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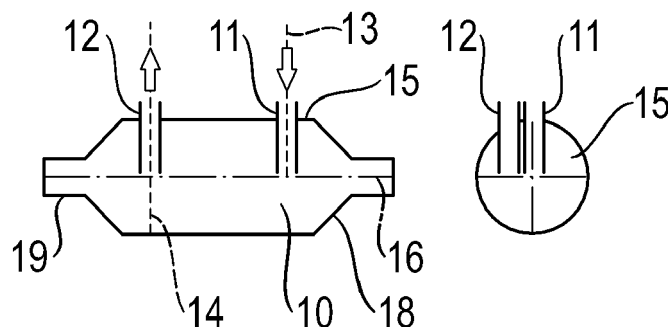
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Amended claims in accordance with Rule 137(2) EPC.

(54) **HEAT PUMP COMPRISING A MUFFLER**

(57) The invention comprises a heat pump comprising a heat source heat exchanger, a compressor, a utilization side heat exchanger and an expansion valve connected by refrigerant piping; and a muffler having first and second ports and a pressure pulsation reducing space, the pressure pulsation reducing space being in fluid communication with at least the first port and the

second port, wherein the first and second ports are respectively connected to the refrigerant piping, characterized in that a first centre axis of the first port and a second centre axis of the second port are oriented so that a flow direction of refrigerant flowing in the refrigerant piping changes at least once between the first port and the second port.

Fig. 2



Description

Technical field

[0001] The present invention relates to a heat pump comprising a muffler, for example a heat pump to be used in an air conditioner.

Technical problem

[0002] In heat pumps, such as heat pumps used in air conditioners, a heat source heat exchanger, a compressor, a utilisation side heat exchanger and an expansion valve are connected by refrigerant piping. The compressor often contains an electric motor, which produces noise. This noise can be transmitted via the refrigerant, for example to the room to be air conditioned where it will be deemed disturbing. In particular, such air conditioners are frequently used in domestic and work environments, where noise should be kept to a minimum so as to not disturb sleep or to distract employees.

[0003] In order to attenuate the noise, it has, in the prior art, been the case that mufflers have been used (cf. EP 2 058 609 A1). A typical prior art muffler 10' is shown in Figure 1. The left part of that figure shows a cross-section along the length of the muffler 10' whilst the right part of that figure shows a cross-section perpendicular to the length of the muffler 10'.

[0004] This muffler 10' is provided as part of the refrigerant piping so that refrigerant can be led through it via a first port 11' and an outlet port 12'. Noise sound waves carried by the refrigerant entering through the first port 11' will (partially) impinge on the enlarged section A of the muffler 10'. This reflection will cause them to lose some of their energy, which will lead to an attenuation of the noise.

[0005] In that case, the area S1 of the enlarged section A is determinative in the attenuation of the noise. Put simply, the larger it is, the stronger the attenuation. However, one cannot enlarge this area indefinitely.

[0006] An additional issue is that the attenuation of the noise also depends on the length of the muffler 10'. Typical noise from a compressor has a frequency of 50 Hz to 400 Hz. This leads to a wavelength of from about 1 to about 4 m. The muffler should be larger than that wavelength or should at least have a length of half that wavelength, which would lead to mufflers having a length of between about 1 to 4 m. It is clear that such mufflers would be too long for being installed in a lot of domestic and work environments.

[0007] It is also to be noted that sound from a compressor will have a main frequency f , but will also have higher order harmonics $2f$, $4f$, $6f$, Also those components need to be dampened. Additionally, the wavelength depends on the state of the refrigerant and in particular on its density and its temperature, since the temperature and the density of the refrigerant strongly affects the speed of sound v in that medium. This is because the

wavelength λ of the sound is equal to v/f . It is therefore clear that one wants to have a heat pump comprising a muffler where the noise dampening performance does not significantly depend on the state of the refrigerant, given its variability.

[0008] Additionally, one often has resonance in the mufflers if the frequencies present in the noise match with the resonant frequencies of the muffler. Given the increased volume of those frequency components thanks to the resonance, it is important to avoid a resonant behaviour or to also dampen those components.

Summary of the invention

[0009] The present invention aims to solve or at least alleviate some of the problems mentioned above.

[0010] The invention is defined by claim 1. Preferred embodiments are defined in the dependent claims.

[0011] According to claim 1, a heat pump comprises a heat source heat exchanger, a compressor, a utilisation side heat exchanger and an expansion valve connected by refrigerant piping.

[0012] The heat pump comprises a muffler which has first and second ports (inlet and outlet, respectively) and a pressure pulsation reducing space. By the first and second ports, we mean any inlet/outlet which can be used for introducing a refrigerant into the pressure pulsation reducing space or through which a refrigerant can be led out of that space. The pressure pulsation reducing space is an enclosed space. The shape of the pressure pulsation reducing space is nonlimited and could, in principle, be any sort of shape as long as a space is enclosed. In most practical situations, it will have the shape of a closed cylinder (i.e. a cylinder which is blind at both ends). However, purely from the point of view of noise attenuation, a spherical shape would be preferable. The first and the second ports are respectively connected to the refrigerant piping and are also in communication with the pressure pulsation reducing space. Through those ports, a fluid (such as the refrigerant) can flow into the pressure pulsation reducing space and can then flow out of it.

[0013] According to the invention, a first centre axis of the first port and a second centre axis of the second port are oriented so that a flow direction of the refrigerant flowing in through the first port and exiting the pressure pulsation reducing space via the second port changes at least once between the first port and the second port. This means, for example, that the first port and the second port cannot be axially aligned with each other, since otherwise, no such change in the fluid flow direction would be induced. The centre axis of a port is defined as the axis at which the refrigerant leaves the port and flows into the pressure pulsation reducing space. In most cases, it will be the centre axis of the pipe constituting the port. In other cases, it may be the centre axis of one opening provided at the end of or in the shell of the pipe constituting the port.

[0014] By enforcing this change in direction of the re-

frigerant flow, the refrigerant needs to lose energy thanks to it having to change its direction. This then means that some energy is lost, which, in turn, reduces the noise, in particular at audible frequencies. This reduction in noise volume occurs regardless of the frequency. Also, since there will almost certainly be reflections of the refrigerant at the housing of the pressure pulsation reducing space, those reflections will lead to a significant energy loss of the sound wave, thus reducing the noise volume. Further, due to the reflections, an interference phenomenon occurs, which tends to reduce the sound volume which is transmitted through the muffler. The energy which is lost will be converted into thermal energy (heat).

[0015] If a pressure pulsation reducing space is used which is spherical, this shape would lead to the highest number of sound wave reflections and to the highest corresponding reduction in noise volume. However, such a heat pump would also be comparatively expensive to produce.

[0016] In a preferred embodiment, the first and second centre axes are parallel to each other and offset. This means that a particularly high number of reflections occurs, so that the noise attenuation is particularly significant.

[0017] It is also preferred if the first and second centre axes are offset in two directions. That is, when viewed along the longitudinal direction of the pressure pulsation reducing space, the first and second centre axis are at different positions. By this feature, a large number of reflections is achieved.

[0018] It is also possible that the first and second centre axes are at an angle relative to each other. This, again, leads to a comparatively high number of reflections and, accordingly, a significant attenuation whilst giving greater flexibility in the design of the muffler.

[0019] In that particular context, it is preferred if the first and second centre axis are perpendicular to each other. By them being arranged at a right angle, the reflections are particularly strong, so that the noise attenuation is particularly pronounced.

[0020] It is also preferred that the pressure pulsation reducing space has a circular cross-section, with the cross-section being perpendicular to the longitudinal axis of the pressure pulsation reducing space. Such a circular cross-section leads to a significant number of reflections, which is beneficial for attenuating noise. This feature could, for example, be realised by a cylindrical or spherical pressure pulsation reducing space.

[0021] In that context, it is preferred if the diameter of the pressure pulsation reducing space is larger than the diameter of the first port and/or the second port. As a result, since the cross-sectional area of the pressure pulsation reducing space will be larger than that of the first and the second port, a significant number of reflections will occur, which is, again, beneficial for reducing the sound volume of the noise.

[0022] It is also preferred that the pressure pulsation reducing space has a cylindrical portion, wherein a third

centre axis of the cylindrical portion is non-parallel to the first centre axis of the first port and/or the second centre axis of the second port. By the centre axis of the cylindrical portion of the pressure pulsation reducing space being nonparallel to at least one of the first and the second centre axes of the first and second port, it becomes possible to ensure that the sound which enters from the first or the second port has to bounce several times in the pressure pulsation reducing space, which reduces the sound volume.

[0023] In that context, it is particularly preferred if the third centre axis is perpendicular to the first centre axis and/or the second centre axis. A large number of reflections occurs in such a case, which attenuates the noise.

[0024] It is also preferred that the first centre axis extends along a chord of the cylindrical portion and the second centre axis extends radially. By such a configuration, the sound which enters via the first port will need to "flow" along the wall of the cylindrical portion and will thus have to significantly change its direction in order to enter into the second port. This leads to a strong loss in noise volume.

[0025] It is also preferred that the first and the second port each comprise a pipe having opposite first and second ends, where the first end is connected to the refrigerant piping and where the second end is located within the pressure pulsation reducing space, compared with the second end being provided in the wall of the pressure pulsation reducing space, without extending into that pressure pulsation reducing space. I.e., the second end is located in the interior of the pressure pulsation reducing space. By doing so, the refrigerant flow needs to change direction significantly, again leading to a significant reduction in noise volume.

[0026] It is preferred that an opening of the pipes at the second end has a smaller cross-sectional area than an opening at the first end. By requiring the refrigerant to "squeeze" through those openings, a significant reduction in volume occurs.

[0027] It is also preferred that the second end is closed and at least one opening is provided in a shell of the pipe adjacent the second end. Again, a change of direction of the refrigerant is enforced, thanks to it having to squeeze through the openings, which reduces the noise volume.

[0028] It is also possible that a plurality of openings are provided in the shell of the pipe adjacent the second end. By such a plurality of openings, the refrigerant enters in a variety of directions, which reduces the noise.

[0029] It is also preferred that the second port opens into the pressure pulsation reducing space in a bottom portion of the pressure pulsation reducing space. That is, the heat pump is to be arranged so that the second end of the second port is arranged in a bottom portion (for example the bottom half or the bottom third of the pressure pulsation reducing space) rather than a top portion of the pressure pulsation reducing space. The reason for this is that, when in use, oil will often accumulate in the pressure pulsation reducing space. By the second

port being arranged in that space where, potentially, oil is present, the interaction of the refrigerant with that oil reduces the noise volume.

Brief description of the drawings

[0030]

- Fig. 1 shows a muffler for use in a prior art heat pump.
- Fig. 2 shows a muffler for use in a heat pump according to a first embodiment.
- Fig. 3 shows a muffler for use in a heat pump according to a second embodiment.
- Fig. 4 shows a muffler for use in a heat pump according to a third embodiment.
- Fig. 5 shows a muffler for use in a heat pump according to a fourth embodiment.
- Fig. 6 shows a muffler for use in a heat pump according to a fifth embodiment.
- Fig. 7 shows two mufflers for use in a heat pump according to a sixth embodiment.
- Figure 8 shows a muffler for use in a heat pump according to an eighth embodiment.
- Figure 9 shows a heat pump circuit comprising a heat pump according to the invention.

Detailed description of the drawings

[0031] Figure 2 shows a muffler for use in a heat pump according to a first embodiment. The left drawing shows a longitudinal cross-section whilst the right drawing shows a cross-section taken perpendicular to the longitudinal direction.

[0032] The muffler has a first port 11 and a second port 12 and a cylindrical pressure pulsation reducing space 10 into which the first and the second ports 11, 12 extend with their second ends, with their first ends being outside of the pressure pulsation reducing space 10. The pressure pulsation reducing space 10 has a roughly cylindrical shape, with tapered portion ends 18 and tube-like stubs 19 at the outer ends of the tapered portions 18. The tapering is provided at each longitudinal end of a cylindrical space 15. As can be seen in the drawing shown at the right of Figure 2, the first and second ports 11, 12 extend parallel to each other but are displaced relative to each other - i.e., they are not provided at the same position when viewed along the third centre axis 16 of the cylindrical space 15. They have a roughly equal length and extend to approximately the same position

inside the cylindrical space 15, as seen in the cross-sections shown in Figure 2. By them being parallel to each other, it is meant that the first centre axis 13 of the first port 11 and the second centre axis 14 of the second port 12 are parallel to each other. The first and second centre axes 13, 14 extend perpendicular to the third centre axis 16 of the cylindrical portion 15. Since any sound entering via the first port 11 has to undergo a change of direction before it leaves through the second port 12 (and most likely several such changes of direction), the noise volume will be attenuated.

[0033] Further, compared with Figure 1, the area with which the sound waves can interfere and by which they can be reflected is much larger - whilst in the case of Figure 1, only the area S1 was available for such reflections, it is now possible to reflect the sound waves by the whole length of the cylindrical portion 15.

[0034] Ideally, the muffler should be arranged in the configuration shown in in Figure 2, i.e. with the first and second ports 11, 12 pointing upwards (or, alternatively, horizontal). This is because during use, oil will accumulate at the bottom of the pressure pulsation reducing space 10.

[0035] Figure 3 shows the configuration of a muffler for use in a heat pump according to the second embodiment. Here, there are, again, a first port 11 and a second port 12 with respective first and second centre axes 13, 14. However, in the present embodiment, the pressure pulsation reducing space 10 uses a simple pipe as the cylindrical portion 15 and has two closed ends (stubs) 19 which extend past the points where the first and second ports 11, 12 are connected to the cylindrical portion 15. The first and second ports 11, 12 are arranged so that their first and second centre axes 13, 14 are perpendicular to the third centre axis 16 of the cylindrical portion 15. Such a device is easier to manufacture than the more complicated muffler according to Figure 2. Stubs 19 lead to further reflections of the sound wave, thus leading to a stronger attenuation of the noise. The diameter of the cylindrical portion 15 is greater than or equal to the diameter of the first port 11 (which serves as the inlet). The diameter of the first port 11 is greater than the diameter of the second port 12. This also reduces the noise volume.

[0036] Figure 4 shows a muffler for use in a heat pump according to a third embodiment. Again, a cylindrical portion 15 having cone-shaped tapered portions 18 leading into closed pipe stubs 19 constitutes the pressure pulsation reducing space 10. Into this space, at an approximately perpendicular direction relative to the third centre axis 16 of the pressure pulsation reducing space 10, first and second ports 11, 12 are provided so as to extend into the pressure pulsation reducing space 10. The first port 11 has a curvature along its length and has a hole 22 in its sidewall which, in addition to an opening at the second end of that port, allows for a refrigerant to enter into the pressure pulsation reducing space 10. The second port 12 has a tapered second end 12' which is closed

and has also provided in its side wall several holes 21. By the bend in the first port 11, and by the holes 21, 22, a change in direction of the refrigerant is enforced, which reduces the sound volume.

[0037] Figure 5 shows a muffler for use in a heat pump according to the fourth embodiment. The pressure pulsation reducing space 10 comprises a cylindrical portion 15 which has tapered portions 18 at either end. One of those tapered portions 18 leads into a closed pipe stub 19, but the respective other tapered portion 18 leads to the second port 12. The first port 11 is provided so as to extend into the cylindrical portion 15 and extends along a radial direction and past the centre of the cylindrical portion 15 when viewed perpendicularly to both the third centre axis 16 and to the respective one of the first and second centres axis 11, 12. The first centre axis 13 of the first port is at right angles to the second centre axis 14 of the second port 12.

[0038] Figure 6 shows a muffler for use in the fifth embodiment of the present invention. A first port 11 and a second port 12 extend into the cylindrical portion 15 such that the first and second centre axes 13, 14 are at right angles relative to the third centre axis 16 of the cylindrical portion 15. The pressure pulsation reducing space 10 comprises the cylindrical portion 15 which is joined at either longitudinal end to tapered portions 18 which lead into closed pipe stubs 19. Both the first and the second port 13, 14 extend past the centre of the cylindrical portion 15 when viewed perpendicularly to both the third centre axis 16 and to the respective one of the first and second centres axis 11, 12.

[0039] Figure 7 shows two mufflers for use in a heat pump according to the sixth embodiment. Figure 7a) shows a first variant of a muffler which can be used in that embodiment. A pressure pulsation reducing space 10 comprises a cylindrical portion 15 which is joined, at either longitudinal end, to tapered portions 18 leading into closed pipe stubs 19. Into the cylindrical portion 15, a single pipe constituting the first port 11 extends from one side whilst, from the respective other side, two pipes extend into the cylindrical portion 15. Those two pipes form the second port 12. The second ends of the pipe of the first port 11 and of the pipes of the second port 12 are arranged such that they extend past each other and past the centre of the cylindrical portion when viewed perpendicularly to both the third centre axis 16 and to the respective one of the first and second centres axes 13, 14. In that way, a refrigerant which enters via the first port 11 will need to flow backwards before it can leave via the second ports 12. This enforced change of direction reduces the noise volume.

[0040] Figure 7b) shows the muffler according to a second variant. A pressure pulsation reducing space 10 comprises a cylindrical portion 15 which is joined, at either longitudinal end, to tapered portions 18. One of those tapered portions 18 leads into a pipe stub 19 whilst the respective other tapered portion 18 leads into a bent pipe 24 which is then connected to the cylindrical portion 15

so that its end extends through that wall and opens towards the interior of the cylindrical portion 15. There are furthermore provided first and second ports 11, 12, whose second ends extend into the space defined by the cylindrical portion 15. By the configuration described above, any pressure pulsations can also be transmitted into the bent pipe 24 and can lead to resonance inside that cylindrical portion 15, which reduces the noise volume. Further, the second end of the first pipe 11 extends past the second outlet of the second port 12 when viewed perpendicularly to the third centre axis 16 and to the respective one of the first and second centres axis 13, 14, so that, similarly to what was discussed previously, the refrigerant entering via the first port 11 needs to change direction at least once, again reducing the sound volume.

[0041] Figure 8 shows a muffler for use in a heat pump according to the seventh embodiment. A cylindrical portion 15 is provided which is joined at either longitudinal end to tapered portions 18 leading into pipe stubs 19. Both pipe stubs 19 are closed. The cylindrical portion 15, together with the tapered portions 18 and the pipe stubs 19, define the pressure pulsation reducing space 10. A first port 11 and a second port 12 extend into the pressure pulsation reducing space 10. The first centre axis 13 of the first port 11 and the second centre axis 14 of the second port 12 are provided at an acute angle relative to the third centre axis 16 of the cylindrical portion 15 when viewed perpendicularly to both the third centre axis 16 and to the respective one of the first and second centres axis 13, 14, as shown in Figure 8a).

[0042] Likewise, when viewed in a cross-section perpendicular to the third centre axis 16, the first port 11 and the second port 12 have their respective first centre axis 13 and second centre axis 14 arranged at an angle relative to each other, as is seen in figure 8b). By having such an angle, the reflections are more significant, which reduces the noise volume.

[0043] It is possible to tune the mufflers by adjusting their length and their diameter, by adjusting the depth of penetration and the position of the first and second ports, and by adjusting the second ends of the first and second ports (e.g. their diameter, whether they are closed, their shape, ...). It is also possible to modify the muffler by changing the respective arrangement of the first and second ports - in particular whether they are arranged radially or tangentially (along the direction of a chord) or whether they are arranged at some other angle. It is also possible to insert further reflective and absorbing surfaces into the muffler, and one can use several first and second ports.

[0044] Figure 9 shows an air conditioning apparatus 1 which is a heat pump according to the invention. The air conditioning apparatus 1 includes a refrigerant circuit 7. The refrigerant circuit 7 is configured so that a compressor 2 for compressing a refrigerant, an indoor heat exchanger 3, an outdoor heat exchanger 4, and a four-way switch valve 5 are connected via a refrigerant piping 6. The four-way switch valve 5 switches the flow of refrigerant compressed by the compressor 2 to either the in-

door heat exchanger 3 or the outdoor heat exchanger 4.

[0045] The air conditioning apparatus 1 further includes a pressure pulsation reducing component (muffler) 10, which is the muffler according to one of the preceding Figures. The muffler 10 is provided between the four-way switch valve 5 and the indoor heat exchanger 3. The muffler 10 reduces pressure pulsations inside the refrigerant circuit 7 that are generated by the compressor 2. Further, an electromagnetic expansion valve 8 is connected to the refrigerant piping 6. The outdoor heat exchange 4, expansion valve 8, muffler 10, heat pump 2, four-way switch valve 5, and parts of the refrigerant piping 6 form an outdoor unit 9 of the air conditioning apparatus 1.

[0046] Whilst it is the case that in the embodiment shown in Figure 9, the muffler 10 is provided as part of the outdoor unit 9 and is provided directly between the four-way switch valve 5 and the indoor unit 3, its position is not limited to this. As long as the muffler 10 is provided somewhere on the refrigerant piping 6, it will reduce pressure pulsation.

Claims

1. Heat pump comprising
a heat source heat exchanger (4), a compressor (2),
a utilization side heat exchanger (5) and an expansion valve (8) connected by refrigerant piping (6);
and
a muffler having first (11) and second (12) ports and
a pressure pulsation reducing space (10), the pressure pulsation reducing space (10) being in fluid communication with at least the first port (11) and the second port (12), wherein the first (11) and second (12) ports are respectively connected to the refrigerant piping (6),
characterized in that
a first centre axis (13) of the first port (11) and a second centre axis (14) of the second port (12) are oriented so that a flow direction of refrigerant flowing in the refrigerant piping (6) changes at least once between the first port (11) and the second port (12).
2. Heat pump according to claim 1, wherein the first (13) and second (14) centre axes are parallel and offset.
3. Heat pump according to claim 2, wherein the first (13) and second (14) centre axes are offset in two directions.
4. Heat pump according to claim 1, wherein the first (13) and second (14) centre axes are angled.
5. Heat pump according to claim 4, wherein the first (13) and second (14) centre axes are perpendicular.

6. Heat pump according to any one of the preceding claims, wherein the pressure pulsation reducing space (10) has a circular cross-section.
7. Heat pump according to claim 6, wherein the diameter of the pressure pulsation reducing space (10) is larger than the diameter of the first port (11) and/or the second port (12).
8. Heat pump according to any one of the preceding claims, wherein the pressure pulsation reducing space (10) has a cylindrical portion (15), wherein a third centre axis (16) of the cylindrical portion (15) is nonparallel to the first centre axis (13) of the first port (11) and/or the second centre axis (14) of the second port (12).
9. Heat pump according to claim 8, wherein the third centre axis is perpendicular to the first centre axis and/or the second centre axis.
10. Heat pump according to claim 8, wherein the first centre axis (13) of the first port (11) extends along a chord and the second centre axis (14) of the second port (12) extends radially.
11. Heat pump according to any one of the preceding claims, wherein the first (11) and/or second port (12) comprise a pipe having opposite first and second ends, wherein the first end is connected to the refrigerant piping and the second end is located within the pressure pulsation reducing space (10).
12. Heat pump according to claim 11, wherein an opening at the second end has a smaller cross-sectional area than an opening at the first end.
13. Heat pump according to claim 11, wherein the second end is closed and at least one opening is provided in a shell of the pipe adjacent the second end.
14. Heat pump according to claim 12, 12 or 13, wherein a plurality of openings is provided in the shell of the pipe adjacent the second end.
15. Heat pump according to any one of the preceding claims, wherein the second port (12) opens into the pressure pulsation reducing space (10) in a bottom portion of the pressure pulsation reducing space (10).

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

1. Heat pump comprising
a heat source heat exchanger (3), a compressor (2),
a utilization side heat exchanger (4) and an expansion valve (8) connected by refrigerant piping (6);
and
a muffler having first (11) and second (12) ports and
a pressure pulsation reducing space (10), the pressure pulsation reducing space (10) being in fluid communication with at least the first port (11) and the second port (12), wherein the first (11) and second (12) ports are respectively connected to the refrigerant piping (6),
characterized in that
a first centre axis (13) of the first port (11) and a second centre axis (14) of the second port (12) are oriented so that a flow direction of refrigerant flowing in the refrigerant piping (6) changes at least once between the first port (11) and the second port (12).

sion valve (8) connected by refrigerant piping (6); and

a muffler having first (11) and second (12) ports and a pressure pulsation reducing space (10), the pressure pulsation reducing space (10) being in fluid communication with at least the first port (11) and the second port (12), wherein the first (11) and second (12) ports are respectively connected to the refrigerant piping (6),

wherein a first centre axis (13) of the first port (11) and a second centre axis (14) of the second port (12) are oriented so that a flow direction of refrigerant flowing in the refrigerant piping (6) changes at least once between the first port (11) and the second port (12),

the pressure pulsation reducing space (10) has a cylindrical portion (15), wherein a third centre axis (16) of the cylindrical portion (15) is nonparallel to the first centre axis (13) of the first port (11) and/or the second centre axis (14) of the second port (12),

characterized in that

the first centre axis (13) of the first port (11) extends along a chord and the second centre axis (14) of the second port (12) extends radially.

2. Heat pump according to claim 1, wherein the first (13) and second (14) centre axes are parallel and offset.

3. Heat pump according to claim 2, wherein the first (13) and second (14) centre axes are offset in two directions.

4. Heat pump according to claim 1, wherein the first (13) and second (14) centre axes are angled.

5. Heat pump according to claim 4, wherein the first (13) and second (14) centre axes are perpendicular.

6. Heat pump according to any one of the preceding claims, wherein the pressure pulsation reducing space (10) has a circular cross-section.

7. Heat pump according to claim 6, wherein the diameter of the pressure pulsation reducing space (10) is larger than the diameter of the first port (11) and/or the second port (12).

8. Heat pump according to any one of the preceding claims, wherein the first (11) and/or second port (12) comprise a pipe having opposite first and second ends, wherein the first end is connected to the refrigerant piping and the second end is located within the pressure pulsation reducing space (10).

9. Heat pump according to claim 8, wherein an opening at the second end has a smaller cross-sectional area than an opening at the first end.

10. Heat pump according to claim 8, wherein the second end is closed and at least one opening is provided in a shell of the pipe adjacent the second end.

11. Heat pump according to claim 8, 8 or 10, wherein a plurality of openings is provided in the shell of the pipe adjacent the second end.

12. Heat pump according to any one of the preceding claims, wherein the second port (12) opens into the pressure pulsation reducing space (10) in a bottom portion of the pressure pulsation reducing space (10).

Fig. 1

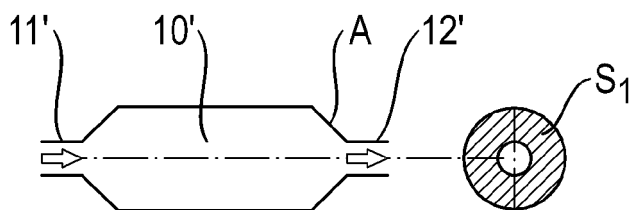


Fig. 2

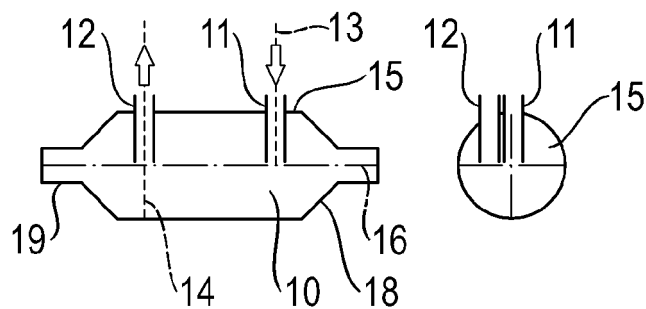


Fig. 3

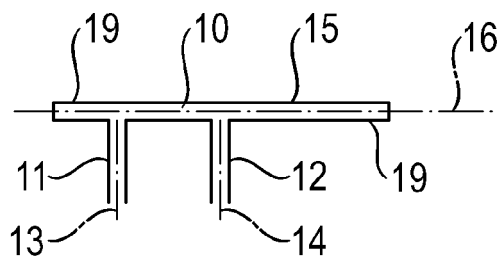


Fig. 4

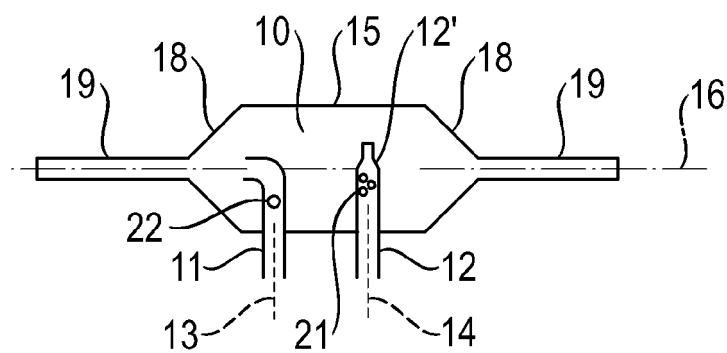


Fig. 5

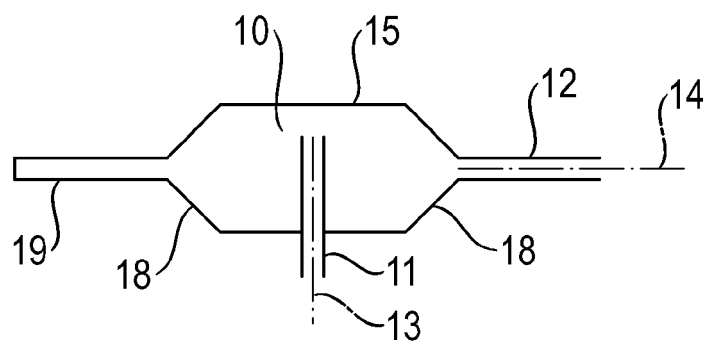


Fig. 6

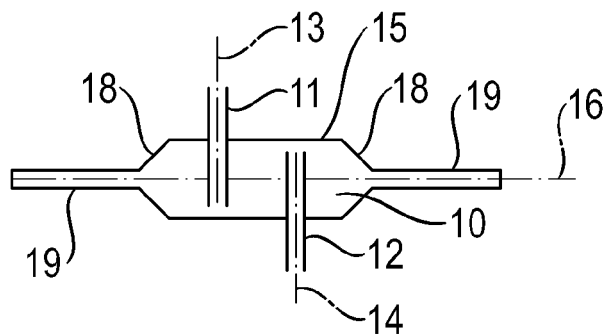
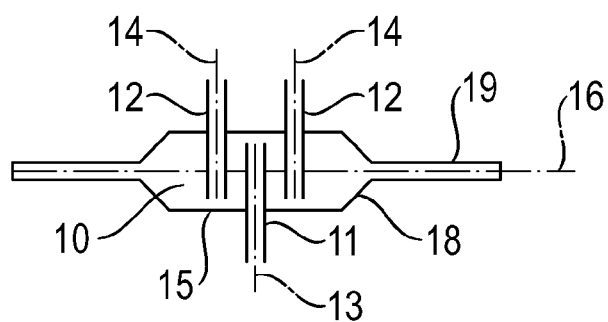


Fig. 7

a)



b)

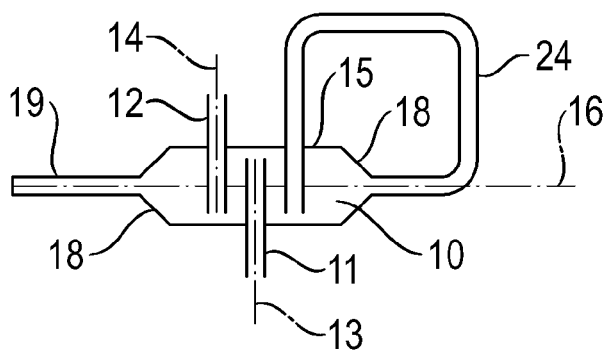
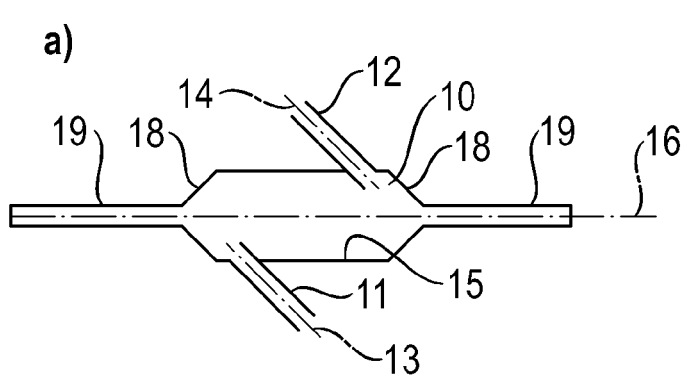


Fig. 8

a)



b)

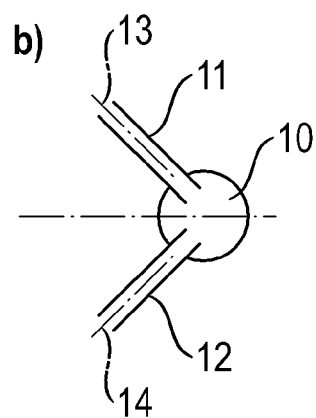
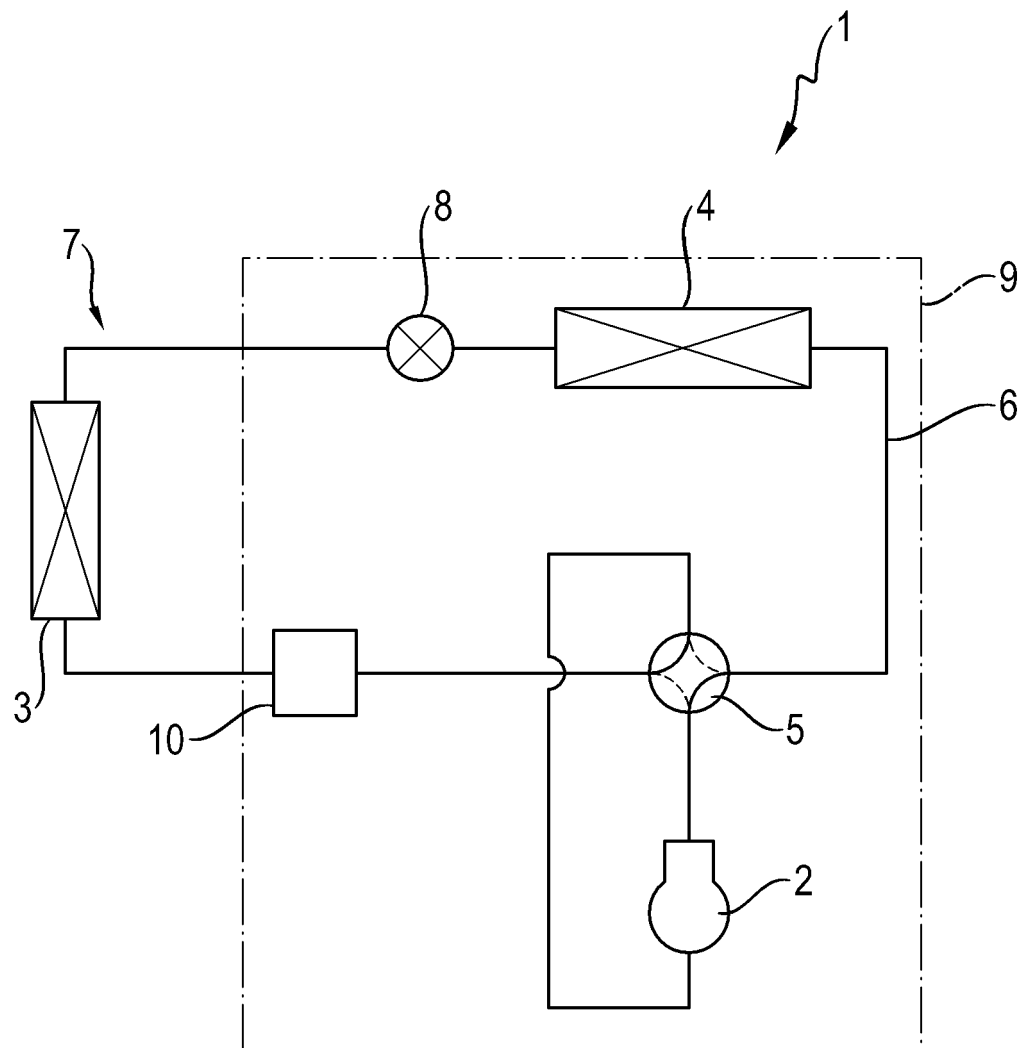


Fig. 9





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