



(11)

EP 4 368 932 A1

(12)

EUROPEAN PATENT APPLICATION

(43) Date of publication:
15.05.2024 Bulletin 2024/20

(21) Application number: 22207325.6

(22) Date of filing: 14.11.2022

(51) International Patent Classification (IPC):
F28D 7/00 (2006.01) F28D 1/02 (2006.01)
F28D 1/06 (2006.01) F28D 7/10 (2006.01)
F28D 21/00 (2006.01)

(52) Cooperative Patent Classification (CPC):
F28D 1/0213; F28D 1/06; F28D 7/10;
F25B 2339/044; F25B 2339/0444; F25B 2339/0446;
F25B 2400/13; F25B 2400/16; F28D 2021/007

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB
GR HR HU IE IS IT LI LT LU LV MC ME MK MT NL
NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA
Designated Validation States:
KH MA MD TN

(71) Applicant: Danfoss A/S
6430 Nordborg (DK)

(72) Inventors:
• VAN BEEK, Johan
Almind (DK)

• KOBBERØ ANDERSEN, Ejner
Nordborg (DK)

(74) Representative: Keil & Schaafhausen
Patentanwälte PartGmbH
Bockenheimer Landstraße 25
60325 Frankfurt am Main (DE)

Remarks:

Amended claims in accordance with Rule 137(2)
EPC.

(54) TANK CASING FOR REFRIGERANT RECEIVER WITH INTEGRATED HEAT EXCHANGER FUNCTIONALITY

(57) The invention relates to a tank casing (2, 102, 202) for enclosing a refrigerant reservoir (3) of a refrigerant receiver (1, 100, 200). In order to reduce the refrigerant leakage in refrigerant circuits, especially for mobile application, a first fluid channel structure (20) and a separate second fluid channel structure (30) for an integrated heat exchanger functionality are integrally formed in the tank casing (2, 102, 202).

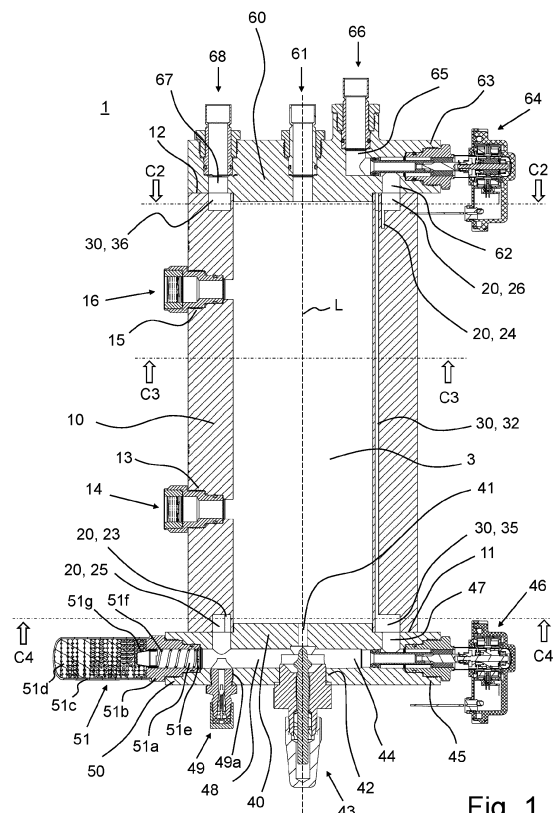


Fig. 1

Description

[0001] The present invention relates to a tank casing for enclosing a refrigerant reservoir of a refrigerant receiver.

[0002] Typical refrigerant circuits for mobile cooling applications used for the transport of reefer goods include a compressor, a condenser, a refrigerant receiver with a refrigerant reservoir, a discharge expansion valve, and an evaporator. Mobile cooling applications may be, for example, refrigerated intermodal containers, refrigerated train carriages, refrigerated road vehicles (e.g. refrigerated trucks, trailers, and utility vans), refrigerated air cargo containers, refrigerated ships, and the like.

[0003] In such a refrigerant circuit, the refrigerant is compressed by the compressor. The compressed refrigerant is supplied with high pressure from an outlet of the compressor to the condenser. The condenser is an air heat exchanger for cooling down the refrigerant. After having passed the condenser, the compressed refrigerant is collected within the refrigerant reservoir of the refrigerant receiver. Liquid refrigerant is discharged from the refrigerant reservoir to the discharge expansion valve, which then expands the refrigerant. The expanded refrigerant flows into the evaporator. Therein, the expanded refrigerant evaporates and takes up heat. The evaporator is installed in an interior for transporting the reefer goods and cools said interior. For example, the evaporator can be installed in the interior of an intermodal container. After having passed the evaporator, the refrigerant is sucked into the compressor and compressed again.

[0004] Some refrigerant circuits include an additional economizer installed downstream of the refrigerant receiver. The flow of liquid refrigerant from the refrigerant receiver splits up into two flow branches. The refrigerant of a first flow branch directly enters the economizer in liquid form with high pressure. The refrigerant of a second flow branch flow is firstly expanded by an economizer expansion valve and then enters the economizer. Due to the expansion by the economizer expansion valve, it has a lower temperature than the refrigerant of the first flow branch. The economizer acts as heat exchanger for the two flow branches: In the economizers, the non-expanded refrigerant of the first flow branch gives off heat to the expanded refrigerant of the second flow branch. Hence, the non-expanded refrigerant of the first flow branch is additionally pre-cooled. Then, it is guided to the discharge expansion valve. The refrigerant of the second flow branch exiting the economizer is instead guided to an economizer inlet of the compressor. It typically enters the compressor with a medium pressure and a medium temperature.

[0005] The additional economizer allows subcooling the liquid refrigerant of the first flow branch before the latter enters the discharge expansion valve. This enhances a pull-down capacity of the evaporator as more heat can be taken up at the evaporator. Further, the refrigerant

of the second flow branch leaving the economizer enters the compressor at a higher pressure than the refrigerant from the evaporator and less energy is required to compress it to the desired condensing conditions.

[0006] It turned out that an annual leakage of refrigerant is particularly high in mobile applications compared to other application, for example refrigeration applications in buildings.

[0007] The problem underlying the invention is to reduce the refrigerant leakage in refrigerant circuits, especially for mobile applications.

[0008] This problem is solved by a tank casing for enclosing a fluid reservoir, for example a refrigerant reservoir of a refrigerant receiver, wherein a first fluid channel structure and a separate second fluid channel structure for an integrated heat exchanger (functionality) are integrally formed in the tank casing.

[0009] The tank casing exhibits an integrated heat exchanger functionality. In more detail, it exhibits an integrated heat exchanger functionality for heat exchange between fluid flowing through the first fluid channel structure and fluid flowing from the second fluid channel structure. In other words, the tank casing of the refrigerant receiver is configured to additionally exhibit an integrated economizer functionality.

[0010] This significantly reduces the number of elements, joints, pipes, pipe attachments, seals, and the like in a refrigerant circuit. This results in reduced leakage and improved ruggedness. Less surveillance and/or maintenance is required. In addition, it reduces the complexity of installing the refrigerant circuit at the mobile application.

[0011] Especially in mobile applications, joints, seals, and pipe connections in refrigerant circuits are subjected to frequent vibrations, shocks, and changes in environmental conditions (e.g. temperature, solar irradiation, and the like). This promotes the formation of micro cracks, especially at the joints, seals, and pipe attachments. Micro cracks lead to ongoing leakage of refrigerant. Further, it has turned out that joints, e.g. copper joints, between different components of refrigerants are particularly prone to corrosion. As the present invention allows to considerably reduce the number of such joints, there is less risk of problems, leakage and/or failure due to corrosion of such joints.

[0012] Furthermore, combining different functionalities, which are provided by several separate components in the prior art, in particular at least the refrigerant receiver functionality and the economizer functionality, in one monolithic component helps to reduce the weight and the size of the overall refrigerant system. As a result, a better transport efficiency in the transportation of reefer goods can be reached.

[0013] The first fluid channel structure and the separate second fluid channel structure are configured to allow heat transfer between fluid flowing through the first fluid channel structure and fluid flowing through the second fluid channel structure. The first fluid channel struc-

ture is formed integrally in the tank casing. The second fluid channel structure is formed integrally in the tank casing as well but formed separately from the first fluid channel structure. This allows passing refrigerant through the first fluid channel structure with a first pressure while passing refrigerant through the second fluid channel structure with a second pressure, wherein the second pressure is different from the first pressure, e.g. lower than the first pressure.

[0014] An inner volume of the tank casing may be configured to constitute the refrigerant reservoir of the refrigerant receiver. The inner volume may be referred to as the refrigerant reservoir. In other words, the tank casing as such directly forms the refrigerant reservoir. According to an aspect, the first fluid channel structure and the second fluid channel structure can be integrally formed within walls enclosing the refrigerant reservoir.

[0015] The tank casing may be configured for fluid supply (especially refrigerant supply) from the refrigerant reservoir, e.g. via an outlet of the refrigerant reservoir, to the first fluid channel structure and/or to the second fluid channel structure.

[0016] The refrigerant reservoir may extend along a longitudinal direction. A middle section along the longitudinal direction may have a uniform cross-sectional shape. The uniform cross-sectional shape in the middle section may be, for example, circular, elliptic, oblong-hole-shaped, polygonal (e.g. rectangular including quadrangular, pentagonal, hexagonal, heptagonal, octagonal, etc.) or the like.

[0017] Additionally or alternatively, the refrigerant reservoir may have a basic shape with a n -fold discrete rotational symmetry around a central axis, where n is natural number of at least 3, especially of at least 6. In one embodiment, it is (at least substantially) rotationally symmetric about the central axis, corresponding to $n = \infty$. For example, the refrigerant reservoir has a cylindrical basic shape.

[0018] The central axis may be parallel to the longitudinal axis.

[0019] According to one aspect, any one of a first end and a second end of the refrigerant reservoir in the longitudinal direction (along the central axis) may be of the following basic shape: flat, conical, hemispherical, ellipsoidal, semi-ellipsoidal dish. The first end and the second end of the refrigerant reservoir may be of the same shape or of different shapes.

[0020] The first fluid channel structure may be configured such that it guides fluid consecutively several times alongside the refrigerant reservoir in the longitudinal direction (i.e. between the first end of the refrigerant reservoir and the second end of the refrigerant reservoir). Additionally or alternatively, the second fluid channel structure may be configured such that it guides fluid consecutively several times alongside the refrigerant reservoir in the longitudinal direction. This provides more efficient heat transfer between the fluid in the first fluid channel structure and the fluid in the second fluid channel

structure.

[0021] According to one aspect, the first fluid channel structure may include at least one meandering flow path for fluid and/or the second fluid channel structure may include at least one meandering flow path for fluid. The use of the meandering flow path(s) improves the heat exchange. An effective area for heat exchange is increased. The meander shape increases a time it takes for the fluid to pass. The fluid passing through can give off or take up more heat. Furthermore, the meander shape of the flow path(s) helps to distribute the heat transfer more uniformly. This allows for a higher efficiency.

[0022] Each meandering flow path may be configured such that it guides the fluid (the refrigerant) flowing there-through several times alongside the refrigerant reservoir in the longitudinal direction, for example at least three times, especially at least five times.

[0023] In one embodiment, the first fluid channel structure includes at least two meandering flow paths for fluid. In other words, the first fluid channel structure includes its at least one meandering flow path and a (at least one) further meandering flow path. This helps to improve the integrated heat exchanger functionality.

[0024] In particular, the first fluid channel structure branches into its at least one meandering flow path and its further meandering flow path. The first fluid channel structure may include a common inlet for its meandering flow paths. Additionally or alternatively, the first fluid channel structure may include a common outlet for its (at least two) meandering flow path. This helps to reduce the number of valves needed for controlling the integrated receiver and economizer functionalities.

[0025] Additionally or alternatively, the second fluid channel structure includes at least two meandering flow paths for fluid. In other words, the second fluid channel structure includes its at least one meandering flow path and a (at least one) further meandering flow path. This helps to improve the integrated heat exchanger functionality.

[0026] In particular, the second fluid channel structure branches into its at least one meandering flow path and its further meandering flow path. The second fluid channel structure may include a common inlet for its meandering flow paths. Additionally or alternatively, the second fluid channel structure may include a common outlet for its meandering flow path. This helps to reduce the number of valves needed for controlling the integrated receiver and economizer functionalities.

[0027] According to another aspect, the second fluid channel structure can be arranged between the first fluid channel structure and the refrigerant reservoir. The second fluid channel structure can be integrally formed within the tank casing (i.e. integrally formed within walls enclosing the refrigerant reservoir) further inward than the first fluid channel structure. For example, the second fluid channel structure is integrally formed within an inner side (reservoir-side portions) of the walls enclosing the refrigerant reservoir and first fluid channel structure is integral-

ly formed within an outer side (environment-side portions) of the walls enclosing the refrigerant reservoir. Therefore, fluid flowing through the second fluid channel structure exchanges heat with both the fluid flowing through the first fluid channel structure and the fluid within the refrigerant reservoir. Especially, the refrigerant receiver may be configured such that, at least under certain operation conditions, fluid flowing through the second fluid channel structure has a lower temperature (and pressure) than the fluid flowing through the first fluid channel structure and the fluid in the refrigerant reservoir, wherein the fluid flowing through the second fluid channel structure takes up heat from both the fluid flowing through the first fluid channel structure and the fluid within the refrigerant reservoir. This increases the efficiency.

[0028] According to another aspect, the tank casing may comprise a circumferential wall, a lower end portion, and an upper end portion. The circumferential wall may extend between the lower end portion and the upper end portion, e.g. along the longitudinal direction. For example, the lower end portion may be fixed to the circumferential wall at a side of the first end in the longitudinal direction and the upper end portion may be fixed to the circumferential wall at a side of the second end in the longitudinal direction.

[0029] The circumferential wall may have, for example, the basic shape of a hollow cylinder. This results in cost-efficient production and good pressure resistance.

[0030] In one embodiment, the lower end portion may be integrally fixed to the circumferential wall by brazing, e.g. by a circumferential brazed joint. Additionally or alternatively, the upper end portion may be integrally fixed to the circumferential wall by brazing, e.g. by a circumferential brazed joint. This reduces the risk of leakage and ensures high ruggedness of the tank casing. Further, no separate sealing is needed at the corresponding joint.

[0031] Alternatively, at least one of the lower end portion and the upper end portion, for example the upper end portion, is releasably fixed to the circumferential wall, e.g. by screw connections. This is particularly beneficial if the tank casing comprises an additional heat exchange duct for external fluid as described below.

[0032] The tank casing may be configured to be installed such that the longitudinal direction is at least substantially parallel with a direction of gravity in operation, wherein the lower end portion forms a bottom of the refrigerant reservoir and wherein the upper end portion forms a top of the refrigerant reservoir.

[0033] In one embodiment, the refrigerant reservoir (i.e. the inner volume of the tank casing) extends from the first end to the second end along the longitudinal direction, wherein the first fluid channel structure includes:

- two end-to-end channels (i.e. at least two end-to-end channels) arranged adjacently in a circumferential direction, each extending between the first end and the second end, and
- a fluid passage, which is arranged at one of the first

end and the second end and extends, preferably along the circumferential direction, between the adjacent two end-to-end fluid channels of the first fluid channel structure.

[0034] The fluid passage allows the fluid to flow from one of the two end-to-end fluid channels into the other.

[0035] The circumferential direction might be perpendicular to the longitudinal direction.

[0036] In addition, the first fluid channel structure may include:

- at least one further end-to-end channel (i.e. at least a third end-to-end channel), which is arranged adjacently, in the circumferential direction, to one of the two end-to-end channels of the first fluid channel structure and extends between the first end and the second end, and
- a fluid passage, which is arranged at the other one of the first end and the second end and extends, preferably along the circumferential direction, between the at least one further end-to-end channel and the adjacent one of the two end-to-end channels of the first fluid channel structure.

[0037] In one embodiment, the refrigerant reservoir extends from the first end to the second end along the longitudinal direction, wherein the second fluid channel structure includes:

- two end-to-end channels (i.e. at least two end-to-end channels) arranged adjacently in the circumferential direction, each extending between the first end and the second end, and
- a fluid passage, which is arranged at one of the first end and the second end and extends, preferably along the circumferential direction, between the adjacent two end-to-end fluid channels of the second fluid channel structure.

[0038] In addition, the second fluid channel structure may include:

- at least one further end-to-end channel (i.e. at least a third end-to-end channel), which is arranged adjacently, in the circumferential direction, to one of the two end-to-end channels of the second fluid channel structure and extends between the first end and the second end, and
- a fluid passage, which is arranged at the other one of the first end and the second end and extends, preferably along the circumferential direction, between the at least one further end-to-end channel and the adjacent one of the two end-to-end channels of the second fluid channel structure.

[0039] According to a further aspect, the end-to-end channels (of the first fluid channel structure and/or the

second fluid channel structure) may extend straight along the longitudinal direction. This facilitates the production. Furthermore, this can help to reduce a flow resistance of the end-to-end channels.

[0040] The end-to-end channels (of the first fluid channel structure and/or the second fluid channel structure) may be integrally formed in the circumferential wall. Especially, they may be formed completely within the circumferential wall. They may extend along an entire length of the circumferential wall in the longitudinal direction.

[0041] The respective fluid passage (of the first fluid channel structure and/or the second fluid channel structure) at the first end may be formed in the circumferential wall and/or in the lower end portion of the tank casing. It may be arranged at a joint between the circumferential wall and the lower end portion. Especially, it may be formed by a groove, which extends along the circumferential direction between the end-to-end channels connected by it, in a first end front face of the circumferential wall. Additionally or alternatively, it may be formed by a groove, which extends along the circumferential direction between the end-to-end channels connected by it, in a circumferential contact area of the lower end portion that is in contact with the first end front face of the circumferential wall.

[0042] The respective fluid passage (of the first fluid channel structure and/or the second fluid channel structure) at the second end may be formed in the circumferential wall and/or in the upper end portion of the tank casing. It may be arranged at a joint between the circumferential wall and the upper end portion. Especially, it may be formed by a groove, which extends along the circumferential direction between the end-to-end channels connected by it, in a second end front face of the circumferential wall. Additionally or alternatively, it may be formed by a groove, which extends along the circumferential direction between the end-to-end channels connected by it, in a circumferential contact area of the upper end portion that is in contact with the second end front face of the circumferential wall.

[0043] According to one aspect, at least one of the fluid passages of the first fluid channel structure may connect three end-to-end channels of the of the first fluid channel structure. Additionally or alternatively, at least one of the fluid passages of the second fluid channel structure may connect three end-to-end channels of the of the second fluid channel structure. This is especially relevant for a fluid passage that is in direct fluid communication with an inlet or an outlet of the respective fluid channel structure.

[0044] In one embodiment, the first fluid channel structure is mirror-symmetric with respect to a longitudinal central plane. Additionally or alternatively, the second fluid channel structure may be mirror-symmetric with respect to the longitudinal central plane. This ensures a particularly uniform flow of fluid through the respective channel structure. The central axis may lie in the central

plane.

[0045] The whole circumferential wall may be pre-produced as one single integral part.

[0046] According to one aspect, the circumferential wall of the tank casing is at least one of

- made of aluminum alloy and
- made by extrusion.

[0047] Manufacturing the circumferential wall by extrusion, e.g. by aluminum alloy extrusion, ensures relatively uniform material properties along the whole circumferential wall. This is beneficial for high ruggedness and reliable resistance to high pressure. As the circumferential wall can be formed as one single integral part, the risk of leakage at the circumferential wall is particularly low. Furthermore, it is a cost-efficient production method to produce the end-to-end channels.

[0048] Aluminum alloys exhibit relatively high heat conduction. This improves the additionally integral economizer functionality. Furthermore, aluminum alloys are lightweight and does not rust.

[0049] In one embodiment, the tank casing includes an additional heat exchange duct for external fluid extending through the refrigerant reservoir. The additional heat exchanger may be configured for heat uptake from refrigerant inside the refrigerant reservoir by the external fluid. For example, the refrigerant receiver with the tank casing can be used in a refrigerant circuit of an intermodal container. If the intermodal container is placed inside a ship hull, especially in a lower part thereof, it might be difficult the dissipate enough heat from the refrigerant circuit by a common condenser (in the form of an air heat exchanger) of the refrigerant circuit. The additional heat exchange duct can be used to guide cold water, e.g. sea water or water cooled by sea water, through the refrigerant reservoir for cooling the refrigerant stored therein.

[0050] According to one aspect, the tank casing, for example, the circumferential wall, comprise at least one of

- a (first) sight glass for checking a liquid refrigerant level in the refrigerant reservoir and
- a (first) sight glass mount for a (first) sight glass.

[0051] The (first) sight glass may allow to check for a predetermined low level of liquid refrigerant in the refrigerant reservoir.

[0052] Especially, the tank casing, for example the circumferential wall, can comprise at least one of

- two sight glasses for checking the liquid refrigerant level in the refrigerant reservoir and
- two sight glass mounts.

[0053] A second sight glass may allow to check for a predetermined high level of liquid refrigerant in the refrigerant reservoir. The first sight glass and/or the corre-

sponding first sight class mount may be provided nearer to the first end of the refrigerant reservoir than the second sight glass.

[0054] According to one aspect, the tank casing may have a refrigerant inlet for receiving refrigerant into the refrigerant reservoir. The refrigerant inlet may comprise an inlet port and/or an inlet port mount for releasably mounting the inlet port to the tank casing, for example to the upper end portion. The inlet port mount may be integrally formed in the upper end portion. It can include a threading, e.g. an inner thread.

[0055] The tank casing may have a first refrigerant outlet. The first refrigerant outlet may comprise a first outlet port and/or a first outlet mount for releasably mounting the first outlet port to the tank casing, for example to the upper end portion. The first outlet mount may be integrally formed in the upper end section. It can include a threading, e.g. an inner thread.

[0056] In one embodiment, the tank casing includes an integral discharge duct for supplying refrigerant from the refrigerant reservoir to the first refrigerant outlet, wherein the first fluid channel structure forms part of the discharge duct, and wherein at least one of

- a discharge expansion valve and
- a mount for the discharge expansion valve

is arranged in the discharge duct between the first fluid channel structure and the first refrigerant outlet.

[0057] The first refrigerant outlet may be in fluid communication with the refrigerant reservoir via the first fluid channel structure (at least when the discharge expansion valve is open).

[0058] The refrigerant flowing out of the first refrigerant outlet can be guided to an evaporator of a refrigerant circuit in which the refrigerant receiver with the tank casing is employed.

[0059] The discharge expansion valve may control expansion of the refrigerant downstream of the first fluid channel structure (and upstream of the first refrigerant outlet). Hence, the refrigerant entering the first fluid channel structure during operation has a high pressure and high temperature as the refrigerant within the refrigerant reservoir. It therefore gives off heat in the first fluid channel structure. Thereby, it is pre-cooled before by the economizer functionality before it is expanded by the discharge expansion valve. As a result, the refrigerant can take up more heat in the evaporator. The efficiency and/or effectivity of the refrigerant circuit are enhanced.

[0060] The mount for the discharge expansion valve may be configured for releasably mounting the discharge expansion valve to the tank casing, for example to the upper end portion. It may be formed integrally in the upper end portion. It can include a threading, e.g. an inner thread.

[0061] The tank casing may have a second refrigerant outlet. It may comprise a second outlet port and/or a second outlet mount for releasably mounting the second out-

let port to the tank casing, for example to the upper end portion. The second outlet mount may be integrally formed in the upper end section. It can include a threading, e.g. an inner thread.

[0062] In one embodiment, the tank casing includes an integral economizer duct for supplying refrigerant from the refrigerant reservoir to the second refrigerant outlet, wherein the second fluid channel structure forms part of the economizer duct, and wherein at least one of

- an economizer expansion valve and
- a mount for mounting the economizer expansion valve

is arranged in the economizer duct between the refrigerant reservoir and the second fluid channel structure.

[0063] The second refrigerant outlet may be in fluid communication with the refrigerant reservoir via the second fluid channel structure (at least when the economizer expansion valve is open).

[0064] The economizer expansion valve may control expansion of the refrigerant upstream of the second fluid channel structure (and downstream of the refrigerant reservoir). Hence, the refrigerant flowing through the second fluid channel structure during operation has a lower pressure and a lower temperature than the refrigerant flowing through the first fluid channel structure. It therefore takes up heat in the second fluid channel structure. As explained above, vice versa, heat is given off by the fluid streaming through the first fluid channel structure towards the discharge expansion valve (and later to the evaporator), thereby improving the efficiency and/or effectivity of the refrigeration circuit.

[0065] Furthermore, if the second fluid channel structure is arranged between the first fluid channel structure and the refrigerant reservoir, the fluid flowing through the second fluid channel structure additionally takes up heat from the fluid in the refrigerant reservoir. This further contributes to pre-cooling the refrigerant to be discharged to the evaporator via the discharge expansion valve.

[0066] The mount for the economizer expansion valve may be configured for releasably mounting the economizer expansion valve to the tank casing, for example to the lower end portion. It may be formed integrally in the lower end portion. It can include a threading, e.g. an inner thread.

[0067] According to one aspect, at least one of

- a refrigerant dryer and
- a mount for the refrigerant dryer

may be arranged in the discharge duct, e.g. between the refrigerant reservoir and the first fluid channel structure, and/or in the economizer duct, e.g. between the refrigerant reservoir and the economizer expansion valve. This helps to extract moisture from the refrigerant in order to prevent corrosion. The dryer may include synthetic zeolite as a desiccant.

[0068] According to another aspect, the tank casing can include at least one of

- an isolation valve for opening and closing an outlet of the refrigerant reservoir and
- a mount for the isolation valve.

[0069] The mount for the isolation valve may be configured for releasably mounting the isolation valve to the tank casing, for example to the lower end portion. It may be formed integrally in the lower end portion. It can include a threading, e.g. an inner thread. The outlet of the refrigerant reservoir may be located at a downstream end of the refrigerant reservoir. It may belong to a common portion of the integral discharge duct and the integral economizer duct. The isolation valve may be adapted to prevent, in a closed state, flow of refrigerant from the refrigerant reservoir through the discharge duct and the economizer duct.

[0070] In one embodiment, a condenser is formed integrally with the tank casing, for example monolithically by brazing.

[0071] The tank casing may comprise a condenser outlet channel. The condenser outlet channel may be integrally formed in the tank casing, for example completely within the circumferential wall. In one embodiment, the condenser outlet channel and the end-to-end channels may be formed together with the circumferential wall by extrusion, e.g. by aluminum alloy extrusion (in one step).

[0072] The condenser outlet channel may extend along the longitudinal direction. It may have a kidney-shaped cross-section.

[0073] With respect to the refrigerant reservoir, the condenser outlet channel may be formed further outward than the first fluid channel structure.

[0074] A connecting duct may extend integrally within the tank casing for guiding refrigerant from the condenser outlet channel into the refrigerant reservoir. Especially, the connecting duct may be formed integrally in the upper end portion of the tank casing. It may include at least two branches. This allows for a lower flow resistance.

[0075] The condenser may comprise a plurality of heat exchange conduits. The heat exchange conduits may respectively extend from a common inlet distribution portion to the condenser outlet channel. The condenser outlet channel serves as common outlet portion for the plurality of heat exchange conduits. All joints between the heat exchange conduits and the tank casing, e.g. the circumferential wall, and the common inlet distribution portion may be formed by brazing.

[0076] In one embodiment, the condenser is a micro-channel heat exchanger. It may be an air heat exchanger.

[0077] The common inlet distribution portion may comprise a mount for releasably mounting a condenser inlet port. The condenser inlet port may include a pressure switch. A relay may be activated depending on a pressure at the condenser inlet port. Additionally or alternatively, the condenser inlet port may comprise a pressure sensor.

[0078] According to a further aspect, the tank casing (or the whole refrigerant receiver) is free of soldered joints. This reduces the risk of accidents in the course of installation and maintenance, especially if a flammable refrigerant is used.

[0079] Additionally or alternatively, the tank casing (or the whole refrigerant receiver) is free of flare connections. This reduces the risk of leakage and improves the ruggedness.

[0080] In one embodiment, the tank casing (or the whole refrigerant receiver) is free of brass and/or free of lead. This is eco-friendly.

[0081] According to one aspect, the first fluid channel structure and the second fluid channel structure may be arranged concentrically, e.g. concentrically about the central axis.

[0082] The problem mentioned above is further solved by a refrigerant receiver with a tank casing according to any one of the embodiments described herein, wherein the refrigerant receiver exhibits an integrated economizer functionality.

[0083] The refrigerant receiver is configured to use the tank casing, especially the first fluid channel structure and the second fluid channel structure, as heat exchanger for the economizer functionality.

[0084] The refrigerant receiver may be configured for use with R290 as refrigerant.

[0085] In one embodiment, the mounting of one of, several, or all of the following includes a metal sealing:

- The first sight glass,
- the second sight glass,
- the isolation valve,
- the economizer expansion valve,
- the service valve,
- the dryer,
- the inlet port,
- the discharge expansion valve,
- the first outlet port,
- the second outlet port, and
- the condenser inlet port.

[0086] Additionally, the respective mounting(s) may include an O-ring protection. The O-ring protection can be arranged on an outward side (environment side) of the respective mounting, wherein the metal sealing may be arranged on an inward side (refrigerant side) of the respective mounting. The metal sealing prevents leakage of the refrigerant. The O-ring protection prevents that the metal sealing corrodes due to moisture from the environment.

[0087] According to another aspect, the refrigerant receiver may be used in a refrigerant circuit for mobile cooling applications, e.g. for cooling an intermodal container.

[0088] The present disclosure also relates to a refrigerant circuit including the refrigerant receiver with the tank casing according to any one of the embodiments disclosed herein, a compressor, and an evaporator,

wherein the first refrigerant outlet is in fluid connection with an inlet of the evaporator and the second refrigerant outlet is in fluid connection with an economizer inlet of the compressor.

[0089] The present disclosure also relates to a method for manufacturing a receiver tank, especially according to any one of the embodiments described herein, the method including at least the following steps:

- forming the circumferential wall including the end-to-end channels by extrusion (and if applicable, the condenser outlet channel), e.g. by aluminum extrusion,
- machining grooves for the fluid passage(s) of the first fluid channel structure and/or the second fluid channel structure
 - into the first end front face of the circumferential front face and/or
 - into the circumferential contact area of the lower end portion that is intended to come in contact with the first end front face of the circumferential wall, and
- machining grooves for the fluid passages (s) of the first fluid channel structure and/or the second fluid channel structure
 - into the second end front face of the circumferential front face and/or
 - at the circumferential contact area of the upper end portion that is intended to come in contact with the second end front face of the circumferential wall.

[0090] Preferably, the grooves are only machined into the first end front face and the second end front face of the circumferential wall.

[0091] The method may further comprise the step of fixing the lower end portion to the first end front face of the circumferential wall, e.g. monolithically by a brazing step.

[0092] The same brazing step may additionally comprise monolithically fixing the upper end portion to the second end front face of the circumferential wall. The same brazing step may additionally comprise monolithically fixing the plurality of the heat exchange conduits for the condenser to the tank casing (e.g. to the condenser outlet channel in the circumferential wall) and to the common inlet distribution portion.

[0093] The brazing step forms an integral, rugged, monolithic tank casing component of the elements joined by the brazing step. Even the heat exchange conduits and the common inlet distribution pipe can be monolithically fixed to the rest of the tank casing in this way.

[0094] The brazing step may be performed in an oven. It may be performed with a maximum temperature in the range from 600 °C to 700 °C.

[0095] According to one aspect, the above-mentioned

fluid passages of the first fluid channel structure and the second fluid channel structure may be caulked (closed) by the brazing step.

[0096] The embodiments, modifications, and advantages described with respect to any one of the tank casing, the refrigerant receiver, the refrigerant circuit, and the method apply accordingly to the other subject matters, respectively.

[0097] Preferred embodiments of the invention will now be described with reference to the drawings, wherein:

Fig. 1 shows a longitudinal cross-section of a refrigerant receiver with a tank casing according to a first embodiment of the present invention in a central plane;

Fig. 2 shows a transversal cross-section of the refrigerant receiver of Fig. 1 according to indication C2 in Fig. 1;

Fig. 3 shows a transversal cross-section of the refrigerant receiver of Fig. 1 according to indication C3 in Fig. 1;

Fig. 4 shows a transversal cross-section of the refrigerant receiver of Fig. 1 according to indication C4 in Fig. 1;

Fig. 5 is a front view of the refrigerant receiver of Fig. 1;

Fig. 6 is a perspective view of the tank casing of the refrigerant receiver of Fig. 1;

Fig. 7 is a perspective view of a refrigerant receiver with a tank casing according to a second embodiment of the present invention;

Fig. 8 shows a longitudinal cross-section of the refrigerant receiver of Fig. 7 in a central plane;

Fig. 9 shows a longitudinal cross-section of a refrigerant receiver with a third embodiment of a tank casing according to the present invention with a monolithically integrated condenser functionality;

Fig. 10 shows a transversal cross-section of the refrigerant receiver of Fig. 9 according to indication C10 in Fig. 9;

Fig. 11 is a detailed cross-sectional view according to indication C11 in Fig. 10, showing a refrigerant inlet integrally formed in an upper end portion of the tank casing of Fig. 9 that leads from a condenser outlet channel to a refrigerant reservoir;

- Fig. 12 is a perspective view of the refrigerant receiver of Fig. 9;
- Fig. 13 is a perspective view of the tank casing of the refrigerant receiver of Fig. 9;
- Fig. 14 is a longitudinal cross-sectional view of a modified lower end portion for the tank casings of the refrigerant receivers in Figs. 1, 7, and 9 along a middle plane that is perpendicular to the central plane with an alternative embodiment of a dryer being mounted to the lower end portion; and
- Fig. 15 is a longitudinal cross-sectional view of the modified lower end portion of Fig. 14 along the central plane.

[0098] Fig. 1 shows a longitudinal cross-section of a first embodiment of a refrigerant receiver 1 in a central plane M (see Fig. 3). The refrigerant receiver 1 comprises a tank casing 2 according to a first embodiment of the present invention. The refrigerant receiver 1 can be integrated in a refrigerant circuit, e.g. for a mobile cooling application.

[0099] The tank casing 2 includes a circumferential wall 10, a lower end portion 40, and an upper end portion 60. The circumferential wall 10, the lower end portion 40 and the upper end portion 60 enclose an inner volume, which constitutes a refrigerant reservoir 3 of the refrigerant receiver 1. The refrigerant reservoir 3 extends along a longitudinal direction L from a first end to a second end. It is of basically cylindric shape and has a high degree of rotational symmetry (it is at least substantially rotationally symmetric) about a central axis. The central axis is parallel to the longitudinal direction L. In particular, the central axis corresponds to the line in Fig. 1 that indicates the longitudinal direction L.

[0100] The refrigerant receiver 1 and its tank casing 2 are configured to be installed such that the longitudinal direction L is at least substantially parallel to a direction of gravity in operation, wherein a first end shall constitute a lower end as shown in Fig. 1. Correspondingly, a second end of the refrigerant reservoir 3 may be referred to as its upper end.

[0101] The lower end portion 40 is fixed to a first end (a lower end) of the circumferential wall 10 in the longitudinal direction L. In more detail, the lower end portion 40 is monolithically fixed to a first end front face of the circumferential wall 10 at a joint 11 by a brazing step. Similarly, the upper end portion 60 is fixed to a second end of the circumferential wall 10 in the longitudinal direction L. In more detail, it is monolithically fixed to a second end front face of the circumferential wall 10 at a joint 12 by the same brazing step. The lower end portion 40, the circumferential wall 10, and the upper end portion 60 together constitute an integral, monolithic main body.

[0102] The tank casing 2, in particular its upper end

portion 40, comprises a refrigerant inlet 61, a first refrigerant outlet 66, and a second refrigerant outlet 68.

[0103] The refrigerant inlet 61 is configured for receiving refrigerant into the refrigerant reservoir 3. It may be connected to a condenser of the refrigerant circuit such that refrigerant can be supplied from the condenser into the refrigerant reservoir 3. In this embodiment, the upper end portion 40 of the tank casing 2 comprises an inlet mount 61a (see Fig. 6) for releasably mounting an inlet port 61b (see Fig. 7, 8). The additional inlet port 61b facilitates the installation and the maintenance of the refrigerant receiver 1. Similarly, the first refrigerant outlet 66 includes at least a first outlet mount 66, to which a second outlet port 66b can be mounted. Further, the second refrigerant outlet 68 includes at least a second outlet mount 68a, to which a second outlet port 68b can be mounted. The tank casing 2 may comprise the inlet port 61b, the first outlet port 66b, and/or the second outlet port 68b.

[0104] According to one aspect, for integration in the refrigerant circuit, firstly, a corresponding pipe may be brazed to each one of the inlet port 61b, the first outlet port 66b, and the second outlet port 68b, respectively. Secondly, the inlet port 61b, the first outlet port 66b, and the second outlet port 68b with the corresponding pipe fixed thereto may be releasably mounted to the corresponding one of the inlet mount 61a, the first outlet mount 66a, and the second outlet mount 68a, respectively.

[0105] The circumferential wall 10 comprises two sight glass mounts 13, 15 for releasably mounting sight glasses 14, 16. This facilitates manufacture and maintenance. Alternatively, the sight glasses 14, 16 can be permanently fixed to the circumferential wall 10. In this case, there is no need for the sight glass mounts 13, 15 for releasably mounting the sight glasses 14, 16. Housings of the sight glasses 14, 16 may be made of stainless steel.

[0106] A first one of the sight glasses 14 (a first sight glass 14) allows to check for a predetermined low level of liquid refrigerant inside the refrigerant reservoir 3. A second one of the sight glasses 16 (a second sight glass 16) allows to check for a predetermined high level of liquid refrigerant inside the refrigerant reservoir 3.

[0107] The first refrigerant outlet 66 may be fluidly connected to an inlet of an evaporator of the refrigerant circuit.

[0108] The tank casing 2 includes an integral discharge duct for supplying refrigerant from the refrigerant reservoir 3 to the first refrigerant outlet 66. The discharge duct extends through the lower end portion 40, through the circumferential wall 10, and through the upper end portion 60 of the tank casing 2.

[0109] The discharge duct includes an outlet 41 of the refrigerant reservoir 3, a duct section 48 formed in the lower end portion 40, a first fluid channel structure 20 formed in the circumferential wall 10, and a duct section 62, 65 formed in the upper end portion 60.

[0110] The tank casing 2 further includes an integral economizer duct for supplying refrigerant from the refrig-

erant reservoir 3 to the second refrigerant outlet 68. The economizer duct extends through the lower end portion 40, through the circumferential wall 10, and through the upper end portion 60 of the tank casing 2.

[0111] The economizer duct includes the outlet 41 of the refrigerant reservoir 3, a duct section 44 formed in the lower end portion 40, a second fluid channel structure 30 formed in the circumferential wall 10, and a duct section 67 formed in the upper end portion 60.

[0112] In other words, the outlet 41 of the refrigerant reservoir 3 constitutes both a beginning of the discharge duct and the economizer duct.

[0113] The outlet 41 is integrally formed in the lower end portion 40. The lower end portion 40 includes a mount 42 for releasably mounting an isolation valve 43. The isolation valve 43 is configured to close the outlet 41 of the refrigerant reservoir 3 when desired, e.g. for maintenance. When the isolation valve 43 is closed, both the discharge duct and the economizer duct are blocked.

[0114] Downstream of the outlet 41 of the refrigerant reservoir 3 and the isolation valve 43 mounted in the corresponding mount 42, the discharge duct continues with the duct section 48 formed in the lower end portion 40.

[0115] The first fluid channel structure 20, which forms part of the discharge duct, comprises

- a common inlet 25 at the first end front face of the circumferential wall 10 (see Figs. 1 and 4),
- a common outlet 26 at the second end front face of the circumferential wall 10 (see Figs. 1 and 2),
- a plurality of longitudinal end-to-end channels 22, respectively extending between the first end front face and the second end front face,
- fluid passages 23 at the first end front face, and
- fluid passages 24 at the second end front face.

[0116] A downstream end of the duct section 48 of the discharge duct opens into the inlet 25 of the first fluid channel structure 20. In this exemplary embodiment, the inlet 25 is machined into the first end front face of the circumferential wall 10 (see Figs. 1 and 4). Additionally or alternatively, it may be machined into a circumferential contact area of the lower end portion 40 with the first end front face of the circumferential wall 10 at the joint 11.

[0117] The first fluid channel structure 20 is formed mirror-symmetrically with respect to the central plane M (see Figs. 2 to 4). One meandering flow path 21a of the first fluid channel structure 20 is formed in one (semicircular) half of the circumferential wall 10 along a circumferential direction and another meandering flow path 21b of the first fluid channel structure 20 is formed in another (semicircular) half of the circumferential wall 10 along the circumferential direction. In the shown embodiments, the two meandering flow paths 21a, 21b of the first fluid channel structure 20 extend mirror-symmetrically with respect to the central plane M. The first fluid channel structure 20 branches into its two meandering flow paths 21a, 21b directly at the inlet 25 (see Fig. 4). They reunite down-

stream at the outlet 26 (see Fig. 2).

[0118] The end-to-end channels 22 of the one meandering flow path 21a are evenly arranged along the circumferential direction in the one half of the circumferential wall 10. The end-to-end channels 22 of the other meandering flow path 22a are evenly arranged along the circumferential direction in the other half of the circumferential direction. A circumferential width of the end-to-end channels 22 corresponds to at least 2 times a radial width of the end-to-end channels 22.

[0119] Adjacent end-to-end channels 22 of the first fluid channel structure 20 (i.e. end-to-end channels 22 of only the first fluid channel structure 20 that are located next to each other along the circumferential direction) are fluidly connected alternately at the first end front face and at the second front face. This creates the meander shapes of the meandering flow paths 21a, 21b. The fluid connections 23, 24 are formed by grooves extending along the circumferential direction between the adjacent end-to-end channels 22 to be directly fluidly connected.

[0120] For example, the two adjacent end-to-end channels 22 next to the inlet 25, which belong to different meandering flow paths 21a, 21b, are in fluid communication via the fluid passage defined by one of the grooves 23 that is formed in the first end front face of the circumferential wall 10. The inlet 25 is also in fluid communication with exactly this fluid passage (with exactly this one of the grooves 23), see left side of Fig. 4. Hence, the refrigerant can flow from the inlet 25 into said two adjacent end-to-end channels 22 and pass through the circumferential wall 10 along the longitudinal direction L for a first time. Then, a further fluid passage to the respective next adjacent end-to-end channel 22 of the same respective meandering flow path 21a, 21b is formed by a corresponding groove 24 on the second end front face of the circumferential wall 10, respectively. The refrigerant flows back (downward in Fig. 1) through the circumferential wall 10 along the longitudinal direction L for a second time. Another fluid passage to the respective next adjacent end-to-end-channel 22 of the same respective meandering flow path 21a, 21b is formed by a next corresponding groove 23 on the first end front face of the circumferential wall 10. The refrigerant passes through the circumferential wall 10 along the longitudinal direction L and hence along the refrigerant reservoir 3 for a third time, and so one.

[0121] In the exemplary embodiment of the tank casing 2 shown in Figs. 1 to 6, each of the meandering flow paths 21a, 21b of the first fluid channel structure 20 causes the refrigerant to pass the circumferential wall 10 along the longitudinal direction L five times. Along a flow direction, a last fluid passage between adjacent end-to-end channels 22 is formed by a groove 24 extending in the second end front face of the circumferential wall 10 between the two end-to-end channels 22 next to the outlet 26 (see right side of Fig. 2). It allows the reunion of the two meandering flow paths 21a, 21b of the first fluid channel structure 20 at the latter's outlet 26.

[0122] The outlet 26 of the first fluid channel structure 20 directly opens into the duct section 62, 65 of the discharge duct, wherein the duct section 62, 65 is formed in the upper end portion 60 of the tank casing 2.

[0123] A mount 63 for removably mounting an expansion valve 64 to the upper end portion 60 of the tank casing 2 is arranged in the discharge duct 62, 65. Due to its functionality, the expansion valve 64 may be also referred to as discharge expansion valve 64. The mount 63 is arranged between the first fluid channel structure 20 and the first refrigerant outlet 66. Fig. 1 shows the refrigerant receiver 1 with the discharge expansion valve 64 being mounted. Fig. 6 shows the tank casing 2 without the discharge expansion valve 64.

[0124] The mount 63 for the discharge expansion valve 64 is arranged downstream of the first fluid channel structure 20. In operation, the refrigerant from the refrigerant reservoir 3 entering the first fluid channel structure 20 has at least substantially the same high pressure and at least substantially the same high temperature as the refrigerant within the refrigerant reservoir 3. While passing through the meandering fluid flow paths 21a, 21b of the first fluid channel structure 20, this refrigerant gives off heat and gradually cools down. A major part of the heat is taken up by the refrigerant flowing through the second fluid channel structure 30. Some heat may dissipate through an outer circumferential surface of the circumferential wall 10 to the environment.

[0125] As the temperature of the refrigerant flowing through the discharge duct is already gradually decreased by passing through the first fluid channel structure 20, the tank casing 2 and the refrigerant receiver 1 employing it exhibit an integrated economizer functionality. The refrigerant arriving at the discharge expansion valve 64 is already pre-cooled by the integrated economizer functionality.

[0126] If said refrigerant is expanded by the discharge expansion valve 64 and then flows via the first refrigerant outlet 66 to the evaporator of the refrigerant circuit, it can take up more heat in the evaporator.

[0127] Turning now to the economizer duct, downstream of the outlet 41 of the refrigerant reservoir 3 and the isolation valve 43 mounted in the corresponding mount 42, the economizer duct continues with a duct section 44, 47 formed in the lower end portion 40.

[0128] A mount 45 for removably mounting an expansion valve 46 to the lower end portion 40 of the tank casing 2 is arranged in the duct section 44, 47. Due to its functionality, the expansion valve 46 may be also referred to as economizer expansion valve 46. In the flow direction, the mount 45 is arranged between the refrigerant reservoir 3 and the second fluid channel structure 30. Fig. 1 shows the refrigerant receiver 1 with the economizer expansion valve 46 being mounted. Fig. 6 shows the tank casing 2 without the economizer expansion valve 46.

[0129] The second fluid channel structure 30, which forms part of the economizer duct, comprises

- a common inlet 35 at the first end front face of the circumferential wall 10 (see Figs. 1 and 4),
- a common outlet 36 at the second end front face of the circumferential wall 10 (see Figs. 1 and 2),
- a plurality of longitudinal end-to-end channels 32, respectively extending between the first end front face and the second end front,
- fluid passages 33 at the first end front face, and
- fluid passages 34.

[0130] A downstream end of the duct section 44, 47 of the economizer duct opens into the inlet 35 of the second fluid channel structure 30. The inlet 35 is machined into the first end front face of the circumferential wall 10 (see Figs. 1 and 4). Additionally or alternatively, it may be machined into a circumferential contact area of the upper end portion 60 with the second end front face of the circumferential wall 10 at the joint 12.

[0131] The second fluid channel structure 30 is formed similar to the first fluid channel structure 20.

[0132] It is formed mirror-symmetrically with respect to the central plane M (see Figs. 2 to 4). One meandering flow path 31a of the second fluid channel structure 30 is formed in the one (semicircular) half of the circumferential wall 10 along the circumferential direction and another meandering flow path 31b of the second fluid channel structure 30 is formed in the other (semicircular) half of the circumferential wall 10 along the circumferential direction. In the shown embodiments, the two meandering flow paths 31a, 31b of the second fluid channel structure 30 extend mirror-symmetrically with respect to the central plane M.

[0133] Different from the first fluid channel structure 20, the second fluid channel structure 30 branches into its two meandering flow paths 31a, 31b not directly at its inlet 35 (see Fig. 4) but after its common end-to-end-channel 32 that follows directly downstream of its inlet 35 (see Fig. 2). Its two meandering flow paths 31a, 31b reunite at the outlet 36 (see Fig. 2 as well).

[0134] The end-to-end channels 32 of the one meandering flow path 31a are evenly arranged along the circumferential direction in the one half of the circumferential wall 10. The end-to-end channels 32 of the other meandering flow path 31b are evenly arranged along the circumferential direction in the other half of the circumferential wall 10. A circumferential width of the end-to-end channels 32 corresponds to at least 2 times a radial width of the end-to-end channels 32. The circumferential width of the end-to-end channels 32 of the second fluid channel structure 30 might be different from (e.g. smaller than) the circumferential width of the end-to-end channels 22 of the first fluid channel structure 20.

[0135] Adjacent end-to-end channels 32 of the second fluid channel structure 30 (i.e. end-to-end channels 32 of only the second fluid channel structure 30 that are located next to each other along the circumferential direction) of the respective same meandering flow path 31a, 31b are fluidly connected alternately at the first end

front face and the second front face. This creates the meander shapes of the meandering flow paths 31a, 31b. The fluid connections 33, 34 are formed by grooves extending along the circumferential direction between the adjacent end-to-end channels 32 to be directly fluidly connected.

[0136] The common end-to-end channel 32 is fluidly connected to both of its adjacent end-to-end channels 32 at the first end front face because it is used for both meandering flow paths 31a, 31b.

[0137] For example, the two end-to-end channels 32 adjacent to the common end-to-end channel 32 that belong to different meandering flow paths 31, 31b are in fluid communication with the common end-to-end channel 32 by fluid passages defined by two grooves 34, which are formed in the second end front face of the circumferential wall 10 (see right side of Fig. 2). Then, a further fluid passage to the respective next adjacent end-to-end channel 32 of the same respective meandering flow path 31a, 31b is formed by a corresponding groove 33 on the first end front face of the circumferential wall 10 (see Fig. 4).

[0138] In the exemplary embodiment of the tank casing 2 shown in Figs. 1 to 6, each of the meandering flow paths 31a, 31b of the second fluid channel structure 30 causes the refrigerant to pass through the circumferential wall 10 along the longitudinal direction L seven times (respectively including one time for passing through the common end-to-end channel 32). Along the flow direction, a last fluid passage between adjacent end-to-end channels 32 is formed by the groove 34 extending in the second end front face of the circumferential wall 10 between the two end-to-end channels 32 next to the outlet 36 (see left side of Fig. 2). It allows the reunion of the two meandering flow paths 31a, 31b of the second fluid channel structure 30 at the latter's outlet 36.

[0139] The outlet 36 of the second fluid channel structure 30 directly opens into the duct section 67 of the economizer duct, wherein the duct section 67 is formed in the upper end portion 60 of the tank casing 2.

[0140] The mount 45 for the economizer expansion valve 46 is arranged upstream of the second fluid channel structure 30. In operation, the refrigerant from the refrigerant reservoir 3 entering the second channel structure 30 has already passed the economizer expansion valve 46 and is expanded by the latter. The fluid entering the second fluid channel structure 30 hence has a lower pressure and a lower temperature than the refrigerant entering the first fluid channel structure 20. While passing through the meandering fluid flow paths 31a, 31b of the second fluid channel structure 30, it takes up heat.

[0141] The first fluid channel structure 20 is formed in an outward portion of the tank casing 2 facing away from the refrigerant reservoir 3. Especially, its end-to-end channels 22 are formed in a radially outer section of the circumferential wall 10. The second fluid channel structure 30 is formed in an inward portion of the tank casing 2 facing the refrigerant reservoir 3. Especially, its end-

to-end channels 32 are formed in a radially inner section of the circumferential wall 10.

[0142] This allows that the expanded refrigerant flowing through the second fluid channel structure 30 takes up heat from both the hot, non-expanded refrigerant flowing through the first fluid channel structure 20 and the refrigerant stored in the refrigerant reservoir 3. This results in an additional pre-cooling of the refrigerant stored in the refrigerant reservoir 3. This further enhances the efficiency and/or effectivity of the refrigerant circuit.

[0143] As noted above, arranging the first fluid channel structure 20 of the discharge duct guiding the hot, non-expanded refrigerant in the outward portion has also the advantage that more heat can be dissipated to the environment. Furthermore, a warm outer surface of the circumferential wall 10 reduces the risk that moisture can condense at the outer surface and cause corrosion at the refrigerant receiver 1 or other parts of the refrigerant circuit attached to the refrigerant receiver 1.

[0144] The economizer duct ends at the second refrigerant outlet 68. The latter can be connected to an economizer inlet of a compressor of the refrigerant circuit. Supplying the refrigerant from the economizer duct, which is expanded by the economizer expansion valve 46, to the economizer inlet of the compressor allows to optimize the operation conditions of the compressor. This helps to obtain a higher efficiency. It may also help to prevent the compressor from being damage by unfavorable operation conditions.

[0145] In a middle section of the circumferential wall 10 along the longitudinal direction L, all the end-to-end channels 22, 32 extend uniformly, respectively, and there is no fluid connection between any of the end-to-end channels 22, 32 (see Fig 3).

[0146] In the embodiment shown in Fig. 1, the duct section 48 of the discharge duct includes a mount 50 for releasably mounting a dryer 51. The mount 50 for the dryer 51 branches off from the duct section 48. Here, the dryer 51 includes only a single fluid port 51a, which is formed in a mounting portion 51b of the dryer 51. The dryer 51 further comprises a desiccant housing 51c. In an interior 51d of the desiccant housing 51c, a desiccant for extracting moisture from the refrigerant is accommodated. The dryer 51 hence helps to prevent corrosion. A snap ring 51e, a spring 51f, and a mesh 51g are inserted into the fluid port 51a. The snap ring 51e supports the spring 51f whereas the spring 51f urges a mesh 51 into contact with an inward flange at a desiccant-side end of the mounting portion 51b. The mesh 51g prevents the desiccant from leaving the interior 51d of the desiccant housing 51d. However, the desiccant can be replaced by demounting the dryer 51 from the tank housing 2 and removing the snap ring 51e, the spring 51f as well as the mesh 51g. Thereafter, new desiccant can be filled into the interior 51d and secured therein by re-installing the mesh 51g, the spring 51g and the snap ring 51e. Finally, the dryer 51 can be re-mounted to the corresponding mount 50 formed in the upper end portion 40 of the tank

casing 2. The desiccant may include synthetic zeolite, for example.

[0147] Furthermore, the tank casing 2 comprises a mount 49a for a service valve 49. In more detail, the mount 49a is integrally formed in the lower end portion 40. It is arranged in the duct section 48 of the discharge duct as well.

[0148] Mounting arrangements for one of, several of, or all of the following parts may be provided in accordance with embodiments disclosed in unpublished European patent application with filing number 22203958.8:

- The first sight class 14,
- the second sight class 16,
- the isolation valve 43,
- the economizer expansion valve 46,
- the service valve 49,
- the dryer 51,
- the inlet port 61b,
- the discharge expansion valve 64,
- the first outlet port 66b,
- the second outlet port 68b, and
- a condenser inlet portion 281 (described below).

[0149] The respective part(s) 14, 16, 43, 46, 49, 51, 61, 64, 66, 68, 281 and/or the corresponding mount(s) 13, 15, 42, 45, 49a, 50, 61a, 63, 66a, 68a may be configured accordingly.

[0150] The refrigerant reservoir 3 may have a volume in the range from 0,5 l to 5 l.

[0151] For example, an outer diameter of the circumferential wall 10 may be on the range from 6 cm to 25 cm.

[0152] A length of the circumferential wall 10 along the longitudinal direction L may be in the range from 5 cm to 60 cm.

[0153] A basic wall thickness WT (see Fig. 3) of the circumferential wall 10 may be in the range from 6 mm to 25 mm.

[0154] The end-to-end-channels 22, 32 are formed integrally with the circumferential wall 10 by aluminum alloy extrusion. In this embodiment, the fluid passages between the end-to-end channels 22, 32 are constituted by grooves 23, 24, 33, 34 machined into the first end front face and second end front face of the circumferential wall 10 before the lower end portion 40 and the upper end portion 60 are fixed to the circumferential wall 10. The fluid passages (the grooves 23, 24, 33, 34) between the end-to-end channels 22, 32 are enclosed by fixing the lower end portion 40 and the upper end portion 60 to the circumferential wall 10.

[0155] In other embodiments (not shown), grooves corresponding to the grooves 23 and/or the grooves 33 can be formed additionally or alternatively in the circumferential contact area of the lower end portion 40 at the joint 11 before the lower end portion 40 is fixed to the first end front face of the circumferential wall 10. Additionally or alternatively, other types of fluid passages for connecting adjacent end-to-end channels 22, 32 at the

second end may be provided. For example, such a fluid passage may be formed by two oblique bores in the lower end portion 40 that join together, similar as a refrigerant inlet 261 shown in Fig. 11.

[0156] Similarly, grooves corresponding to the grooves 24 and/or the grooves 34 can be formed additionally or alternatively in a circumferential contact area of the upper end portion 60 at the joint 12 before the upper end portion 60 is fixed to the second end front face of the circumferential wall 10. Additionally or alternatively, other types of fluid passages for connecting adjacent end-to-end channels 22, 32 at the second end may be provided. For example, such a fluid passage may be formed by two oblique bores in the upper end portion 60 that join together, similar as the refrigerant inlet 261 shown in Fig. 11.

[0157] Figs. 7 and 8 show a refrigerant receiver 100 with a tank casing 102 according to a second embodiment of the present invention. Identical elements are referred to by identical reference signs and are not explained again. Only the differences to the embodiment shown in Fig. 1 are explained in the following.

[0158] The tank casing 102 includes an additional an additional heat exchange duct 170 for external fluid that extends through the refrigerant reservoir 3. Connection ports 171, 172 of the additional heat exchange duct 170 are formed in an upper end section 160 of the tank casing 102. Apart from that, the upper end section 160 is identical to the upper end section 60 of the tank casing 2 described above. The additional heat exchange duct 170 comprises a helical portion arranged in the refrigerant reservoir 3. The helical portion may extend at least within a lower third of the refrigerant reservoir 3 along the longitudinal direction L. A tube of the additional heat exchange duct 170 may be made of stainless steel. The tube may be covered with aluminum (alloy).

[0159] External cooling fluid, e.g. water, can flow through the additional heat exchange duct 170 for cooling the refrigerant stored in the refrigerant receiver 3.

[0160] In a modification (not shown), the upper end portion 160 is not permanently fixed to the circumferential wall 10. Instead, it is releasably fixed to the latter, e.g. by means of screws. This facilitates maintenance and replacement of the additional heat exchange duct 170.

[0161] Figs. 9 to 13 show a refrigerant receiver 200 with a tank casing 202 according to a third embodiment of the present invention. Identical elements are referred to by identical reference signs and are not explained again. Only the differences to the embodiment shown in Fig. 1 are explained in the following.

[0162] In this embodiment, a condenser 280 is formed integrally with the tank casing 202.

[0163] The condenser 280 is a micro-channel heat exchanger. It comprises a common inlet distribution portion 283, a common condenser outlet channel 287, and a plurality of heat exchange conduits 285 extending in parallel from the common inlet distribution portion 283 to the condenser outlet channel 287.

[0164] The condenser outlet channel 287 is integrally

formed within the circumferential wall 210 of the tank casing 2, for example together with the end-to-end channels 22, 32 during the aluminum alloy extrusion of the circumferential wall 210.

[0165] A refrigerant inlet 261 for supplying refrigerant from the condenser outlet channel 287 to the refrigerant reservoir 3 is completely formed within the tank casing 202. In more detail, it is completely integrally formed within the upper end portion 260 of the tank casing 202 (see Figs. 10 and 11). It has two parallel branches, each comprising two bores joining together.

[0166] Joints 284 between the common inlet distribution portion 283 and the heat exchange conduits 285 and joints 286 between the heat exchange conduits 285 and the circumferential wall 210 (at the condenser outlet channel 287) may be formed by brazing, especially in the same brazing step in which the upper end portion 260 and the lower end portion 40 are fixed to the circumferential wall 210. This results in a monolithic casing structure shown in Fig. 13 including the lower end portion 40, the upper end portion 60, the circumferential wall 210, the heat exchange conduits 285, and the common inlet distribution pipe 283. In other words, the tank casing 202 integrally includes the condenser functionality.

[0167] The heat exchange conduits 285 may have, for example, a length in the range from 80 cm to 200 cm. They may extend from the circumferential wall 210 in a direction perpendicular to the longitudinal direction L. Additionally or alternatively, the heat exchange conduits 285 may extend along the central plane M.

[0168] A mount for releasably mounting a condenser inlet portion 281 may be formed at the common inlet distribution pipe 283, e.g. at an upper end of the latter (see Fig. 9). The condenser inlet portion 281 may comprise a pressure sensor 282b and/or a pressure switch 282c. In the embodiment shown in Fig. 12, the condenser inlet portion 281 includes a connection structure 282a with a port for the pressure sensor 282b and a port for the pressure switch 282c, wherein the connection structure 282a is releasably mounted to the mount for releasably mounting the condenser inlet portion 281. The condenser inlet portion 281 may be configured to be fluidly connected with a compressor outlet.

[0169] Figs. 14 and 15 show a modified lower end portion 340 that can be used with any one of the tank casings 2, 102, and 202. For tank casing 202, the right end of the lower end portion 340 in Fig. 15 might have to protrude a bit farther in order to safely close the condenser outlet channel 287.

[0170] Fig. 14 show a longitudinal cross-sectional view of the lower end portion 340 in a middle plane that is perpendicular to the central plane M in Fig. 5.

[0171] The modified lower end portion 340 comprises a different mount 350 (see Fig. 15) for releasably mounting a dryer 351 according to an alternative embodiment.

[0172] The dryer 351 comprises a dryer housing 352 and a dryer cartridge mounted inside the dryer housing 352. When the dryer cartridge is accommodated in the

dryer housing 352, a circumferential gap 353 is formed between an outer circumference of a dryer element 354 and an inner circumferential surface of the dryer housing 352.

[0173] The dryer element 354 has a basically hollow-cylindrical shape and extends around an inner space 356. This embodiment of the dryer 351 is configured such that the refrigerant enters the circumferential gap 353 and then flows radially inwards through the dryer element 354 into the inner space 356. The dryer cartridge comprises a bottom cover 355a arranged at a bottom end of the dryer element 354. It prevents that refrigerant can directly flow from the circumferential gap 353 into the inner space 356 at the bottom end of the dryer element 354 without passing through the dryer element 354. The dryer cartridge further comprises a top cover 355b arranged at a top end of the dryer element 354. It guides the refrigerant form a circumferential groove 341 of the mount 350 into the circumferential gap 353. Furthermore, a central portion of the top cover 355b includes opening allowing the refrigerant to flow from the inner space 356 into the central fluid duct 358 in the lower end portion 340.

[0174] The dryer housing 352 is releasably mounted to the mount 350 by means of a plurality of threaded bolts 357. The mount 350 includes corresponding threaded holes. Furthermore, the mount 350 includes the circumferential groove 341 for fluid communication with the circumferential gap 353 in the dryer 351 when the latter is mounted. A fluid duct connects the outlet 41 of the refrigerant reservoir 3 with the circumferential groove 341. In this embodiment, the mount 42 for the isolation valve 43 is arranged within said fluid duct. The mount 350 also includes a central fluid duct 358 for fluidly connecting the inner space 356 of the dryer 351 with the duct sections 44 and 48, which are formed within the lower end portion 340. In this embodiment, not only the outlet 41 of the refrigerant reservoir 3 and the mount 42 for the isolation valve 43 (with the isolation valve 43, if mounted) form part of both the discharge duct and the economizer duct. The mount 350 for the dryer 351 with the circumferential groove 341, the dryer 351 (if mounted), and the central fluid duct 358 form also part of both the discharge duct and the economizer duct. This allows that the dryer 351 also extracts moisture from the refrigerant that flows through the economizer duct including, inter alia, the economizer expansion valve 46 and the second fluid channel structure 30.

List of reference signs:

[0175]	
1, 100, 200	refrigerant receiver
2, 102, 202	tank casing
3	refrigerant reservoir
10	circumferential wall
11, 12	joint
13, 15	mount (for sight glass)

14, 16	sight glass	
20	first fluid channel structure	
21a, 21b	meandering flow path (of the first fluid channel structure 20)	
22	end-to-end channel (of the first fluid channel structure 20)	5
23, 24	circumferential groove (of the first fluid channel structure 20)	
25	inlet (of the first fluid channel structure 20)	10
26	outlet (of the first fluid channel structure 20)	
30	second fluid channel structure	
31a, 31b	meandering flow path (of the second fluid channel structure 30)	15
32	end-to-end channel (of the second fluid channel structure 30)	
33, 34	circumferential groove (of the second fluid channel structure 30)	
35	inlet (of the second fluid channel structure 30)	20
36	outlet (of the second fluid channel structure 30)	
40, 340	lower end portion	
41	outlet (of the refrigerant reservoir 3)	25
42	mount (for the isolation valve 43)	
43	isolation valve	
44, 47, 48	duct section	
45	mount (for the economizer expansion valve 46)	30
46	economizer expansion valve	
49	service valve	
49a	mount (for the service valve 49a)	
50	mount (for the dryer 51)	
51	dryer	35
51a	fluid port	
51b	mounting portion	
51c	desiccant housing	
51d	interior	
51e	snap ring	40
51f	spring	
51g	mesh	
60, 160, 260	upper end portion	
61, 261	refrigerant inlet	
61a	inlet mount	45
61b	inlet port	
62, 65, 67	duct section	
63	mount (for discharge expansion valve)	
64	discharge expansion valve	
66	first refrigerant outlet	50
66a	first outlet mount	
66b	first outlet port	
68	second refrigerant outlet	
68a	second outlet mount	
68b	second outlet port	55
170	additional heat exchange duct	
171, 172	connection port	
280	condenser	

281	condenser inlet portion
282a	connection structure
282b	pressure sensor
282c	pressure switch
283	common inlet distribution channel
284, 286	joint
285	heat exchange conduit
287	condenser outlet channel
351	dryer
352	dryer housing
353	circumferential gap
354	dryer element
355a	bottom cover
355b	top cover
356	inner space
357	threaded bolt
358	central fluid duct
M	central plane
L	longitudinal direction
WT	wall thickness

Claims

1. Tank casing (2, 102, 202) for enclosing a refrigerant reservoir (3) of a refrigerant receiver (1, 100, 200), **characterized in that** a first fluid channel structure (20) and a separate second fluid channel structure (30) for an integrated heat exchanger functionality are integrally formed in the tank casing (2, 102, 202).
2. Tank casing (2, 102, 202) according to claim 1, wherein the first fluid channel structure (20) includes at least one meandering flow path (21a, 21b) for fluid and the second fluid channel structure (30) includes at least one meandering flow path (31a, 31b) for fluid.
3. Tank casing (2, 102, 202) according to claim 2, wherein the first fluid channel structure (20) branches into its at least one meandering flow path (21a, 21b) and a further meandering flow path (21b, 21a) of the first fluid channel structure (20) and/or wherein the second fluid channel structure (30) branches into its at least one meandering flow path (31a, 31b) and a further meandering flow path (31b, 31a) of the second fluid channel structure (30).
4. Tank casing (2, 102, 202) according to any one of the preceding claims, wherein the second fluid channel structure (30) is arranged between the first fluid channel structure (20) and the refrigerant reservoir (3).
5. Tank casing (2, 102, 202) according to any one of the preceding claims, wherein refrigerant reservoir (3) extends from a first end to a second end along a longitudinal direction (L), wherein the first fluid channel structure (20) includes:

- two end-to-end channels (22) arranged adjacently in a circumferential direction, each extending between the first end and the second end, and
 a fluid passage (23, 24), which is arranged at one of the first end and the second end and extends, preferably along the circumferential direction, between the adjacent two end-to end fluid channels (22) of the first fluid channel structure (20).
6. Tank casing (2, 102, 202) according to claim 5, wherein the first fluid channel structure (20) includes:
- at least one further end-to-end channel (22), which is arranged adjacently, in the circumferential direction, to one of the two end-to-end channels (22) of the first fluid channel structure (20) and extends between the first end and the second end, and
 a fluid passage (24, 23), which is arranged at the other one of the first end and the second end and extends, preferably along the circumferential direction, between the at least one further end-to-end channel (22) and the adjacent one of the two end-to-end channels (22) of the first fluid channel structure (20).
7. Tank casing (2, 102, 202) according to any one of the preceding claims, wherein the refrigerant reservoir (3) extends from the first end to the second end along the longitudinal direction (L), wherein the second fluid channel structure (30) includes:
- two end-to-end channels (32) arranged adjacently in the circumferential direction, each extending between the first end and the second end, and
 a fluid passage (33, 34), which is arranged at one of the first end and the second end and extends, preferably along the circumferential direction, between the adjacent two end-to end fluid channels (32) of the second fluid channel structure (30).
8. Tank casing (2, 102, 202) according to claim 7, wherein the second fluid channel structure (30) includes:
- at least one further end-to-end channel (32), which is arranged adjacently, in the circumferential direction, to one of the two end-to-end channels (32) of the second fluid channel structure (30) and extends between the first end and the second end, and
 a fluid passage (34, 33), which is arranged at the other one of the first end and the second end and extends, preferably along the circumferential direction, between the at least one further end-to-end channel (32) and the adjacent one of the two end-to-end channels (32) of the second fluid channel structure (30).
9. Tank casing (2, 102, 202) according to any one of the claims 5 to 8, wherein all end-to-end channels (22, 32) are integrally formed within a circumferential wall (10, 210) of the tank casing (2, 102, 202).
10. Tank casing (22, 102, 202) according to any one of the preceding claims, wherein the circumferential wall (10, 210) of the tank casing (2, 102, 202) is at least one of
- made of aluminum alloy and
 - made by extrusion.
11. Tank casing (2, 102, 202) according to any one of the preceding claims, wherein the tank casing (2, 102, 202) includes an integral discharge duct (20, 41, 48, 62, 65, 341, 358) for supplying refrigerant from the refrigerant reservoir (3) to a first refrigerant outlet (66), wherein the first fluid channel structure (20) forms part of the discharge duct (20, 41, 48, 62, 65, 341, 358), and wherein at least one of
- a discharge expansion valve (64) and
 - a mount (63) for the discharge expansion valve (64)
- is arranged in the discharge duct (20, 41, 48, 62, 65, 341, 358) between the first fluid channel structure (20) and the first refrigerant outlet (66).
12. Tank casing (2, 102, 202) according to any one of the preceding claims, wherein the tank casing (2, 102, 202) includes an integral economizer duct (30, 41, 44, 47, 67, 341, 358) for supplying refrigerant from the refrigerant reservoir (3) to a second refrigerant outlet (68), wherein the second fluid channel structure (30) forms part of the economizer duct (30, 41, 44, 47, 67, 341, 358), and wherein at least one of
- an economizer expansion valve (46) and
 - a mount (45) for mounting the economizer expansion valve (46)
- is arranged in the economizer duct (30, 41, 44, 47, 67, 341, 358) between the refrigerant reservoir (3) and the second fluid channel structure (30).
13. Tank casing (2, 102, 202) according to claim 11 or 12, wherein at least one of
- a refrigerant dryer (51, 351) and
 - a mount (50, 350) for the refrigerant dryer (51, 351)

is arranged in the discharge duct (20, 41, 48, 62, 65, 341, 358) between the refrigerant reservoir (3) and the first fluid channel structure (20) and/or in the economizer duct (30, 41, 44, 47, 67, 341, 358) between the refrigerant reservoir (3) and the economizer expansion valve (46).

14. Tank casing (2, 102, 202) according to any one of the preceding claims, wherein the tank casing (2, 102, 202) includes at least one of

- an isolation valve (43) for opening and closing an outlet (41) of the refrigerant reservoir (3) and
- a mount (42) for the isolation valve (43).

15. Tank casing (210) according to any one of the preceding claims, wherein a condenser (280) is formed monolithically with the tank casing (210) by brazing.

Amended claims in accordance with Rule 137(2) EPC.

1. Tank casing (2, 102, 202) for enclosing a refrigerant reservoir (3) of a refrigerant receiver (1, 100, 200), wherein an inner volume of the tank casing (2, 102, 202) is configured to constitute the refrigerant reservoir (3) of the refrigerant receiver (1, 100, 200) and the tank casing (2, 102, 202) has a first refrigerant outlet (66),

wherein a first fluid channel structure (20) and a separate second fluid channel structure (30) for an integrated heat exchanger functionality are integrally formed in a wall of the tank casing (2, 102, 202) enclosing the refrigerant reservoir (3), **characterized in that** the tank casing (2, 102, 202) includes an integral economizer duct (30, 41, 44, 47, 67, 341, 358) for supplying refrigerant from the refrigerant reservoir (3) to a second refrigerant outlet (68), wherein the second fluid channel structure (30) forms part of the integral economizer duct (30, 41, 44, 47, 67, 341, 358), and wherein at least one of

- an economizer expansion valve (46) and
- a mount (45) for mounting the economizer expansion valve (46) is arranged in the integral economizer duct (30, 41, 44, 47, 67, 341, 358) between the refrigerant reservoir (3) and the second fluid channel structure (30).

2. Tank casing (2, 102, 202) according to claim 1, wherein the first fluid channel structure (20) includes at least one meandering flow path (21a, 21b) for fluid and the second fluid channel structure (30) includes at least one meandering flow path (31a, 31b) for fluid.
3. Tank casing (2, 102, 202) according to claim 2, wherein the first fluid channel structure (20) branch-

es into its at least one meandering flow path (21a, 21b) and a further meandering flow path (21b, 21a) of the first fluid channel structure (20) and/or wherein the second fluid channel structure (30) branches into its at least one meandering flow path (31a, 31b) and a further meandering flow path (31b, 31a) of the second fluid channel structure (30).

4. Tank casing (2, 102, 202) according to any one of the preceding claims, wherein the second fluid channel structure (30) is arranged between the first fluid channel structure (20) and the refrigerant reservoir (3).

5. Tank casing (2, 102, 202) according to any one of the preceding claims, wherein refrigerant reservoir (3) extends from a first end to a second end along a longitudinal direction (L), wherein the first fluid channel structure (20) includes:

two end-to-end channels (22) arranged adjacently in a circumferential direction, each extending between the first end and the second end, and

a fluid passage (23, 24), which is arranged at one of the first end and the second end and extends, preferably along the circumferential direction, between the adjacent two end-to end fluid channels (22) of the first fluid channel structure (20).

6. Tank casing (2, 102, 202) according to claim 5, wherein the first fluid channel structure (20) includes:

at least one further end-to-end channel (22), which is arranged adjacently, in the circumferential direction, to one of the two end-to-end channels (22) of the first fluid channel structure (20) and extends between the first end and the second end, and

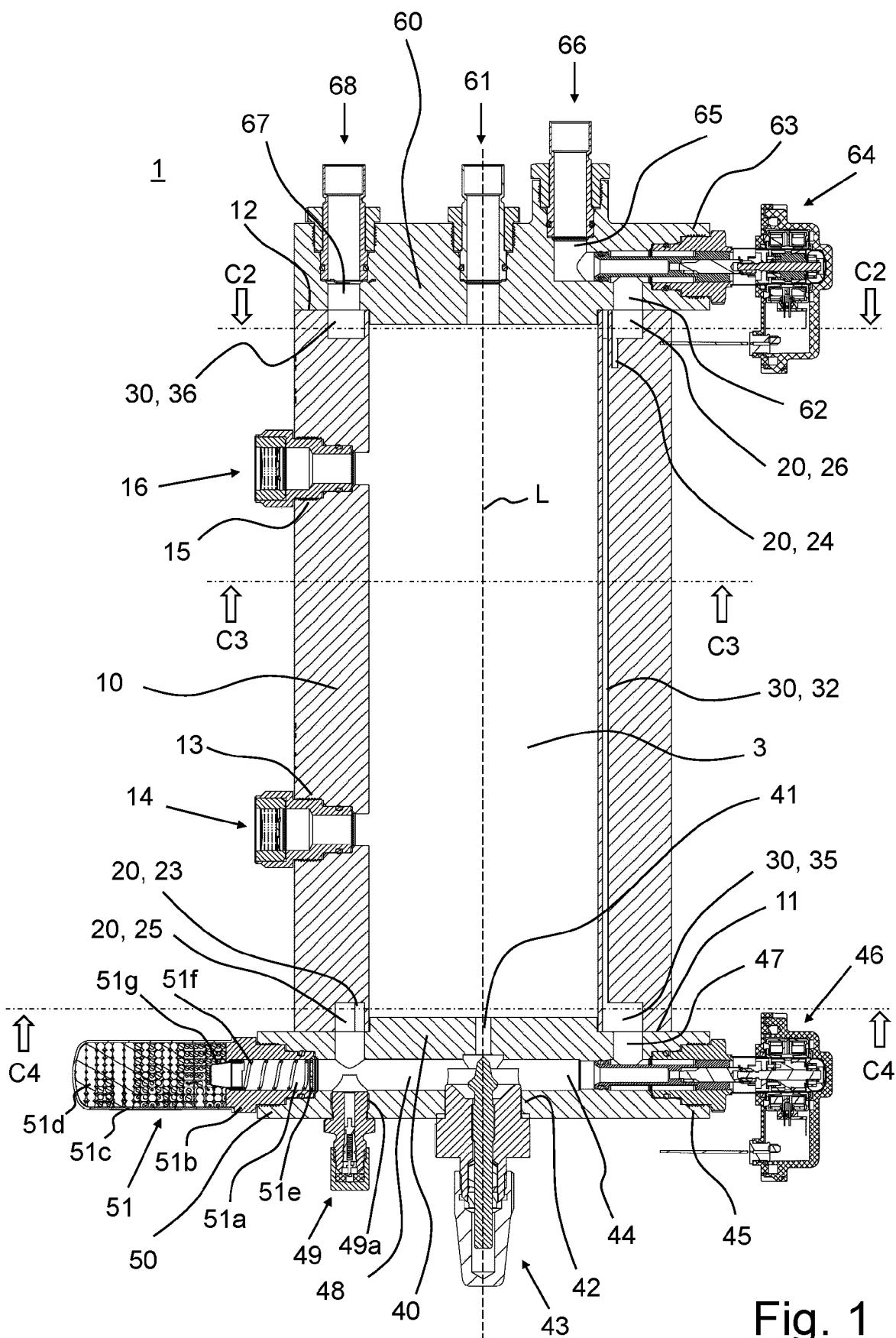
a fluid passage (24, 23), which is arranged at the other one of the first end and the second end and extends, preferably along the circumferential direction,

between the at least one further end-to-end channel (22) and the adjacent one of the two end-to-end channels (22) of the first fluid channel structure (20).

7. Tank casing (2, 102, 202) according to any one of the preceding claims, wherein the refrigerant reservoir (3) extends from the first end to the second end along the longitudinal direction (L), wherein the second fluid channel structure (30) includes:

two end-to-end channels (32) arranged adjacently in the circumferential direction, each extending between the first end and the second

- end, and
a fluid passage (33, 34), which is arranged at one of the first end and the second end and extends, preferably along the circumferential direction, between the adjacent two end-to-end fluid channels (32) of the second fluid channel structure (30).
8. Tank casing (2, 102, 202) according to claim 7, wherein the second fluid channel structure (30) includes:
- at least one further end-to-end channel (32), which is arranged adjacently, in the circumferential direction, to one of the two end-to-end channels (32) of the second fluid channel structure (30) and extends between the first end and the second end, and
a fluid passage (34, 33), which is arranged at the other one of the first end and the second end and extends, preferably along the circumferential direction, between the at least one further end-to-end channel (32) and the adjacent one of the two end-to-end channels (32) of the second fluid channel structure (30).
9. Tank casing (2, 102, 202) according to any one of the claims 5 to 8, wherein all end-to-end channels (22, 32) are integrally formed within a circumferential wall (10, 210) of the tank casing (2, 102, 202).
10. Tank casing (22, 102, 202) according to claim 9, wherein the circumferential wall (10, 210) of the tank casing (2, 102, 202) is at least one of
- made of aluminum alloy and
 - made by extrusion.
11. Tank casing (2, 102, 202) according to any one of the preceding claims, wherein the tank casing (2, 102, 202) includes an integral discharge duct (20, 41, 48, 62, 65, 341, 358) for supplying refrigerant from the refrigerant reservoir (3) to the first refrigerant outlet (66), wherein the first fluid channel structure (20) forms part of the discharge duct (20, 41, 48, 62, 65, 341, 358), and wherein at least one of
- a discharge expansion valve (64) and
 - a mount (63) for the discharge expansion valve (64)
- is arranged in the discharge duct (20, 41, 48, 62, 65, 341, 358) between the first fluid channel structure (20) and the first refrigerant outlet (66).
12. Tank casing (2, 102, 202) according to any of the preceding claims, wherein the tank casing (2, 102, 202) is configured for fluid supply from the refrigerant reservoir (3) to the first fluid channel structure (20) and to the second fluid channel structure (30).
13. Tank casing (2, 102, 202) according to claim 11 or 12, wherein at least one of
- a refrigerant dryer (51, 351) and
 - a mount (50, 350) for the refrigerant dryer (51, 351)
- is arranged in the discharge duct (20, 41, 48, 62, 65, 341, 358) between the refrigerant reservoir (3) and the first fluid channel structure (20) and/or in the integral economizer duct (30, 41, 44, 47, 67, 341, 358) between the refrigerant reservoir (3) and the economizer expansion valve (46).
14. Tank casing (2, 102, 202) according to any one of the preceding claims, wherein the tank casing (2, 102, 202) includes at least one of
- an isolation valve (43) for opening and closing an outlet (41) of the refrigerant reservoir (3) and
 - a mount (42) for the isolation valve (43).
15. Tank casing (210) according to any one of the preceding claims, wherein a condenser (280) is formed monolithically with the tank casing (210) by brazing.



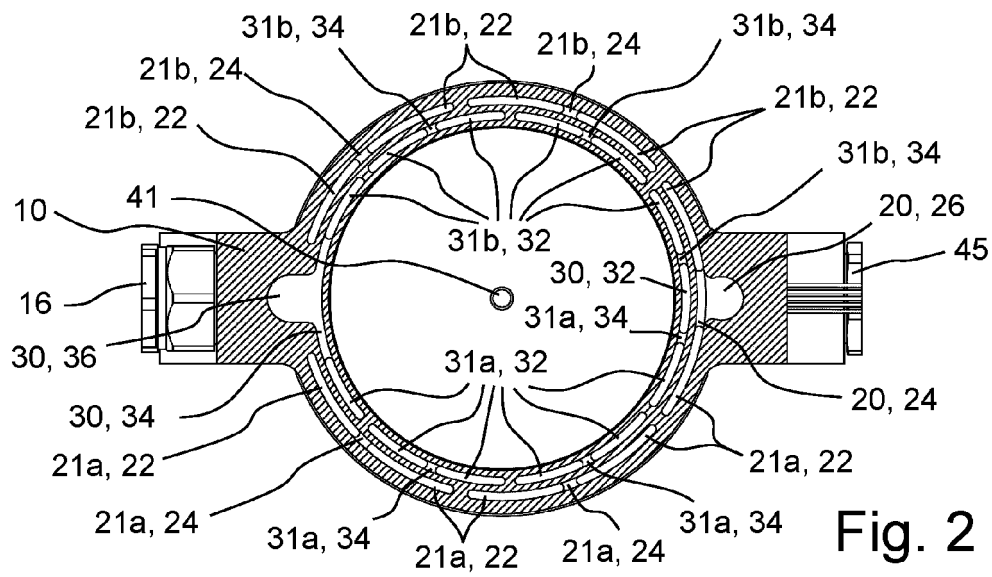


Fig. 2

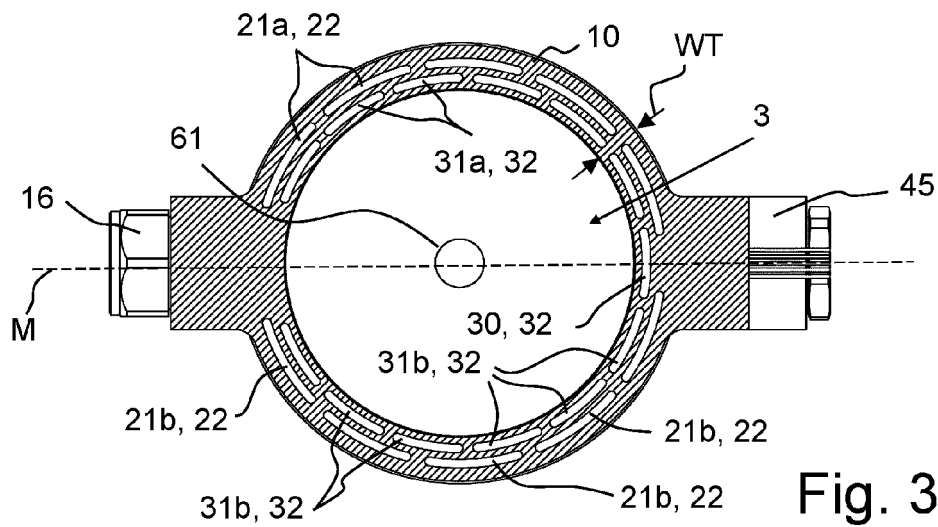


Fig. 3

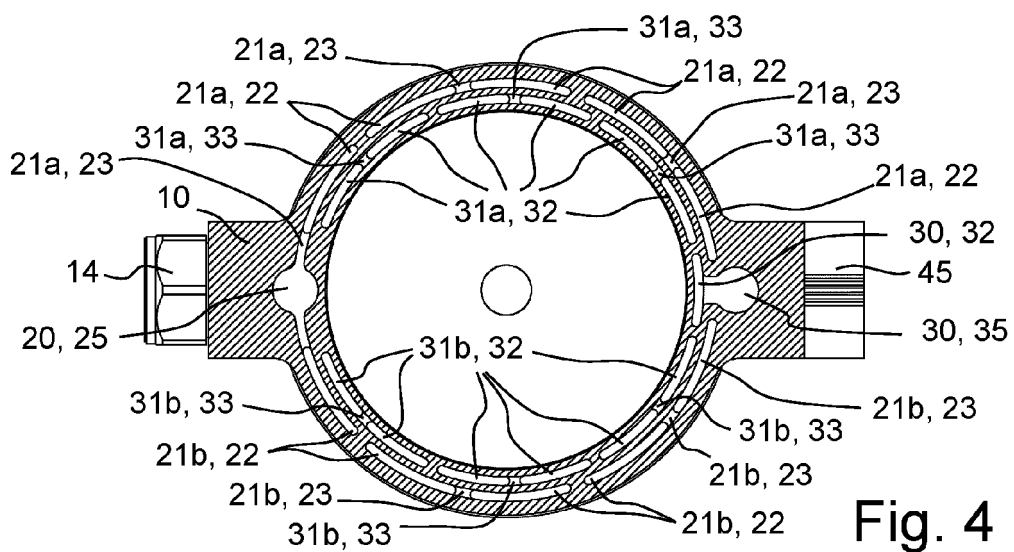


Fig. 4

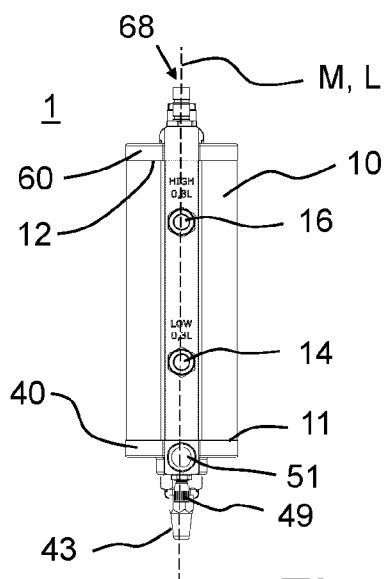


Fig. 5

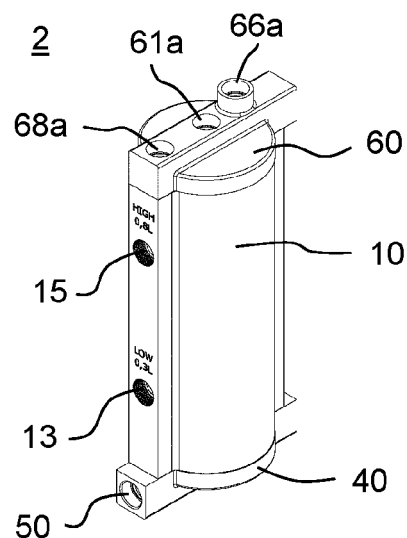


Fig. 6

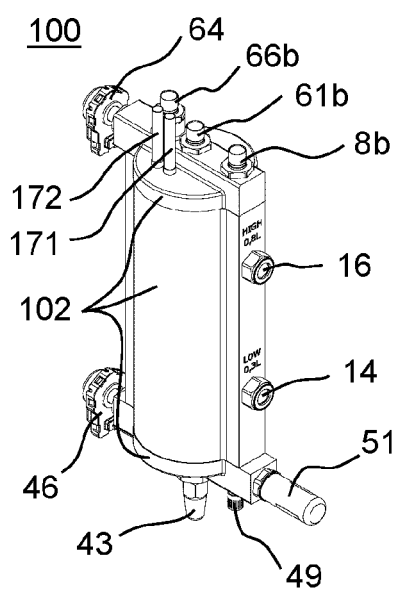


Fig. 7

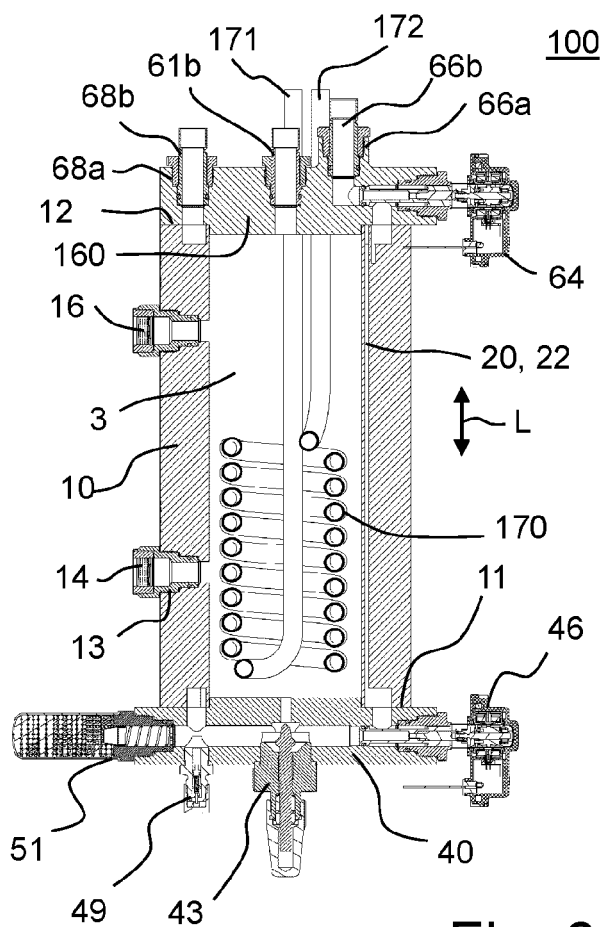
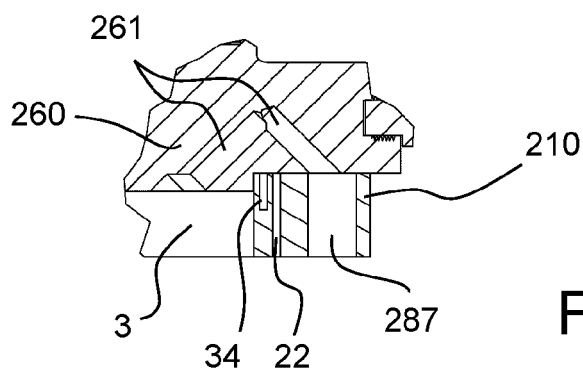
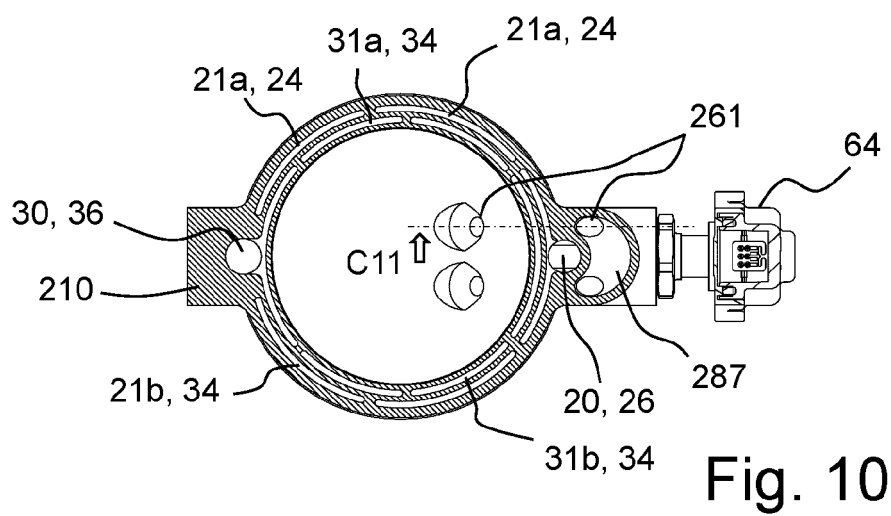
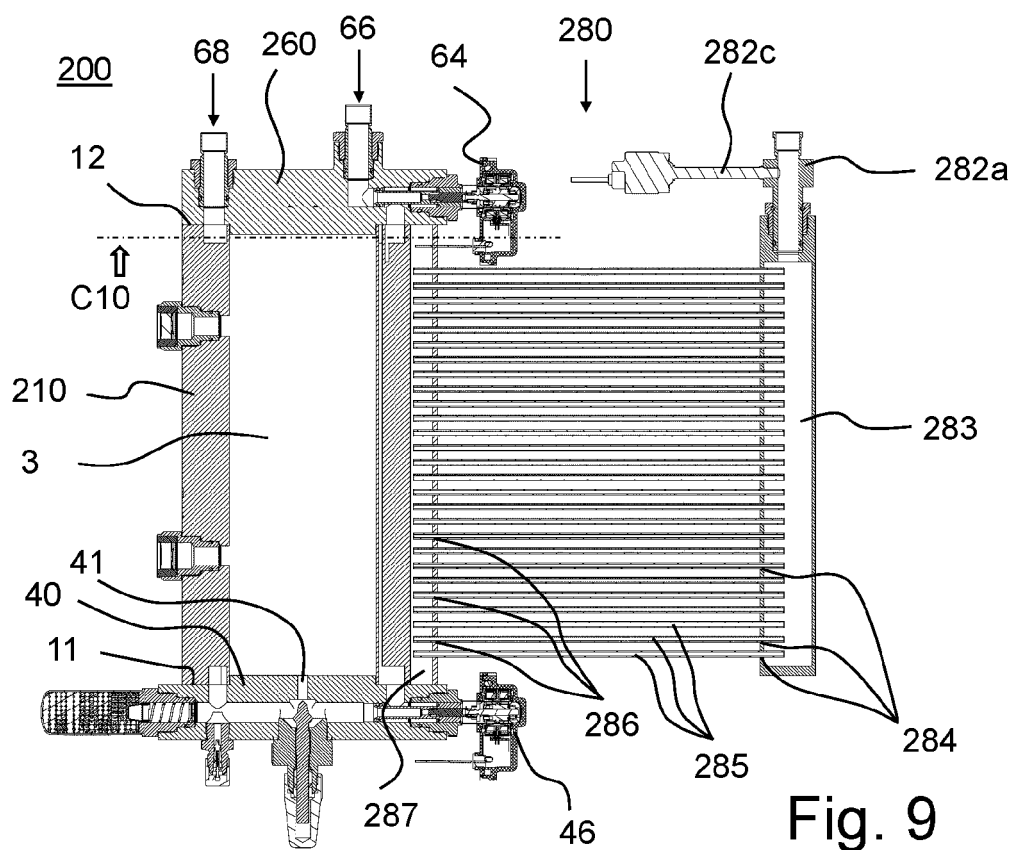


Fig. 8



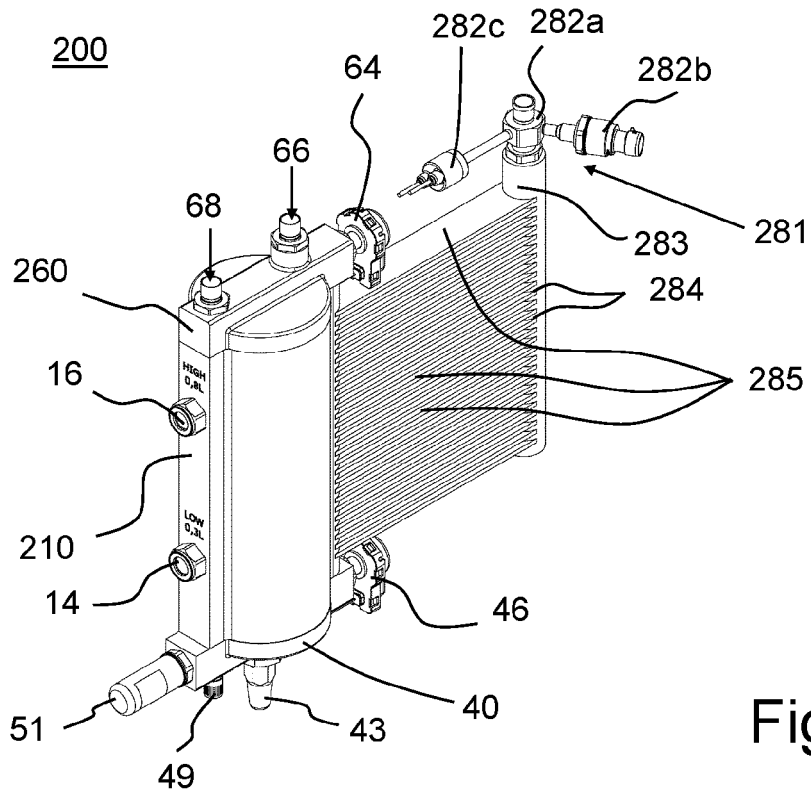


Fig. 12

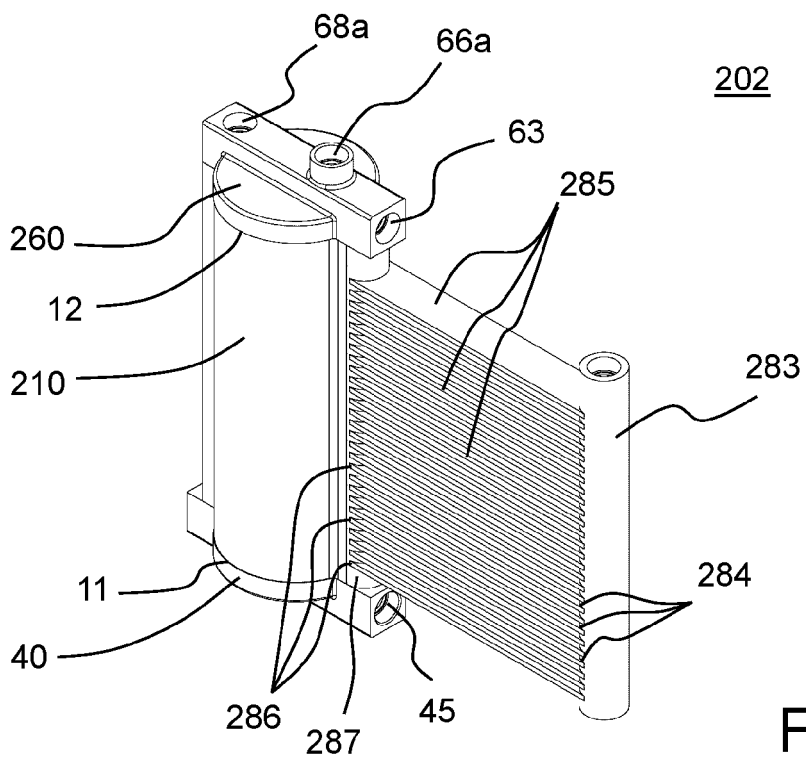


Fig. 13

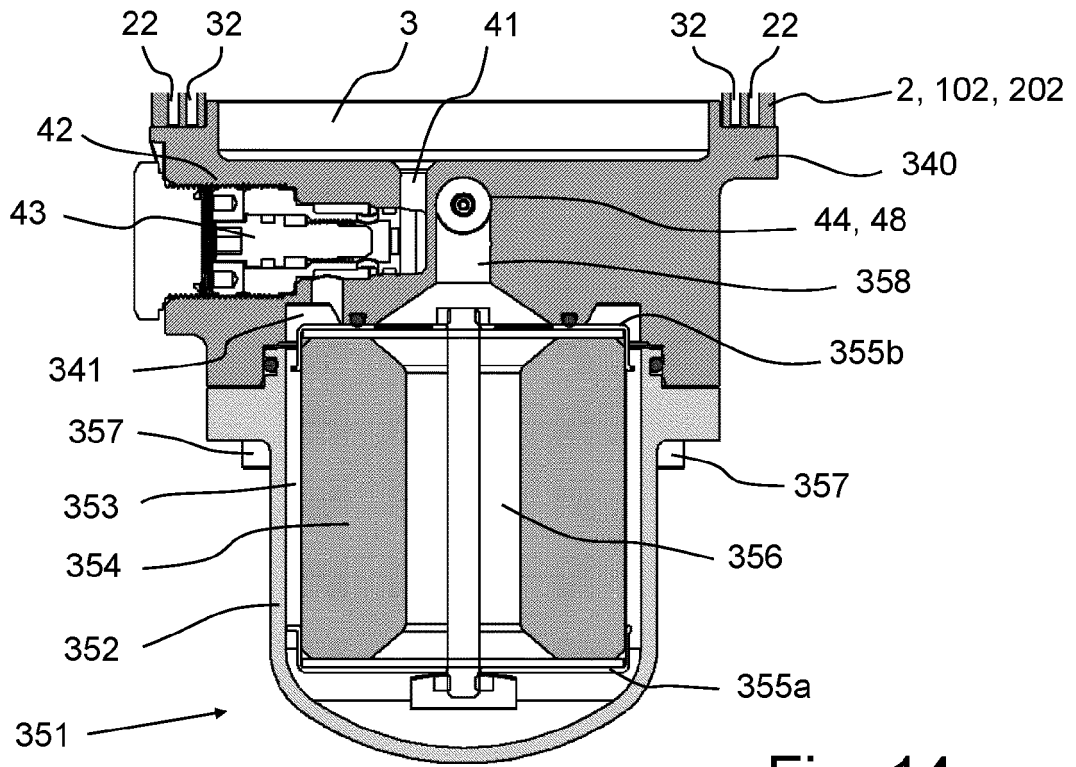


Fig. 14

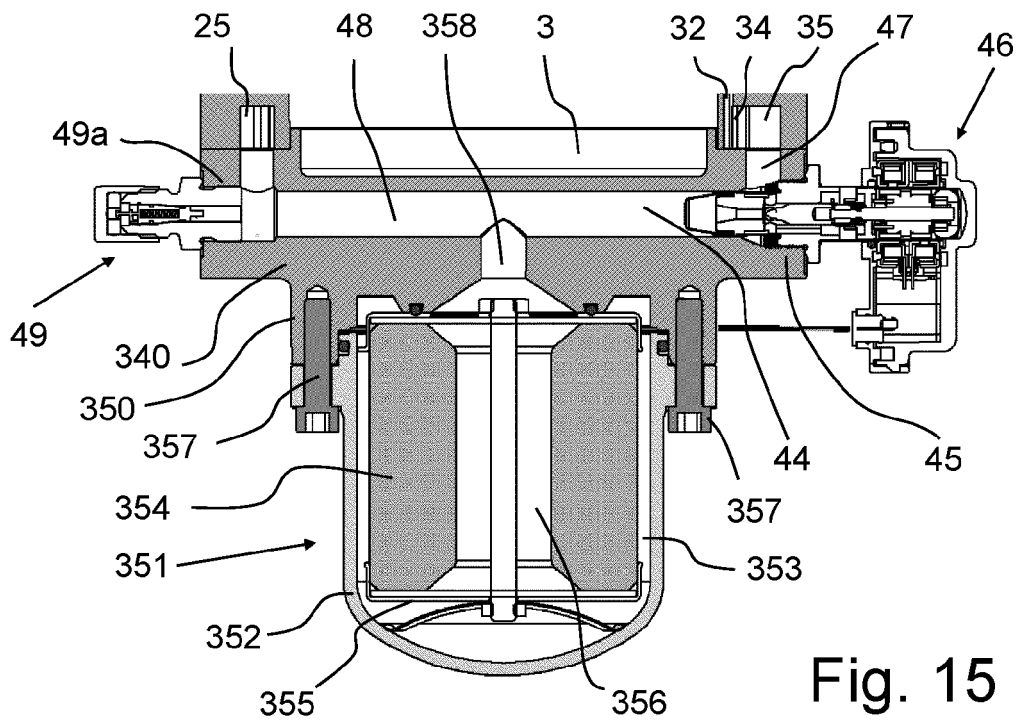


Fig. 15



EUROPEAN SEARCH REPORT

Application Number

EP 22 20 7325

5

10

15

20

25

30

35

40

45

50

55

1

EPO FORM 1503 03.82 (P04C01)

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	DE 10 2020 202313 A1 (MAHLE INT GMBH [DE]) 26 August 2021 (2021-08-26) * & associated description; figures 2-6 *	1-15	INV. F28D7/00
X	EP 1 647 792 A2 (VALEO KLIMASYSTEME GMBH [DE]) 19 April 2006 (2006-04-19) * the whole document *	1-10, 15 11-14	
A	DE 10 2011 111964 A1 (IXETIC BAD HOMBURG GMBH [DE]) 28 February 2013 (2013-02-28) * the whole document *	1-15	
			TECHNICAL FIELDS SEARCHED (IPC)
			F25B F28D F28F
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 20 March 2023	Examiner Gaspar, Ralf
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO.

EP 22 20 7325

5

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 The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

20-03-2023

10

15

20

25

30

35

40

45

50

55

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE 102020202313 A1	26-08-2021	CN 113294942 A	24-08-2021
		DE 102020202313 A1	26-08-2021
		US 2021260966 A1	26-08-2021
EP 1647792 A2	19-04-2006	AT 516474 T	15-07-2011
		DE 102004050409 A1	27-04-2006
		EP 1647792 A2	19-04-2006
		ES 2369141 T3	25-11-2011
		JP 5350578 B2	27-11-2013
		JP 2006112778 A	27-04-2006
		PL 1647792 T3	31-01-2012
		US 2006080997 A1	20-04-2006
DE 102011111964 A1	28-02-2013	CN 103765130 A	30-04-2014
		DE 102011111964 A1	28-02-2013
		DE 112012003568 A5	12-06-2014
		EP 2751502 A1	09-07-2014
		JP 6072037 B2	01-02-2017
		JP 2014525559 A	29-09-2014
		KR 20140105429 A	01-09-2014
		US 2014174120 A1	26-06-2014
		WO 2013029769 A1	07-03-2013