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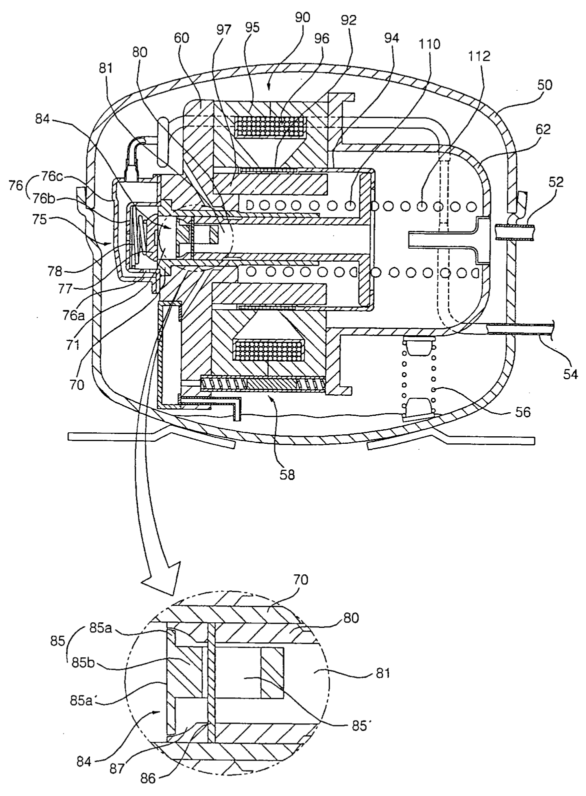
(54) **Linear compressor**

(57) Disclosed herein is a linear compressor in which a piston reciprocally moves in a cylinder upon receiving a reciprocating drive force of a linear motor to compress working-fluid, for example, refrigerant, received in the cylinder. The linear compressor comprises a piston (80) adapted to reciprocally move in a cylinder (70), the piston (80) being internally formed with a suction path (81), and a suction valve (84) inserted in the suction path (81) of the piston (80) to move relative to the suction path (81), the suction valve performing opening/closing operations as it moves relative to the piston (80) when the piston (80) reciprocally moves. With this configuration, the suction valve (84) always exhibits an even stroke, achieving an improvement in response and durability and minimizing vibration and noise due to the opening/closing operations thereof.

Fig. 4



EP 1 785 626 A1

Description

[0001] The present invention relates to a linear compressor, and more particularly, to a linear compressor in which a suction valve performs opening/closing operations as it moves relative to a piston by an inertial force when the piston reciprocally moves.

[0002] Generally, a linear compressor is an apparatus configured in such a fashion that a piston reciprocally moves in a cylinder upon receiving a reciprocating drive force of a linear motor, to compress working-fluid received in the cylinder, for example, refrigerant. The linear compressor is mainly used in refrigerators, etc.

[0003] FIG. 1 is a sectional view illustrating a conventional linear compressor. FIG. 2 is a view of important parts of the conventional linear compressor, illustrating the advance movement of a piston. FIG. 3 is a view of important parts of the conventional linear compressor, illustrating the retraction movement of the piston.

[0004] As shown in FIGS. 1 to 3, the conventional linear compressor comprises a shell 2 forming the outer appearance of the compressor, a cylinder block 4 and a back cover 6 which are arranged in the shell 2, and a compression unit provided between the cylinder block 4 and the back cover 6. The compression unit serves to compress working-fluid by a desired compression ratio.

[0005] The shell 2 is provided with a fluid suction pipe 8 and a fluid discharge pipe 9, such that the working-fluid to be compressed is sucked into the compression unit from the outside of the shell 2, and then, is again discharged out of the shell 2 after being compressed in the compression unit.

[0006] The compression unit includes a cylinder 10 having a compression chamber 11 in which the working-fluid, having passed through the fluid suction pipe 8, is compressed, a piston 20 to compress the working-fluid received in the compression chamber 11 of the cylinder 10 while performing reciprocating movements in the cylinder 10, and a linear motor 30 to reciprocally move the piston 20.

[0007] The cylinder 10 is provided with a discharge valve assembly 12, such that the working-fluid, compressed in the compression chamber 11 of the cylinder 10, is discharged into the fluid discharge pipe 9 in accordance with the operation of the discharge valve assembly 12.

[0008] The piston 20 is internally formed with a suction path 21 for allowing the working-fluid, having passed through the fluid suction pipe 8, to be sucked into the cylinder 10. Also, the piston 20 has a suction valve 22 to open or close the suction path 21.

[0009] The suction valve 22 is an elastic member fastened to the piston 20 by means of a bolt B. The suction valve 22 is designed to be opened or closed as it is elastically deformed in accordance with a pressure difference between the suction path 21 of the piston 20 and the interior of the cylinder 10.

[0010] The linear motor 30 basically includes a stator 32, and a mover 34. The mover 34 is adapted to reciprocally move while electromagnetically interacting with the stator 32. The mover 34 is connected to the piston 20.

[0011] The compression unit further includes a main spring assembly 40 for providing the piston 20 with an elastic force in a reciprocating movement direction of the piston 20. Thus, the main spring assembly 40 allows vibrations of the piston 20 to some extent when the piston 20 reciprocally moves.

[0012] The main spring assembly 40 consists of a first main spring 42 located between the back cover 6 and the piston 20, and a second main spring 44 located between the cylinder 10 and the linear motor 30 to be supported by the cylinder block 4 and the piston 20.

[0013] The operation of the conventional linear compressor having the above-described configuration will now be explained.

[0014] If the linear motor 30 is driven, the piston 20 reciprocally moves in the cylinder 10 upon receiving the drive force of the linear motor 30. Then, the first and second main springs 42 and 44 are repeatedly compressed and tensioned in accordance with the reciprocating movements of the piston 20, thereby serving to allow vibrations of the piston 20 to some extent while causing the discharge valve assembly 12 and the suction valve 22 to be repeatedly opened or closed.

[0015] Thereby, the working-fluid is sucked into the compression chamber 11 of the cylinder 10 through the fluid suction pipe 8, such that it is compressed to a high-pressure state by the piston 20 in the compression chamber 11 of the cylinder 10. Subsequently, the compressed working-fluid is discharged from the cylinder 10 through the discharge valve assembly 12, to be discharged out of the shell 2 through the fluid discharge pipe 9.

[0016] The suction, compression, and discharge operations of the working fluid as stated above are continuously repeated in this sequence so long as the linear motor 30 is driven.

[0017] A problem of the above-described conventional linear compressor is that the suction valve 22 of the linear compressor is adapted to use an elastic force thereof, and therefore, may exhibit different elastic strains in accordance with a pressure difference between the suction path 21 of the piston 20 and the interior of the cylinder 10. This makes it impossible for the linear compressor to achieve improved constant compression efficiency, and results in deterioration of reliability.

[0018] In particular, the suction valve 22 using an elastic force may exhibit excessive elastic deformation as shown in FIG. 3 when a pressure difference between the suction path 21 of the piston 20 and the interior of the cylinder 10 is large or liquid phase working-fluid is introduced into the cylinder 10. Accordingly, there is a high risk in that the suction valve 22 may be plastically deformed or damaged due to an increased stress. Furthermore, the suction valve 22 suffers from deterioration of durability with the lapse of time, and consequently has a poor response property.

[0019] Excessive elastic deformation of the suction valve 22 also exposes the piston 20 to severe shock. This is due to an increase of stress as well as inordinate vibration and noise.

[0020] Another problem of the conventional linear compressor is that, when the bolt B is used to fasten the suction valve 22 to the piston 20, a bolt head inevitably protrudes into the compression chamber 11 of the cylinder 10, increasing the dead volume of the compression chamber 11 of the cylinder 10. This results in deterioration of compression efficiency. Also, if the bolt head directly collides with the discharge valve assembly 12, the bolt head may be severely damaged, and excessive vibration and noise may be generated.

[0021] Recently, high-density nitrogen dioxide is widely used as working fluid. However, the use of the nitrogen dioxide working fluid requires a relatively reduced diameter of the piston 20. Thus, in this case, it is very difficult to fasten the suction valve 22 to the piston 20 by use of the bolt B, and the piston 20 suffers from an increased flow resistance.

[0022] Therefore, the present invention has been made in view of the above problems, and it is an object of the present invention to provide a linear compressor in which a suction valve performs opening/closing operations as it moves relative to a piston by an inertial force, rather than an elastic force, when the piston reciprocally moves, whereby the suction valve can always exhibit an even opening/closing stroke, achieving several advantageous effects, for example, improved constant compression efficiency, little risk of deformation or damage, high response and durability, and minimized vibration and noise.

[0023] In accordance with one aspect of the present invention, the above and other objects can be accomplished by the provision of a linear compressor comprising: a piston adapted to reciprocally move in a cylinder, the piston being internally formed with a suction path; and a suction valve inserted in the suction path of the piston to move relative to the suction path, the suction valve performing opening/closing operations as it moves relative to the piston when the piston reciprocally moves.

[0024] Preferably, a suction valve may be adapted to open or close the suction path of the piston as it moves relative to the suction path when the piston reciprocally moves, the suction valve including: a suction valve body formed with an elongated slot extending in a reciprocating movement direction of the piston; and a suction valve guide pin fitted through the piston and the slot of the suction valve body to move relative to the suction valve body while being fixed to the piston.

[0025] Preferably, the suction valve body may have: a head portion disposed to protrude out of the suction path of the piston; and a body portion configured to move into or out of the suction path of the piston, the body portion having a partially cut-away cross sectional shape to allow the passage of working-fluid.

[0026] Preferably, the body portion may have a D-cut shape for the passage of the working-fluid.

[0027] Preferably, the suction valve body may have: a head portion disposed to protrude out of the suction path of the piston; and a body portion configured to have a diameter smaller than a diameter of the suction path of the piston to move into or out of the suction path of the piston.

[0028] Preferably, the suction valve body may have: a head portion disposed to protrude out of the suction path of the piston; and a body portion configured to move into or out of the suction path of the piston, the body portion having holes for allowing the passage of working-fluid.

[0029] Preferably, the holes of the body portion may be integrally formed with a slot of the suction valve body.

[0030] Preferably, the piston may be also formed with a suction valve recess such that the suction valve is completely inserted into the piston.

[0031] Preferably, the piston may be also formed with a suction valve recess such that the suction valve is completely inserted into the piston, the suction valve recess being configured to gradually widen away from the suction path of the piston toward a distal end of the piston.

[0032] Preferably, the piston may be also formed with a suction valve recess such that the suction valve is completely inserted into the piston, the suction valve recess having an inclined region where it comes into contact with the suction valve; and the suction valve has an inclined surface to come into surface contact with the inclined region of the suction valve recess when the suction valve is inserted into the suction valve recess.

[0033] In accordance with another aspect of the present invention, the above and other objects can be accomplished by the provision of a linear compressor comprising: a piston adapted to reciprocally move in a cylinder, the piston being internally formed with a suction path; and a suction valve adapted to open or close the suction path of the piston as it moves relative to the suction path when the piston reciprocally moves, the suction valve including: a suction valve body formed with an elongated slot extending in a reciprocating movement direction of the piston; and a suction valve guide pin fitted through the piston and the slot of the suction valve body to move relative to the suction valve body while being fixed to the piston, wherein: the piston is also formed with a suction valve recess such that the suction valve is completely inserted into the piston, the suction valve recess having an inclined region where it comes into contact with the suction valve; and the suction valve has an inclined surface to come into surface contact with the inclined region of the suction valve recess when the suction valve is inserted into the suction valve recess.

[0034] In the linear compressor of the present invention having the above-described configuration, the suction valve is inserted in the suction path of the piston to move relative to the suction path, thereby performing opening/closing operations as it moves relative to the piston by an inertial force when the piston reciprocally moves, whereby the suction valve always exhibits an even opening/closing stroke, and therefore, can achieve various advantageous effects, such as for example, improved constant compression efficiency, little deformation or damage due to excessive stress applied to the suction valve, an improvement in response and durability, and minimized vibration and noise caused by the opening/closing operations of the suction valve.

[0035] Further, as a result of providing the suction valve guide pin in the piston in a radial direction of the piston to couple the suction valve to the piston, it is possible to minimize the dead volume of the compression chamber of the cylinder, to enable the suction valve to be easily mounted to the piston even if the piston has a small diameter, and to reduce the flow resistance of working-fluid due to the existence of the suction valve.

[0036] Furthermore, since the piston is formed with the suction valve recess such that the suction valve is completely inserted into the piston when the suction valve closes the suction path of the piston, the dead volume of the cylinder chamber of the cylinder can be more effectively eliminated, and there is no risk of interference between the suction valve and a discharge valve assembly.

[0037] Finally, by providing the suction valve with an inclined head portion, the head portion of the suction valve can come into surface contact with the suction valve recess of the piston, whereby the suction valve can smoothly move into or out of the suction valve recess of the piston, and in particular, the head portion of the suction valve can achieve an improved stiffness.

[0038] The above and other objects, features and other advantages of the present invention will be more clearly understood from the following detailed description taken in conjunction with the accompanying drawings, in which:

FIG. 1 is a sectional view illustrating a conventional linear compressor;

FIG. 2 is a view of important parts of the conventional linear compressor, illustrating the advance movement of a piston;

FIG. 3 is a view of important parts of the conventional linear compressor, illustrating the retraction movement of the piston;

FIG. 4 is a sectional view illustrating a linear compressor according to a first embodiment of the present invention;

FIG. 5 is an exploded perspective view illustrating a suction valve and a piston included in the linear compressor according to the first embodiment of the present invention;

FIG. 6 is a view illustrating an initially retracted state of the piston of the linear compressor according to the first embodiment of the present invention;

FIG. 7 is a view illustrating a completely retracted state of the piston of the linear compressor according to the first embodiment of the present invention;

FIG. 8 is a view illustrating an initially advanced state of the piston of the linear compressor according to the first embodiment of the present invention;

FIG. 9 is a view illustrating a completely advanced state of the piston of the linear compressor according to the first embodiment of the present invention;

FIG. 10 is a configuration view of important parts of a linear compressor according to a second embodiment of the present invention, illustrating a retracted state of a piston included in the linear compressor;

FIG. 11 is a configuration view of important parts of the linear compressor according to the second embodiment of the present invention, illustrating an advanced state of the piston;

FIG. 12 is a configuration view of important parts of a linear compressor according to a third embodiment of the present invention, illustrating a retracted state of a piston included in the linear compressor;

FIG. 13 is a configuration view of important parts of the linear compressor according to the third embodiment of the present invention, illustrating an advanced state of the piston;

FIG. 14 is a configuration view of important parts of a linear compressor according to a fourth embodiment of the present invention, illustrating a retracted state of a piston included in the linear compressor; and

FIG. 15 is a configuration view of important parts of the linear compressor according to the fourth embodiment of the present invention, illustrating an advanced state of the piston.

[0039] Now, preferred embodiments of the present invention will be explained with reference to the accompanying drawings.

[0040] FIG. 4 is a sectional view illustrating a linear compressor according to a first embodiment of the present invention. FIG. 5 is an exploded perspective view illustrating a suction valve and a piston included in the linear compressor according to the first embodiment of the present invention. FIGS. 6 to 9 are views illustrating, in this sequence, an initially retracted state, a completely retracted state, an initially advanced state, and a completely advanced state of the piston of the linear compressor according to the first embodiment of the present invention.

[0041] As shown in FIGS. 4 to 9, the linear compressor according to the first embodiment of the present invention comprises a shell 50 configured to allow introduction and discharge of working fluid, a cylinder block 60 and a back cover 62 arranged in the shell 50, and a compression unit P provided between the cylinder block 60 and the back cover 62. The working-fluid, introduced into the shell 50, is compressed by a desired compression ratio while passing through the compression unit P, thereby being discharged in a high-pressure state.

[0042] A fluid suction pipe 52 is connected to the shell 50 such that the working-fluid is sucked into the shell 50 from an external station. Also, a fluid discharge pipe 54 is connected to the shell 50 such that the compressed working-fluid, discharged from the compression unit P, is guided out of the shell 50.

[0043] A damper 56 is mounted in the shell 50 to elastically support the compression unit P.

[0044] A lubricating oil pumping device 58 is arranged in the shell 50 to pump lubricating oil G in the bottom of the shell 50 to the compression unit P.

[0045] The back cover 62 is located closer to the fluid suction pipe 52 than the cylinder block 60.

[0046] A muffler (not shown) is mounted to the back cover 62 to reduce the noise of the working-fluid generated when the working-fluid passes through the fluid suction pipe 52.

[0047] The compression unit P includes a linear motor 90 to generate a reciprocating drive force, a cylinder 70 fixedly mounted to the cylinder block 60, the cylinder 70 internally defining a compression chamber 71 for the compression of the working-fluid, a piston 80 which performs reciprocating movements in the cylinder 70 using the reciprocating drive force of the linear motor 90 to compress the working-fluid received in the compression chamber 71 of the cylinder 70, and first and second resonance springs 110 and 112 to allow vibrations of the piston 80 to some extent in a reciprocating movement direction of the piston 80 when the piston 80 reciprocally moves.

[0048] The linear motor 90 is located around the cylinder 70, and is supported by the cylinder block 60 and the back cover 62.

[0049] Considering the configuration of the linear motor 90, it basically consists of a mover connected to the piston 80 to work in conjunction with the piston 80, and a stator adapted to electromagnetically interact with the mover for inducing reciprocating movements of the mover.

[0050] The mover includes a magnet 92 arranged inside the stator in a reciprocally movable manner, and a magnet frame 94 for the fixation of the magnet 92, the magnet frame 94 being connected to the piston 80 to work in conjunction with the piston 80. The magnet frame 94 serves to transmit the reciprocating drive force of the linear motor 90 to the piston 80.

[0051] The stator includes an outer core 95 located on the outer circumference of the mover, a coil 96 provided in the outer core 95 to generate a magnetic field, and an inner core 97 located on the inner circumference of the mover.

[0052] The cylinder 70 has a cylindrical structure having open front and rear ends. The piston 80 is inserted into the open rear end of the cylinder 70. After being compressed in the compression chamber 71 of the cylinder 70, the working-fluid is discharged from the open front end of the cylinder 70.

[0053] The open front end of the cylinder 70 is covered with the discharge valve assembly 75, such that the working-fluid, compressed in the compression chamber 71 of the cylinder 70, is discharged into the fluid discharge pipe 54.

[0054] The discharge valve assembly 75 includes a valve cover 76 mounted to cover the open front end of the cylinder 70 while being connected to the fluid discharge pipe 54, a discharge valve body 77 mounted to reciprocally move in front of the open front end of the cylinder 70 within the discharge valve cover 76, and a discharge valve spring 78 to elastically support the discharge valve body 77.

[0055] The discharge valve cover 76 may have a dual structure. Specifically, the discharge valve cover 76 includes an inner cover 76b having a discharge hole 76a for the discharge of the working-fluid, and an outer cover 76c located at the outside of the inner cover 76b to surround the inner cover 76b, the outer cover 76c being connected to the fluid discharge pipe 54.

[0056] A suction path 81 is formed in the piston 80 to extend longitudinally throughout the interior of the piston 80, such that the suction path 81 is connected to both the fluid suction pipe 52 and the compression chamber 71 of the cylinder 70.

[0057] The suction path 81 of the piston 80 is designed to be selectively connected to the compression chamber 71 of the cylinder 70 by the suction valve 84, which performs opening/closing operations in accordance with the reciprocating movements of the piston 80.

[0058] The suction valve 84 is disposed in the suction path 81 of the piston 80 such that it is movable relative to the suction path 81. Thus, the suction valve 84 is able to perform opening/closing operations as it moves relative to the piston 80 by an inertial force when the piston 80 reciprocally moves.

[0059] The suction valve 84 includes a suction valve body 85 inserted in the suction path 81 of the piston 80 to move relative to the suction path 81, the suction valve body 85 having an elongated slot 85' extending in the reciprocating movement direction of the piston 80, and a suction valve guide pin 86 fitted through the piston 80 and the slot 85' of the suction valve body 85 to move relative to the slot 85' while being fixed to the piston 80.

[0060] The suction valve body 85 has a head portion 85a disposed to protrude out of the suction path 81 of the piston 80, and a body portion 85b inserted in the suction path 81 of the piston 80 to move into or out of the suction path 81.

[0061] The head portion 85a of the suction valve body 85 may take the form of a disk having a diameter smaller than a diameter of the piston 80, but larger than a diameter of the suction path 81 of the piston 80.

[0062] Preferably, the head portion 85a of the suction valve body 85 has a flat outer surface 85a' at an opposite side of the piston 80, to ensure even compression of the working-fluid in the compression chamber 71 of the cylinder 70.

[0063] The body portion 85b of the suction valve body 85 may have a D-cut shape, in order to allow the working-fluid to pass through a space between the body portion 85b of the suction valve body 85 and the suction path 81 of the piston 80 when the suction valve 84 moves to open the suction path 81 of the piston 80.

[0064] Specifically, the body portion 85b of the suction valve body 85 has a partially cut-away cross sectional shape of a circle having approximately the same size as the suction path 81 of the piston 80.

[0065] The slot 85' is formed in the body portion 85b of the suction valve body 85, such that the suction valve guide pin 86 is fitted through the slot 85' to move relative to the slot 85'.

[0066] In a relative movement of the suction valve guide pin 86, one end of the slot 85' toward the head portion 85a of the suction valve body 85 is a top dead point, and the opposite end of the slot 85' is a bottom dead point.

[0067] The suction valve guide pin 86 has a rod shape having a diameter smaller than a length of the slot 85' of the suction valve 84.

[0068] The suction valve guide pin 86 may be arranged in the piston 80 in a radial direction of the piston 80.

[0069] With this configuration, the suction valve guide pin 86 may be press fitted to the piston 80. The suction valve guide pin 86 may have approximately the same length as a diameter of the piston 80 such that opposite ends thereof straddle the piston 80.

[0070] The suction valve 84 is configured such that it can be completely inserted in the piston 80 when it is desired to close the suction path 81 of the piston 80.

[0071] Specifically, a suction valve recess 87 is formed in a front end region of the piston 80 to be connected to the suction path 81 of the piston 80, such that the head portion 85a of the suction valve body 85 is inserted in the suction valve recess 87.

[0072] The suction valve recess 87 may be formed in the piston 80 such that it gradually widens from the suction path 81 of the piston 80 toward a front distal end of the piston 80.

[0073] Hereinafter, the operation of the linear compressor according to the present invention having the above-described configuration will be explained.

[0074] If the linear motor 90 is driven, the magnet 92 reciprocally moves along with the magnet frame 94 via the electromagnetic interaction of both the stator and the mover. The resulting reciprocating drive force of the linear motor 90 is transmitted to the piston 80 that is connected to the magnet frame 94. Thereby, the piston 80 reciprocally moves in the cylinder 70 upon receiving the drive force of the linear motor 90. Simultaneously, the first and second main springs 110 and 112 are repeatedly compressed and tensioned, causing the suction, compression, discharge of the working-fluid to be repeated in this sequence.

[0075] Specifically, as shown in FIG. 6, if the piston 80 begins to retract out of the cylinder 70, the suction valve 84 shows a relative movement to the piston 80 by an inertial force, thereby being protruded from the piston 80 into the compression chamber 71 of the cylinder 70.

[0076] Just prior to beginning the retraction of the piston 80 out of the cylinder 70, the suction valve 84 is completely inserted in the piston 80, and thus, the suction valve guide pin 86 of the suction valve 84 is located at the top dead point of the slot 85' of the suction valve 84 (See. FIG. 4).

[0077] Accordingly, if the piston 80 begins to retract out of the cylinder 70, only the piston 80 retracts, while the suction valve 84 remains stationary. As a result, the suction valve 84 is protruded from the piston 80.

[0078] In this case, the suction valve guide pin 86 moves along the slot 85' of the suction valve 84 from the top dead point to the bottom dead point of the slot 85'.

[0079] If the piston 80 continuously retracts after the suction valve guide pin 86 reaches the bottom dead point of the slot 85' of the suction valve 84, as shown in FIG. 7, the suction valve guide pin 86 is retracted along with the piston 80, thereby pulling the suction valve 84.

[0080] Thereby, the suction valve 84 is retracted along with the piston 80 while being protruded from the piston 80.

[0081] In a state wherein the suction valve 84 is protruded from the piston 80, the suction path 81 of the piston 80 is opened, thereby allowing the working-fluid in the suction path 81 of the piston 80 to be sucked into the compression chamber 71 of the cylinder 70.

[0082] In succession, if the piston 80 advances toward the interior of the cylinder 70, the suction valve 84 shows a relative movement to the piston 80 by an inertial force, thereby being inserted into the piston 80.

[0083] Specifically, if the piston 80 begins to advance into the compression chamber 71 of the cylinder 70, as shown in FIG. 8, the piston 80 approaches the suction valve 84, and simultaneously, the suction valve 84 retracts toward the piston 80 by the pressure of the working-fluid in the compression chamber 71 of the cylinder 70. Thereby, the suction valve 84 is rapidly inserted into the piston 80, thereby closing the suction path 81 of the piston 80.

[0084] In this case, the suction valve guide pin 86 moves along the slot 85' of the suction valve 84 from the bottom dead point to the top dead point of the slot 85'. If the piston 80 continuously advances after the suction valve guide pin 86 reaches the top dead point of the slot 85' of the suction valve 84, the suction valve 84 advances along with the piston 80.

[0085] Of course, the suction valve 84 is continuously inserted in the piston 80 by the pressure of the working-fluid in the compression chamber 71 of the cylinder 70.

[0086] As the piston 80 advances in a state wherein the suction path 81 of the piston 80 is closed by the suction valve 84 as stated above, the working-fluid in the compression chamber 71 of the cylinder 70 is compressed to a high-pressure state.

[0087] If the working-fluid in the compression chamber 71 of the cylinder 70 is compressed to the high-pressure state, as shown in FIG. 9, the discharge valve assembly 75 opens the compression chamber 71 of the cylinder 70 in accordance with the force equilibrium relationship between the pressure of the working-fluid in the compression chamber 71 of the cylinder 70 and the discharge valve spring 78 of the discharge valve assembly 75.

[0088] With the opening operation of the discharge valve assembly 75, the working-fluid, compressed in the compression chamber 71 of the cylinder 70, is discharged out of the shell 50 by passing through the discharge cover 76 and the fluid discharge pipe 54 in this sequence.

[0089] FIGS. 10 and 11 are configuration views of important parts of a linear compressor according to a second embodiment of the present invention, FIG. 10 illustrating a retracted state of a piston included in the linear compressor, and FIG. 11 illustrating an advanced state of the piston.

[0090] As shown in FIGS. 10 and 11, the linear compressor according to the second embodiment of the present invention employs a suction valve 150, which includes a suction valve body 152 inserted in a suction path 161 of a piston 160 to move relative to the suction path 161, the suction valve body 152 having an elongated slot 150' extending in a reciprocating movement direction of the piston 160, and a suction valve guide pin 154 fitted through the piston 160 and the slot 150' of the suction valve body 152 to move relative to the slot 150' while being fixed to the piston 160.

[0091] The suction valve body 152 may be divided into a head portion 152a disposed to protrude out of the suction path 161 of the piston 160, and a body portion 152b configured to have a diameter smaller than a diameter of the suction path 161 of the piston 160 to move into or out of the suction path 161.

[0092] In the present embodiment, the suction valve 150 may further include a guide for allowing the center of the suction valve 150 to continuously align with the center of the piston 160 during a relative movement between the suction valve 150 and the piston 160.

[0093] Other configurations of the second embodiment of the present invention are identical to those of the first embodiment except for the above-described configurations, and thus, their description will be omitted.

[0094] Now, the opening/closing operations of the above-described suction valve 150 of the linear compressor according to the second embodiment of the present invention will be explained.

[0095] When the piston 160 retracts, the suction valve 150 is protruded from the piston 160, such that the working-fluid in the suction path 161 of the piston 160 flows through a space between the body portion 152b of the suction valve body 152 and the suction path 161 of the piston 160.

[0096] When the piston 160 advances, the suction valve 150 is inserted into the piston 160, thereby closing the suction path 161 of the piston 160.

[0097] FIGS. 12 and 13 are configuration views of important parts of a linear compressor according to a third embodiment of the present invention, FIG. 12 illustrating a retracted state of a piston included in the linear compressor, and FIG. 13 illustrating an advanced state of the piston.

[0098] As shown in FIGS. 12 and 13, the linear compressor according to the third embodiment of the present invention employs a suction valve 200, which includes a suction valve body 202 inserted in a suction path 211 of a piston 210 to move relative to the suction path 211, the suction valve body 202 having an elongated slot 200' extending in a reciprocating movement direction of the piston 210, and a suction valve guide pin 204 fitted through the piston 210 and the slot 200' of the suction valve body 202 to move relative to the slot 200' while being fixed to the piston 210.

[0099] The suction valve body 202 may be divided into a head portion 202a disposed to protrude out of the suction path 201 of the piston 210, and a body portion 202b configured to have approximately the same diameter as a diameter of the suction path 211 of the piston 210 to move into or out of the suction path 211, the body portion 202b having holes 202c for the passage of the working-fluid in the suction path 211 of the piston 210.

[0100] The body portion 202b of the suction valve body 202 internally defines a path 202d, which connects the holes 202c of the suction valve body 202 to the suction path 211 of the piston 210.

[0101] The holes 202c of the suction valve body 202 may be integrally formed with the slot 200' of the suction valve 200.

[0102] Other configurations of the third embodiment of the present invention are identical to those of the first embodiment except for the above-described configurations, and thus, their description will be omitted.

[0103] Now, the opening/closing operations of the above-described suction valve 200 of the linear compressor according to the third embodiment of the present invention will be explained.

[0104] When the piston 210 retracts, the suction valve 200 is protruded from the piston 210. Thereby, the holes 202c of the suction valve body 202 are opened, such that the working-fluid in the suction path 211 of the piston 210 passes through the suction valve body 202.

[0105] When the piston 210 advances, the suction valve 200 is inserted into the piston 210, thereby closing the suction path 211 of the piston 210.

[0106] FIGS. 14 and 15 are configuration views of important parts of a linear compressor according to a fourth embodiment of the present invention, FIG. 14 illustrating a retracted state of a piston included in the linear compressor, and FIG. 15 illustrating an advanced state of the piston.

[0107] As shown in FIGS. 14 and 15, the linear compressor according to the fourth embodiment of the present invention includes a suction valve 250, which includes a suction valve body 252 inserted in a suction path 261 of a piston 260 to move relative to the suction path 261, the suction valve body 252 having an elongated slot 250' extending in a reciprocating movement direction of the piston 260, and a suction valve guide pin 254 fitted through the piston 260 and the slot 250' of the suction valve body 252 to move relative to the suction valve body

252 while being fixed to the piston 260.

[0108] The piston 260 is formed in a front end region thereof with a suction valve recess 262 to be connected to the suction path 261 of the piston 260, such that a head portion 252a of the suction valve body 252 is inserted in the suction valve recess 262.

[0109] The suction valve recess 262 of the piston 260 may have an inclined structure on at least the region where the piston 260 comes into contact with the suction valve 250. Specifically, the suction valve recess 262 of the piston 260 may gradually widen away from the suction path 261 of the piston 260 toward a front distal end of the piston 260.

[0110] The suction valve body 252 may be divided into the head portion 252a disposed to protrude out of the suction path 261 of the piston 260, and a body portion 252b having a D-cut shape and adapted to move into or out of the suction path 261 of the piston 260.

[0111] Preferably, the head portion 252a of the suction valve body 252 has an inclined outer surface, such that the head portion 252a comes into surface contact with the suction valve recess 262 of the piston 160 when it is completely inserted into the suction valve recess 262 of the piston 260.

[0112] Other configurations of the fourth embodiment of the present invention are identical to those of the first embodiment except for the above-described configurations, and thus, their description will be omitted.

[0113] Now, the opening/closing operations of the suction valve 250, employed in the linear compressor having the above-described configuration according to the fourth embodiment of the present invention, will be explained.

[0114] When the piston 260 retracts, the suction valve 250 is protruded from the piston 260, such that working-fluid in the suction path 261 of the piston 260 passes through the suction valve body 252.

[0115] When the piston 260 advances, the suction valve 250 is inserted into the piston 260, thereby closing the suction path 261 of the piston 210.

[0116] As is apparent from the above description, the present invention provides a linear compressor having the following several advantages.

[0117] Firstly, the linear compressor of the present invention is configured in such a fashion that a suction valve is inserted in a suction path of a piston to move relative to the suction path, thereby performing opening/closing operations as it moves relative to the piston by an inertial force when the piston reciprocally moves. The suction valve configured as stated above can always exhibit an even opening/closing stroke, and therefore, can achieve various advantageous effects, such as for example, improved constant compression efficiency, little deformation or damage due to excessive stress applied to the suction valve, an improvement in response and durability, and minimized vibration and noise caused by the opening/closing operations of the suction valve.

[0118] Secondly, according to the present invention, a suction valve guide pin is provided in the piston in a radial direction of the piston, to couple the suction valve to the piston. The use of the suction valve guide pin has the effects of minimizing the dead volume of a compression chamber of a cylinder, enabling the suction valve to be easily mounted to the piston even if the piston has a small diameter, and reducing the flow resistance of working-fluid due to the existence of the suction valve.

[0119] Thirdly, the piston is formed with a suction valve recess such that the suction valve is completely inserted into the piston when the suction valve closes the suction path of the piston. This more effectively eliminates the dead volume of the cylinder chamber of the cylinder, and can prevent interference between the suction valve and a discharge valve assembly.

[0120] Fourthly, by providing the suction valve with an inclined head portion, the head portion of the suction valve can come into surface contact with the suction valve recess of the piston, whereby the suction valve can smoothly move into or out of the suction valve recess of the piston, and in particular, the head portion of the suction valve can achieve an improved stiffness.

[0121] Although the preferred embodiments of the present invention have been disclosed for illustrative purposes, those skilled in the art will appreciate that various modifications, additions and substitutions are possible, without departing from the scope and spirit of the invention as disclosed in the accompanying claims.

Claims

1. A linear compressor comprising:

a piston (80) adapted to reciprocally move in a cylinder (70), the piston (80) being internally formed with a suction path (81); and

a suction valve (84) inserted in the suction path (81) of the piston (80) to move relative to the suction path (81), the suction valve (84) performing opening/closing operations as it moves relative to the piston (80) when the piston (80) reciprocally moves.

2. The compressor as set forth in claim 1, wherein a suction valve (84) includes:

a suction valve body (85) adapted to open or close the suction path (81) of the piston (80) as it moves relative to the suction path (81) when the piston (80) reciprocally moves, the suction valve body being formed with an elongated slot (85’) extending in a reciprocating movement direction of the piston (80); and

a suction valve guide pin (86) fitted through the piston (80) and the slot (85’) of the suction valve body (85) to move relative to the suction valve body (85) while being fixed to the piston (80).

3. The compressor as set forth in claim 2, wherein the suction valve body (85) has: a head portion (85a) disposed to protrude out of the suction path (81) of the piston (80); and a body portion (85b) configured to move into or out of the suction path (81) of the piston (80), the body portion having a partially cut-away cross sectional shape to allow the passage of working-fluid.

4. The compressor as set forth in claim 3, wherein the body portion (85b) has a D-cut shape for the passage of the working-fluid.

5. The compressor as set forth in claim 2, wherein the suction valve body (152) has: a head portion (152a) disposed to protrude out of the suction path (161) of the piston (160); and a body portion (152b) configured to have a diameter smaller than a diameter of the suction path (161) of the piston (160) to move into or out of the suction path (161) of the piston (160).

6. The compressor as set forth in claim 2, wherein the suction valve body (202) has: a head portion (202a) disposed to protrude out of the suction path (211) of the piston (210); and a body portion (202b) configured to move into or out of the suction path (211) of the piston (210), the body portion (202b) having holes (202c) for allowing the passage of working-fluid.

7. The compressor as set forth in claim 6, wherein the holes (202c) of the body portion (202b) are integrally formed with a slot (200') of the suction valve body (202).

8. The compressor as set forth in any one of claims 1 to 7, wherein the piston (80) is also formed with a suction valve recess (87) such that the suction valve (84) is completely inserted into the piston (80).

9. The compressor as set forth in any one of claims 1 to 7, wherein the piston (80) is also formed with a suction valve recess (87) such that the suction valve (84) is completely inserted into the piston (80), the suction valve recess (87) being configured to gradually widen away from the suction path (81) of the piston (80) toward a distal end of the piston (80).

10. The compressor as set forth in any one of claims 1 to 7, wherein: the piston (80) is also formed with a suction valve recess (87) such that the suction valve (84) is completely inserted into the piston (80), the suction valve recess (87) having an inclined region where it comes into contact with the suction valve (84); and
the suction valve (84) has an inclined surface to come into surface contact with the inclined region of the suction valve recess (87) when the suction valve (84) is inserted into the suction valve recess (87).

11. A linear compressor comprising:

a piston (80) adapted to reciprocally move in a cylinder (70), the piston (80) being internally formed with a suction path (81); and
a suction valve (84) including: a suction valve body (85) adapted to open or close the suction path (81) of the piston (80) as it moves relative to the suction path (81) when the piston (80) reciprocally moves, the suction valve body (85) being formed with an elongated slot (85') extending in a reciprocating movement direction of the piston (80); and a suction valve guide pin (86) fitted through the piston (80) and the slot (85') of the suction valve body (85) to move relative to the suction valve body (85) while being fixed to the piston (80),

wherein: the piston (80) is also formed with a suction valve recess (87) such that the suction valve (84) is completely inserted into the piston (80), the suction valve recess (87) having an inclined region where it comes into contact with the suction valve (84); and the suction valve (84) has an inclined surface to come into surface contact with the inclined region of the suction valve recess (87) when the suction valve (84) is inserted into the suction valve recess (87).

Fig. 1(related art)

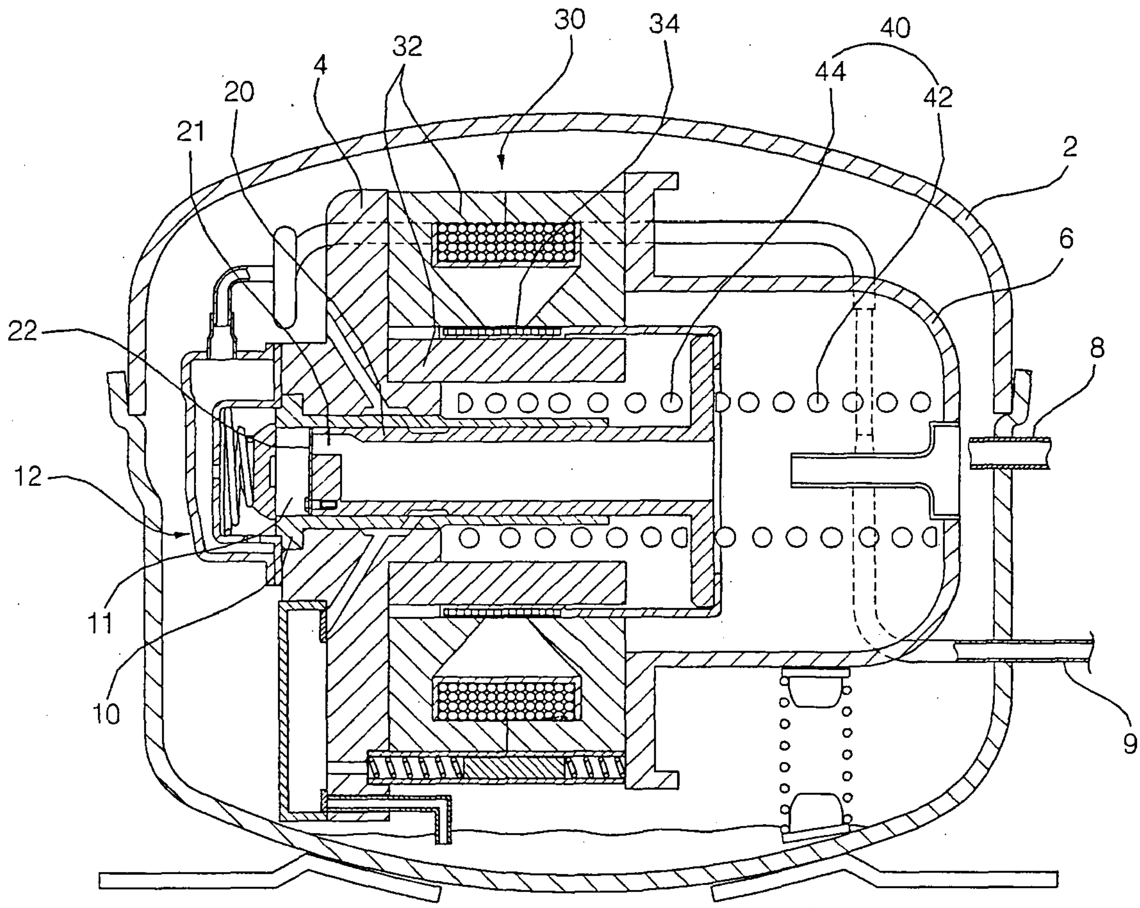


Fig. 2(related art)

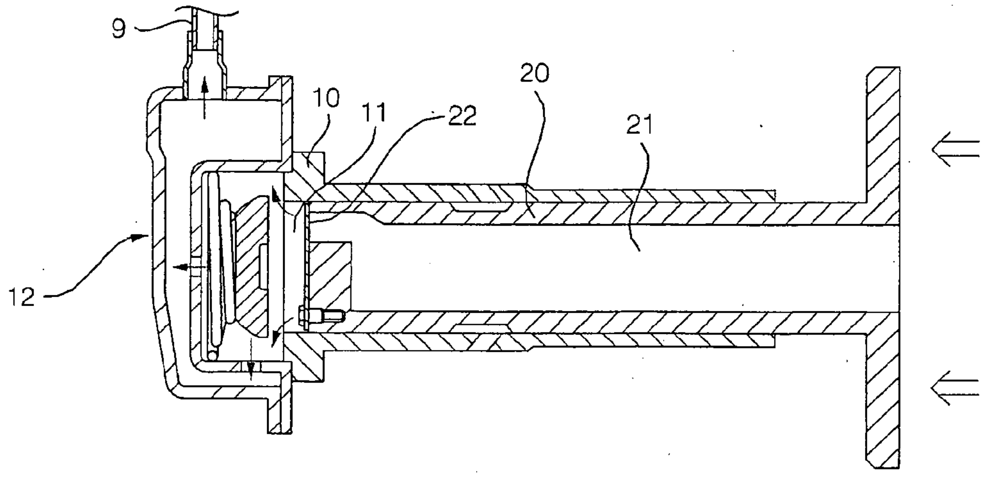


Fig. 3(related art)

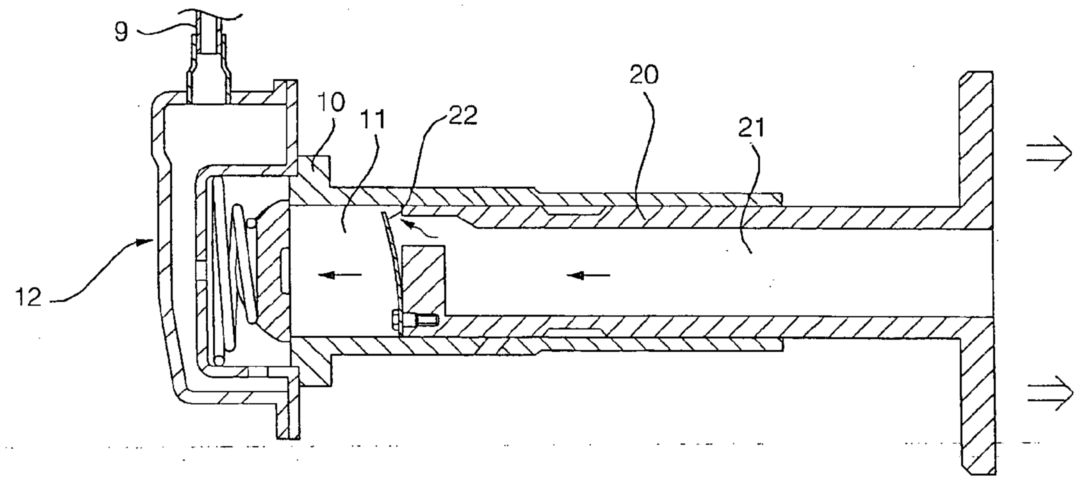
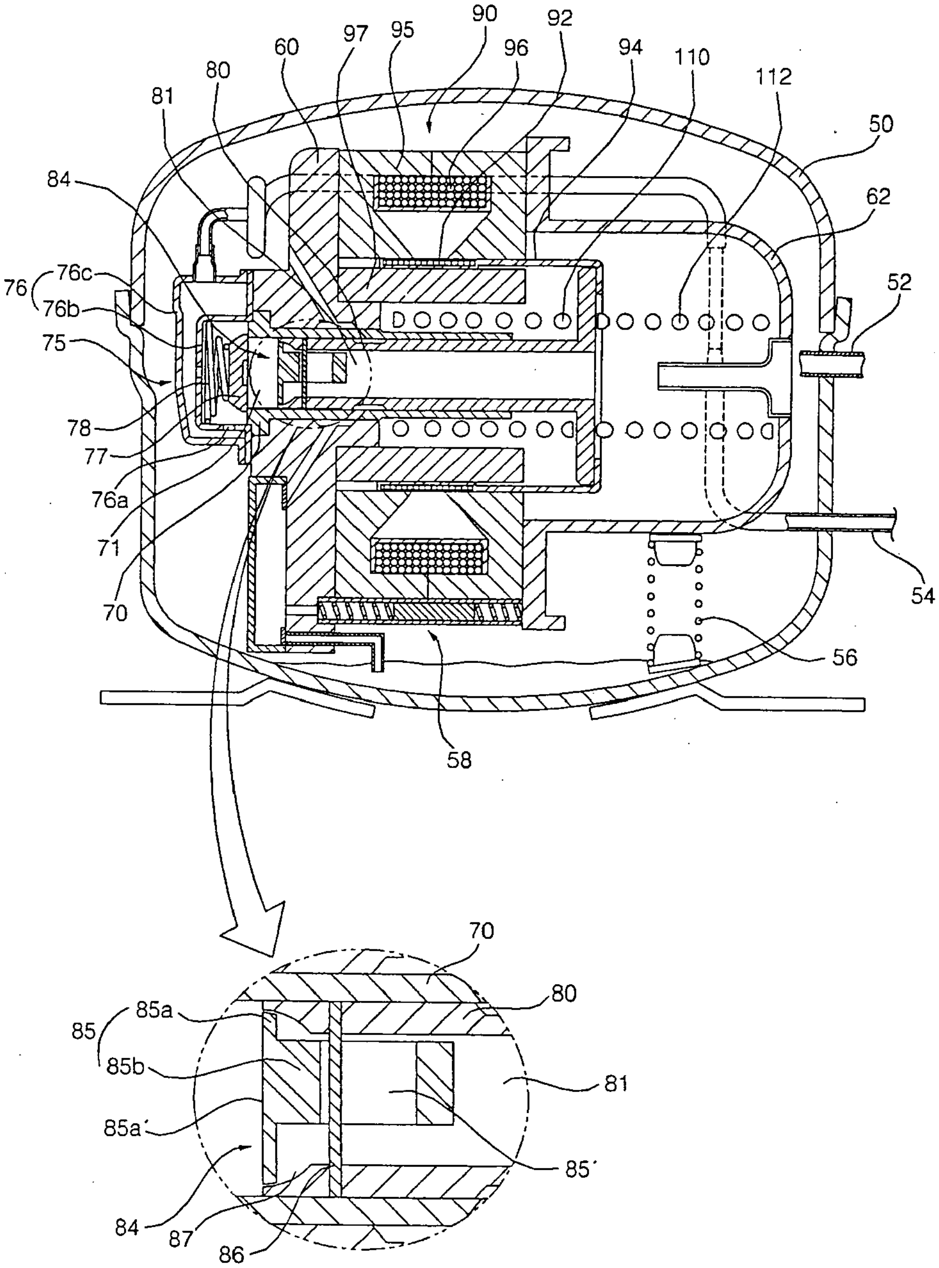


Fig. 4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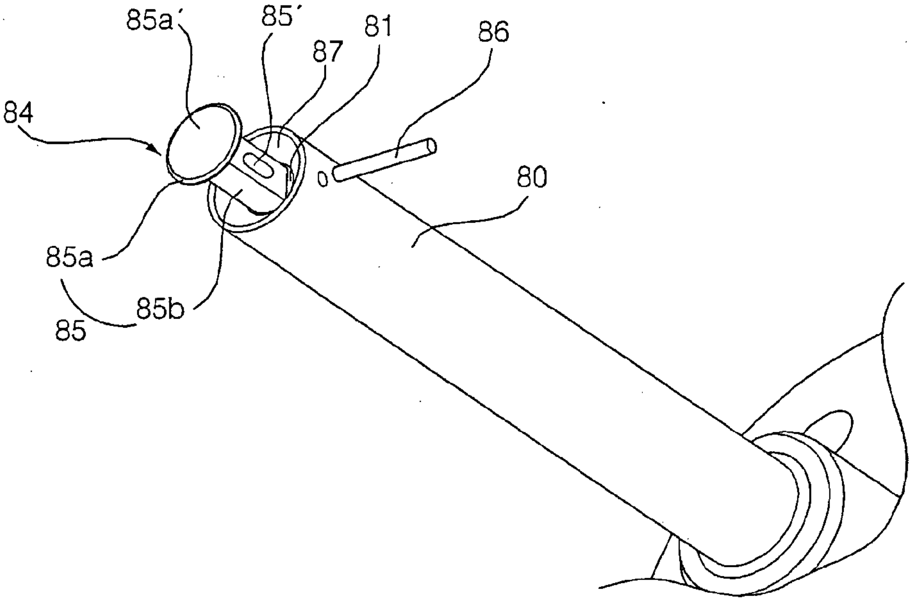
85b
81
85a'
85'
84
87
86

Fig. 5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85b
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Fig. 6

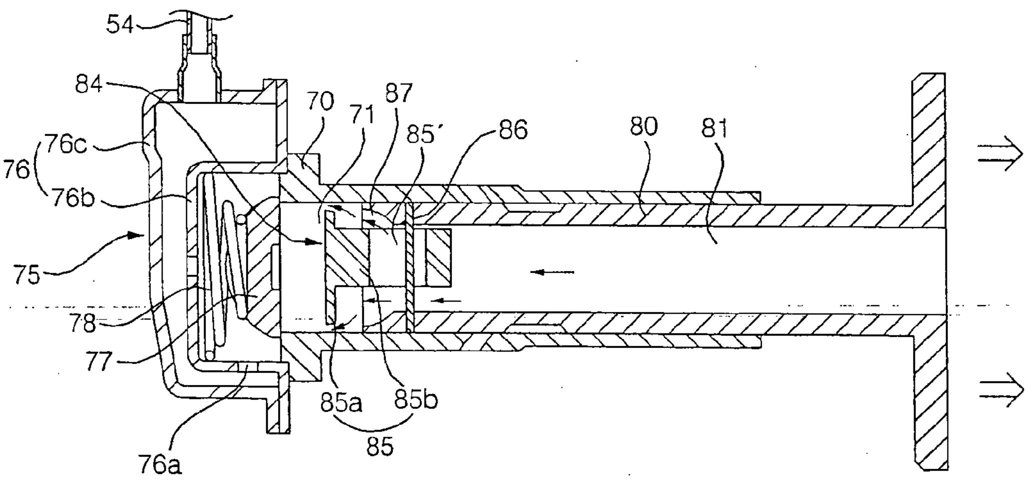
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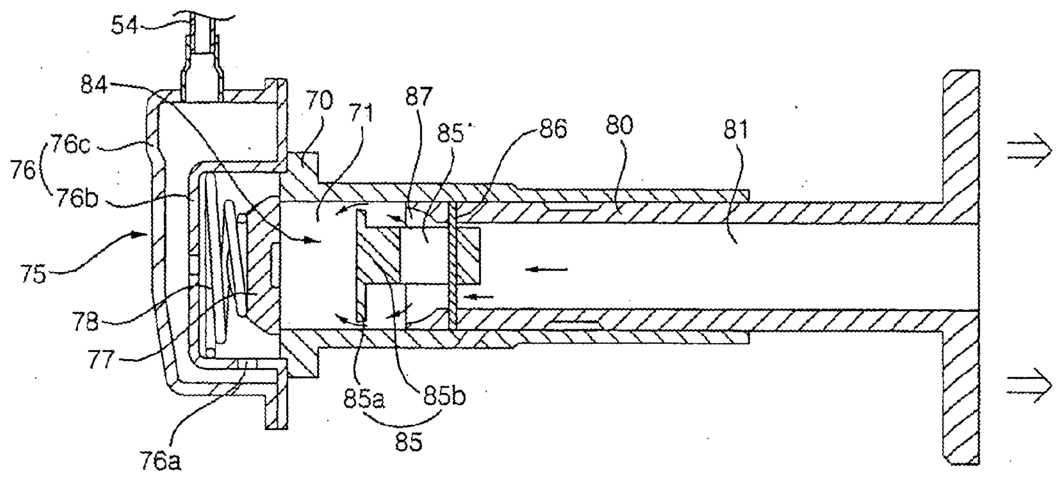
Fig. 7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85b
85

Fig. 8

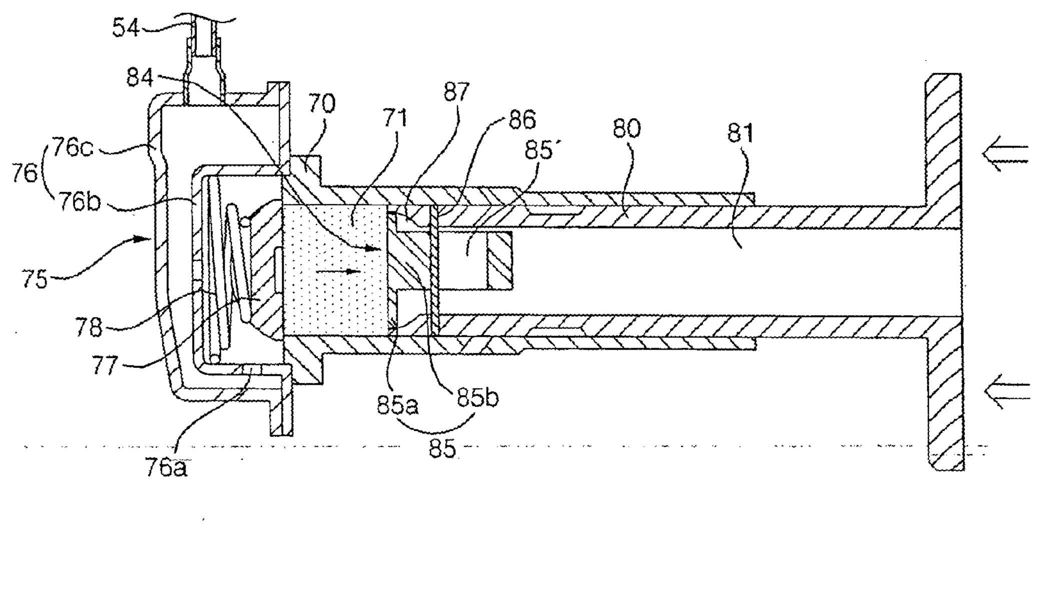
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Fig. 9

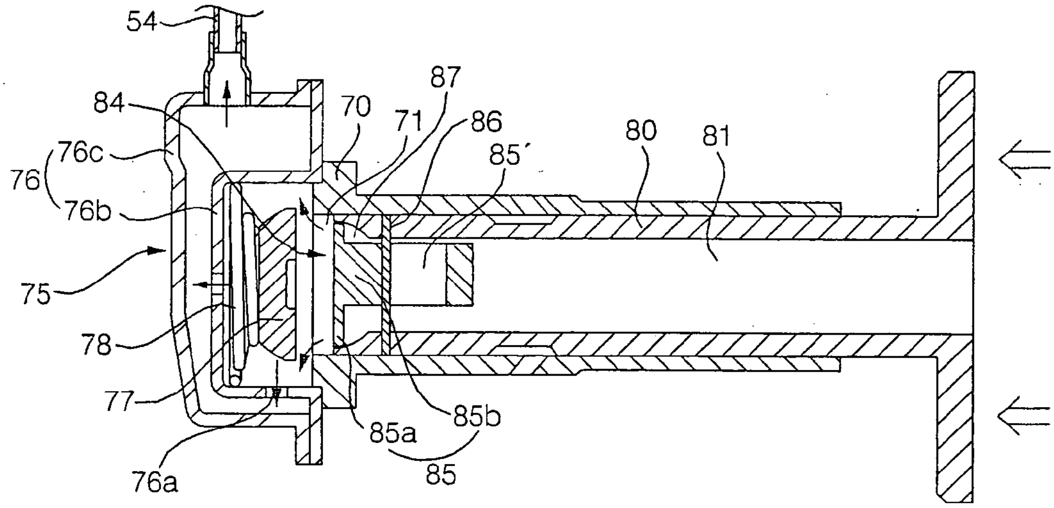
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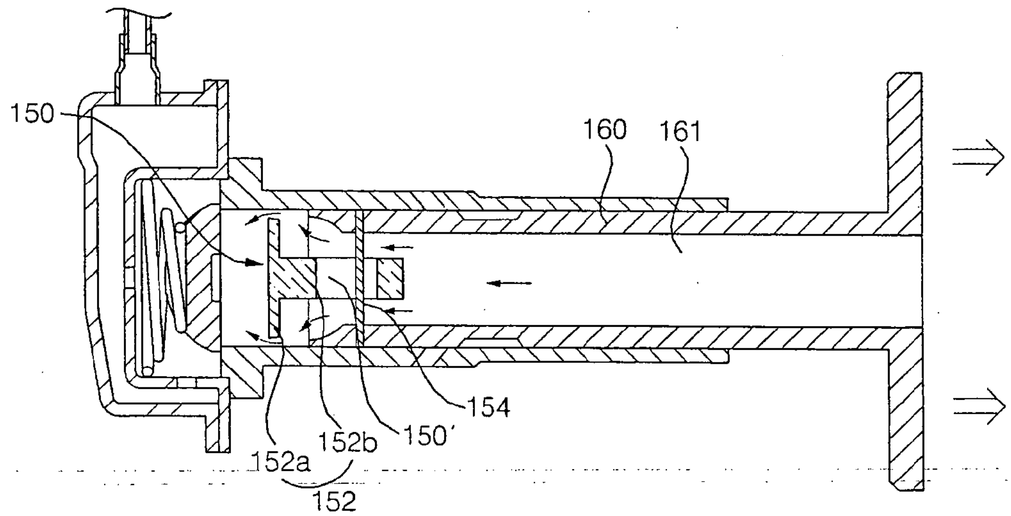
Fig. 10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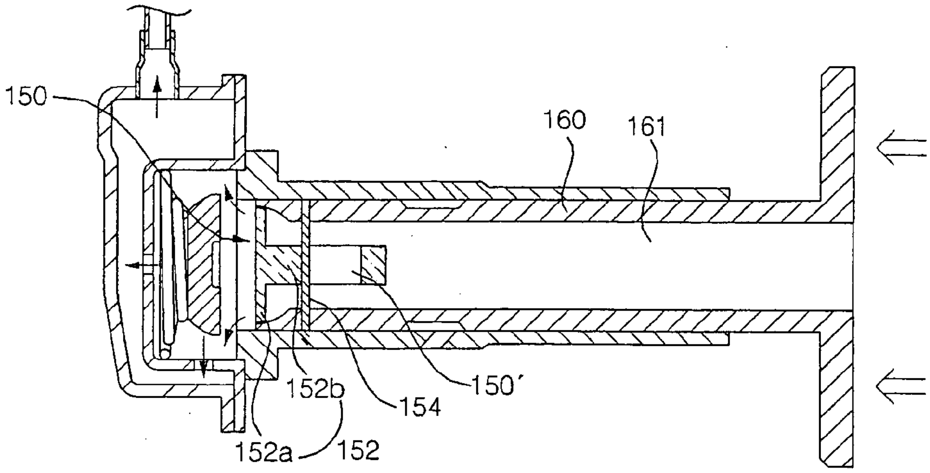
152a
152

Fig. 11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152b
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150′
152a
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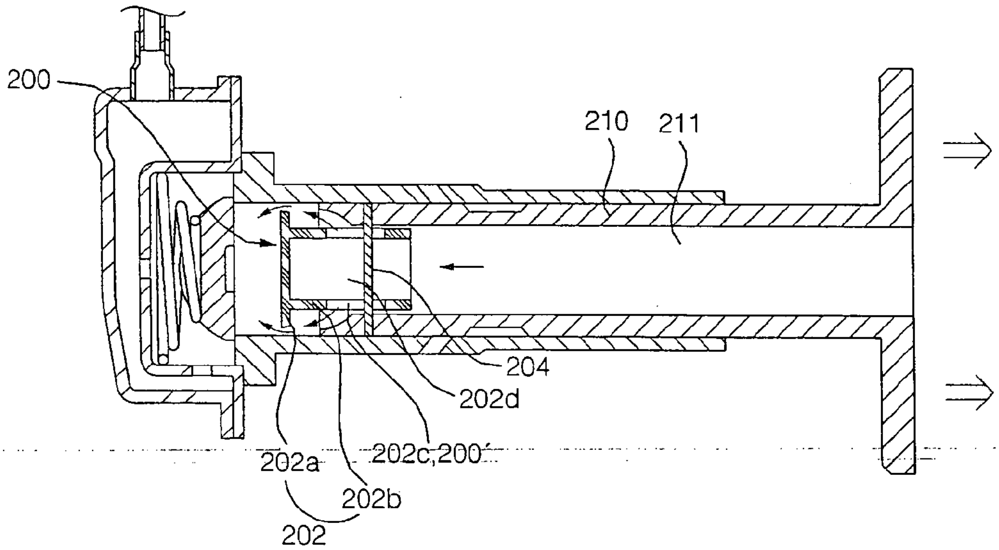
Fig. 12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210
211
204
202d
202a
202c,200′
202b
202

Fig. 13

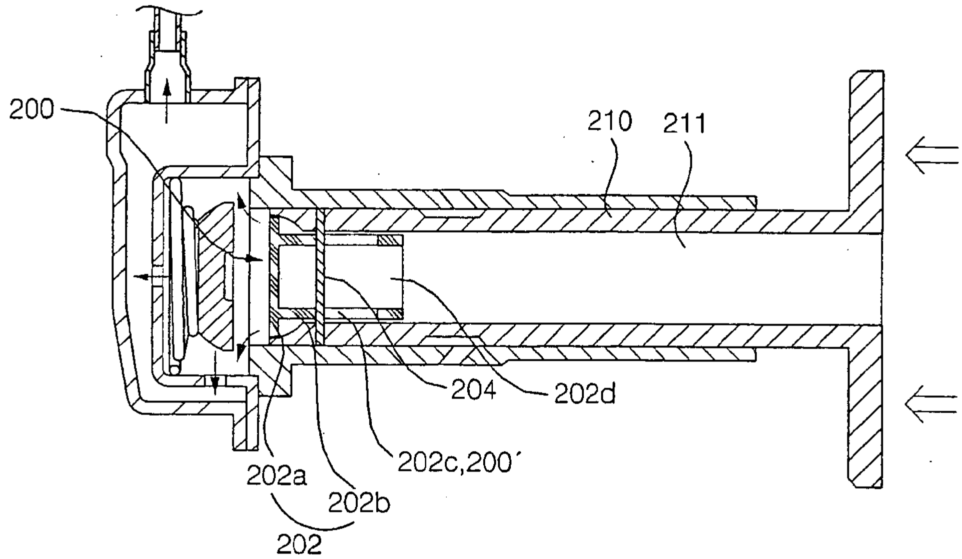


Fig. 14

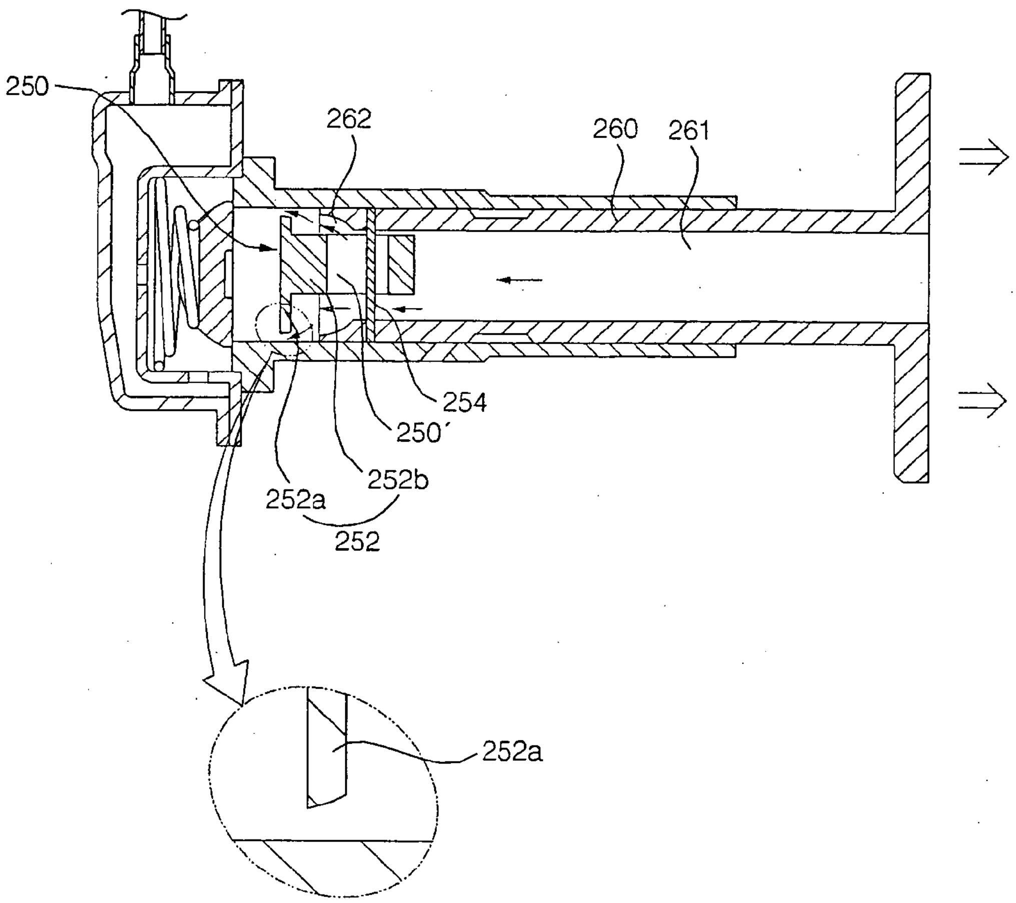
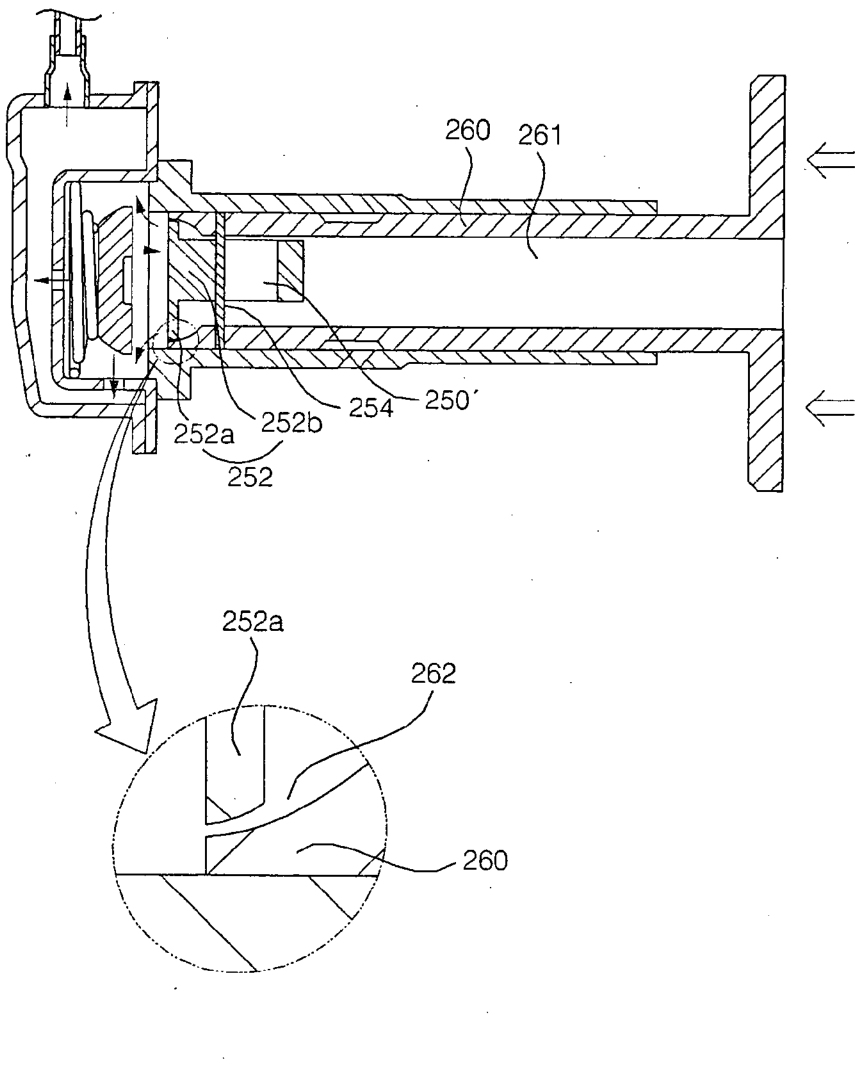


Fig. 15



European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 06 01 7242

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A	US 2003/165391 A1 (KIM HYUNG-JIN [KR]) 4 September 2003 (2003-09-04) * the whole document *		

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1 The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	7 February 2007	OLONA LAGLERA, C

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