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(54) **Title**: A SCROLL COMPRESSOR HAVING TWO OIL SUMPS

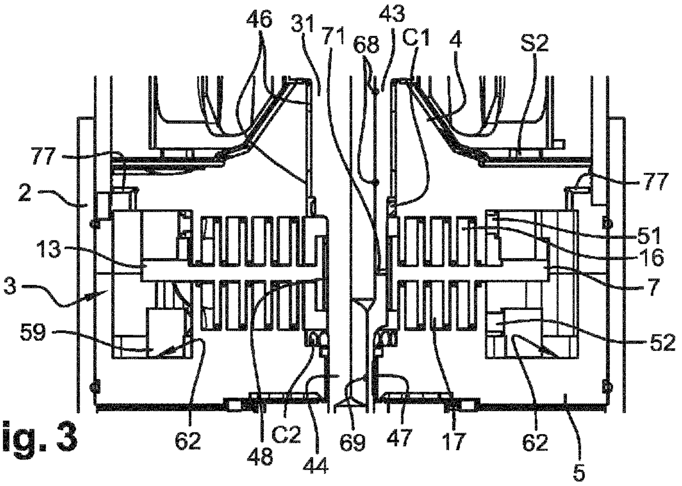

Fig. 3

(57) **Abstract**: The scroll compressor includes a closed container (2), a compression unit (3) including a first fixed scroll (4) and an orbiting scroll arrangement (7), a drive shaft (31) adapted for driving the orbiting scroll arrangement (7) in an orbital movement, a plurality of bearings (46, 47, 48) configured to rotatably support the drive shaft (31), a first anti-rotation device (51) configured to prevent rotation of the orbiting scroll arrangement (7) with respect to the first fixed scroll (4), a first oil sump delimited by the closed container (2), a second oil sump (S2) at least partially delimited by the first fixed scroll (4), a first lubrication system configured to lubricate at least partially the bearings with oil supplied from the first oil sump, and a second lubrication system configured to lubricate at least partially the first anti-rotation device (51) with oil supplied from the second oil sump (S2).

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A SCROLL COMPRESSOR HAVING TWO OIL SUMPS

The present invention relates to a scroll compressor, and in particular to a scroll refrigeration compressor.

Background of the invention

As known, a scroll refrigeration compressor includes:

- a closed container,
- a compression unit disposed in the closed container and including at least:
  - a first fixed scroll including a first fixed base plate and a first fixed spiral wrap,
  - an orbiting scroll arrangement including a first orbiting spiral wrap, the first fixed spiral wrap and the first orbiting spiral wrap forming a plurality of compression chambers,
- at least a first anti-rotation device, such as an Oldham coupling, configured to prevent rotation of the orbiting scroll arrangement with respect to the first fixed scroll, the first anti-rotation device including at least a pair of first engaging elements respectively slidably engaged with a pair of complementary engaging elements provided on the first fixed scroll,
- a drive shaft adapted for driving the orbiting scroll arrangement in an orbital movement,
- a driving motor coupled to the drive shaft and configured for driving in rotation the drive shaft about a rotation axis,
- a plurality of bearings configured to rotatably support the drive shaft,
- a refrigerant suction part suitable for supplying the compression unit with refrigerant to be compressed, and
- an oil sump.

Typically, the first anti-rotation device is disposed inside the refrigerant flow path. Thus, the engaging elements of the first anti-rotation device can be lubricated by the oil droplets contained in the refrigerant.

However, such a lubrication of the engaging elements of the first anti-rotation device by means of the refrigerant may be insufficient, notably when the refrigerant has a low oil content or when the first anti-rotation device is disposed outside the refrigerant flow path, which may harm the efficiency and the reliability of the compression unit, and thus of the scroll compressor.

Summary of the invention

It is an object of the present invention to provide an improved scroll compressor which can overcome the drawbacks encountered in conventional scroll compressors.

Another object of the present invention is to provide a scroll compressor which has an improved reliability and efficiency compared to the conventional scroll compressors.

According to the invention such a scroll compressor includes:

- a closed container,
- a compression unit located in the closed container and including:
  - a first fixed scroll comprising a first fixed base plate and a first fixed spiral wrap,
  - an orbiting scroll arrangement including a first orbiting spiral wrap, the first fixed spiral wrap and the first orbiting spiral wrap forming a plurality of first compression chambers,
- a drive shaft including a driving portion adapted for driving the orbiting scroll arrangement in an orbital movement,
- a plurality of bearings configured to rotatably support the drive shaft,
- at least a first anti-rotation device configured to prevent rotation of the orbiting scroll arrangement with respect to the first fixed scroll,
- a first oil sump delimited by the closed container, and a second oil sump at least partially delimited by the first fixed base plate,
- a first lubrication system configured to lubricate at least partially the bearings with oil supplied from the first oil sump, and
- a second lubrication system configured to lubricate at least partially the first anti-rotation device with oil supplied from the second oil sump.

Such a configuration of the first and second lubrication systems enables on the one hand an optimized lubrication of the bearings and the first anti-rotation device, which improves the reliability and efficiency of the first anti-rotation device and of the compression unit, and on the other hand a simplification of the compressor assembly.

Further, due to the configuration of the second lubrication system, the lubrication of the first anti-rotation device is independent from the rotational speed of the drive shaft.

According to an embodiment of the invention, the first and second oil sumps are separated from each other.

According to an embodiment of the invention, the second lubrication system includes:

- an oil supplying passage fluidly connected to the second oil sump and delimited at least partially by the first fixed base plate, and

- at least one first lubrication passage provided on the first fixed base plate and fluidly connected to the oil supplying passage, the at least one first lubrication passage being configured to supply with oil the first anti-rotation device.

According to an embodiment of the invention, the oil supplying passage extends along at least a part of a perimeter edge of the first fixed base plate.

According to an embodiment of the invention, the oil supplying passage is delimited by the first fixed base plate and the closed container.

According to an embodiment of the invention, the oil supplying passage is helicoidal.

According to an embodiment of the invention, the first fixed base plate includes a helicoidal groove provided on the perimeter edge of the first fixed base plate and defining partially the oil supplying passage.

According to an embodiment of the invention, the second lubrication system further includes a cavity provided on the first fixed base plate and fluidly connected to the oil supplying passage, the cavity being configured to collect at least a part of the oil contained in the second oil sump and to supply the oil supplying passage with oil. The cavity may for example be provided with a filter.

According to an embodiment of the invention, the scroll compressor further includes an oil return passage fluidly connecting the first oil sump and the second oil sump, and configured to return an excess of oil from the second oil sump to the first oil sump.

According to an embodiment of the invention, the oil return passage includes:

- an oil return channel at least partially defined by the first fixed base plate and fluidly connected to the second oil sump, and

- an oil return pipe fluidly connecting the oil return channel and the first oil sump, the oil return pipe including a mounting portion mounted on the compression unit.

According to an embodiment of the invention, the first fixed scroll includes at least one first discharge passage configured to conduct, in use, the refrigerant compressed in the first compression chambers towards the second oil sump.

According to an embodiment of the invention, the at least one first discharge passage is fluidly connected to a central first compression chamber, and is configured to conduct the refrigerant compressed in the central first compression chamber towards the second oil sump.

According to an embodiment of the invention, the at least one first discharge passage is inclined relative to the rotation axis of the drive shaft.

According to an embodiment of the invention, the first fixed base plate has a first face directed towards the orbiting scroll arrangement and a second face opposite to the first face, the at least one first discharge passage including an outlet aperture emerging in the second face of the first fixed base plate.

According to an embodiment of the invention, the compression unit further includes a second fixed scroll including a second fixed base plate and a second fixed spiral wrap, the first and second fixed scrolls defining an inner volume, the orbiting scroll arrangement being disposed in the inner volume and further including a second orbiting spiral wrap, the second fixed spiral wrap and the second orbiting spiral wrap forming a plurality of second compression chambers.

According to an embodiment of the invention, the first fixed scroll is disposed above the second fixed scroll.

According to an embodiment of the invention, the oil return channel is defined by the first and second fixed base plates. For example, the oil return channel extends substantially parallely to the rotation axis of the drive shaft.

According to an embodiment of the invention, the second fixed scroll includes at least one second discharge passage configured to conduct, in use, the refrigerant compressed in the second compression chambers outside the inner volume.

According to an embodiment of the invention, the second fixed base plate has a first face directed towards the first fixed scroll and a second face opposite to the first face, the at least one second discharge passage including an outlet aperture emerging in the second face of the second fixed base plate.

According to an embodiment of the invention, the at least one second discharge passage is inclined relative to the rotation axis of the drive shaft.

According to an embodiment of the invention, the closed container defines a high pressure discharge volume, and the compression unit further includes at least one refrigerant communication passage configured to fluidly connect the at least one second discharge passage and the high pressure discharge volume.

According to an embodiment of the invention, the first fixed base plate includes at least one projecting element surrounding and defining a refrigerant outlet aperture of a respective refrigerant communication passage, the at least one projecting element being configured to avoid a discharge of the oil contained in the upper oil sump into the respective refrigerant communication passage.

According to an embodiment of the invention, the refrigerant outlet aperture emerges above the second oil sump.

According to an embodiment of the invention, the compression unit includes a plurality of, for example two, refrigerant communication passages angularly offset.

According to an embodiment of the invention, the at least one refrigerant communication passage is independent, i.e. distinct, from the oil return passage. This configuration limits the oil circulation rate in a system including a compressor according to the present invention, and avoids an emptying of the first oil sump.

According to an embodiment of the invention, the at least one refrigerant communication passage is defined by the first and second fixed base plates. The at least one refrigerant communication passage extends for example substantially parallely to the rotation axis of the drive shaft.

According to an embodiment of the invention, the scroll compressor further includes a communication chamber fluidly connecting the at least one second discharge passage and the at least one refrigerant communication passage. The communication chamber may be for example annular.

According to an embodiment of the invention, the at least one refrigerant communication passage includes a refrigerant inlet aperture emerging in the communication chamber.

According to an embodiment of the invention, the scroll compressor includes a separating element at least partially delimiting the communication chamber. The separating element may for example be configured to at least partially separate and/or fluidly isolate the communication chamber from the first oil sump.

According to an embodiment of the invention, the scroll compressor further includes a driving motor coupled to the drive shaft and configured for driving in rotation the drive shaft about a rotation axis, the high pressure discharge volume containing the driving motor.

According to an embodiment of the invention, the at least one first discharge passage emerges nearby the driving motor.

According to an embodiment of the invention, the at least one first discharge passage and the at least one second discharge passage are fluidly connected to the high pressure discharge volume and are configured to conduct, in use, the refrigerant compressed respectively in the first and second compression chambers towards the high pressure discharge volume.

According to an embodiment of the invention, the first and second orbiting spiral wraps are respectively provided on first and second faces of a common base plate, the second face being opposite to the first face.

According to an embodiment of the invention, the first lubrication system includes a lubrication channel provided on the drive shaft and fluidly connected to the first oil sump, the lubrication channel extending over at least a part of the length of the drive shaft. The lubrication channel may be configured to be supplied with oil from the first oil sump by an oil pump driven by the drive shaft.

According to an embodiment of the invention, the drive shaft extends across the orbiting scroll arrangement and further includes a first guided portion and second guided portion located on either side of the driving portion, the scroll compressor further including at least one first guide bearing and at least one second guide bearing located on either side of the orbiting scroll arrangement and configured to respectively guide the first and second guided portions of the drive shaft. The first lubrication system is notably configured to lubricate at least partially the first and second guide bearings with oil supplied from the first oil sump.

According to an embodiment of the invention, the first lubrication system further includes at least one first lubrication hole and at least one second lubrication hole provided on the drive shaft and fluidly connected to the lubrication channel, the at least one first and second lubrication holes emerging respectively into an outer wall of the first and second guided portions of the drive shaft.

According to an embodiment of the invention, the first lubrication system further includes at least one third lubrication hole provided on the drive shaft and fluidly connected to the lubrication channel, the at least one third lubrication hole emerging into an outer wall of the driving portion of the drive shaft.

According to an embodiment of the invention, the first anti-rotation device is an Oldham coupling.

According to an embodiment of the invention, the first anti-rotation device includes at least a pair of first engaging elements respectively slidably engaged with a pair of complementary engaging elements provided on the first fixed scroll, the at least one first lubrication passage being configured to supply with oil at least one of the first engaging elements of the first anti-rotation device.

According to an embodiment of the invention, the second lubrication system includes a plurality of first lubrication passages provided on the first fixed base plate and fluidly connected to the oil supplying passage, each of the first lubrication passages being configured to supply with oil a respective one of the first engaging elements of the first anti-rotation device.

According to an embodiment of the invention, each first lubrication passage includes an oil outlet aperture emerging in an outer surface of a respective one of the complementary engaging elements provided on the first fixed scroll.

According to an embodiment of the invention, each first lubrication passage includes an oil inlet aperture emerging in the oil supplying passage.

According to an embodiment of the invention, the first anti-rotation device further includes a pair of second engaging elements respectively slidably engaged with a pair of first complementary engaging elements provided on the orbiting scroll arrangement, the second lubrication system being further configured to lubricate at least partially the second engaging elements of the first anti-rotation device with oil supplied from the second oil sump.

According to an embodiment of the invention, the second lubrication system further includes at least one second lubrication passage provided on the first fixed base plate and fluidly connected to the oil supplying passage, the at least one second lubrication passage being configured to supply with oil at least one of the second engaging elements of the first anti-rotation device.

According to an embodiment of the invention, the second lubrication system includes a plurality of second lubrication passages provided on the first fixed base plate and fluidly connected to the oil supplying passage, each of the second lubrication passages being configured to supply with oil a respective one of the second engaging elements of the first anti-rotation device.

According to an embodiment of the invention, each second lubrication passage includes an oil outlet aperture configured to be located vertically above a respective one of the first complementary engaging elements provided on the orbiting scroll arrangement during at least a part of the orbital movement of the orbiting scroll arrangement.

According to an embodiment of the invention, the oil outlet aperture of each second lubrication passage emerges vertically above a respective one of the second engaging elements of the first anti-rotation device and/or a respective one of the first complementary engaging elements provided on the orbiting scroll arrangement.

According to an embodiment of the invention, each second lubrication passage includes an oil inlet aperture emerging in the oil supplying passage.

According to an embodiment of the invention, the scroll compressor further includes a second anti-rotation device configured to prevent rotation of the orbiting scroll arrangement with respect to the second fixed scroll. The second anti-rotation device may be for example an Oldham coupling.

According to an embodiment of the invention, the first anti-rotation device is slidable with respect to the first and second fixed scrolls along a first displacement direction, and the second anti-rotation device is slidable with respect to the first and second fixed scrolls along a second displacement direction, the first and second displacement directions being transverse with respect to each other, and for example substantially orthogonal with respect to each other.

According to an embodiment of the invention, the first and second anti-rotation devices are disposed in the inner volume.

According to an embodiment of the invention, the second lubrication system is configured to lubricate at least partially the second anti-rotation device with oil supplied from the second oil sump.

According to an embodiment of the invention, the second anti-rotation device includes at least a pair of first engaging elements respectively slidably engaged with a pair of complementary engaging elements provided on the second fixed scroll, the second lubrication system being further configured to lubricate at least partially the first engaging elements of the second anti-rotation device with oil supplied from the second oil sump.

According to an embodiment of the invention, the second anti-rotation device further includes a pair of second engaging elements respectively slidably engaged with a pair of second complementary engaging elements provided on the orbiting scroll arrangement, the second lubrication system being further configured to lubricate at least partially the second engaging elements of the second anti-rotation device with oil supplied from the second oil sump.

According to an embodiment of the invention, each of the first lubrication passages is configured to supply with oil a respective one of the second engaging elements of the second anti-rotation device.

According to an embodiment of the invention, each of the second lubrication passages is configured to supply with oil a respective one of the first engaging elements of the second anti-rotation device.

According to an embodiment of the invention, each of the second complementary engaging elements provided on the orbiting scroll arrangement includes an oil passage provided with an oil outlet aperture emerging vertically above a respective one of the second engaging elements of the second anti-rotation device.

According to an embodiment of the invention, the scroll compressor is a vertical scroll compressor and the drive shaft extends substantially vertically. For example, the driving motor may be located above the compression unit.

According to an embodiment of the invention, the bearings are spaced apart from each other along a longitudinal axis of the drive shaft.

According to an embodiment of the invention, the scroll compressor further includes a refrigerant suction part suitable for supplying the compression unit with refrigerant to be compressed.

According to an embodiment of the invention, the first and second fixed base plates are each sealingly fixed to the closed container. Advantageously, each of the first and second fixed base plates includes a peripheral mounting surface sealingly fixed to the closed container.

These and other advantages will become apparent upon reading the following description in view of the drawing attached hereto representing, as non-limiting example, an embodiment of a scroll compressor according to the invention.

Brief description of the drawings

The following detailed description of one embodiment of the invention is better understood when read in conjunction with the appended drawings being understood, however, that the invention is not limited to the specific embodiment disclosed.

Figure 1 is a longitudinal section view of a scroll compressor according to the invention.

Figure 2 is a partial longitudinal section view, in perspective, of the scroll compressor of figure 1.

Figure 3 is a partial longitudinal section view of the scroll compressor of figure 1.

Figure 4 is a perspective view of an upper fixed scroll of the scroll compressor of figure 1.

Figure 5 is a longitudinal section view, in perspective, of the upper fixed scroll of figure 4.

Figure 6 is a longitudinal section view of the upper fixed scroll of figure 4.

Figure 7 is an exploded perspective view of a lower fixed scroll and of a refrigerant suction element of the scroll compressor of figure 1.

Figures 8 and 9 are exploded perspective views of two Oldham couplings and of an orbiting scroll arrangement of the scroll compressor of figure 1.

Detailed description of the invention

Figure 1 shows a vertical scroll compressor 1 including a closed container 2 defining a high pressure discharge volume V, and a compression unit 3 disposed inside the closed container 2. The scroll compressor 1 further includes a lower oil sump S1 delimited by a bottom part of the closed container 2, and an upper oil sump S2 delimited by the compression unit 3 and a middle part of the closed container 2.

The compression unit 3 includes upper and lower fixed scrolls 4, 5 defining an annular inner volume 6, and an orbiting scroll arrangement 7 disposed in the inner volume 6. In particular the upper and lower fixed scrolls 4, 5 are each sealingly fixed to the closed container 2. Advantageously, each of the upper and lower fixed scrolls 4, 5 includes a peripheral mounting surface sealingly fixed to the closed container 2, and for example provided with at least one O-ring.

The upper fixed scroll 4 includes a base plate 8 having a first face oriented towards the lower fixed scroll 5 and a second face opposite to the first face of the base plate 8, and a spiral wrap 9 projecting from the first face of the base plate 8 towards the lower fixed scroll 5. The lower fixed scroll 5 includes a base plate 11 having a first face oriented towards the upper fixed scroll 4 and a second face opposite to the first face of the base plate 11, and a spiral wrap 12 projecting from the first face of the base plate 11 towards the upper fixed scroll 4. According to the embodiment shown on the figures, the upper oil sump S2 is advantageously delimited by the base plate 8 and the closed container 2.

The orbiting scroll arrangement 7 includes a base plate 13, a first spiral wrap 14 projecting from a first face of the base plate 13 towards the upper fixed scroll

4, and a second spiral wrap 15 projecting from a second face of the base plate 13 towards the lower fixed scroll 5, the second face being opposite to the first face such that the first and second spiral wraps 14, 15 project in opposite directions. The upper and lower fixed scrolls 4, 5 are respectively located above and below the orbiting scroll arrangement 7.

The first spiral wrap 14 of the orbiting scroll arrangement 7 meshes with the spiral wrap 9 of the upper fixed scroll 4 to form a plurality of compression chambers 16 between them, and the second spiral wrap 15 of the orbiting scroll arrangement 7 meshes with the spiral wrap 12 of the lower fixed scroll 5 to form a plurality of compression chambers 17 between them. Each of the compression chambers 16, 17 has a variable volume which decreases from the outside towards the inside, when the orbiting scroll arrangement 7 is driven to orbit relative to the upper and lower fixed scrolls 4, 5.

The base plate 8, the spiral wrap 9 and the base plate 13 delimit a refrigerant inlet passage P1, while the base plate 11, the spiral wrap 12 and the base plate 13 delimit a refrigerant inlet passage P2.

The base plate 8 of the upper fixed scroll 4 further includes a plurality of discharge passages 23 fluidly connected to second oil sump S2 and the high pressure discharge volume V, and configured to conduct the refrigerant compressed in the compression chambers 16 outside the inner volume 6. The base plate 11 of the lower fixed scroll 5 further includes a plurality of discharge passage 24 fluidly connected to the high pressure discharge volume V and configured to conduct the refrigerant compressed in the compression chambers 17 outside the inner volume 6.

Each discharge passage 23 includes an inlet aperture emerging in an annular chamber C1 partially defined by the base plate 8 of the upper fixed scroll 4 and fluidly connected to the central compression chamber 16, and an outlet aperture emerging in the second face of the base plate 8. Each discharge passage 24 includes an inlet aperture emerging in an annular chamber C2 partially defined by the base plate 11 of the lower fixed scroll 5 and fluidly connected to the central compression chamber 17, and an outlet aperture emerging in the second face of the base plate 11.

The compression unit 3 further includes a plurality of, for example two, refrigerant communication passages 25 angularly offset and configured to fluidly connect the discharge passages 24 and the high pressure discharge volume V. Each refrigerant communication passage 25 is defined by the first and second base plates 8, 11. Each refrigerant communication passage 25 for example includes a refrigerant inlet aperture fluidly connected to the discharge passages 24 and emerging in the second face of the base plate 11, and a refrigerant outlet aperture emerging in the high pressure discharge volume V near the second oil sump S2.

According to the embodiment shown on the figures, the scroll compressor 1 includes a separating element 26 at least partially delimiting an annular communication chamber 27 fluidly connecting the discharge passages 24 and the refrigerant communication passages 25. The separating element 26 may for example be configured to separate and/or fluidly isolate the communication chamber 27 from the first oil sump S1. Advantageously, the refrigerant inlet aperture of each refrigerant communication passage 25 emerges in the communication chamber 27.

According to the embodiment shown on the figures, the base plate 8 includes two protection elements or edges 28 projecting from the second face of the base plate 8 and each surrounding and defining the refrigerant outlet aperture of a respective one of the refrigerant communication passages 25. The protection elements or edges 28 are configured to avoid a discharge of the separated oil contained in the upper oil sump S2 into the refrigerant communication passages 25, notably at the compressor stop.

The scroll compressor 1 also includes a refrigerant suction pipe 29 for supplying the compression unit 3 with refrigerant, and a refrigerant discharge pipe 30 for discharging the compressed refrigerant outside the scroll compressor 1. For example, the refrigerant suction pipe 29 extends along a longitudinal axis, and is sealingly connected to the compression unit 3.

The refrigerant suction pipe 29 is advantageously oriented towards the refrigerant inlet passages P1, P2 and is configured to conduct, and more particularly to canalize, in use, at least a first part of the refrigerant suctioned in the refrigerant suction pipe 29 towards the refrigerant inlet passage P1 and at least a second part of the refrigerant suctioned in the refrigerant suction pipe 29 towards the refrigerant inlet passage P2.

According to the embodiment shown on the figures, the scroll compressor 1 is provided with a deflector 50 configured to deflect the first part of the refrigerant suctioned in the refrigerant suction pipe 29 towards the refrigerant inlet passage P1 and the second part of the refrigerant suctioned in the refrigerant suction pipe 29 towards the refrigerant inlet passage P2. The deflector 50 may for example include a connecting portion 50a fluidly connected to the refrigerant suction pipe 29, a first deflecting part 50b configured to deflect the first part of the refrigerant entering the connecting portion 50a towards the refrigerant inlet passage P1, and a second deflecting part 50c configured to deflect the second part of the refrigerant entering the connecting portion 50a towards the refrigerant inlet passage P2.

According to the embodiment shown on the figures, the deflector 50 includes a notch 50d suitable for receiving a portion of the base plate 13 of the orbiting scroll arrangement 7 during at least a part of the orbital movement of the orbiting scroll arrangement 7.

Furthermore the scroll compressor 1 includes a stepped drive shaft 31 adapted for driving the orbiting scroll arrangement 7 in orbital movements, and an electric driving motor 32 coupled to the drive shaft 31 and configured for driving in rotation the drive shaft 31 about a rotation axis.

The driving motor 32, which may be a variable-speed electric motor, is located above the upper fixed scroll 4. The driving motor 32 has a rotor 33 fitted on the drive shaft 31, and a stator 34 disposed around the rotor 33 and fixed relative to the closed container 2. According to the embodiment shown on the figures, the outlet aperture of each discharge passages 23 emerges nearby the driving motor 32, and particularly nearby a winding head of the stator 34. Advantageously, each of the discharge passages 23, 24 is inclined relative to the rotation axis of the drive shaft 31.

The drive shaft 31 extends vertically across the base plate 13 of the orbiting scroll arrangement 7. The drive shaft 31 comprises a first end portion 40 located above the upper fixed scroll 4 and on which is fitted the rotor 33, and a second end portion 41 opposite to the first end portion 40 and located below the lower fixed scroll 5. The first end portion 40 has an external diameter larger than the external diameter of the second end portion 41. The first end portion 40 includes a central recess 42 emerging in the end face of the drive shaft 31 opposite to the second end portion 41.

The drive shaft 31 further comprises a first guided portion 43 and a second guided portion 44 located between the first and second end portion 40, 41, and an eccentric driving portion 45 located between the first and second guided portions 43, 44 and being off-centered from the center axis of the drive shaft 31. The eccentric driving portion 45 is configured to cooperate with the orbiting scroll arrangement 7 so as to cause the latter to be driven in an orbital movement relative to the upper and lower fixed scrolls 4, 5 when the driving motor 32 is operated.

The scroll compressor 1 further comprises guide bearings 46, 47 provided on the upper and lower fixed scrolls 4, 5 and configured for guiding in rotation the first and second guided portions 43, 44 of the drive shaft 31. The scroll compressor 1 further comprises at least one bearing 48 provided on the orbiting scroll arrangement

7 and configured for cooperating with the eccentric driving portion 45 of the drive shaft 31.

The scroll compressor 1 also comprises an Oldham coupling 51 which is slidably mounted with respect to the upper fixed scroll 4 along a displacement direction D1, and an Oldham coupling 52 which is slidably mounted with respect to the lower fixed scroll 5 along a displacement direction D2 which is substantially orthogonal to the displacement direction D1. The displacement directions D1, D2 are substantially perpendicular to the rotation axis of the drive shaft 31. The Oldham couplings 51, 52 are configured to prevent rotation of the orbiting scroll arrangement 7 with respect to the upper and lower fixed scrolls 4, 5. Each of the Oldham couplings 51, 52 undergoes a reciprocating motion respectively along the displacement directions D1, D2. The Oldham couplings 51, 52 are located in the inner volume 6 and extend respectively above and below the refrigerant suction pipe 29.

The Oldham coupling 51 includes an annular body 53 disposed between the base plate 8 of the upper fixed scroll 4 and the base plate 13 of the orbiting scroll arrangement 7, and around the spiral wraps 9, 14.

The Oldham coupling 51 further includes a pair of first engaging projections 54 diametrically opposed and provided on a first side of the annular body 53, and a pair of second engaging projections 55 diametrically opposed and provided on a second side of the annular body 53. The first engaging projections 54 of the Oldham coupling 51 are respectively slidably engaged with a pair of complementary engaging grooves 56 provided on the base plate 8 of the upper fixed scroll 4, the complementary engaging grooves 56 being offset and extending parallel to the displacement direction D1. The second engaging projections 55 of the Oldham coupling 51 are respectively slidably engaged with a pair of complementary engaging grooves 57 provided on the base plate 13 of the orbiting scroll arrangement 7, the complementary engaging grooves 57 being offset and extending parallel to the displacement direction D2, i.e. perpendicularly to the displacement direction D1.

The Oldham coupling 52 includes an annular body 58 disposed between the base plate 11 of the lower fixed scroll 5 and the base plate 13 of the orbiting scroll arrangement 7, and around the spiral wraps 12, 15.

The Oldham coupling 52 further includes a pair of first engaging projections 59 diametrically opposed and provided on a first side of the annular body 58, and a pair of second engaging projections 61 diametrically opposed and provided on a second side of the annular body 58. The first engaging projections 59 of the Oldham coupling 52 are respectively slidably engaged with a pair of complementary engaging grooves 62 provided on the base plate 11 of the lower fixed scroll 5, the complementary engaging grooves 62 being offset and extending parallel to the displacement direction D2. The second engaging projections 61 of the Oldham coupling 52 are respectively slidably engaged with a pair of complementary engaging grooves 63 provided on the base plate 13 of the orbiting scroll arrangement 7, the complementary engaging grooves 63 being offset and extending parallel to the displacement direction D1.

The scroll compressor 1 further includes a first lubrication system 64 configured to lubricate at least partially the guide bearings 46, 47 and the bearing(s) 48 with oil supplied from the first oil sump S1, and a second lubrication system 65 configured to lubricate at least partially the first and second Oldham couplings 51, 52 with oil supplied from the second oil sump S2.

The first lubrication system 64 includes a lubrication channel 66 provided on the drive shaft 31 and fluidly connected to the first oil sump S1. The lubrication channel 66 extends over at least a part of the length of the drive shaft 31, and is configured to be supplied with oil from the first oil sump S1 by an oil pump 67 driven by the second end portion 41 of the drive shaft 31.

The first lubrication system 64 further includes lubrication holes 68, 69 provided on the drive shaft 31 and fluidly connected to the lubrication channel 66, the lubrication holes 68 emerging respectively into an outer wall of the first guided portion 43 of the drive shaft 31 and the lubrication hole 69 emerging into an outer wall of the second guided portion 44 of the drive shaft 31. The first lubrication system 64 further includes at least one lubrication hole 71 provided on the drive shaft 31 and fluidly connected to the lubrication channel 66, the at least one lubrication hole 71 emerging into an outer wall of the driving portion 45 of the drive shaft 31. According to the embodiment shown on the figures, each lubrication hole 68 faces a respective guide bearing 46, the lubrication hole 69 faces the guide bearing 47, and the lubrication hole 71 faces the bearing 48.

The second lubrication system 65 includes a cavity 72 provided on the second face of the base plate 8, and configured to collect at least a part of the oil contained in the second oil sump S2. The cavity 72 may possibly be provided with a filter.

The second lubrication system 65 includes further includes an oil supplying passage 73 fluidly connected to the cavity 72 so as to be supplied with oil from the second oil sump S2. The oil supplying passage 73 is delimited by the base plate 8 and the closed container 2. According to the embodiment shown on the figures, the oil supplying passage 73 is partially defined by a helicoidal groove provided on the perimeter edge of the base plate 8, and laterally closed by the closed container 2.

The second lubrication system 65 also includes two lubrication passages 74 (see figure 6) provided on the base plate 8 of the upper fixed scroll 4 and fluidly connected to the oil supplying passage 73. Each lubrication passage 74 is configured to supply with oil a respective one of the first engaging projections 54 of the Oldham coupling 51. According to the embodiment shown on the figures, each lubrication passage 74 includes (see figures 4 and 6) an oil inlet aperture 75 emerging in the oil supplying passage 73 and an oil outlet aperture 76 emerging in an engaging surface of a respective one of the complementary engaging grooves 56 provided on the upper fixed scroll 4. Each oil outlet aperture 76 may for example emerge vertically above the respective one of the first engaging projections 54 of the Oldham coupling 51.

The second lubrication system 65 further includes a two lubrication passages 77 (see figures 3 to 5) provided on the base plate 8 of the upper fixed scroll 4 and fluidly connected to the oil supplying passage 73. Each lubrication passage 77 is configured to supply with oil, by gravity, a respective one of the second engaging projections 55 of the Oldham coupling 51. Each lubrication passage 77 includes an oil inlet aperture 78 emerging in the oil supplying passage 73 and an oil outlet aperture 79 emerging in the inner volume 6. The oil outlet aperture 79 of each lubrication passage 77 is configured to be located vertically above a respective one of the complementary engaging grooves 57 during at least a part of the orbital movement of the orbiting scroll arrangement 7.

According to an embodiment not shown on the figures, the orbiting scroll arrangement 7 may include, at each complementary engaging groove 63, an oil passage having an oil inlet aperture emerging in the first face of the base plate 13 of the orbiting scroll arrangement 7 and an oil outlet aperture emerging vertically above a respective one of the second engaging projections 61 of the Oldham coupling 52.

The scroll compressor 1 further includes an oil return passage 84 fluidly connecting the first oil sump S1 and the second oil sump S2, and configured to return an excess of oil from the second oil sump S2 to the first oil sump S1. According to the embodiment shown on the figures, the oil return passage 84 is formed by an oil return channel 85 defined by the base plates 8, 11 and fluidly connected to the second oil sump S2, and by an oil return pipe 86 fluidly connecting the oil return channel 85 and the first oil sump S1. The oil return pipe 86 may includes a mounting portion mounted on the compression unit 3, and notably on the base plate 11.

In operation, a first part of the refrigerant supplied by the refrigerant suction pipe 29 enters the refrigerant inlet passage P1 and is guided towards the outermost compression chambers 16, then is compressed into the compression chambers 16 and escapes from the centre of the upper fixed scroll 4 and of the orbiting scroll arrangement 7 through the discharge passages 23. The compressed refrigerant coming out of the discharge passages 23 then flows upwardly towards the discharge pipe 30 by passing through refrigerant flow passages delimited by the stator 34 and the closed container 2 and through gaps delimited between the stator 34 and the rotor 33.

Thus the compressed refrigerant passing through the refrigerant flow passages cools down the stator 34, and the compressed refrigerant passing through the gaps cools down the stator 34, the stator windings and the rotor 33. Such a cooling down of the driving motor 32 protects the stator 34 and the rotor 33 against damage (by limiting the temperature by forced convection) and improves the efficiency of the scroll compressor 1.

In operation, a second part of the refrigerant supplied by the refrigerant suction pipe 29 enters the refrigerant inlet passage P2 and is guided towards the outermost compression chambers 17, then is compressed into the compression chambers 17 and escapes from the centre of the lower fixed scroll 5 and of the orbiting scroll arrangement 7 through the discharge passages 24. The compressed refrigerant coming out of the discharge passages 24 then flows upwardly towards the discharge pipe 30 by passing through the communication chamber 27, the refrigerant communication passages 25, the refrigerant flow passages and the gaps. Therefore, the refrigerant compressed in the compression chambers 17 is discharged by the refrigerant discharge pipe 30 after having cooling down the driving motor 32.

In operation, the oil separated from the compressed refrigerant coming out from the discharge passages 23 and the refrigerant communication passages 25 and collected in the second oil sump S2 and in the cavity 72, is supplied to the oil supplying passage 73. The oil supplied to the oil supplying passage 73 is then supplied to the first and second engaging projections 54, 55, 59, 61 of the Oldham couplings 51, 52 via the lubrication passages 74, 77.

Of course, the invention is not restricted to the embodiment described above by way of non-limiting example, but on the contrary it encompasses all embodiments thereof. For example, the Oldham couplings 51, 52 may include first and second engaging grooves instead of the first and second engaging projections 54, 55, 59, 61. Further, the orbiting scroll arrangement 7 may include complementary engaging projections instead of the complementary engaging grooves 57, 63. Furthermore, the upper and lower fixed scrolls 4, 5 may include complementary engaging projections instead of the complementary engaging grooves 56, 62.

CLAIMS

1. A scroll compressor (1) including:

- a closed container (2),

- a compression unit (3) located in the closed container and including:

- a first fixed scroll (4) comprising a first fixed base plate (8) and a first fixed spiral wrap (9),

- an orbiting scroll arrangement (7) including a first orbiting spiral wrap (14), the first fixed spiral wrap (9) and the first orbiting spiral wrap (14) forming a plurality of first compression chambers (16),

- a drive shaft (31) including a driving portion adapted for driving the orbiting scroll arrangement (7) in an orbital movement,

- a plurality of bearings (46, 47, 48) configured to rotatably support the drive shaft (31),

- at least a first anti-rotation device (51) configured to prevent rotation of the orbiting scroll arrangement (7) with respect to the first fixed scroll (4),

- a first oil sump (S1) delimited by the closed container (2), and a second oil sump (S2) at least partially delimited by the first fixed base plate (8),

- a first lubrication system (64) configured to lubricate at least partially the bearings with oil supplied from the first oil sump (S1), and

- a second lubrication system (65) configured to lubricate at least partially the first anti-rotation device (51) with oil supplied from the second oil sump (S2).

2. The scroll compressor according to claim 1, wherein the second lubrication system (65) includes:

- an oil supplying passage (73) fluidly connected to the second oil sump (S2) and delimited at least partially by the first fixed base plate (8), and

- at least one first lubrication passage (74) provided on the first fixed base plate (8) and fluidly connected to the oil supplying passage (73), the at least one first lubrication passage (74) being configured to supply with oil the first anti-rotation device (51).

3. The scroll compressor according to claim 2, wherein the oil supplying passage (73) extends along at least a part of a perimeter edge of the first fixed base plate (8).

4. The scroll compressor according to claim 3, wherein the oil supplying passage (73) is delimited by the first fixed base plate (8) and the closed container (2).

5. The scroll compressor according to any one of claims 2 to 4, wherein the oil supplying passage (73) is helicoidal.

6. The scroll compressor according to any one of claims 2 to 5, wherein the second lubrication system (65) further includes a cavity (72) provided on the first fixed base plate (8) and fluidly connected to the oil supplying passage (73), the cavity (72) being configured to collect at least a part of the oil contained in the second oil sump (S2) and to supply the oil supplying passage (73) with oil.

7. The scroll compressor according to any one of claims 1 to 6, further including an oil return passage (84) fluidly connecting the first oil sump (S1) and the second oil sump (S2), and configured to return an excess of oil from the second oil sump (S2) to the first oil sump (S1).

8. The scroll compressor according to claim 7, wherein the oil return passage (84) includes:

- an oil return channel (85) at least partially defined by the first fixed base plate (8) and fluidly connected to the second oil sump (S2), and

- an oil return pipe (86) fluidly connecting the oil return channel (85) and the first oil sump (S1), the oil return pipe (86) including a mounting portion mounted on the compression unit (3).

9. The scroll compressor (1) according to any one of claims 1 to 8, wherein the first fixed scroll (4) includes at least one first discharge passage (23) configured to conduct a refrigerant compressed in the first compression chambers (16) towards the second oil sump (S2).

10. The scroll compressor (1) according to any one of claims 1 to 9, wherein the compression unit (3) further includes a second fixed scroll (5) including a second fixed base plate (11) and a second fixed spiral wrap (12), the first and second fixed scrolls (4, 5) defining an inner volume (6), the orbiting scroll arrangement (7) being disposed in the inner volume (6) and further including a second orbiting spiral

wrap (15), the second fixed spiral wrap (12) and the second orbiting spiral wrap (15) forming a plurality of second compression chambers (17).

11. The scroll compressor (1) according to claim 10, wherein the second fixed scroll (4) includes at least one second discharge passage (24) configured to conduct a refrigerant compressed in the second compression chambers (17) outside the inner volume (6).

12. The scroll compressor (1) according to claim 11, wherein the closed container (2) defines a high pressure discharge volume, the compression unit (3) further including at least one refrigerant communication passage (25) configured to fluidly connect the at least one second discharge passage (24) and the high pressure discharge volume (V).

13. The scroll compressor (1) according to claim 12, wherein the first fixed base plate (8) includes at least one projecting element (28) surrounding and defining a refrigerant outlet aperture of a respective refrigerant communication passage (25), the at least one projecting element (28) being configured to avoid a discharge of the oil contained in the upper oil sump (S2) into the respective refrigerant communication passage (25).

14. The scroll compressor (1) according to claim 12 or 13, further including a communication chamber (27) fluidly connecting the at least one second discharge passage (24) and the at least one refrigerant communication passage (25).

15. The scroll compressor (1) according to any one of claims 1 to 14, wherein the first lubrication system (64) includes a lubrication channel (66) provided on the drive shaft (31) and fluidly connected to the first oil sump (S1), the lubrication channel (66) extending over at least a part of the length of the drive shaft (31).

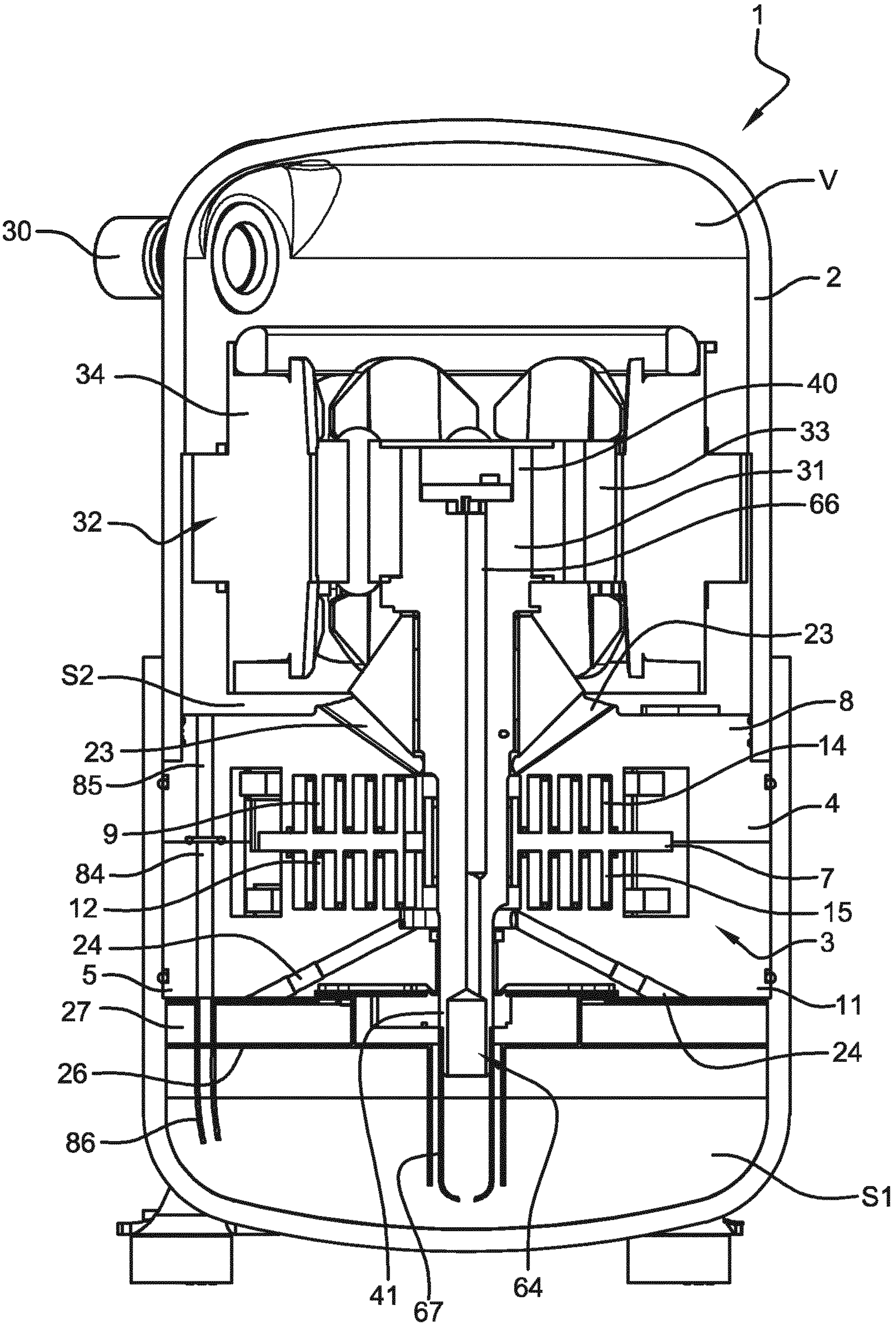
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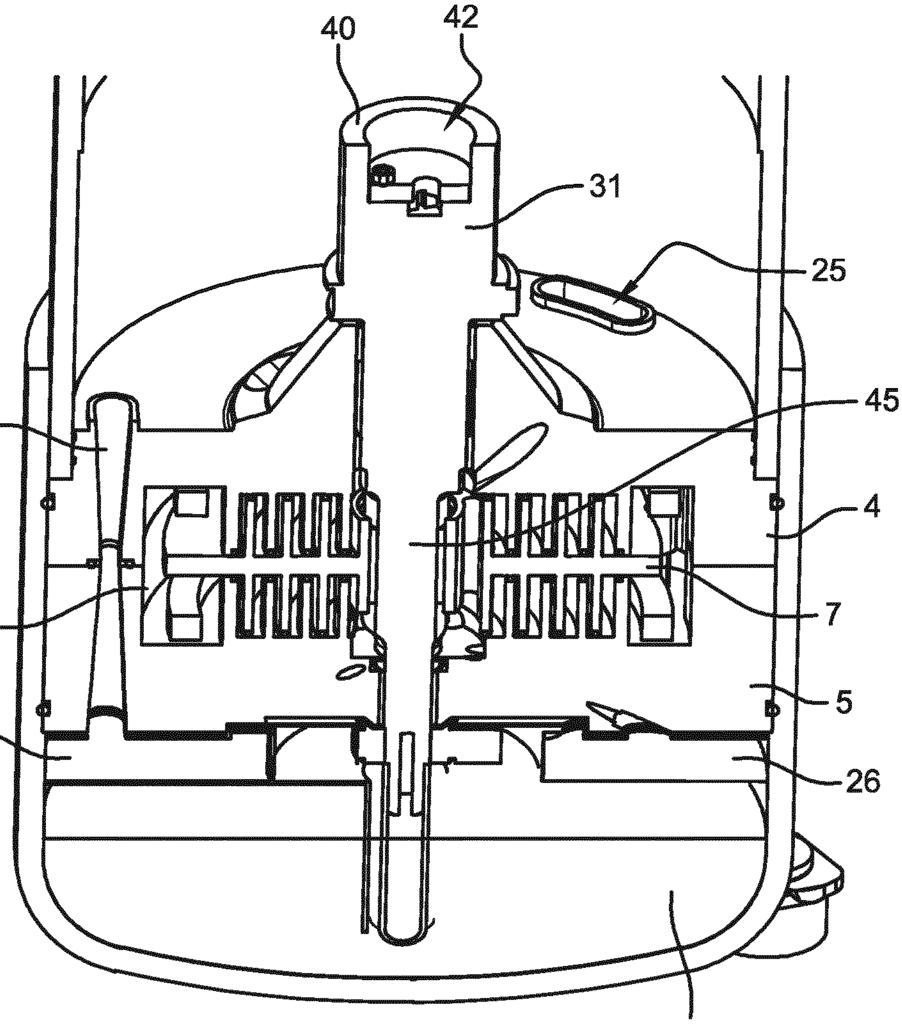
Fig. 1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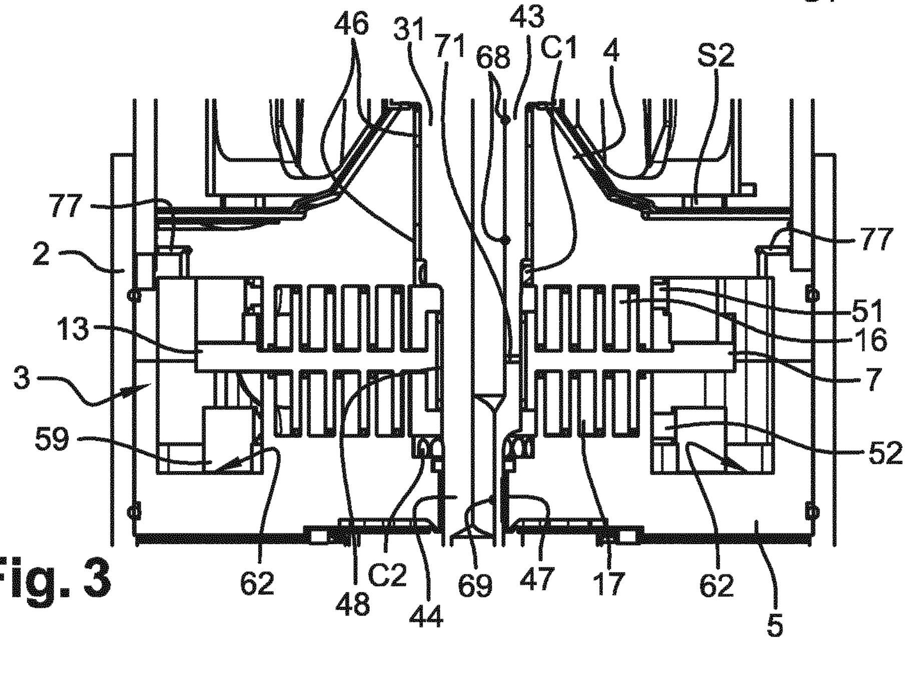
S1

Fig. 2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17
62
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Fig. 3

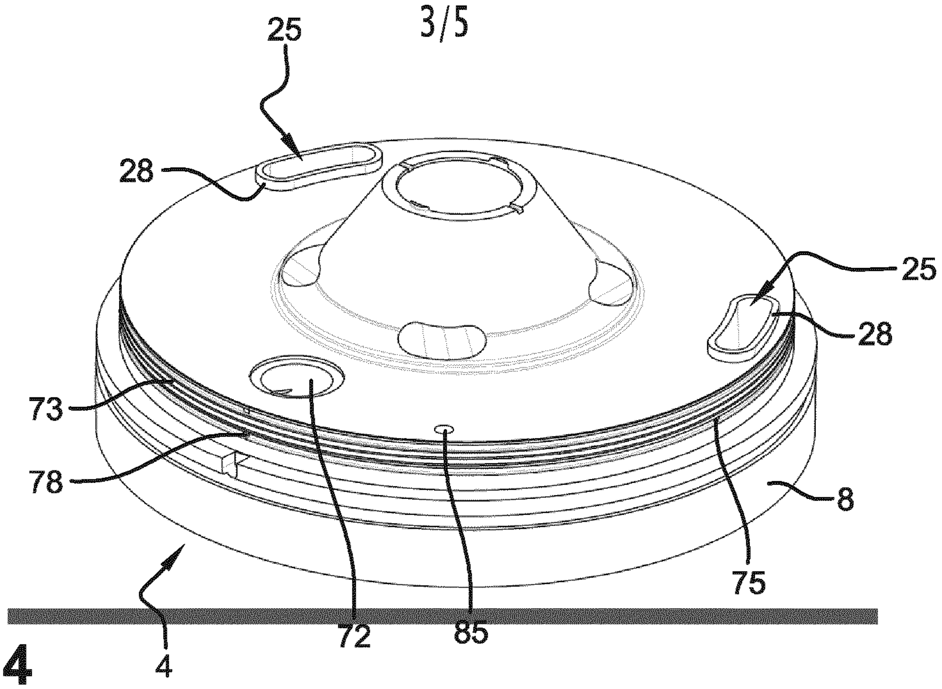


Fig. 4

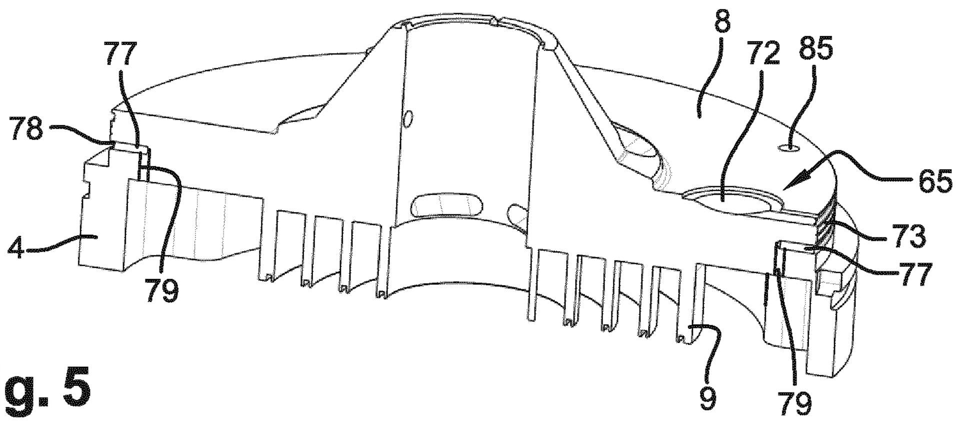


Fig. 5

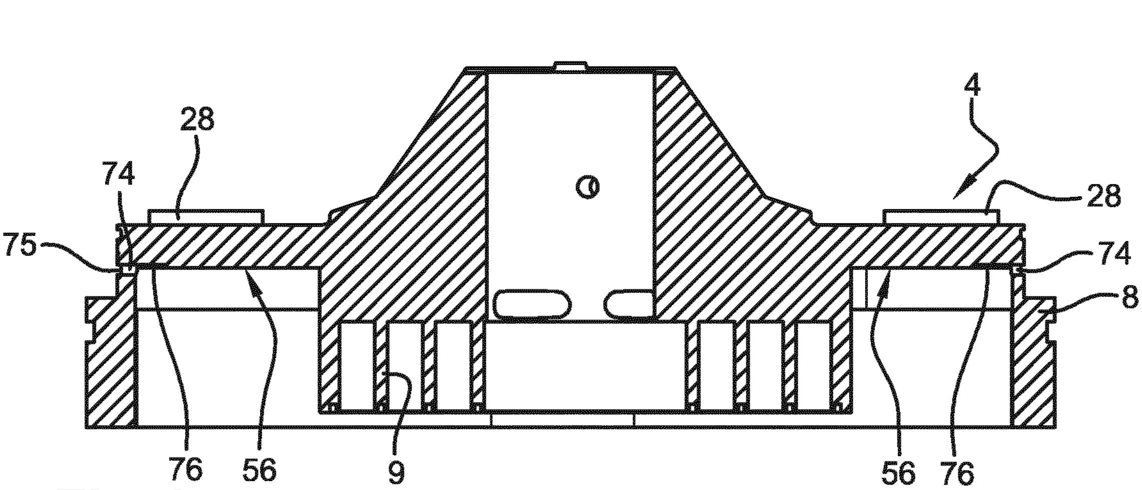
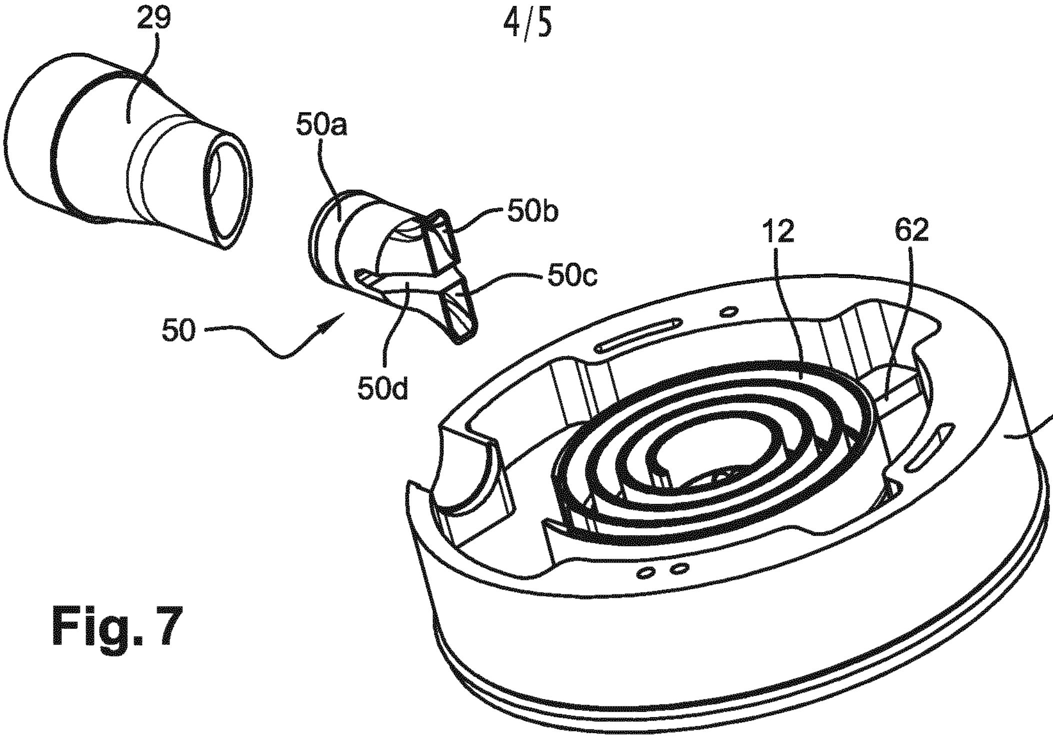


Fig. 6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50c
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50d
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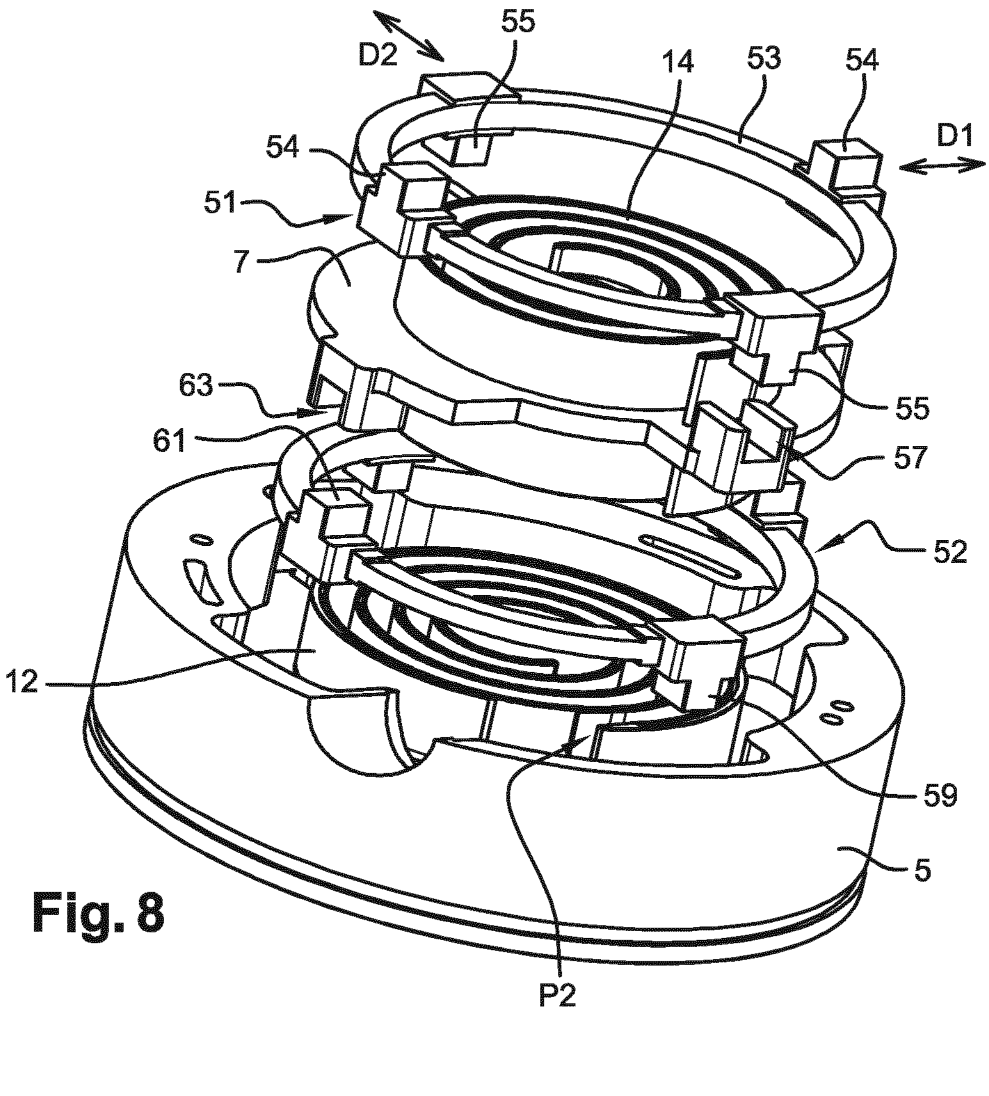
Fig. 7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P2

Fig. 8

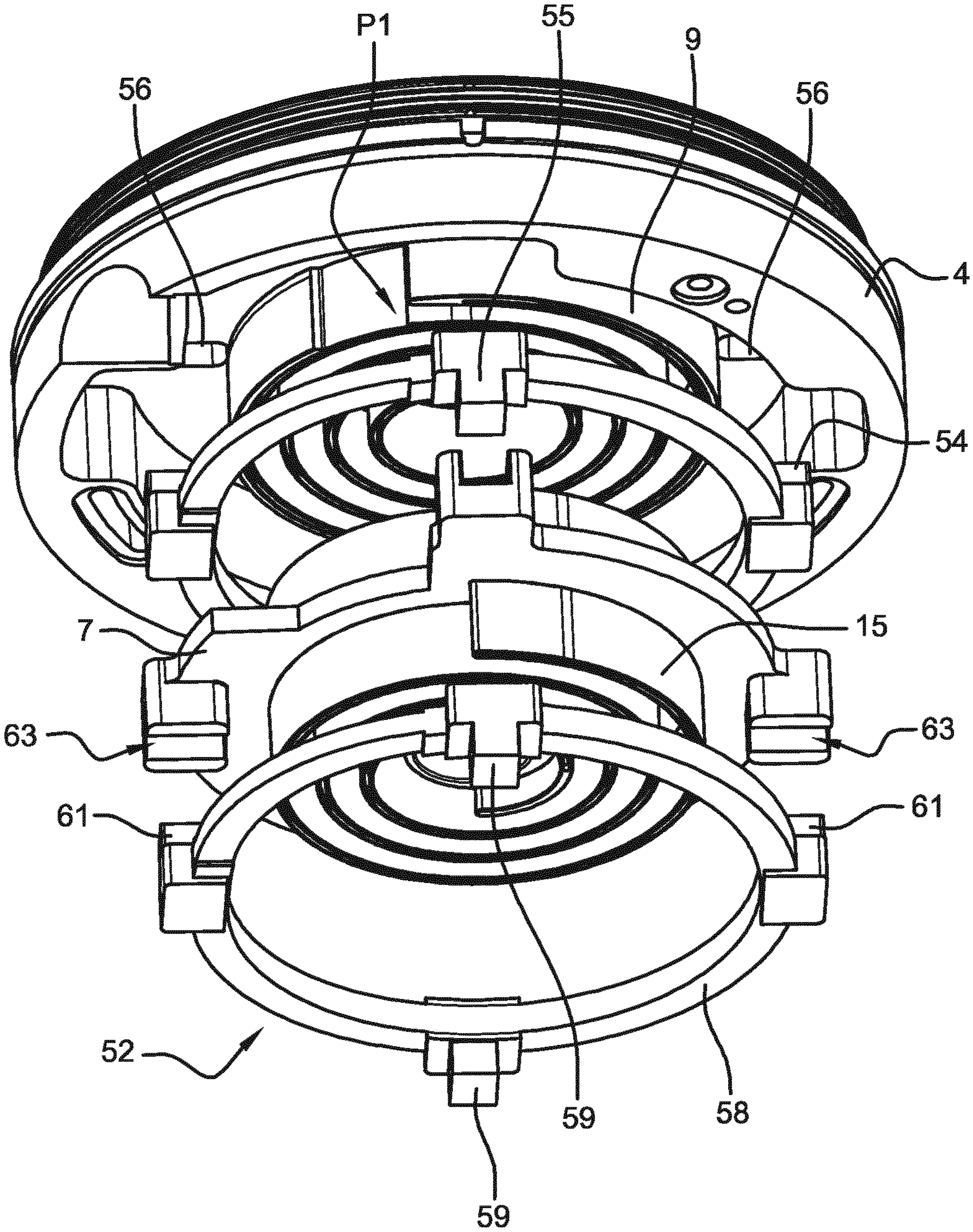

Fig. 9

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2015/074009

A. CLASSIFICATION OF SUBJECT MATTER
INV. F04C29/02 F04C18/02 F04C23/00
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F04C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
15 December 2015	03/05/2016

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Papastefanou, M

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International application No
PCT/EP2015/074009

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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