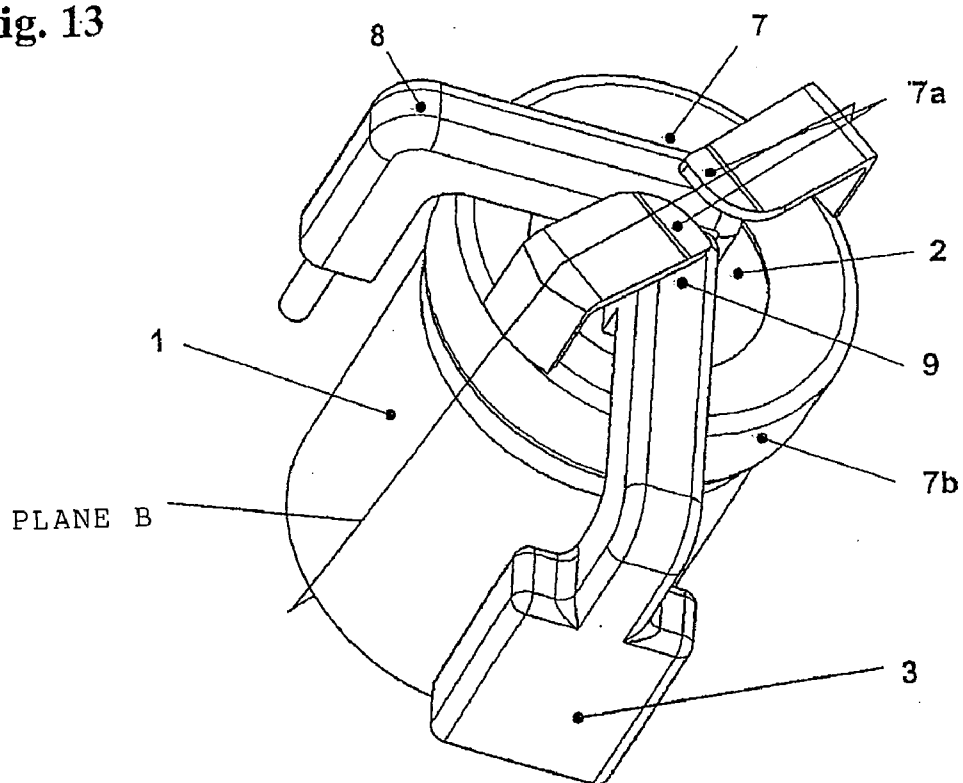


Fig. 14

CROSS SECTION THROUGH PLANE B

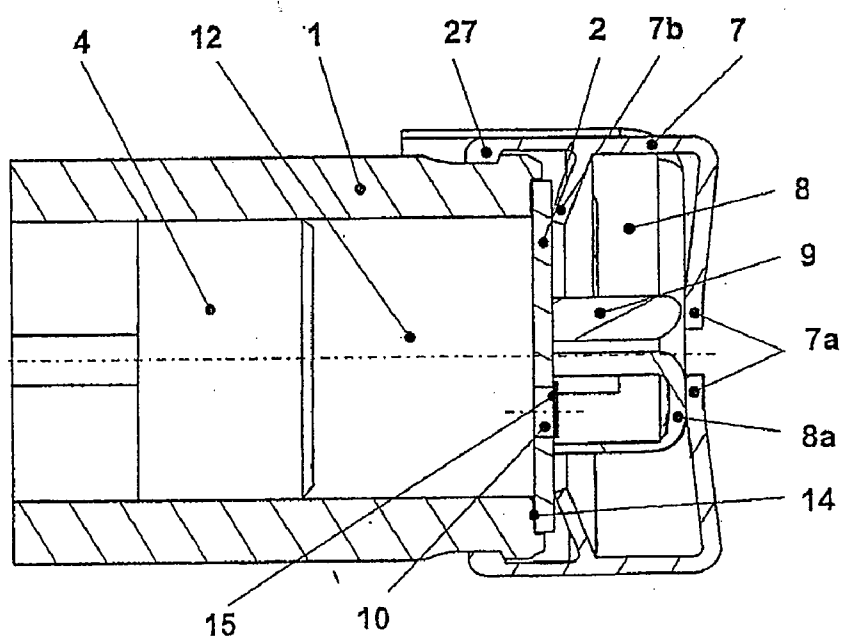


Fig. 15

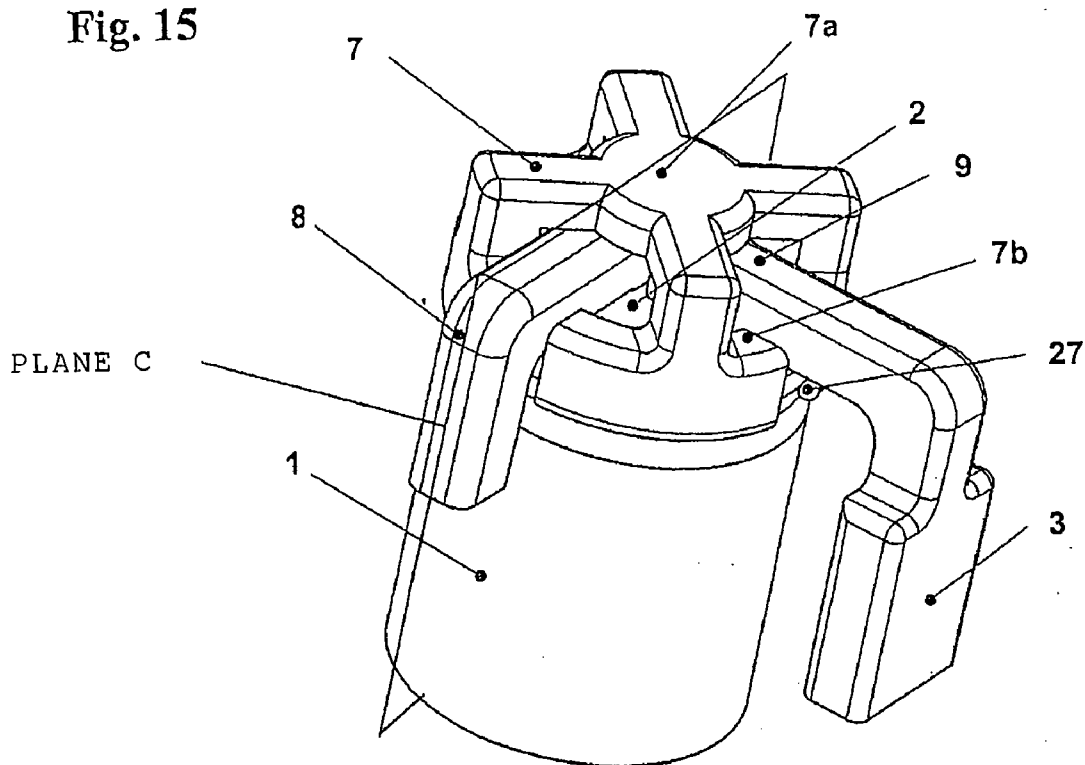


Fig. 16 CROSS SECTION THROUGH PLANE C

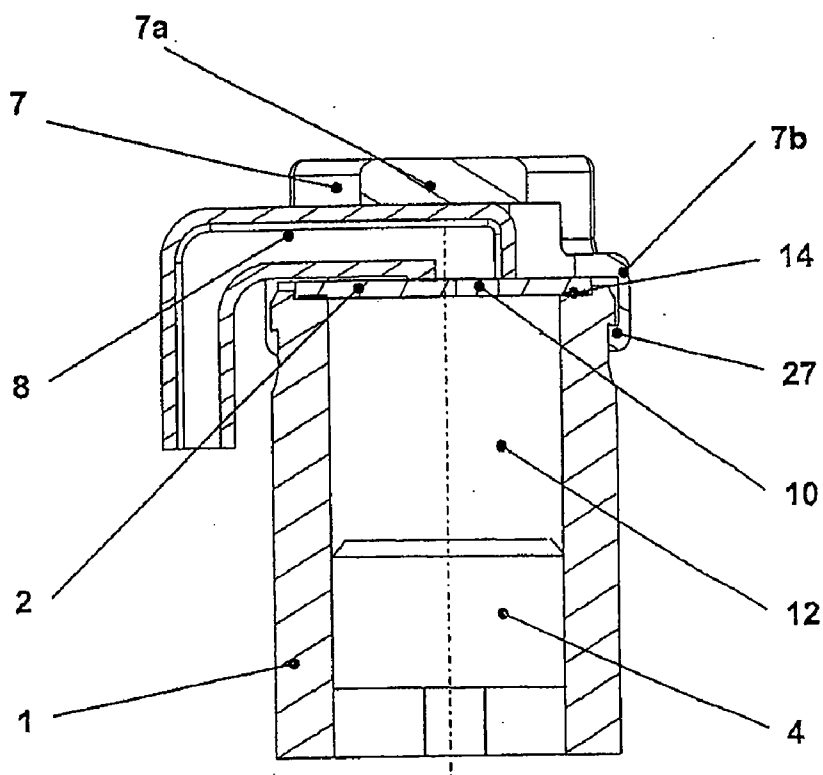


Fig. 17

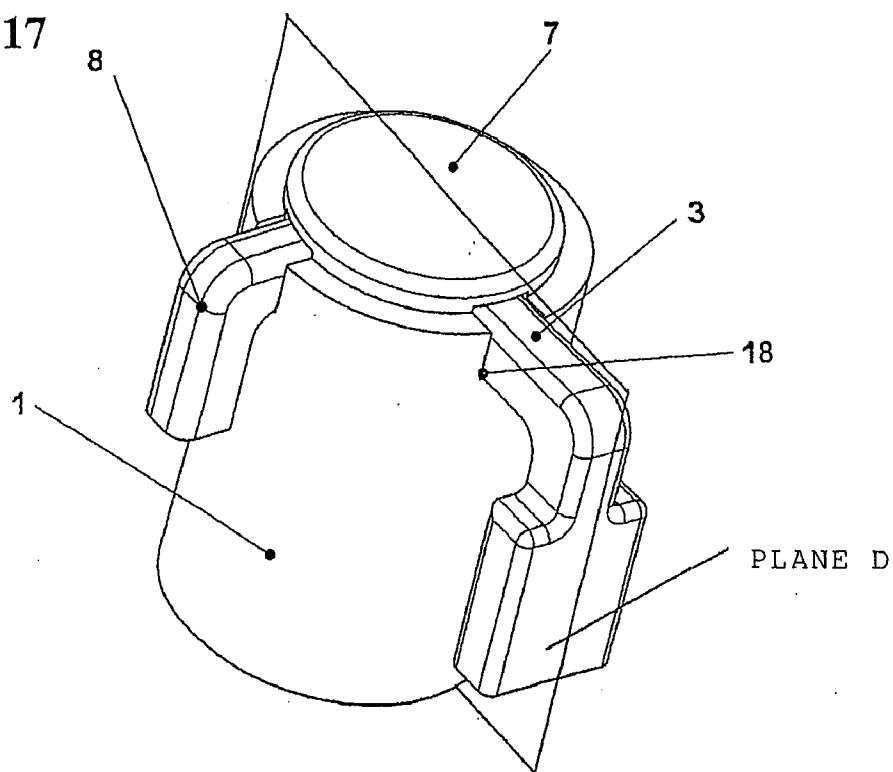


Fig. 18

CROSS SECTION THROUGH PLANE D

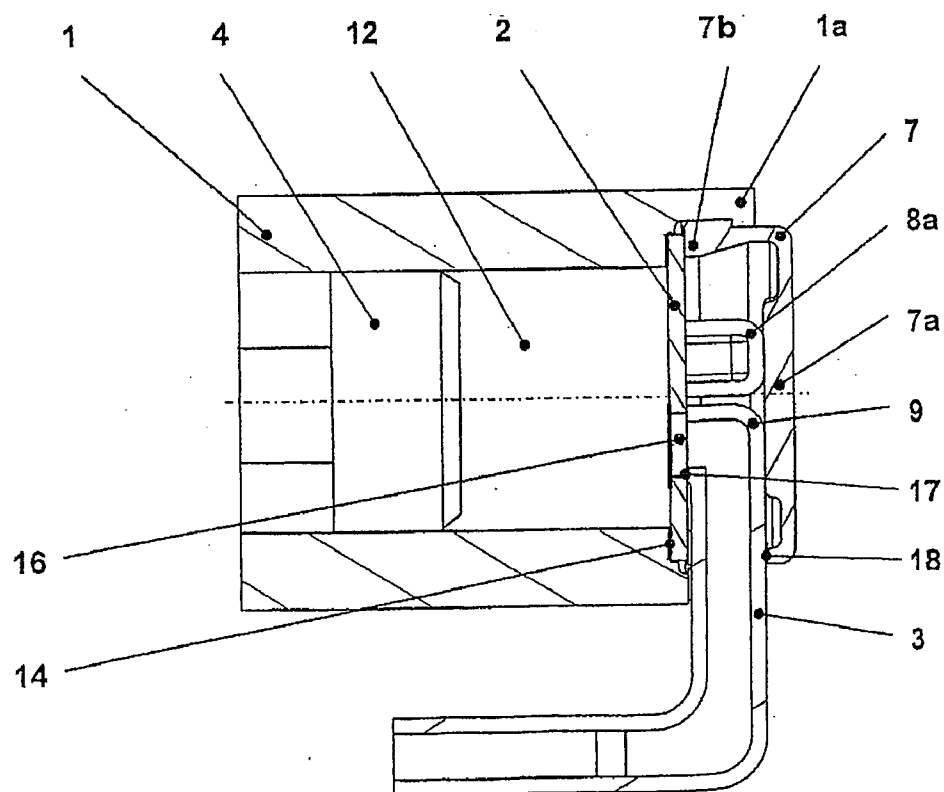


Fig. 19

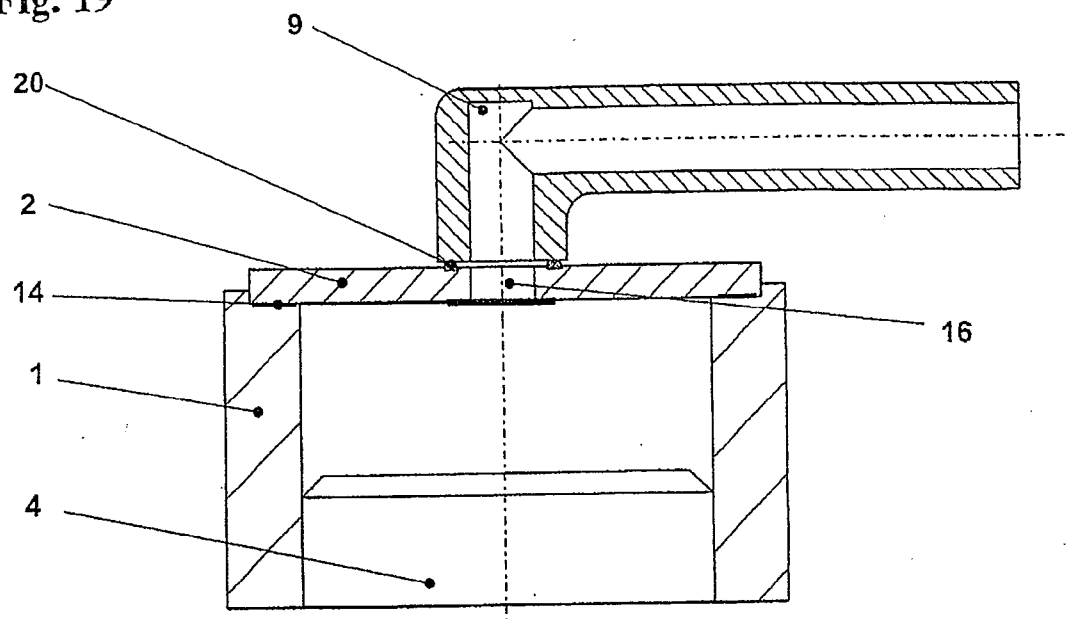


Fig. 20

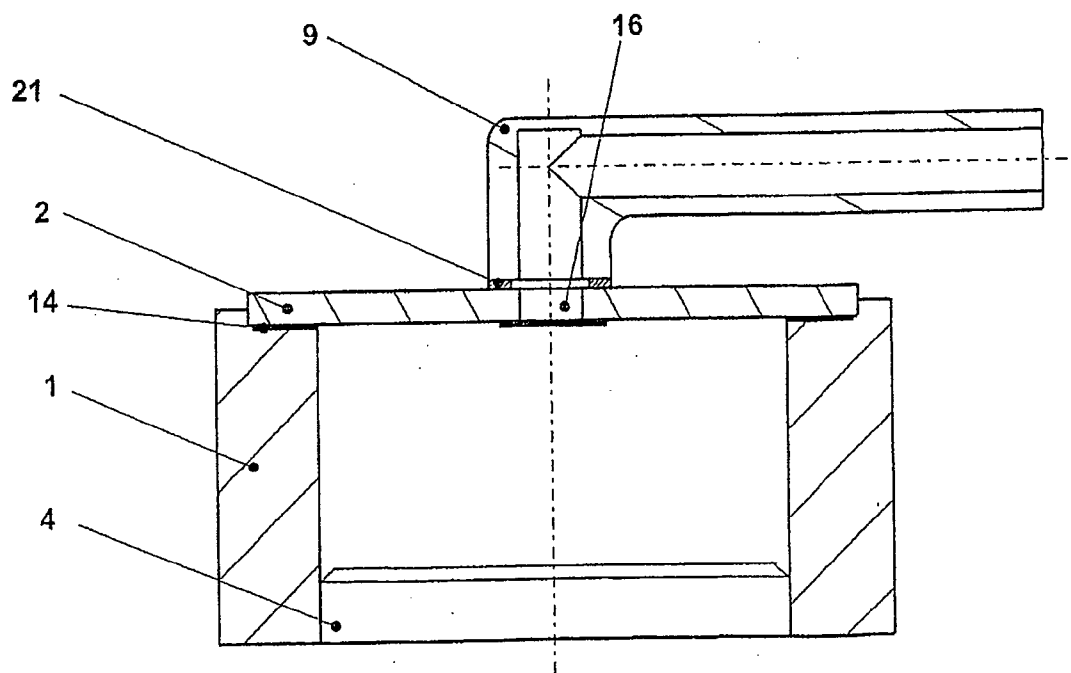


Fig. 21

CROSS SECTION
THROUGH
PLANE E

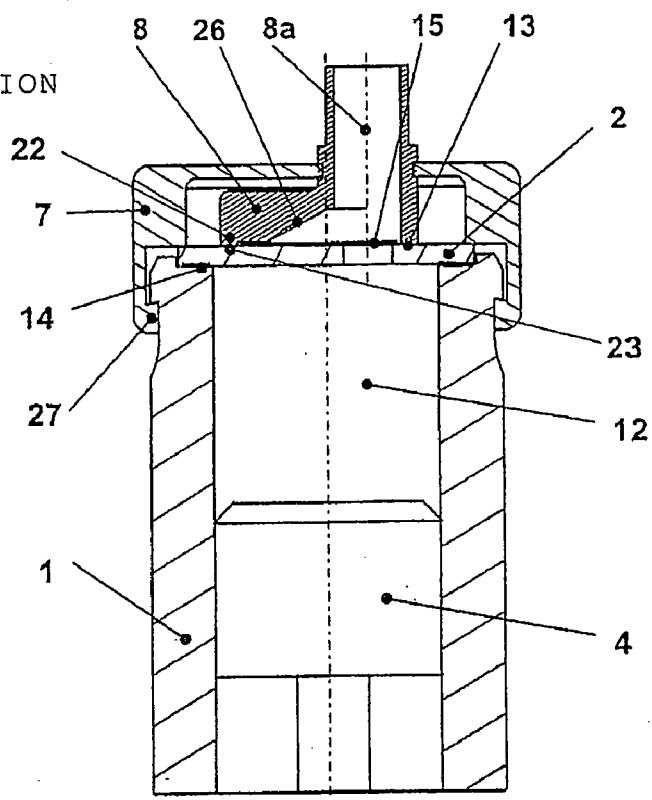


Fig. 22

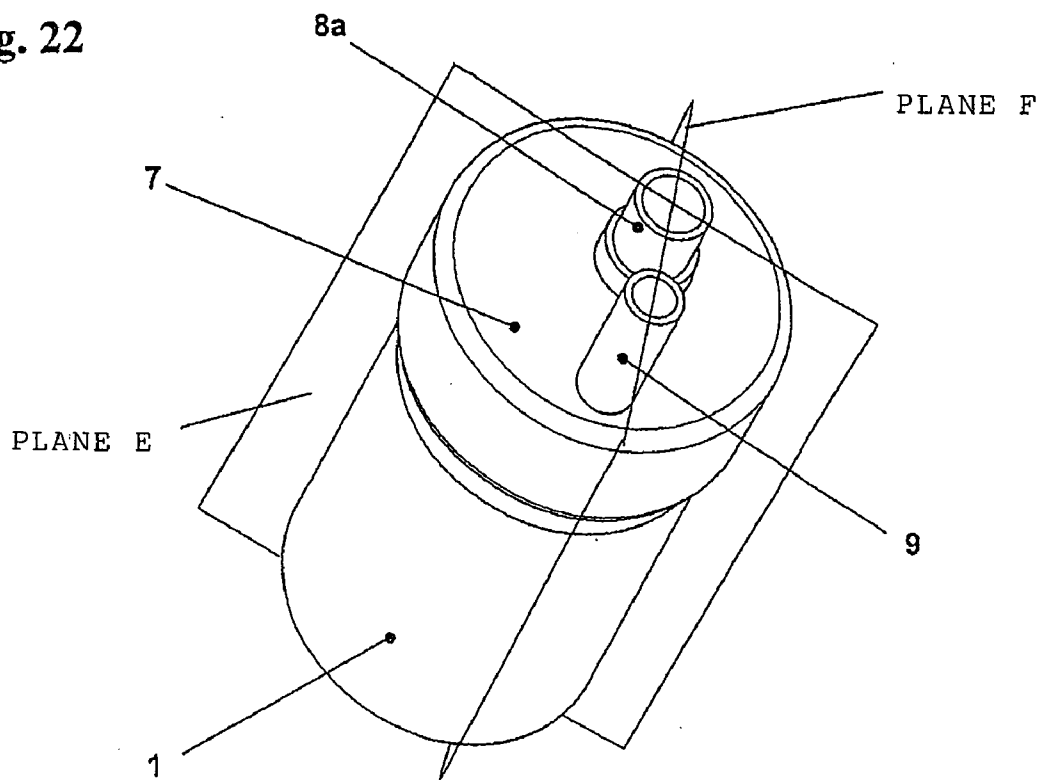


Fig. 23

CROSS SECTION THROUGH PLANE F

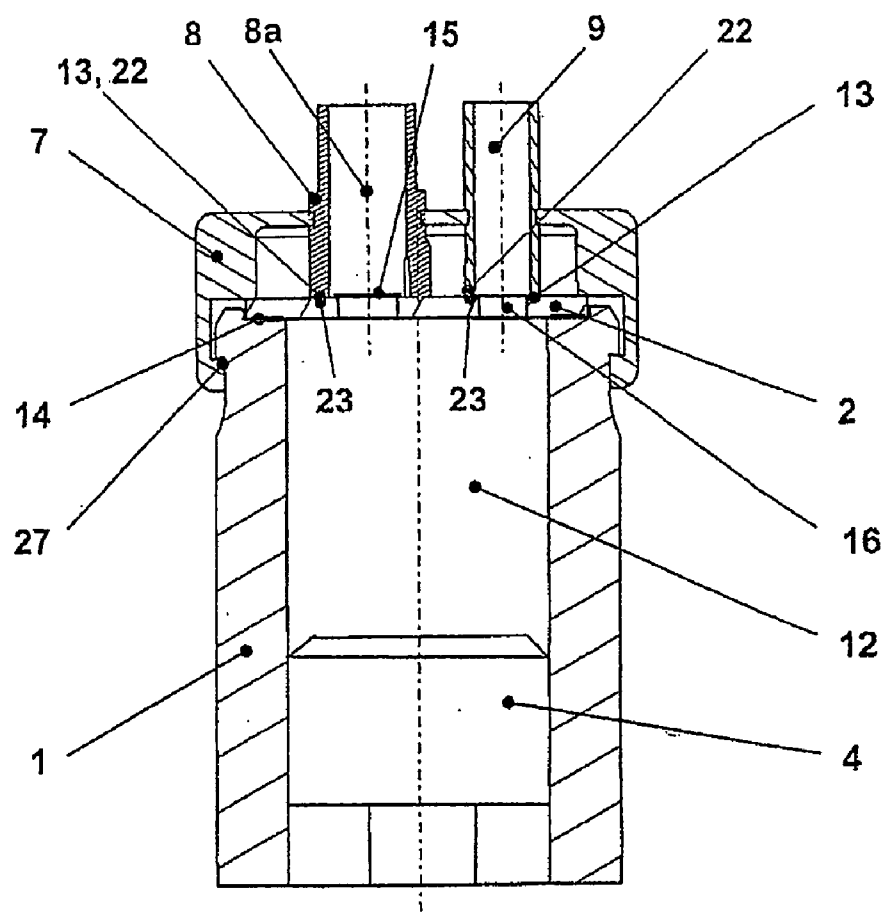


Fig. 24

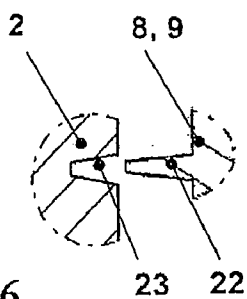


Fig. 26

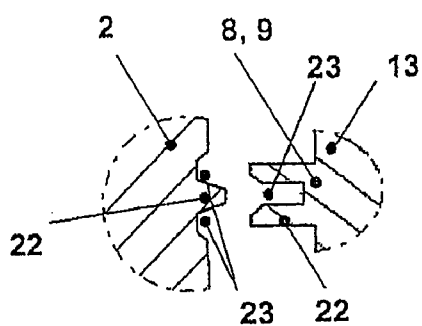


Fig. 28

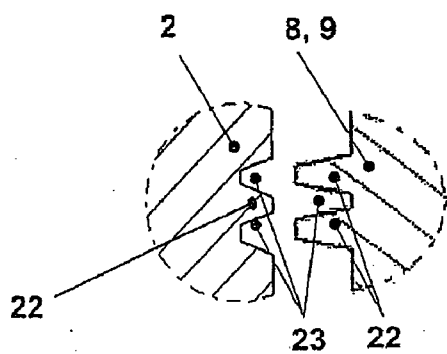


Fig. 30

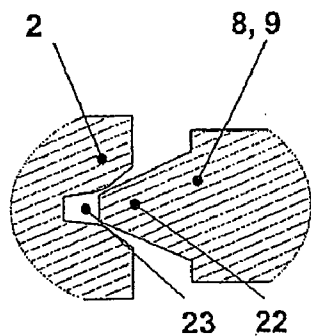


Fig. 25

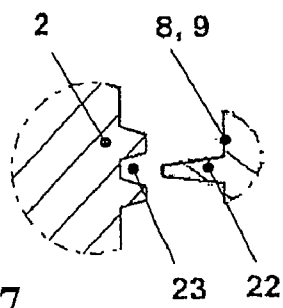


Fig. 27

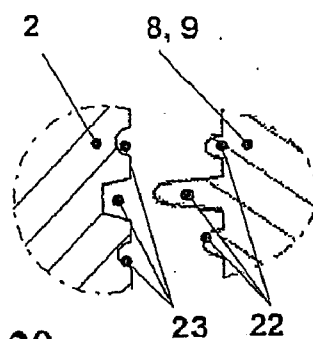


Fig. 29

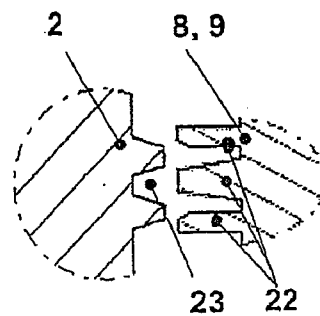


Fig. 31

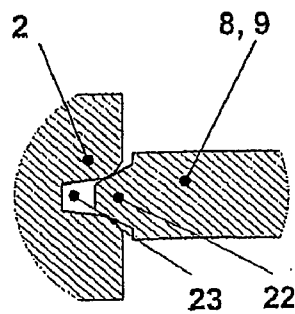


Fig. 32

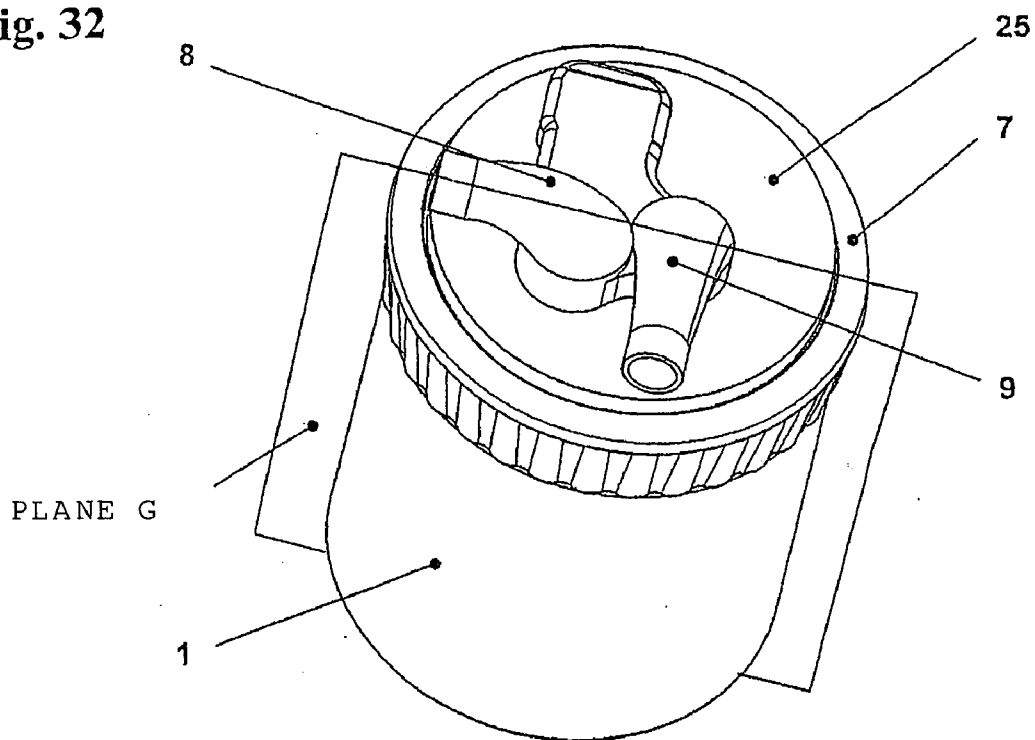


Fig. 33

CROSS SECTION THROUGH PLANE G

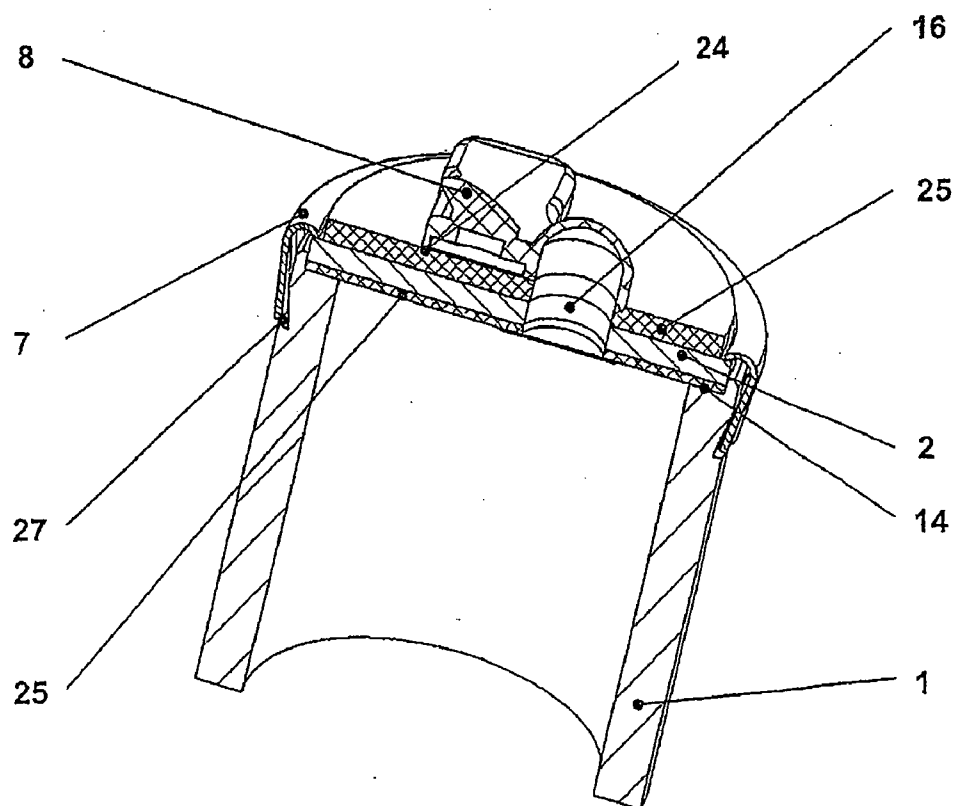


Fig. 34

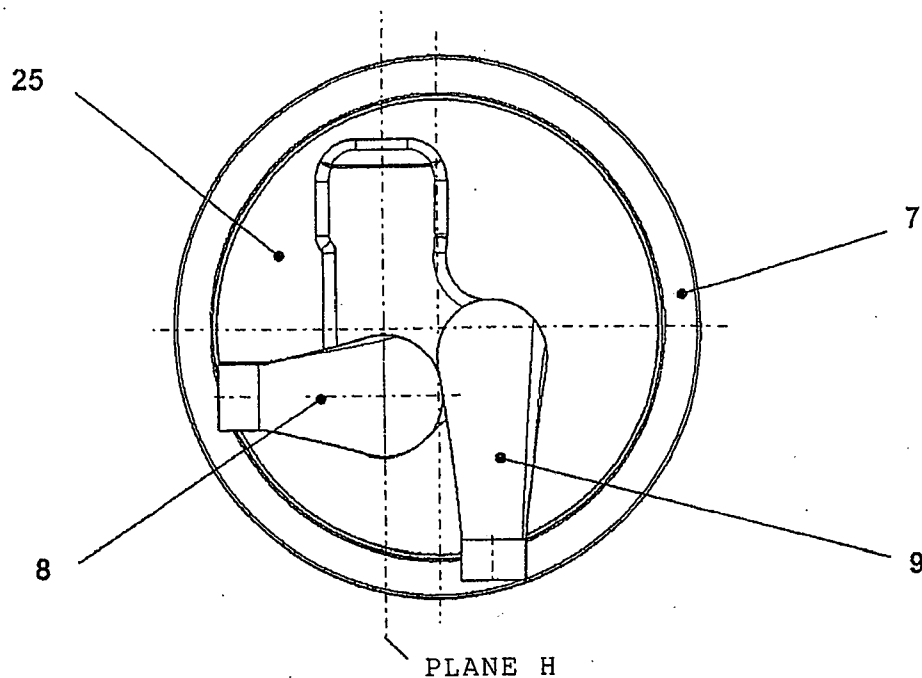


Fig. 35

CROSS SECTION THROUGH PLANE H

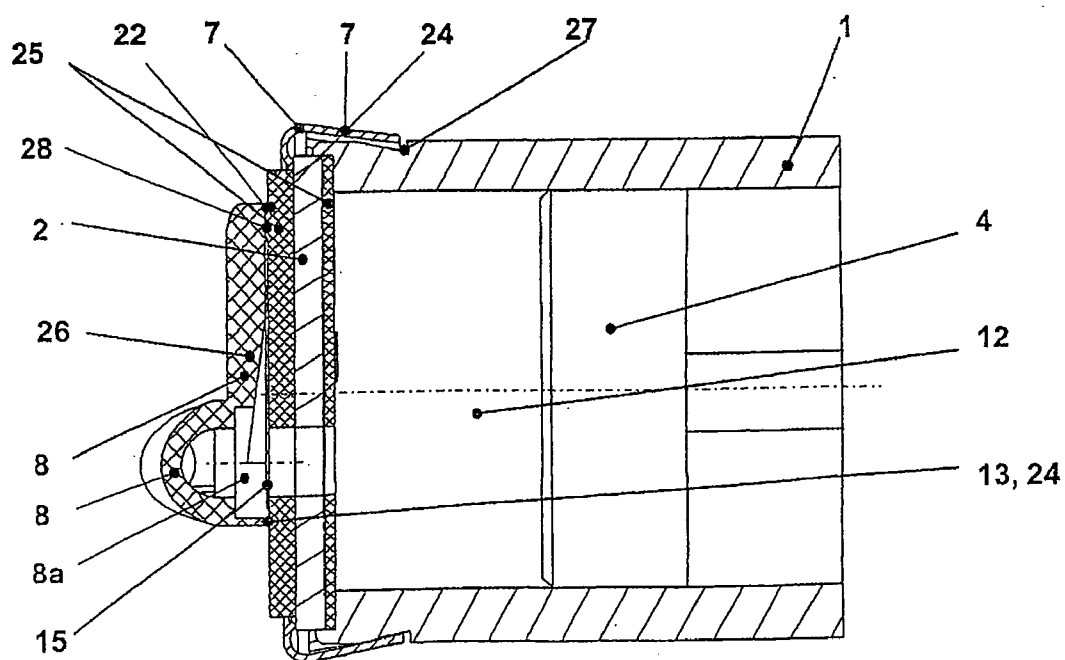


Fig. 36

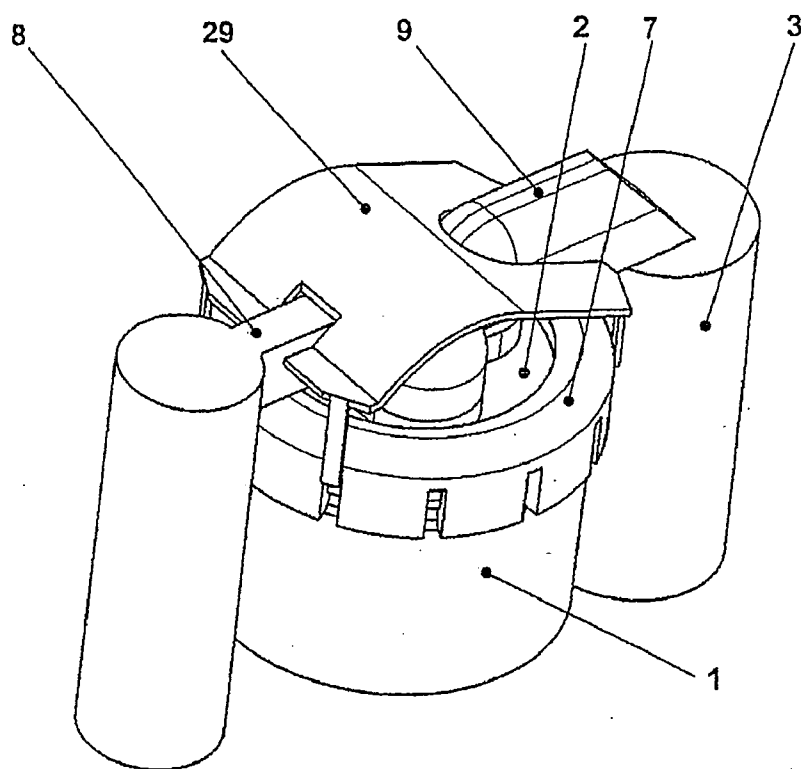


Fig. 37

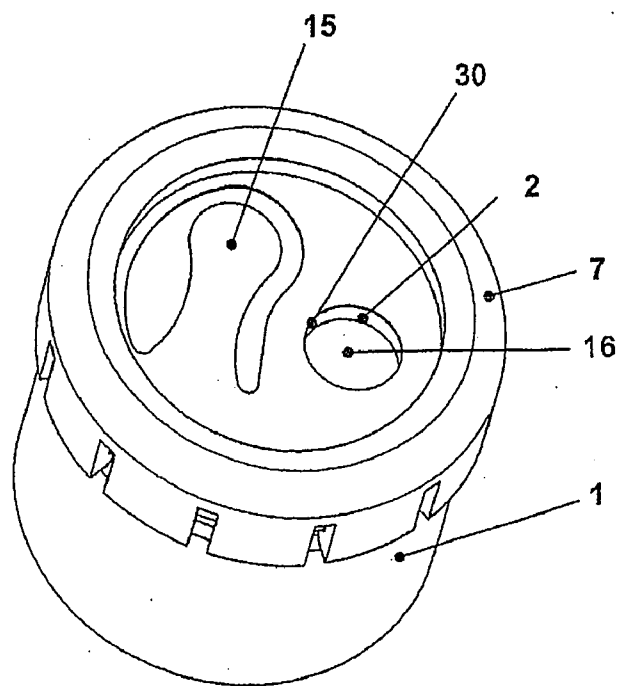


Fig. 38

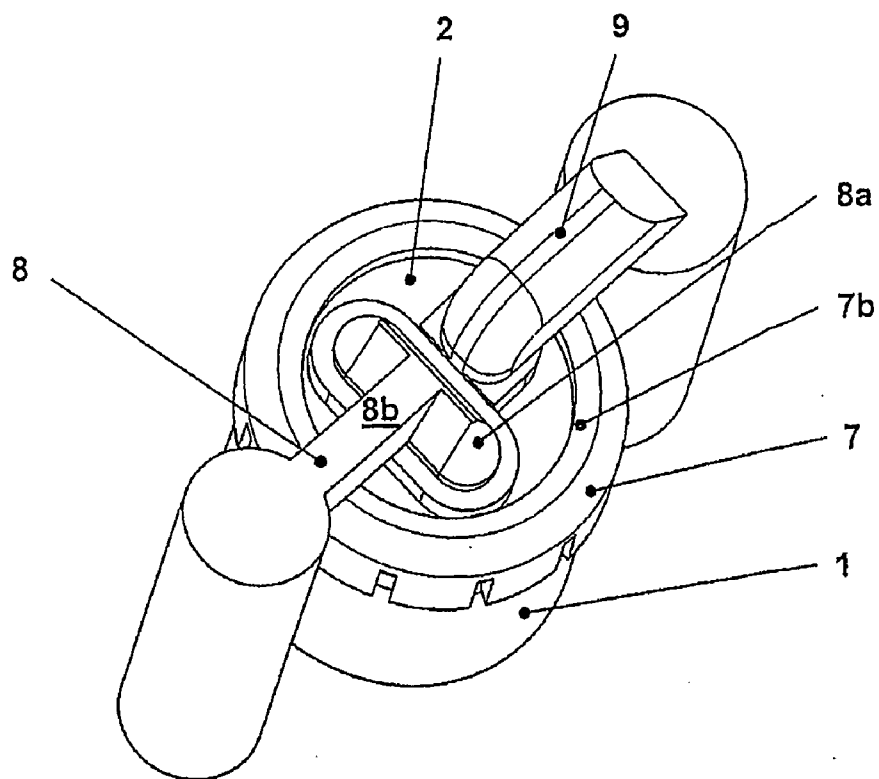
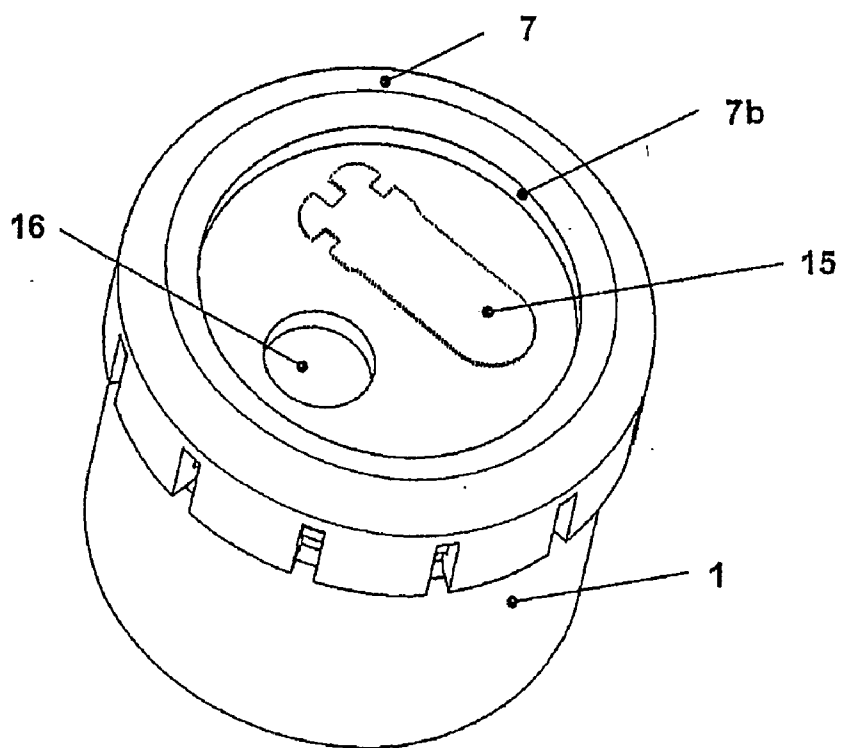


Fig. 39



REFRIGERANT COMPRESSOR

[0001] The present invention relates to a hermetically encapsulated refrigerant compressor having a hermetically sealed compressor housing, in whose interior a piston-cylinder unit, which compresses a refrigerant, operates, whose cylinder is closed using a valve plate having a pressure hole and a suction hole, and a suction channel and a pressure channel are provided, via which refrigerant is suctioned via a suction valve into the suction hole and is compressed via a pressure valve from the pressure hole into the pressure channel, the suction channel being formed by a channel-shaped component, which is connected to the valve plate to form a seal along a suction contact edge and connects the suction hole to a preferably provided suction noise damper, according to the preamble of Claim 1 or 2.

[0002] Such refrigerant compressors have been well-known for some time and predominantly are used in refrigerators or refrigerated cases. The piece count produced yearly is accordingly high.

[0003] Although the energy consumption of a single refrigerant compressor is only between 50 and 150 W, a very high energy consumption results upon consideration of all refrigerant compressors used worldwide, which is increasing continuously because of the rapidly progressing development of the so-called developing countries.

[0004] Any technical improvement which is performed on a refrigerant compressor and increases its efficiency thus conceals an enormous savings potential for energy when multiplied by the refrigerant compressors in use worldwide.

PRIOR ART

[0005] The refrigerant process per se has been known for some time. The boiling refrigerant is vaporized in the evaporator by energy absorption from the space to be cooled and finally overheats and is pumped to a higher energy level using the refrigerant compressor, where it dissipates heat via a condenser and is conveyed back into the evaporator via a throttle, in which pressure reduction and cooling of the refrigerant occurs.

[0006] The greatest and most important potential for a possible improvement of the efficiency is the reduction of the temperature of the refrigerant at the beginning of its compression procedure, i.e., upon intake into the cylinder of the piston-cylinder unit. Any reduction of this so-called suction temperature therefore causes, like the reduction of the temperature during the compression procedure and, connected thereto, the expulsion temperature, a reduction of the required work for the compression procedure.

[0007] In known hermetic refrigerant compressors according to the prior art, the refrigerant is strongly heated on its way from the evaporator (cooling space) to the intake valve of the piston-cylinder unit because of the construction.

[0008] The intake of the refrigerant occurs via a suction channel coming directly from the evaporator during an intake stroke of the piston-cylinder unit. From this suction channel, the refrigerant is suctioned via a suction noise damper and a suction valve into the interior of the cylinder, where it is compressed by the piston and expelled via a pressure valve from the interior of the cylinder into a pressure channel leading to the cooling chamber. Known refrigerant compressors have a construction in which the cylinder housing accommodating the piston is terminated by a valve plate having the

suction and/or pressure holes. The valve plate is used as a seat for a cylinder cover, which is typically screwed to the valve plate and the cylinder housing. The cylinder cover has intermediate walls, which divide the cavity between cylinder cover and valve plate into chambers, which then form the suction and/or pressure channel, via which the refrigerant is suctioned into the cylinder or expelled therefrom.

[0009] The suction channel typically discharges directly into the interior of the compressor housing, which is encapsulated hermetically sealed, in proximity to the entry opening into a suction noise damper, which reduces the intake noise of the piston-cylinder unit and is typically constructed from multiple volumes which are connected to one another, as well as having the cited entry opening and an exit opening which presses against the suction hole of the valve plate to form a seal.

[0010] In addition to the cited discharge of the suction pipe into the compressor housing in proximity to the entry opening into the suction noise damper, embodiment variants are also known, for example, from WO 03/038280, in which the suction channel is conducted directly into the suction noise damper, without a bypass via the interior of the compressor housing. In this way, the mixing of the refrigerant flows, which results in heating of the refrigerant at the beginning of the compression procedure, may not occur. However, this solution has the disadvantage that there is usually a greater pressure drop during the intake, which reduces the volumetric efficiency and thus the energy efficiency to varying degrees.

[0011] All known refrigerant compressors have an identical construction of the piston-cylinder unit, however, in particular of the cylinder housing, which is closed using a valve plate and a cylinder cover adjoining thereto. The cylinder cover preferably covers the entire valve plate, which also has the suction hole and the pressure hole. The suction valve temporarily closing the suction hole and the pressure valve temporarily closing the pressure hole are also situated on the valve plate. The cylinder cover is typically provided with a recess for the suction channel, and/or for the end section of the suction noise damper, which discharges into the suction hole.

[0012] The refrigerant heated by the compression procedure is pressed via the pressure valve and the pressure hole out of the cylinder into the cylinder cover, where, because of the design of the cylinder cover, it fills up the cylinder cover completely at least in the section forming a pressure channel and thus also comes into contact with the valve plate forming a part of this pressure channel. Because of this, the temperature of the valve plate essentially corresponds to the temperature of the compressed refrigerant. Because the gas in the interior of the cylinder is colder than the valve plate over more than 300° crank angle, a heat flow occurs directly from the valve plate or indirectly from the valve plate to the cylinder wall and from there to the gas in the interior of the cylinder, which has a negative effect on the energy efficiency.

[0013] Furthermore, the high temperature existing in the cylinder cover also causes a heat flow in the direction of the end section of the suction noise damper, which is enclosed by the cylinder cover, but by which the refrigerant coming from the suction noise damper, which is still to be compressed, is also undesirably heated. In summary, it may thus be stated that the known refrigerant compressor designs act contrary to the object cited at the beginning, namely a reduction of the suction temperature and the expulsion temperature, because of their cylinder cover design.

DESCRIPTION OF THE INVENTION

[0014] It is the object of the present invention to be able to guarantee suppression of outflow of the refrigerant from the

channels into the interior of the compressor housing. This is to support a significant reduction of the suction temperature and the expulsion temperature. In particular, it is an object of the present invention to connect the suction and/or pressure channel hermetically sealed to the valve plate reliably.

[0015] This is made possible according to the present invention by the characterizing features of Claim 1 or 2.

[0016] The characterizing features of Claims 1 or 2 describe a preferred embodiment variant of the sealed connection of the components forming the suction and/or pressure channel to the valve plate to be able to guarantee suppression of outflow of the refrigerant from the channels into the interior of the compressor housing. The implementation of the sealing beads in connection with the sealing projections causes a significantly lower pressure force to be required between pressure and/or suction channel and valve plate than between cylinder cover and valve plate in known cylinder heads.

[0017] The known embodiment variants described above additionally have the disadvantage that the refrigerant heats up too much on its path from the entry into the interior of the compressor housing to the suction hole. Measurements have shown that heating by more than 20° C. occurs between a point in the suction channel shortly before the entry into the compressor housing and the first volume of the suction noise damper. The main cause of this undesired heating of the refrigerant is the fact that fresh refrigerant flowing from the suction channel into the compressor housing is mixed with refrigerant already located in the compressor housing. However, this refrigerant has a higher temperature because of the heat released by the piston-cylinder unit in operation than the refrigerant flowing from the suction channel into the compressor housing, so that a mixing temperature results upon mixing of the two refrigerant streams which is higher in any case than the temperature of the refrigerant in the suction channel before entry into the compressor housing. The cause of the mixing is the fact that the intake valve, which is seated on the valve plate and alternately closes and releases the suction hole, only releases the suction hole over a crankshaft angle range of 180° and therefore refrigerant may only be suctioned into the cylinder of the piston-cylinder unit within this time. The suction valve is closed during the other 180° crankshaft angle range, the compression cycle, but the refrigerant coming from the evaporator has a nearly constant mass flow, so that it still flows into the compressor housing even when the suction valve is closed and remains there and cools the piston-cylinder unit and heats up at the same time. In addition, due to the pressure oscillations during the compression phase, further flow procedures occur from the compressor housing to the suction noise damper and vice versa, which cause additional mixing of the refrigerant.

[0018] Therefore, an independent component is also provided according to Claim 2, which forms the pressure channel and completely envelops it. By direct connection of this component to the pressure hole, the pressure channel is completely thermally separated from the valve plate. These components allow the direct exit of the hot, compressed refrigerant via the pressure hole into the pressure channel, without having to flow out along a section of the valve plate. Only the area of the valve plate immediately surrounding the pressure hole comes into contact with the hot refrigerant on its side facing away from the piston. The heat transfer from the hot, already compressed refrigerant to the valve plate may thus be drastically reduced in relation to typical cylinder

heads in refrigerant compressors. The valve plate and the cylinder wall remain cooler and thus allow a dissipation of the heat from the interior of the cylinder housing, and/or prevent the flow of heat into the gas in the cylinder. Furthermore, in this way, the heat transfer from the valve plate to the suction hole and thus into the suction channel may also be reduced, by which the intake temperature may be lowered.

[0019] The area of the pressure channel which is incident on the valve plate, i.e., the area which lies inside the pressure contact edge, may be dimensioned precisely and optimized in regard to heat transfer by the characterizing features of Claim 4. It is necessary on one hand for the pressure hole to be inside this area and on the other hand for the transition between pressure channel and pressure hole to be implemented for favorable flow and nonetheless allow a sealed connection. Because, according to the present invention, the pressure channel or more precisely the last section of this channel is incident essentially perpendicularly on the pressure hole and thus on the valve plate, to prevent a heat transfer from the valve plate to the pressure channel or vice versa, the shape of the pressure contact edge may be selected in such a way that the refrigerant only flows around the valve plate along a small area.

[0020] According to the present invention, the ratio of the cross-sectional area of the pressure hole to the area enclosed by the pressure contact edge is more than $\frac{1}{12}$.

[0021] According to the characterizing features of Claim 6, the component forming the pressure channel has a section directly adjoining the pressure hole and leading away from the valve plate and a further section adjoining this section, which runs radially outward in relation to the cylinder hole, preferably at a distance to the valve plate and preferably parallel thereto. The compressed refrigerant may thus be conveyed rapidly away from the valve plate and its heat dissipation to the valve plate may be prevented or reduced.

[0022] According to the characterizing features of Claim 7, the section leading away from the valve plate and/or the further section of the pressure channel is/are manufactured from poorly conductive plastic, by which the heat dissipation of the compressed refrigerant may be reduced still further.

[0023] According to the characterizing features of Claim 8, an insulating material, preferably made of rubber or plastic, is situated between the further section and the valve plate to reduce the heat transfer from the compressed refrigerant to the valve plate still further.

[0024] The characterizing features of Claim 9, namely the one-piece manufacture of each component and/or the joint one-piece manufacture of the two components forming the pressure and suction channels, in the latter case the two components manufactured jointly in one piece being in contact at least along an intermediate wall, provide the advantage of simplified manufacture. The component comprising the two channels may thus be manufactured from plastic using injection molding, by which the heat transfer from the pressure channel into the interior of the compressor housing, from the interior of the compressor housing into the suction channel, and in the area of the suction or pressure contact edge into the valve plate may be reduced still further.

[0025] The characterizing features of Claim 10 provide that the pressure valve closing the pressure hole is situated in the component forming the pressure channel. The valve plate may thus be manufactured more simply, i.e., in fewer work steps, because providing a fastener for the pressure valve in the valve plate is no longer necessary. Simultaneously, imple-

menting this feature allows pre-assembling of pressure channel and pressure valve and/or, jointly with the features of Claim 10, pre-assembling of pressure channel and pressure valve including suction channel.

[0026] According to the characterizing features of Claims 11 and 12, namely the implementation of the pressure chamber in the pressure channel directly adjoining the pressure hole, excess pressures in the pressure channel may be avoided during expulsion of the refrigerant from the cylinder, which would result in a reduction of the energy efficiency.

[0027] According to the characterizing features of Claims 13, 14, and 15, the valve plate is fastened to the cylinder housing a clamping element which clamps the valve plate to the cylinder housing at least along a section of its circumference, but preferably along the entire circumference. By this measure, the deformation and the costs of the cylinder mold may be drastically reduced in relation to typical cylinder heads of refrigerant compressors, because screws are no longer required for fastening the valve plate to the cylinder housing.

[0028] The clamping element is engageable at an end section on undercuts provided on the cylinder housing according to the characterizing features of Claim 16.

[0029] According to the characterizing features of Claim 17, the valve plate is clamped to the cylinder housing the other end section, which forms a first clamping leg.

[0030] The cylinder housing may also be provided with a shoulder, in which the valve plate is at least partially countersunk to allow positioning thereof, because positioning by screw connections as is known in typical cylinder heads of refrigerant compressors is no longer possible because of the clamping, in a preferred embodiment variant, the surface of the valve plate facing away from the piston terminating flush with the cylinder housing.

[0031] According to the characterizing features of Claim 18, the components forming the suction and/or pressure channels are fastened to the valve plate using further clamping legs situated on the clamping element. Therefore, the use of screws for fastening the cylinder head may be entirely dispensed with.

[0032] As an alternative thereto, according to the characterizing feature of Claim 19, a separate further clamping element may be provided, which clamps the components forming the suction and pressure channels to the valve plate, this separate clamping element being able to be engaged with the clamping element.

[0033] The characterizing features of Claims 20 through 22 describe a further preferred embodiment of the present invention, according to which the valve plate is fastened using separate fasteners, such as screws, to the cylinder housing, but the components forming the pressure and/or suction channels are clamped to the valve plate, thus, a combination of clamping and screwing.

BRIEF DESCRIPTION OF THE DRAWINGS

[0034] In the following, the present invention is described in greater detail on the basis of exemplary embodiments.

[0035] FIG. 1 shows an axonometric view of a piston-cylinder unit including cylinder head according to the present invention

[0036] FIG. 2 shows a frontal view of a cylinder head

[0037] FIG. 3 shows an axonometric view of a piston-cylinder head including cylinder head without clamping element

[0038] FIG. 4 shows an axonometric sectional detail view of a cylinder head

[0039] FIG. 5 shows a view in the direction of the crankshaft axis of a cylinder head including cylinder housing and crankcase

[0040] FIG. 6 shows a section along line AA from FIG. 2

[0041] FIG. 7 shows a view in the direction of the crankshaft axis of a cylinder head including cylinder housing and crankcase without clamping element

[0042] FIG. 8 shows an axonometric view of the component forming the pressure channel

[0043] FIG. 8a shows an axonometric view of the component forming the pressure channel in section

[0044] FIG. 9 shows an alternative embodiment variant of a cylinder head according to the present invention

[0045] FIG. 10 shows a sectional view of the alternative embodiment variant from FIG. 9 along plane A1 from FIG. 9

[0046] FIG. 11 shows a detail view from FIG. 10

[0047] FIG. 12 shows a sectional view along plane A from FIG. 9

[0048] FIG. 13 shows a further alternative embodiment variant of a cylinder head

[0049] FIG. 14 shows a sectional view along plane B from FIG. 13

[0050] FIG. 15 shows an additional alternative embodiment variant of a cylinder head

[0051] FIG. 16 shows a sectional view along plane C from FIG. 15

[0052] FIG. 17 shows another alternative embodiment variant of a cylinder head

[0053] FIG. 18 shows a sectional view along plane D from FIG. 17

[0054] FIG. 19 shows a sectional view of a cylinder head having O-ring seal

[0055] FIG. 20 shows a sectional view of a cylinder head having paper seal

[0056] FIG. 21 shows an illustration of a sealing system according to the present invention in section along plane E from FIG. 22

[0057] FIG. 22 shows an additional further embodiment variant of a cylinder head according to the present invention from FIG. 21

[0058] FIG. 23 shows a sectional view along plane F from FIG. 22

[0059] FIG. 24-31 show sectional views of an alternative sealing system according to the present invention

[0060] FIG. 32 shows an additional, alternative embodiment variant of a cylinder head

[0061] FIG. 33 shows a sectional view along plane G from FIG. 32

[0062] FIG. 34 shows a top view of a cylinder head from FIG. 32

[0063] FIG. 35 shows a sectional view along plane H from FIG. 34

[0064] FIG. 36 shows a further exemplary embodiment of a cylinder head

[0065] FIG. 37 shows an axonometric view of the cylinder housing including clamping element from FIG. 36

[0066] FIG. 38 shows a further exemplary embodiment of a cylinder head

[0067] FIG. 39 shows the exemplary embodiment from FIG. 38 without the components forming the pressure and suction channels.

WAYS OF IMPLEMENTING THE INVENTION

[0068] FIG. 1 shows an axonometric view of a cylinder head, sections of the cylinder housing 1, the valve plate 2, and the suction noise damper 3 including intake opening 3a being visible.

[0069] The fundamental construction of the hermetically encapsulated refrigerant compressor which is the subject matter is known per se. The piston-cylinder-motor unit essentially comprises a cylinder housing 1 and the piston 4, which executes a stroke movement therein, as well as a crankshaft bearing 5 in a crankcase 5a, which is situated perpendicularly to the cylinder axis 6. The crankshaft bearing 5 accommodates a crankshaft (not shown) and projects into a central hole of the rotor of an electric motor (also not shown). The rotational movement of the crankshaft is transferred to the piston 4 in a way also known per se via a connecting rod (not shown). A suction noise damper 3 is situated on the cylinder head itself, which is to reduce the noise development to a minimum during the intake procedure of the refrigerant.

[0070] FIG. 1 and FIG. 2 show an embodiment variant of a cylinder head in the completely assembled state, i.e., having a clamping element 7, while in contrast FIG. 3 shows the same cylinder head but without clamping element 7. The pressure channel is formed by the component 8 according to the present invention, and the suction channel is formed by the component 9. Both components 8, 9 are independent of one another and are particularly also independent of the valve plate 2, to which they are connected to form a seal along a contact edge, however, namely a pressure contact edge 13 or a suction contact edge 17, which will be discussed in greater detail later. In other words, the components 8, 9, which may also be referred to as pressure channel 8 and suction channel 9, each delimit a completely autonomous channel, which they completely envelop up to incidence on the valve plate. According to the present invention, the component 8 forming the pressure channel has a section 8a, which directly adjoins the pressure hole 10 and leads away from the valve plate 2, and a further section 8b adjoining this section 8a, which runs essentially radially outward in relation to the cylinder hole, and preferably parallel to the valve plate 2 at a distance Z thereto (see also FIGS. 10 and 11).

[0071] The distance Z between the component 8 and the valve plate 2 causes optimum insulation of the valve plate 2 from the pressure channel, so that heat transfer from the compressed, hot refrigerant in the pressure channel 8 to the valve plate 2 and to the suction channel 9 is strongly prevented here.

[0072] Directly adjoining the pressure hole 10 situated in the valve plate 2, which is visible in FIG. 4, for example, but is concealed in FIGS. 1 and 2, the component 8 forms a pressure chamber, which is situated in the section 8a of the pressure channel 8 leading away from the valve plate 2 and does not fall below a defined minimum volume as a fraction of the cooling performance. This pressure chamber, which is also identified by 8a in the following, is used for the purpose of avoiding excess pressures possibly arising during expulsion of the refrigerant from the cylinder. The pressure channel 8 then passes into the further section 8b, which leads the refrigerant out of the compressor housing.

[0073] As is obvious from FIG. 1, the components 8, 9 are pressed by a clamping element 7 against the valve plate 2. The clamping element 7 shown in the exemplary embodiment of FIG. 1 is implemented as essentially Y-shaped and arching away from the piston 4 and is exclusively used for clamping the components 8, 9 to the valve plate 2. The clamping element 7 is fastened to the valve plate 2 using screws 11. The screws 11 are also used for fastening the valve plate 2 to the cylinder housing 1.

[0074] FIG. 4 shows the cylinder head described up to this point having clamping element 7 and valve plate 2 partially in section. One clamping section 7a of the clamping element 7 presses against a section of the component 8 forming the pressure channel, by which this is pressed against the valve plate 2 or more precisely against the valve plate via the pressure contact edge 13.

[0075] FIG. 5 shows a view of the cylinder head in the direction of the crankshaft axis. The construction of the cylinder head according to the present invention may be recognized very well, in particular the clamping element 7, the valve plate 2, and the cylinder housing 1, all three of which are connected to one another via the screws 11.

[0076] FIG. 6 shows a section along lines AA from FIG. 2. The component 8 according to the present invention, which forms the pressure channel and completely envelops it, is very well recognizable. The clamping element 7, whose section 7a clamps the component 8 at its end area 8c in the form of the pressure contact edge 13 against the valve plate 2, is also very well recognizable. In this view, the distance Z which is implemented between the further section 8b of the component 8 and the valve plate 2 and prevents a heat transfer from the pressure channel 8 containing the compressed, hot refrigerant to the valve plate 2 and thus further into the cylinder interior 12 and/or into the suction channel 9, which is not visible in the sectional view, is also very well recognizable in this view. In contrast to typical cylinder heads, the compressed refrigerant is guided away from the valve plate in the first section 8a of the pressure channel 8 and then guided away from the cylinder housing 1 at a distance Z in the radial direction in relation to the cylinder hole, without the compressed refrigerant having further contact with the valve plate 2.

[0077] FIG. 7 shows a view of the cylinder head in the direction of the crankshaft axis, like FIG. 5, but without clamping element 7, so that the component 8 forming the pressure channel is very well recognizable, as is the distance Z between the component 8 and the valve plate 2.

[0078] FIG. 8 and FIG. 8a both show the end section of the section 8a of the component 8 forming the pressure channel, which is tightly connected to the valve plate 2, which is not visible in these figures, via the pressure contact edge 13. This end section adjoining and thus connected to the valve plate 2 forms a pressure chamber 8a according to the present invention to prevent excess pressures during expulsion of the refrigerant from the cylinder. The section 8a is also provided with receptacle devices 19 in the form of pins, in which an end section of a pressure valve 15 may be suspended. The pressure valve 15 is implemented in a way known per se as a leaf spring element. The end section which may be suspended in the receptacle devices is used as a fixed fastening section, while in contrast the free end section 15a diametrically opposite this end section alternately releases or closes the pressure hole 10 situated directly behind it in the valve plate 2 as a function of the compression cycle. The component 8 according to the present invention is also provided with an opening

boundary 26 in the form of a stop, as is obvious from FIG. 8a. This opening boundary is used for delimiting the opening path of the pressure valve 15.

[0079] The configuration of the pressure valve 15 in the component 8 according to the present invention allows the pre-manufacturing of these two parts along a separate manufacturing line. Component 8 including pressure valve 15 and opening boundary 26 may be rapidly and easily connected to valve plate 2 using clamping element 7. The typical type of fastening of the pressure valve 15 to the valve plate 2 by rivets, for example, is no longer necessary, which results in significant simplification and above all acceleration of the manufacturing process.

[0080] FIG. 9 shows an alternative embodiment variant of a cylinder head, in which in addition to the components 8, 9 forming the pressure and suction channels, the valve plate 2 is also fastened via a clamping element 7 having the clamping sections 7a and 7b to the cylinder housing 1. The embodiment variant of a cylinder head disclosed in FIG. 9 thus manages entirely without screws. In other words, the entire cylinder head is solely clamped.

[0081] FIG. 10 shows a sectional view of the alternative embodiment variant from FIG. 9, the distance Z inhibiting the heat transfer between pressure channel 8 and valve plate 2 and/or between suction channel 9 and valve plate 2 being very clearly visible. In this case, the clamping element 7 comprises a clamping section 7b, which encloses the valve plate 2 in its edge area around its entire circumference and engages on an undercut 27 on the cylinder housing 1 in this exemplary embodiment, as is also clearly recognizable in the detail view in FIG. 11. The clearance volume seal 14, which is situated between valve plate 2 and cylinder housing 1, as well as the suction valve 32, are also clearly recognizable in FIG. 11.

[0082] The clamping element 7 has an additional clamping section 7a, which is implemented as essentially U-shaped and clamps the components 8, 9 to the valve plate 2.

[0083] FIG. 12 shows a section along plane A from FIG. 9. In this view, the one-piece nature of the clamping element 7 having the clamping sections 7a and 7b may be recognized very clearly. In addition, the transition of the component 8 forming the pressure channel into the pressure hole 10 is shown. The component 8 according to the present invention is tightly connected along the pressure contact edge 13 to the valve plate 2. The pressure hole 10, as well as the mobile part of the pressure valve 15, is located inside the area enclosed by the pressure contact edge 13. The area enclosed by the pressure contact edge 13 is simultaneously the single section of the valve plate 2 which comes into contact with the compressed refrigerant from the cylinder.

[0084] This is also true, of course, for the suction contact edge 17, along which the suction channel 9 is tightly connected to the valve plate 2. The suction hole 16 is located inside the area enclosed by the suction contact edge 17. The area enclosed by the suction contact edge 17 is simultaneously the single section of the valve plate 2 which comes into contact with the refrigerant suctioned into the cylinder.

[0085] The cylinder housing 1 has a shoulder 27, in which the valve plate 2 is at least partially, but preferably entirely countersunk, by which positioning of the valve plate 2 is simultaneously achieved.

[0086] FIG. 13 and FIG. 14 both show a further alternative embodiment variant of the cylinder head. However, the clamping element 7 is implemented as divided in the area of

its clamping section 7a, so that each component 8, 9 has a clamping element 7 assigned thereto.

[0087] FIG. 15 and FIG. 16 both show an additional embodiment variant of a cylinder head having an alternatively implemented clamping element 7. The clamping section 7b of the clamping element 7 does not enclose the valve plate 2 around its entire circumference in the edge area, but rather is implemented as interrupted in this case, the interruptions forming openings in this clamping section, by which the components 8, 9 are led away from the cylinder head or toward the cylinder head, so that actually multiple clamping sections 7b are provided. However, the individual clamping sections 7b engage on an undercut 27 on the cylinder housing 1 in the same way as already noted for the exemplary embodiments listed above. The clamping section 7a is implemented in a cross shape in this exemplary embodiment, one arm of this cross passing into each clamping section 7b. The area in which the individual arms of the cross meet is implemented as cylindrical and causes the clamping of the components 8, 9.

[0088] FIG. 17 and FIG. 18 show another alternative embodiment variant of the cylinder head, in which the clamping element 7 clamps both the components 8, 9 and also the valve plate 2 to the cylinder housing 1. In this case, the cylinder housing 1 is implemented as laterally raised, the raised section 1a having an undercut, however, in which the clamping section 7b of the clamping element 7 may engage. The valve plate 2, which terminates the cylinder housing 1 on its front face and whose sections 1a project axially beyond it, is clamped to the cylinder housing 1 in this case by the clamping sections 7b, which are engaged with the undercut of the section 1a. The clamping section 7a, which again forms the clamping element 7 in one piece with the clamping section 7b, clamps the components 8, 9 to the valve plate 2. The raised section 1a is provided with openings 18, through which the components 8, 9 are led away from the cylinder head or toward the cylinder head.

[0089] FIGS. 19 and 20 each show a sectional view of cylinder heads according to the present invention, in which on one hand an O-ring seal 20 and on the other hand a paper seal 21 are used for sealing the connection of the suction channel 9 and/or also the pressure channel 8 to the valve plate 2. This type of seal is already known from the prior art, but therein the connection of the valve plate to the cylinder cover is sealed, which is no longer necessary in a cylinder head.

[0090] FIG. 21 shows an alternative embodiment variant of a possible seal of the connection of pressure channel 8 or suction channel 9 to the valve plate 2 on the basis of an additional, further embodiment variant of a cylinder head according to the present invention. The valve plate 2 is provided with a sealing bead 23 as a sealing system here, in which a sealing projection 22 (see also FIGS. 8 and 8a), which is situated on the pressure contact edge 13 of the component 8 forming the pressure channel and/or on the suction contact edge of the component 9 forming the suction channel, and which essentially corresponds to the outline of the sealing bead 23 on the valve plate 2, engages

[0091] Of course, a reverse implementation is also conceivable, i.e., a sealing bead 23 is provided on the pressure contact edge 13 of the component 8 forming the pressure channel and/or on the suction contact edge 17 of the component 9 forming the suction channel (see also FIGS. 8 and 8a), in which a sealing projection 22, which is situated on the valve plate 2 and corresponds to the outline of the sealing bead 23, engages.

[0092] To ensure a seal of the connection, the sealing projection 22 must either have a larger volume than the sealing bead 23 or the shape of the sealing projection 22 must be different from that of the sealing bead 23. The compression forces applied during assembly of the cylinder head, in particular also the clamping forces of the clamping element 7, cause the sealing projection 22 to flow into the sealing bead 23 and/or parts of the sealing projection 22 because of the high local surface pressure.

[0093] The implementation of the sealing bead 23 in connection with the sealing projections 22 causes significantly less contact pressure to be required between pressure or suction channel 8, 9 and valve plate 2 than is required between cylinder cover and valve plate 2 in known cylinder heads for the same tightness. The required surface pressure is the same in both systems, but the seal areas differ greatly, however, namely a long wide seal in the case of the paper seal and a short narrow seal area in the case of the system of sealing bead 23—sealing projection 22.

[0094] The sealing system functions independently of the material pairs used. Thus, for example, typical material pairs are possible, such as metal (valve plate 2)—metal (components 8, 9) or also metal (valve plate 2)—flowable plastic (components 8, 9) or plastic (valve plate 2)—flowable plastic (components 8, 9).

[0095] The surface pressure required for the present application may be specified as 5 to 20 N/mm². An especially preferred geometric shape of the sealing bead 23 is the V-shape or U-shape as shown in FIGS. 24 through 31, that of the sealing projection 23 is the pin shape, the free end of the sealing projection preferably being implemented as flattened and/or rounded.

[0096] FIG. 24 shows a simple design of the sealing system having V-shaped sealing bead 23 and pin-shaped sealing projection 22.

[0097] FIG. 25 shows a sealing bead 23 formed by two projecting ribs on the valve plate 2, which works together with a pin-shaped sealing projection 22.

[0098] In both cases, the pin-shaped sealing projection 22 is implemented as flattened on its free end.

[0099] In FIG. 26, two pin-shaped sealing projections 22 are provided on the pressure channel 8, which delimit a V-shaped sealing bead 23, in which the pin-shaped sealing projection 22 situated on the valve plate 2 engages. In addition, sealing beads 23 are also situated on the valve plate 2, in which the two sealing projections 22 situated on the pressure channel 8 engage, so that a type of meshing occurs between the components 8, 9 forming the pressure channel and the suction channel and the valve plate 2. The pin-shaped sealing projections 22 are provided with a bevel on their free end area.

[0100] FIGS. 27 through 31 show refinements of the sealing system just described, the pin-shaped sealing projections 22 also being implemented as rounded on their free end area.

[0101] The sealing system according to the present invention may be used both in cylinder heads according to the present invention described in this application and also in cylinder heads according to the prior art, i.e., using cylinder covers. In the latter case, the cylinder cover has the sealing projection 22 or the sealing bead 23 and the valve plate 2 has the corresponding counterpart.

[0102] FIGS. 22 and 23 show further views of the additional further embodiment variants of the cylinder head from FIG. 21.

[0103] FIGS. 32 through 35 show an additional alternative embodiment variant of a cylinder head having the components 8, 9. The valve plate 2 is covered, with the exception of the suction or pressure hole 16, 10, by a plastic sheath 25, which has a section facing away from the cylinder housing 1 and a section facing toward the cylinder housing. The components 8, 9 forming the pressure and suction channels are integrated in the plastic layer 25, i.e., they also comprise plastic.

[0104] The production is performed in multiple steps in this case.

[0105] Firstly, the valve plate 2 is extrusion coated using plastic 25 (insert technology), pins 28, which are used for location positioning of the pressure valve 15 (corresponding to the receptacle devices 19), also already being injected on the side of the valve plate 2 facing away from the cylinder housing 1.

[0106] The side facing away from the piston 4 is extrusion coated flat. No retention devices for the suction valve are required here. Only an exposed area for the location positioning of the suction valve is to be provided. The suction valve itself is clamped between the front face of the cylinder housing 1 and valve plate 2.

[0107] In a further step, to connect the component 8 forming the pressure channel and the component 9 forming the suction channel, which are also produced from plastic in a separate work step, to the valve plate 2 along the sealing beads 24, whose outline corresponds to the pressure contact edge 13 or suction contact edge 17 and which are not situated in the valve plate 2 in this exemplary embodiment, but rather in the plastic sheath 25 enclosing the valve plate 2, laser welding or vibration welding of the plastic parts is performed.

[0108] The valve plate 2 is fastened to the cylinder housing 1 using clamping element 7, as in the prior embodiment variants.

[0109] FIGS. 36 and 37 show an embodiment variant of the cylinder head in which a further clamping element 29 is provided in addition to clamping element 7. This further clamping element is fastened to clamping element 7 and/or engaged therewith according to the present invention. A plate-shaped element 30, preferably made of metal, forming the pressure valve 15 is provided on the valve plate 2 in this case, which is clamped to the valve plate 2 by the clamping element 7. The opening boundary 26 for the pressure valve 15 is integrated in the component 8 as already shown in FIG. 21 or 35.

[0110] The components 8, 9 are manufactured in this case as a one-piece plastic part.

[0111] In the embodiment variant shown in FIG. 38, the components 8, 9 are glued to the valve plate 2, the pressure valve 15 being situated in the component 8 in this case, as already described above.

[0112] FIG. 39 shows the orientation of the pressure valve 15 as a leaf spring in relation to the valve plate 2, the components 8, 9 having been left out to clarify the readability of the figure.

1. A hermetically encapsulated refrigerant compressor having a hermetically sealed compressor housing, in whose interior a piston-cylinder unit, which compresses a refrigerant, operates, whose cylinder housing (1) is closed using a valve plate (2) having a pressure hole (10) and a suction hole (16), and a suction channel and a pressure channel are provided, via which refrigerant is suctioned via a suction valve (32) into the suction hole (16) and is compressed via a pres-

sure valve (15) from the pressure hole (10) in the pressure channel, the suction channel being formed by a channel-shaped component (9), which is connected sealingly along a suction contact edge (17) to the valve plate (2) and which connects the suction hole (16) to a preferably provided suction noise damper (3), wherein preferably V-shaped sealing beads (23) or sealing projections (22) are provided in the valve plate (2) and the front face of the component (9) forming the suction channel, which faces toward the valve plate (2), is equipped along its suction contact edge (17) with sealing projections (22) or sealing beads (23) essentially corresponding to the V-shaped sealing beads (23) or sealing projections (22), whereas the sealing projections (22) being implemented differently from the sealing beads (23) in their geometrical design and/or having a different volume.

2. A hermetically encapsulated refrigerant compressor having a hermetically sealed compressor housing, in whose interior a piston-cylinder unit, which compresses a refrigerant, operates, whose cylinder housing (1) is closed using a valve plate (2) having a pressure hole (10) and a suction hole (16), and a suction channel and a pressure channel are provided, via which refrigerant is suctioned via a suction valve (32) into the suction hole (16) and is compressed via a pressure valve (15) from the pressure hole (10) in the pressure channel, the suction channel being formed by a channel-shaped component (9), which is connected sealingly to the valve plate (2) along a suction contact edge (17) and which connects the suction hole (16) to a preferably provided suction noise damper (3), wherein the pressure channel is formed by an independent component (8) completely enveloping the pressure channel, which is tightly connected to the valve plate (2) along a pressure contact edge (13) formed by an end section of the component (8), preferably V-shaped sealing beads (23) or sealing projections (22) being provided in the valve plate (2) and the front face of the component (8) forming the pressure channel, which faces toward the valve plate (2), being equipped along its pressure contact edge (13) with sealing projections (22) or sealing beads (23) essentially corresponding to the V-shaped sealing beads (23) or sealing projections (22), whereas the sealing projections (22) being implemented as different in their geometrical design from the sealing beads (23) and/or having a different volume.

3. The hermetically encapsulated refrigerant compressor according to claim 1, wherein the pressure hole (10) and the movable part of the pressure valve (15) are situated inside the area enclosed by the pressure contact edge (13).

4. The hermetically encapsulated refrigerant compressor according to claim 3, wherein the ratio of the cross-sectional area of the pressure hole (10) to the area enclosed by the pressure contact edge (13) is greater than $\frac{1}{12}$.

5. The hermetically encapsulated refrigerant compressor according to claim 1, wherein the area enclosed by the pressure contact edge (13) exceeds the area of the mobile parts of the pressure valve (15) by less than 50%.

6. The hermetically encapsulated refrigerant compressor according to claim 1, wherein the component (8) forming the pressure channel has a section (8a) directly adjoining the pressure hole (10) and leading away from the valve plate (2), and a further section (8b) adjoining this section (8a), which runs radially outward in relation to the cylinder hole, preferably at a distance to the valve plate (2) and preferably parallel thereto.

7. The hermetically encapsulated refrigerant compressor according to claim 6, wherein the section (8a) leading away

from the valve plate (2) and/or the further section (8b) of the pressure channel (8) is/are manufactured from plastic.

8. The hermetically encapsulated refrigerant compressor according to claim 6, wherein an insulating material, preferably made of rubber or plastic, is situated between the further section (8b) and the valve plate (2).

9. The hermetically encapsulated refrigerant compressor according to claim 1, wherein the component (8) forming the pressure channel and the component (9) forming the suction channel are each manufactured in one piece and/or are preferably manufactured jointly in one piece, the two components (8, 9) manufactured jointly in one piece preferably being in contact along an intermediate wall, but at least along connecting webs.

10. The hermetically encapsulated refrigerant compressor according to claim 1, wherein the pressure valve (15) closing the pressure hole (10) is fastened in the component (8) forming the pressure channel.

11. The hermetically encapsulated refrigerant compressor according to claim 1, wherein a pressure chamber (8a), which does not fall below a predefined minimum volume, is provided in the component (8) forming the pressure channel.

12. The hermetically encapsulated refrigerant compressor according to claim 11, wherein the pressure chamber (8a) is situated directly adjoining the pressure hole (10) in the component (8) forming the pressure channel.

13. The hermetically encapsulated refrigerant compressor according to claim 1, wherein a clamping element (7) is provided, which clamps the valve plate (2) to the cylinder housing (1) along at least a section of its circumference, but preferably along the entire circumference.

14. The hermetically encapsulated refrigerant compressor according to claim 13, wherein the clamping element (18) has an essentially J-shaped cross-section.

15. The hermetically encapsulated refrigerant compressor according to claim 13, wherein the clamping element (7) is implemented as circular.

16. The hermetically encapsulated refrigerant compressor according to claim 13, wherein one or more undercuts (27), which are engageable with an end section of the clamping element (7), are provided on the cylinder housing (1).

17. The hermetically encapsulated refrigerant compressor according to claim 16, wherein the other end section of the clamping element (7) forms a first clamping section (7b), which clamps the valve plate (2) to the cylinder housing (1).

18. The hermetically encapsulated refrigerant compressor according to claim 13, wherein the clamping element (7) has at least one further clamping section (7a), which clamps the components (8, 9) forming the pressure channel or the suction channel to the valve plate (2) or in the suction hole (16) and/or the pressure hole (10) respectively.

19. The hermetically encapsulated refrigerant compressor according to claim 13, wherein a further clamping element (29) is provided, which is engageable on the clamping element (7) and clamps the components (8, 9) forming the pressure channel or the suction channel to the valve plate (2) or in the suction hole (16) and/or the pressure hole (10) respectively.

20. The hermetically encapsulated refrigerant compressor according to claim 1, wherein separate fasteners (11) are

provided or a separate fastener (7b) is provided for fastening the valve plate (2) to the cylinder housing (1).

21. The hermetically encapsulated refrigerant compressor according to claim 20, wherein the separate fasteners are screws (11).

22. The hermetically encapsulated refrigerant compressor according to claim 20, wherein a clamping element is pro-

vided, which is engageable on the cylinder housing (3) and clamps the components (8, 9) forming the pressure channel or the suction channel to the valve plate (2) or in the suction hole (16) and/or the pressure hole (10) respectively.

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