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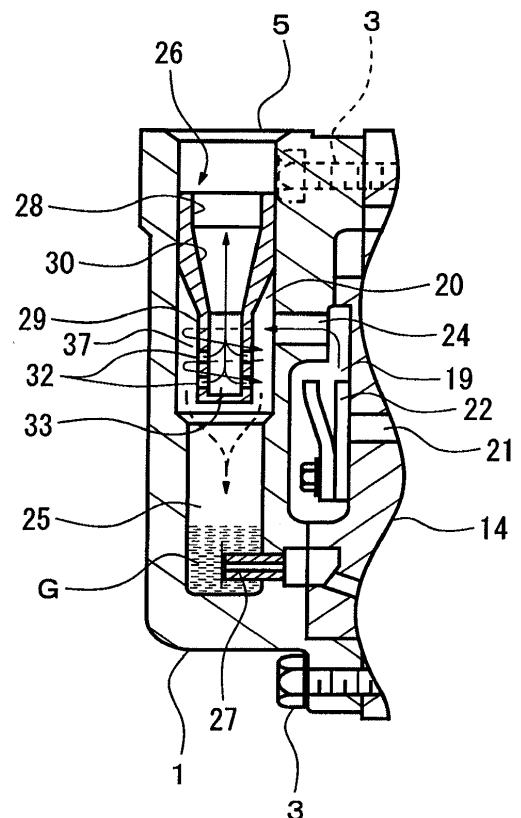
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(54) **Compressor**

(57) A compressor includes a housing having a discharge chamber into which compressed refrigerant gas is discharged, an oil separation chamber, a passage connecting between the discharge chamber and the oil separation chamber, and an outlet port through which the refrigerant gas passed through the oil separation chamber flows out of the housing; and a cylindrical oil separator provided in the oil separation chamber. The oil separator includes a large-diameter portion, a small-diameter portion, and an intermediate portion formed between the large-diameter portion and the small-diameter portion and tapered toward the small-diameter portion. Plural holes are formed in the periphery of the small-diameter portion of the oil separator. The passage is directed toward the small-diameter portion of the oil separator in such a manner that the refrigerant gas swirls around the small-diameter portion, so that the refrigerant gas from which lubricating oil is separated enters the oil separator through the hole.

FIG. 4



Description

BACKGROUND OF THE INVENTION

[0001] The present invention relates to a compressor.

[0002] In a refrigerant gas compressor, pulsation of discharge refrigerant gas occurs. When such compressor is used in a vehicle air conditioner, the pulsation may be transmitted through a conduit of a refrigerant circuit to a passenger compartment of the vehicle and cause vibration to equipment in the compartment and abnormal noise. To reduce such pulsation, there has been proposed various methods such as providing a large volume muffler on the side where refrigerant gas is discharged or throttling a passage where discharged refrigerant gas flows.

[0003] However, the provision of a large volume muffler leads to an increased size of the compressor and hence to an increased installation space for the compressor, which is disadvantageous in the installation in an environment such as a vehicle where layout space is limited. The throttling of the refrigerant gas passage by reducing the cross sectional area of the passage for reduction of the pulsation of discharge refrigerant gas leads to an increased pressure loss of refrigerant gas, resulting in reduced cooling efficiency of the air conditioner.

[0004] Japanese Unexamined Patent Application Publication No. 2005-16454 discloses a compressor in which a muffler is formed by a large-volume discharge chamber where compressed refrigerant gas is discharged from a compression chamber. The discharge chamber has therein a vertically extending pipe connected to an external refrigerant circuit and serving as an oil separator. The discharge chamber is connected to the compression chamber through a discharge port and a discharge valve. The pipe is positioned above the discharge port and the discharge valve. The pipe has a throttling portion which is opened at its lower end to the discharge chamber and a diffuser portion which is connected at its upper end to the external refrigerant circuit.

[0005] In the compressor disclosed in the publication No. 2005-16454, the provision of the large discharge chamber as the muffler helps to reduce the pulsation of discharge refrigerant gas, and the throttling of discharged refrigerant gas flowing from the discharge chamber into the pipe helps to further reduce the pulsation. The pressure of the refrigerant gas flowing through the pipe is reduced at the throttling portion, but recovered at the diffuser portion. Then the refrigerant gas flows out of the compressor into the external refrigerant circuit.

[0006] Japanese Unexamined Patent Application Publication No. 11-107959 discloses another compressor having in its hermetic housing a discharge space into which compressed refrigerant gas is discharged from a compression mechanism through a delivery pipe. The discharge space is provided with a discharge pipe through which compressed refrigerant gas is discharged out of the housing. The discharge pipe is closed at its

lower end in the housing by a plate and has plural small holes in its peripheral surface adjacent to such bottom end. When the refrigerant gas discharged into the discharge space flows through the holes, lubricating oil contained in the refrigerant gas is separated therefrom and attached to the outer surface of the discharge pipe, with simultaneous reduction of pulsation of the refrigerant gas.

[0007] The provision of a large volume discharge chamber as the muffler disclosed in the publication No. 2005-16454 leads to an increased size of the compressor, and hence is not a practical option. In addition, the throttling of refrigerant gas flow through the pipe by reducing the cross sectional area of the throttling portion is limited to the pressure level that can be recovered by the diffuser portion, which does not necessarily lead to the desired reduction of pulsation of discharge refrigerant gas.

[0008] In the structure disclosed in the publication No. 11-107959 in which compressed refrigerant gas discharged into the discharge space directly enters the discharge pipe through the holes, the lubricating oil separated from the refrigerant gas by the hole and attached to the pipe surface adjacent to the holes may block refrigerant gas flow through the holes, which is disadvantageous in the prevention of increased pressure loss of refrigerant gas due to the throttling of refrigerant gas flow by the hole. In addition, the lubricating oil separated from refrigerant gas may be blown up into the discharge pipe by the compressed gas entering through the holes, which does not necessarily lead to the desired separation of lubricating oil.

[0009] The present invention is directed to providing a compressor of a structure that prevents increased pressure loss of refrigerant gas and reduces pulsation of discharge refrigerant gas.

SUMMARY OF THE INVENTION

[0010] In accordance with an aspect of the present invention, a compressor includes a housing having a discharge chamber into which compressed refrigerant gas is discharged, an oil separation chamber in which lubricating oil contained in the discharged refrigerant gas is separated, a passage connecting between the discharge chamber and the oil separation chamber, and an outlet port through which the refrigerant gas passed through the oil separation chamber flows out of the housing; and a cylindrical oil separator provided in the oil separation chamber and connected at one end to the outlet port. The oil separator includes a large-diameter portion, a small-diameter portion having a smaller diameter than the large-diameter portion, and an intermediate portion formed between the large-diameter portion and the small-diameter portion and tapered toward the small-diameter portion. Plural holes are formed in the periphery of the small-diameter portion of the oil separator. The passage is directed toward the small-diameter portion of

the oil separator in such a manner that the refrigerant gas flowed through the passage into the oil separation chamber swirls around the small-diameter portion, so that the refrigerant gas from which lubricating oil is separated enters the oil separator through the hole and then exits the large-diameter portion of the oil separator.

[0011] Other aspects and advantages of the invention will become apparent from the following description, taken in conjunction with the accompanying drawings, illustrating by way of example the principles of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012]

Fig. 1 is a longitudinal sectional view of an electric motor driven compressor according to a first embodiment of the present invention;

Fig. 2 is an enlarged view of a cylindrical oil separator of the compressor of Fig. 1;

Fig. 3 is a top view of the oil separator of Fig. 2;

Fig. 4 is an enlarged fragmentary view of the compressor of Fig. 1, showing an oil separation chamber and its related components;

Fig. 5A is a top view of a second embodiment of the oil separator of the compressor according to the present invention; and

Fig. 5B is a sectional view taken along the line VB-VB of Fig. 5A.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0013] The following will describe the embodiments of the electric motor driven compressor according to the present invention with reference to the accompanying drawings. Figs. 1 to 4 show the electric motor driven scroll compressor of the first embodiment according to the present invention. It is noted that the left-hand side and the right-hand side of the compressor as viewed in Fig. 1 correspond to its front side and rear side, respectively, and that the upper and lower sides of the compressor as viewed in Fig. 1 correspond to its upper and lower sides, respectively.

[0014] Referring to Fig. 1, the compressor has a front housing 1 and a rear housing 2 which are fixed together by plural bolts 3 thereby to form a hermetic compressor housing. The rear housing 2 and the front housing 1 has an inlet port 4 and an outlet port 5, respectively, which are connected to an external refrigerant circuit (not shown). Refrigerant gas enters the compressor through the inlet port 4 of the rear housing 2 and flows in the rear housing 2 and the front housing 1 toward the outlet port 5 of the front housing 1.

[0015] The rear housing 2 accommodates therein a scroll compression mechanism 6 and an electric motor 7 for driving the compression mechanism 6. The electric motor 7 is a three-phase AC motor and has a rotary shaft 8 rotatably supported in the rear housing 2 by bearings, a rotor 9 fixed to the rotary shaft 8, and a stator 10 fixed to the inner surface of the rear housing 2 around the rotor 9. The stator 10 has a three-phase coil 11 that is electrically connected through a cluster block 12 to an inverter (not shown) provided in an inverter housing 13.

[0016] The compression mechanism 6 is mainly composed of a fixed scroll 14 fixed to the inner surface of the rear housing 2 and a movable scroll 15 disposed in facing relation to the fixed scroll 14 so as to form therebetween plural compression chambers 16, the volume of which is variable for compressing refrigerant gas. The movable scroll 15 is connected through a bearing and an eccentric bush 17 to an eccentric pin 18 of the rotary shaft 8 and orbits about the fixed scroll 14 with the rotation of the rotary shaft 8 so as to vary the volume of the compression chambers 16.

[0017] The front and rear housings 1, 2 form therebetween a discharge chamber 19. The front housing 1 forms therein an oil separation chamber 20. The fixed scroll 14 has at the center thereof a discharge port 21 through which the compression chamber 16 then located at the innermost position communicates with the discharge chamber 19. The discharge port 21 is normally closed by a discharge valve 22 provided in the discharge chamber 19. Refrigerant gas compressed in the compression chamber 16 is discharged into the discharge chamber 19 while pushing open the discharge valve 22. The opening of the discharge valve 22 is restricted by a retainer 23.

[0018] The space of the discharge chamber 19 is formed large enough only to accommodate therein at least the discharge valve 22 and the retainer 23. The discharge chamber 19 is connected at its upper part to the oil separation chamber 20 through a passage 24.

[0019] The oil separation chamber 20 is made in the form of a vertically extending space. The lower part of the oil separation chamber 20 serves as an oil reservoir 25 and the upper part thereof is equipped with an oil separator 26. Lubricating oil collected in the oil reservoir 25 is flowed toward the compression mechanism 6 through an oil return passage 27 provided adjacent to the bottom of the oil reservoir 25.

[0020] Figs. 2 and 3 show the structure of the oil separator 26 in detail. The oil separator 26 is of a generally hollow cylindrical shape and has on its upper side a large-diameter portion 28 and on its lower side adjacent to the oil reservoir 25 a small-diameter portion 29 having a smaller inner diameter than the large-diameter portion 28. The oil separator 26 further has an intermediate portion 30 formed between the large-diameter portion 28 and the small-diameter portion 29 and tapered toward the small-diameter portion 29. The upper end of the large-diameter portion 28, that is, one end of the oil separator 26 is opened, while the lower end of the small-diameter

portion 29 facing the oil reservoir 25, that is, the other end of the oil separator 26 is closed by a bottom plate 31. As shown in Fig. 1, the large-diameter portion 28 of the oil separator 26 is fixed to the inner surface of the oil separation chamber 20 and connected at its upper end to the outlet port 5 and hence to the external refrigerant circuit.

[0021] Plural round holes 32 are formed in the periphery of the lower part of the small-diameter portion 29 of the oil separator 26. The holes 32 are divided into two vertically spaced groups each having eight holes 32 arranged at an equal angular interval along the circumference of the small-diameter portion 29. That is, the small-diameter portion 29 has a total of sixteen holes 32. The holes 32 serve to provide fluid communication between the interior 33 and the exterior 37 of the oil separator 26. The small-diameter portion 29 has a perforated region 34 where the holes 32 are formed and a non-perforated region 35 where no hole such as 32 is formed. The hole 32 is formed in such a manner that the cross sectional area S2 of the hole 32 is as small as possible relative to the cross sectional area S1 of the passage 24 at the connection thereof to the oil separation chamber 20.

[0022] The oil separator 26 is disposed in such a manner that the non-perforated region 35 of the small-diameter portion 29 faces the passage 24. The passage 24 is directed toward the small-diameter portion 29 and also directed in tangential relation to the small-diameter portion 29. Specifically, the passage 24 is formed in such a manner that, as shown in Fig. 3, the central axis X1 of the passage 24 coincides with the tangent to the small-diameter portion 29, as seen in the direction in which refrigerant gas is discharged from the passage 24. In other words, the central axis X1 of the passage 24 extends tangentially to the outer circumference of the small-diameter portion 29, as shown in Fig. 3. It is noted that according to the present invention the passage 24 may be formed in such a manner that the central axis X1 of the passage 24 passes through a point located radially inward or outward of the small-diameter portion 29, and also that the formation of the passage 24 with the central axis X1 extending tangentially to any circle concentric with the outer circumference of the small-diameter portion 29 having the central axis X2 falls within the scope of the present invention.

[0023] Refrigerant gas flowed through the passage 24 into the oil separation chamber 20 swirls around the small-diameter portion 29 of the oil separator 26, so that lubricating oil contained in the refrigerant gas is separated therefrom by centrifugal force. The separated lubricating oil is attached to the inner surface of the oil separation chamber 20 and moved downward therealong to be collected in the oil reservoir 25.

[0024] Referring to Fig. 4, refrigerant gas compressed in the central compression chamber 16 of the compression mechanism 6 (Fig. 1) is discharged through the discharge port 21 into the discharge chamber 19 while pushing open the discharge valve 22. The refrigerant gas then

flows through the passage 24 toward the non-perforated region 35 of the small-diameter portion 29 of the oil separator 26 in the oil separation chamber 20 and then moves down toward the perforated region 34 while swirling around the small-diameter portion 29 from the non-perforated region 35, as indicated by spiral arrow. While the refrigerant gas is swirling, lubricating oil contained in the refrigerant gas is separated therefrom by centrifugal force, and the separated lubricating oil is attached to the inner surface of the oil separation chamber 20. The separated lubricating oil is then moved downward on the inner surface of the oil separation chamber 20 to the oil reservoir 25 as indicated by dashed arrow and stored therein as indicated by reference symbol G.

[0025] The refrigerant gas from which almost all lubricating oil having been separated swirls around the perforated region 34 of the oil separator 26 and then enters the interior 33 of the oil separator 26 through the holes 32 of the perforated region 34. Because of the small cross sectional area S2 of the hole 32, the flow of refrigerant gas passing through the holes 32 is effectively throttled, resulting in the reduction of pulsation of discharge refrigerant gas. The provision of plural holes 32 in the perforated region 34 allows sufficient amount of refrigerant gas to flow and enter the interior 33 of the oil separator 26, which helps to prevent increased pressure loss of refrigerant gas due to the throttling of discharged refrigerant gas flow by the holes 32.

[0026] When the refrigerant gas, which has entered the interior 33 of the oil separator 26 and the pressure of which has been reduced, flows from the small-diameter portion 29 into the intermediate portion 30, the pressure of the refrigerant gas is recovered because of the diverging structure of the intermediate portion 30 serving as a diffuser, which further helps to prevent an increase of the pressure loss of refrigerant gas. The refrigerant gas flowed from the intermediate portion 30 to the large-diameter portion 28 in the oil separator 26 exits the compressor through the outlet port 5 and flows in the external refrigerant circuit.

[0027] Fig. 5 shows the second embodiment of the electric motor driven compressor according to the present invention. In the drawing, same reference numerals are used for the common elements or components in the first and the second embodiments, and the description of such elements or components of the second embodiment will be omitted. The second embodiment differs from the first embodiment in that three holes 36 are formed through the bottom plate 31 of the small-diameter portion 29 of the oil separator 26 in addition to the holes 32 formed in the small-diameter portion 29. The cross sectional area S3 of the hole 36 is smaller than the cross sectional area S2 (Fig. 2) of the hole 32. Refrigerant gas flowed into the oil separation chamber 20 swirls around the small-diameter portion 29 of the oil separator 26 and lubricating oil contained in the refrigerant gas is separated therefrom by centrifugal force. The refrigerant gas from which lubricating oil having been separated

swirls around the small-diameter portion 29 and enters the interior 33 of the oil separator 26 through the holes 32 formed in the periphery of the oil separator 26 and also through the holes 36 formed in the bottom plate 31 of the oil separator 26.

[0028] The provision of the holes 36 makes it easy for the refrigerant gas swirling around the small-diameter portion 29 of the oil separator 26 to enter the interior 33 of the oil separator 26, which leads to an increased flow rate of refrigerant gas in the interior 33 and further helps to prevent an increase of pressure loss of refrigerant gas. Although the lubricating oil collected in the oil reservoir 25 is blown up against the bottom plate 31 of the oil separator 26 by the swirling refrigerant gas flow, such lubricating oil is prevented from entering the interior 33 of the oil separator 26 through the hole 36 because the cross sectional area of the hole 36 formed in the bottom plate 31 is small.

[0029] It is to be understood that the present invention is not limited to the above-described embodiments, but it may be modified in various ways as exemplified below without departing from the scope of the invention.

(1) Although in the first and second embodiments the passage 24 is directed toward the non-perforated region 35 having no hole such as 32, the passage 24 may be directed toward the part of the oil separator 26 where the holes such as 32 are formed. Also in such configuration, the refrigerant gas discharged from the passage 24 and containing lubricating oil swirls around the small-diameter portion 29 of the oil separator 26 and, therefore, the amount of refrigerant gas flowing directly through the holes is little, thereby offering the advantages similar to those of the first and second embodiments.

(2) The cross section of the oil separator 26 and of the hole 32 may not only be of a round shape, but also of an elliptical, square shape or of any combination of round, elliptical and square.

(3) The holes 32 do not necessarily have the same diameter or same cross sectional area. The holes 32 may be replaced by holes with different diameters or different cross sectional areas.

(4) The present invention is applicable not only to an electric motor driven scroll compressor as described in the first and second embodiments, but also to a mechanically driven compressor of various types such as a scroll type, piston type or vane type.

[0030] A compressor includes a housing having a discharge chamber into which compressed refrigerant gas is discharged, an oil separation chamber, a passage connecting between the discharge chamber and the oil separation chamber, and an outlet port through which the refrigerant gas passed through the oil separation cham-

ber flows out of the housing; and a cylindrical oil separator provided in the oil separation chamber. The oil separator includes a large-diameter portion, a small-diameter portion, and an intermediate portion formed between the large-diameter portion and the small-diameter portion and tapered toward the small-diameter portion. Plural holes are formed in the periphery of the small-diameter portion of the oil separator. The passage is directed toward the small-diameter portion of the oil separator in such a manner that the refrigerant gas swirls around the small-diameter portion, so that the refrigerant gas from which lubricating oil is separated enters the oil separator through the hole.

Claims

1. A compressor, comprising:

a housing (1, 2) having a discharge chamber (19) into which compressed refrigerant gas is discharged, an oil separation chamber (20) in which lubricating oil contained in the discharged refrigerant gas is separated, a passage (24) connecting between the discharge chamber (19) and the oil separation chamber (20), and an outlet port (5) through which the refrigerant gas passed through the oil separation chamber (20) flows out of the housing (1, 2); and

a cylindrical oil separator (26) provided in the oil separation chamber (20) and connected at one end to the outlet port (5), the oil separator (26) including a large-diameter portion (28), a small-diameter portion (29) having a smaller diameter than the large-diameter portion (28), and an intermediate portion (30) formed between the large-diameter portion (28) and the small-diameter portion (29) and tapered toward the small-diameter portion (29),

characterized in that plural holes (32) are formed in the periphery of the small-diameter portion (29) of the oil separator (26), and the passage (24) is directed toward the small-diameter portion (29) of the oil separator (26) in such a manner that the refrigerant gas flowed through the passage (24) into the oil separation chamber (20) swirls around the small-diameter portion (29), so that the refrigerant gas from which lubricating oil is separated enters the oil separator (26) through the hole (32) and then exits the large-diameter portion (28) of the oil separator (26).

2. The compressor of claim 1, wherein the cross sectional area (S2) of the hole (32) is smaller than the cross sectional area (S1) of the passage (24) at the connection thereof to the oil separation chamber (20).

3. The compressor of claim 1 or 2, wherein the small-diameter portion (29) of the oil separator (26) has a perforated region (34) where the holes (32) are formed and a non-perforated region (35) where no hole is formed, and the passage (24) is directed toward the non-perforated region (35) of the small-diameter portion (29). 5
4. The compressor of any one of claims 1 to 3, wherein the other end of the oil separator (26) is closed. 10

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FIG. 1

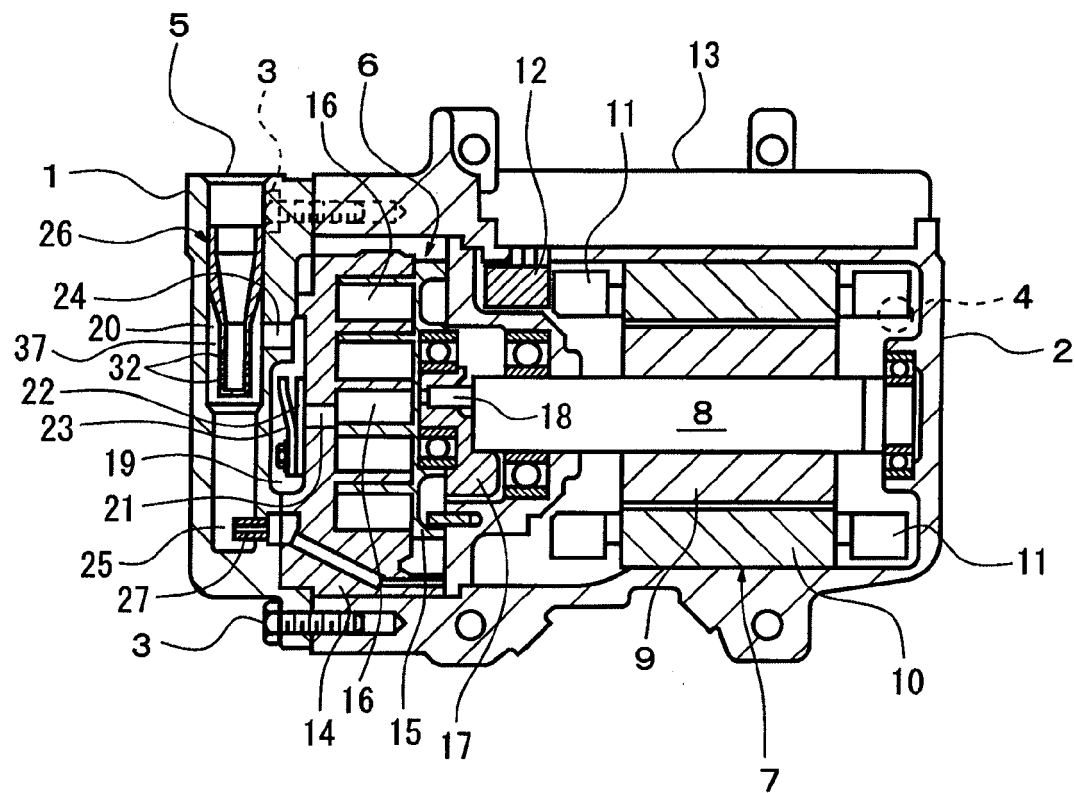


FIG. 2

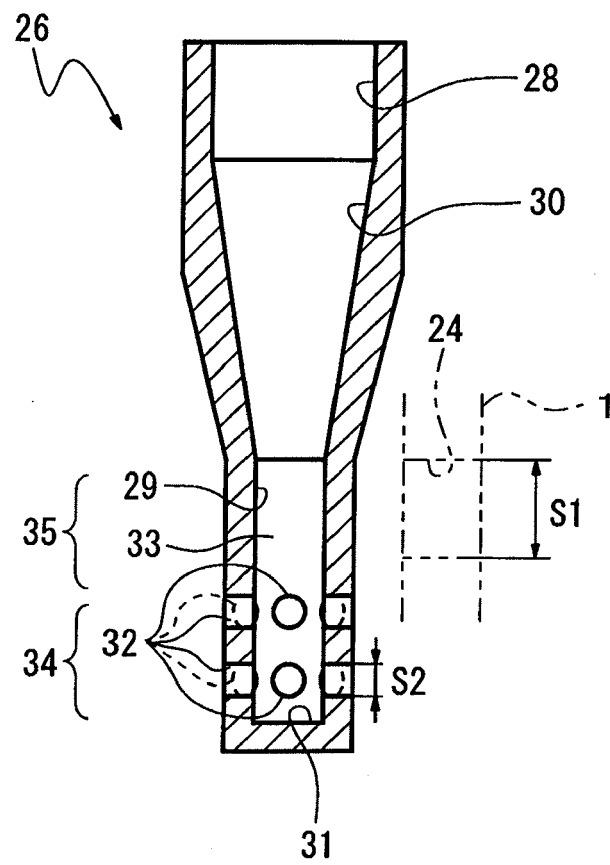


FIG. 3

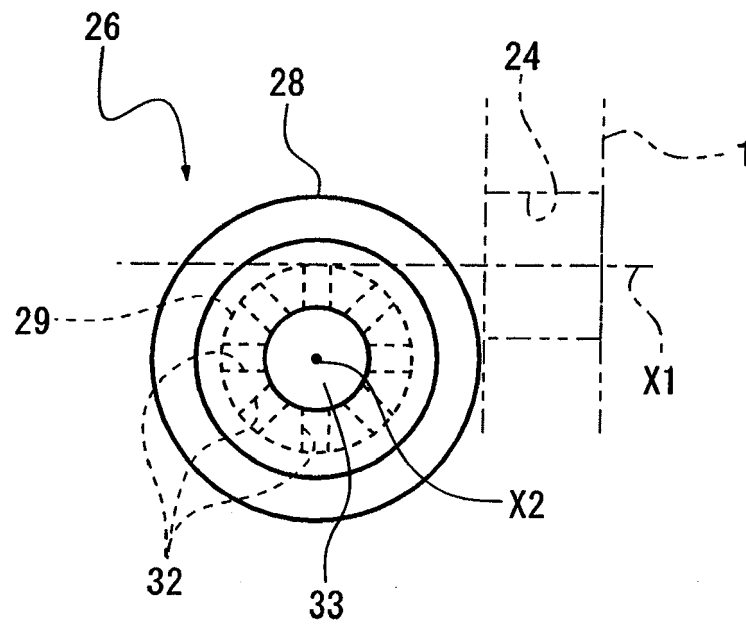


FIG. 4

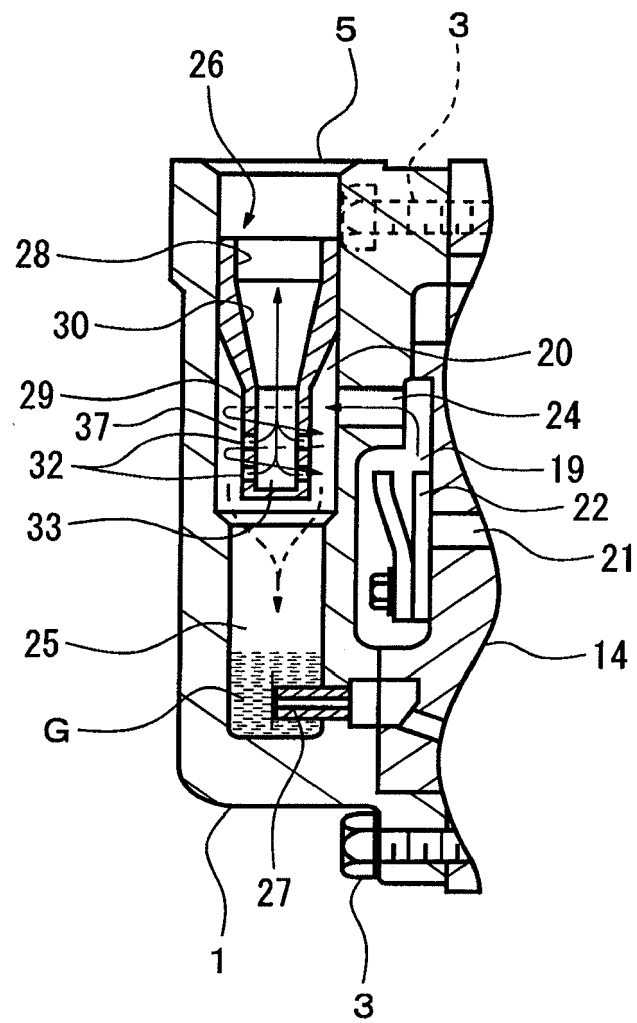


FIG. 5A

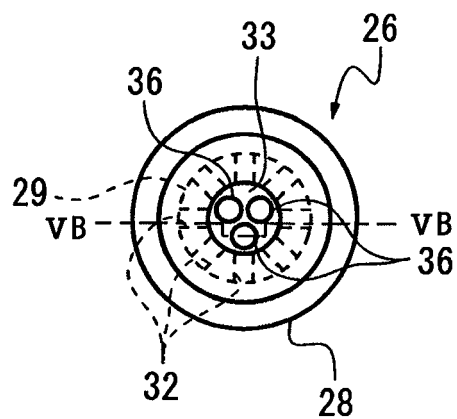
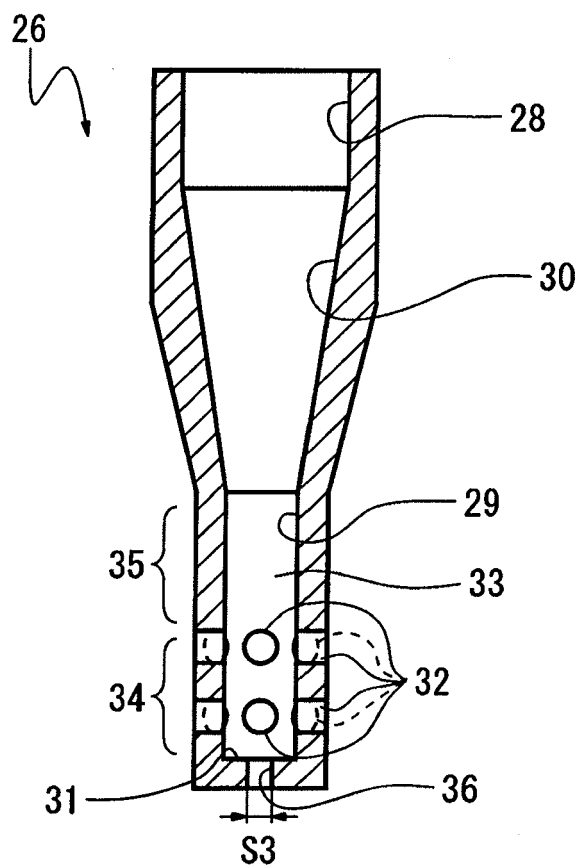


FIG. 5B





EUROPEAN SEARCH REPORT

Application Number
EP 13 17 6449

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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			TECHNICAL FIELDS SEARCHED (IPC)
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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 10 October 2013	Examiner Durante, Andrea
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			

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**ANNEX TO THE EUROPEAN SEARCH REPORT
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EP 13 17 6449

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