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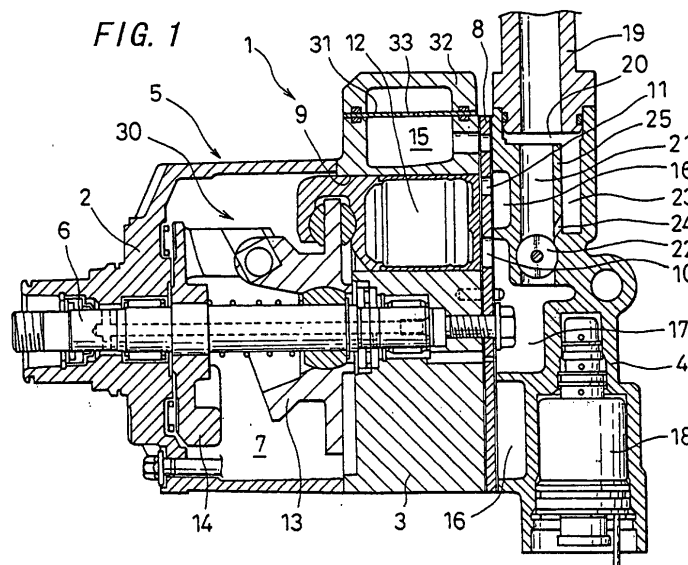
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(54) **COMPRESSOR**

(57) A compressor capable of damping the suction pulsation or discharge pulsation thereof with a simple structure, wherein either of a suction chamber and a discharge chamber formed at the center of a rear head is allowed to communicate with a corresponding port through a tunnel-shaped communication path and a muffler space is formed between the tunnel-shaped communication path and a pipe connection part for con-

necting the port thereto, whereby, when the communication path allows the suction chamber to communicate with the pipe connection part of the suction port, the suction pulsation can be suppressed or prevented and, when the communication path allows the discharge chamber to communicate with the pipe connection part of the discharge port, the discharge pulsation can be prevented.



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Description

TECHNICAL FIELD

[0001] The present invention relates to a compressor achieving a structure for preventing pressure waves generated during suction, compression and discharge phases of the compression mechanism.

BACKGROUND ART

[0002] Examples of compressors in the related art include the compressor disclosed in Japanese Unexamined Patent Publication No. H 11-351142, comprising at least an air inlet port through which a coolant gas from an evaporator is taken in, a suction chamber for containing the coolant gas having flowed in through the air inlet port, a cam plate that is slidably and tiltably mounted at a rotating shaft and is made to rotate with the rotating shaft, a piston that engages in a reciprocal movement as the cam plate oscillates and a cylinder having the piston slidably inserted therein that is allowed to communicate with the suction chamber or a discharge chamber as necessary, which translates the rotation of the rotating shaft to a reciprocal movement of the piston via the cam plate, takes in and compresses the coolant gas from the suction chamber as the piston reciprocates inside the cylinder and thus changes the volumetric capacity of the cylinder and discharges the compressed coolant gas into the discharge chamber.

[0003] In addition, this compressor includes a clutchless mechanism that sets the discharge capacity to the lowest level by raising the pressure in a crank case and thus minimizing the tilt of the cam plate and, at the same time, stops the coolant gas intake by closing the inlet port so as to circulate the coolant gas inside the compressor to prevent the evaporator from becoming frozen when the load is at the smallest level.

[0004] In a so-called piston reciprocating compressor such as that described above, the piston engages in a reciprocal movement as the cam plate rotates and a suction valve and a discharge valve open/close as the pressure in the compression space fluctuates to repeat suction, compression and discharge. Since delays in opening/closing the valves and tramping of the valves themselves are bound to occur during this process, pressure waves are released into the suction chamber or the discharge chamber provided between the suction port and the compression space, which may induce a resonance frequency in the chamber to develop into an extremely intense pulsating wave.

[0005] Particularly problematic is a pulsating wave occurring on the suction chamber side having a frequency within a specific range of 400 Hz ~ 1,000 Hz, which, together with the inherent value (the resonance frequency) of the evaporator, causes a vibration of the evaporator main unit that, in turn, is communicated into the vehicle cabin as unpleasant noise. In addition, while a

damping muffler is provided on a piping to damp the suction pulsation or the suction path of the compressor is constricted as a solution to the problem discussed above in the related art, these measures are bound to increase the production cost and to lower the performance of the compressor. Furthermore, in an air-conditioning system which utilizes a condenser instead of a heater core, the condenser needs to be installed inside the cabin, which gives a rise to an added problem of noise occurring as a result of a vibration of the condenser caused by the discharge pulsation at the compressor.

[0006] Accordingly, an object of the present invention is to provide a compressor capable of damping a suction pulsation or a discharge pulsation of the compressor by adopting a simple structure.

DISCLOSURE OF THE INVENTION

[0007] In order to achieve the object described above, in the compressor according to the present invention having at least a housing constituted of a front head, a cylinder block and a rear head, a compression mechanism that is driven in response to a rotation of a drive shaft passing through the front head, a suction chamber formed at the rear head, at which an inlet port of the compression mechanism opens and a discharge chamber formed at the rear head at which an outlet of the compression mechanism opens, either the suction chamber or the discharge chamber is formed toward the center of the rear head with the other chamber formed further outward relative to the chamber at the center, a tunnel-shaped communication path passing through the suction chamber or the discharge chamber formed toward the center of the rear head and the other chamber formed further outward at the rear head, which communicates the chamber with corresponding port is formed and a muffler space is formed between the communication path and a pipe connection part at which the port is mounted.

[0008] Thus, according to the present invention, in which the suction chamber or the discharge chamber formed toward the center of the rear head is made to communicate with the corresponding port via the tunnel-shaped communication path and a muffler space is formed between the tunnel-shaped communication path and the pipe connection part at which the port is mounted, the suction pulsation can be suppressed if the suction chamber and the pipe connection part at which the suction port is mounted are made to communicate with each other via the communication path and the discharge pulsation can be prevented if the discharge chamber and the pipe connection part at which the discharge port is mounted are made to communicate with each other via the communication path.

[0009] In addition, according to the present invention, it is desirable that the muffler space communicate with the outer end of the communication path.

[0010] The tunnel portion defining the communication

path may be formed as an integrated part of the rear head, or a separate pipe member may be inserted at the rear head to form the tunnel.

[0011] Furthermore, the compression mechanism should include at least a plurality of cylinders formed at the cylinder block, each having an inlet to communicate with the suction chamber and an outlet to communicate with the discharge chamber, pistons each slidably inserted at one of the cylinders so as to freely move reciprocally a rotary cam plate that rotates together with the drive shaft to cause a reciprocal movement of the pistons and a volumetric capacity varying mechanism capable of changing the angle of the rotary cam plate.

[0012] It is also desirable that the communication path be a suction path that communicates between the suction chamber and the corresponding suction port. Since this prevents the pulsating wave on the intake chamber side from resonating with the inherent value (resonance frequency) of the evaporator, a vibration of the evaporator installed in the cabin can be particularly effectively suppressed or prevented.

[0013] It is also desirable that a small hole to communicate with the suction path be formed at the furthest end of the muffler space so as to allow the oil remaining in the muffler space to return to the suction path. Since a specific effective volumetric capacity and a specific effective length are assured with regard to the muffler space as a result, the capability of the muffler space can be maintained at a desirable level.

[0014] Moreover, it is desirable that a valve mechanism capable of opening/closing of the suction path in response to an external signal be provided at the suction path. Since the suction path is shut off even when the pistons are moving over a very small stroke in this structure, the evaporator does not freeze, and a so-called clutchless structure is achieved.

[0015] It is desirable that the small hole mentioned earlier be formed so as to open toward the upstream side of the valve mechanism. In this case, no bypass passage bypassing the valve mechanism is formed and the clutchless structure can be utilized effectively.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016]

FIG. 1 is a sectional view of the compressor achieved in an embodiment of the present invention; and

FIG. 2 illustrates the communication path and the muffler space.

BEST MODE FOR CARRYING OUT THE INVENTION

[0017] The following is an explanation of an embodiment of the present invention, given in reference to the drawings.

[0018] A compressor 1 in FIG. 1 includes a housing 5

constituted of a front head 2, a cylinder block 3 and a rear head 4. A rotating shaft 6 passes through the front head 2 and is rotatably supported at the front head 2 and the cylinder block 3. A crank case 7 is formed inside the front head 2, and an opening of the crank case 7 is blocked by the cylinder block 3. A valve plate 8 is clamped and locked between the cylinder block 3 and the rear head 4.

[0019] A plurality of cylinders 9 extending along the axis of the rotating shaft 6 are formed around the rotating shaft 6 at the cylinder block 3, and an intake 10 and an outlet 11 formed at the valve plate 8 are made to open at each of the cylinders 9. The inlet 10 and the outlet 11 are opened/closed by valve elements. A piston 12 is slidably inserted at each cylinder 9, the end of the piston 12 toward the crank case slidably interlocks with a rotary cam plate 13 and the rotary cam plate 13 is caused to rotate by a rotating plate 14 secured the rotating shaft 6 via a linking mechanism 30. In addition, the rotary cam plate 13 is attached to the rotating shaft 6 so that its angle relative to the rotating shaft 6 can be freely adjusted. A baffle plate 31 and a cover 32 are provided on the outside of the cylinder block 3, with a discharge path 15 to communicate with a discharge port (not shown) formed at the cover 32. at the baffle plate 31, discharge gas path holes 33a are formed to reduce the extent of the discharge pulsation.

[0020] In the compressor 1 achieved in the embodiment, a discharge chamber 16 that communicates with the outlet 11 formed at the valve plate 8 is formed outward at the rear head 4 and a suction chamber 17 to communicate with the suction chamber 10 is formed at the center of the rear head 4. In addition, the discharge chamber 16 communicates with the crank case 7 via a pressure control valve 18 mounted at the rear head 4. It is to be noted that the pressure control valve 18 is controlled with an external control signal, that the power supply to the pressure control valve 18 is stopped if the freezing capability is judged to be unnecessary and that the level of the electrical current that is supplied rises as the heat load rises.

[0021] In addition, a suction port 20, at which a suction-side connector 19 connected with the piping and extending from the evaporator (not shown) is mounted, is formed at an external circumferential side surface of the rear head 4. The suction port 20 is made to communicate with the suction chamber 17 via a communication path 21 defined by a tunnel portion 25 which is formed as an integrated part of the rear head 4. A cutoff valve 22 that opens/closes the communication path 21 is provided on the communication path 21 and the communication path 21 is blocked by the cutoff valve 22 when the freezing operation is judged to be unnecessary so as to ensure that no coolant gas is taken in from the evaporator.

[0022] Furthermore, a muffler space 23 is formed around the tunnel portion 25 defining the communication path 21, as shown in FIGS. 1 and 2. One end of the

muffler space 23 opens at the suction port 20 and a small hole 24 which communicates with the upstream side of the cutoff valve 22 at the communication path 21 is formed at the other end (the furthest end). It is desirable that the muffler space 23 be formed over a length of approximately 30mm along the communication path 21 around the tunnel portion 25. By forming the muffler space 23 over the length of approximately 30mm, a damping peak frequency of approximately 800 Hz is achieved. Under normal circumstances, it is desirable to estimate the damping frequency relative to the length of the muffler space 23 through the finite element method and to set the length of the muffler space 23 in correspondence to the desired damping frequency band.

[0023] As the main drive engine (not shown) rotates, causing rotation of the rotating shaft 6 in the compressor 1 structured as described above, the rotating plate 14 fixed to the rotating shaft 6 also rotates, which, in turn, causes the rotary cam plate 13 to rotate and oscillate via the linking mechanism 30. Then, as the rotary cam plate 13 rotates and oscillates, with the pistons 12 each having one end thereof slidably fixed to the rotary cam plate 13 make reciprocal movement relative to the cylinders 9, thereby changing the volumetric capacity of the compression space defined by the pistons 12 and the cylinders 9. As the volumetric capacity of the compression space changes as described above, the coolant gas is taken in from the suction chamber 17, becomes compressed and is discharged into the discharge chamber 16. Through this process, the coolant gas having been evaporated at the evaporator is taken into the suction chamber 17 from the suction port 20 via the communication path 21, becomes compressed and is then let out from the discharge chamber 16 through the discharge path 15 to the next process, e.g., to the condenser.

[0024] When the heat load is significant, the high-level pressure supplied to the crank case 7 is reduced through the pressure control valve 18 to lower the pressure in the crank case and thus, the back pressure at the pistons 12 is lowered. As a result, the stroke of the pistons 12 becomes larger to increase the quantity of the discharge from the compressor 1. When it is decided that the freezing operation is not necessary, the high-level pressure is supplied to the crank case 7 through the pressure control valve 18, thereby raising the back pressure of the pistons 12 and, as a result, the stroke of the pistons 12 becomes smaller to reduce the quantity of the discharge from the compressor 1. In addition, when the heat load is at the lowest level, the communication path 21 is blocked with the cutoff valve 22, and thus, the coolant gas supply to the suction chamber 17 stops. In this case, the coolant gas is made to circulate inside the compressor 1 with the compressor 1 discharging no coolant gas, thereby achieving a clutchless compressor.

[0025] While the coolant gas is taken in, compressed and discharged through the suction, compression and

discharge phases at the compressor 1, as described above, the individual phases, e.g., the suction phase, are executed intermittently with the plurality of pistons 12 and, as a result, a pressure fluctuation occurs, for instance, in the suction chamber 17, which is then transmitted toward the evaporator as a pulsating wave. Since the evaporator is normally installed in the cabin, this pulsating wave would be communicated as unpleasant noise if its frequency matched the resonance frequency of the evaporator (which varies depending upon the model but is normally within a range of 300 Hz ~ 1,000 Hz). However, according to the present invention in which the muffler space 23 is provided near the communication path 21, the pulsating wave can be damped in the frequency band.

[0026] While a more significant pulsating wave is observed on the high pressure side than on the low pressure side in the compressor under normal circumstances, the high pressure side is usually located in the engine compartment and the evaporator on the low pressure side is installed in the cabin. For this reason, the resonance occurring at the evaporator is a problem to be addressed. However, in an air-conditioning system which utilizes a high pressure side condenser in place of a heater core, the problem of resonance at the condenser manifesting as noise must be addressed. Accordingly, in an air-conditioning system in which the condenser set on the high pressure side of the freezing cycle is installed inside the cabin, a communication path that communicates between a discharge chamber and a discharge port may be provided by forming the discharge chamber toward the center of the rear head 4 and forming a suction chamber around the discharge chamber and a muffler space to communicate with this communication path may be formed around the communication path. By adopting the structure, the pulsating wave propagating from the discharge chamber toward the condenser can be damped to prevent resonance from occurring at the condenser.

[0027] In addition, the small hole 24 which communicates between the muffler space 23 and the upstream side of the cutoff valve 22 at the communication path 21 is formed at the furthest end of the muffler space 23 so as to prevent stagnation of the oil in the muffler space 23. The damping effect achieved by providing the muffler space 23 normally corresponds to the length (depth) of the muffler space 23. For this reason, the small hole 24 is formed to prevent any stagnation of the oil so as to ensure that the damping target frequency band does not change due to a change in the depth of the muffler space 23 caused by remaining oil in the muffler space 23.

[0028] It is desirable to set the diameter of the small hole 24 to approximately 1mm, since the damping target frequency band would change if the diameter was larger than approximately 1mm and the oil discharge efficiency would be lowered if the diameter was smaller than approximately 1mm. However, the diameter of the small

hole 24 may be varied to achieve an intentional change in the damping frequency band. Moreover, as the small hole 24 opens at the upstream side of the cutoff valve 22, the suction chamber 17 and the suction port 20 are not allowed to communicate with each other via the small hole 24 when the communication path 21 is blocked by the cutoff valve 22 and, as a result, the communication path 21 is blocked with a high degree of reliability.

INDUSTRIAL APPLICABILITY

[0029] As explained above, according to the present invention in which a muffler space is provided at a communication path between the suction side or the discharge side and the corresponding port, the pulsating wave generated at the suction side or the discharge side can be damped to prevent unpleasant noise in the cabin.

[0030] In addition, since the muffler space is formed at the external circumference of the tunnel portion which defines the communication path at the rear head and thus the communication path can be formed as an integrated part of the rear head, the production cost does not go up. Even when the communication path is formed by using a separate part, the communication path can be formed with ease by forming spaces to constitute the communication path and the muffler space in advance at the rear head and then mounting a pipe for defining the communication path subsequently. Thus, an increase in the production cost can be minimized.

[0031] Moreover, since the small hole through which the oil is discharged is formed at the muffler space, the damping characteristics achieved in the muffler are stabilized to achieve reliable noise prevention.

Claims

1. A compressor having at least a housing constituted of a front head, a cylinder block and a rear head, a compression mechanism that is driven as a drive shaft passing through said front head rotates, a suction chamber formed at said rear head, at which an inlet of said compression mechanism opens and a discharge chamber formed at said rear head, at which a discharge port of said compression mechanism opens, **characterized in that:**

either one of said suction chamber and said discharge chamber is formed toward the center of said rear head and the other chamber that is not formed toward the center is formed further outward at said rear head;
a tunnel-shaped communication path passing through said suction chamber or said discharge chamber formed toward the center of said rear head and the other chamber formed further outward at said rear head to communicate said suction chamber and said discharge chamber

with a corresponding port is formed; and a muffler space is formed between said communication path and a pipe connection part at which said port is mounted.

2. A compressor according to claim 1, **characterized in that:**

said muffler space communicates with an outer end of said communication path.

3. A compressor according to claim 1, **characterized in that:**

a tunnel portion defining said communication path is formed as an integrated part of said rear head.

4. A compressor according to claim 1 or claim 2, **characterized in that;**

a tunnel portion defining said communication path is formed by inserting a separate pipe member at said rear head.

5. A compressor according to any one of claims 1 through 4, **characterized in that:**

a small hole communicating with said communication path is formed at the furthest end of said muffler space to allow oil remaining in said muffler space to flow back into said communication path.

6. A compressor according to any one of claims 1 through 5, **characterized in that;**

said compression mechanism comprises at least;

a plurality of cylinders formed at said cylinder block, each having an inlet to communicate with said suction chamber and an outlet to communicate with said discharge chamber, pistons each slidably inserted at one of said cylinders so as to freely move reciprocally, a rotary cam plate that rotates together with said drive shaft and causes a reciprocal movement of said pistons and a volumetric capacity varying mechanism capable of varying the angle of said rotary cam plate.

7. A compressor according to any one of claims 1 through 6, **characterized in that:**

said communication path is constituted as a suction path.

8. A compressor according to claim 7, **characterized in that:**

a valve mechanism capable of opening/closing

said suction path in response to an external signal is provided at said suction path.

9. A compressor according to claim 8 **characterized in that:**

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said small hole opens toward the upstream side of said mechanism.

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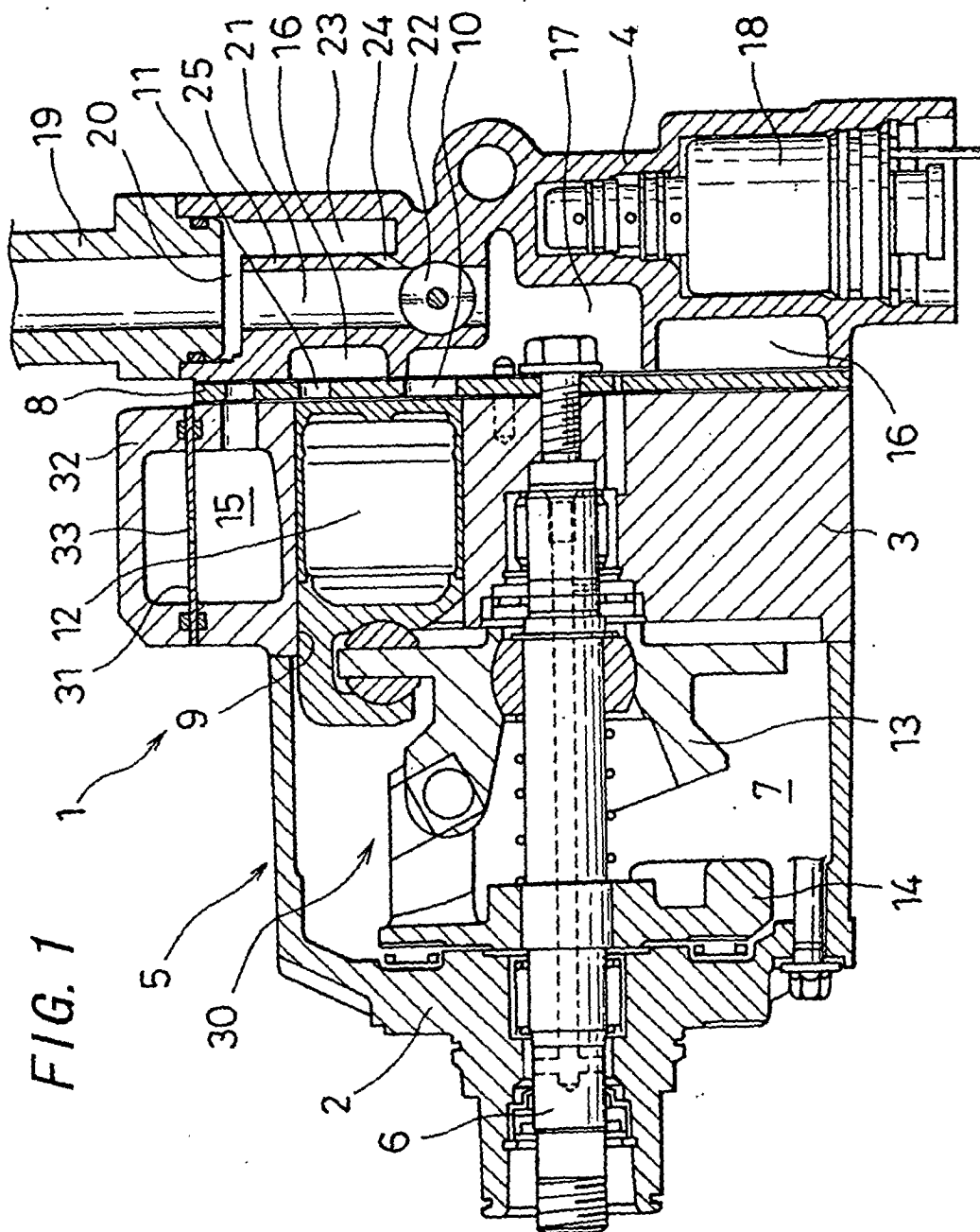
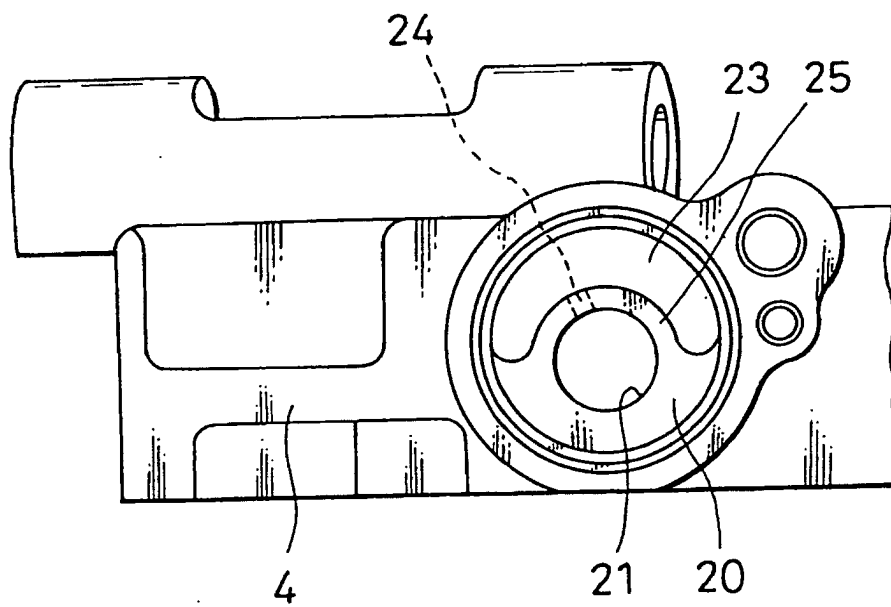


FIG. 2



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP01/05489

A. CLASSIFICATION OF SUBJECT MATTER Int.Cl. ⁷ F04B27/08		
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) Int.Cl. ⁷ F04B27/08-27/18		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Jitsuyo Shinan Koho 1922-1996 Toroku Jitsuyo Shinan Koho 1994-2001 Kokai Jitsuyo Shinan Koho 1971-2001 Jitsuyo Shinan Toroku Koho 1996-2001		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2000-249059 A (Toyoda Automatic Loom Works, Ltd.), 12 September, 2000 (12.09.00), Full text; Figs. 1 to 6 & EP 1033492 A1	1-9
A	JP 9-273477 A (Sanden Corporation), 21 October, 1997 (21.10.97), Full text; Figs. 1 to 7 & EP 799995 A1 & US 5782614 A	1-9
A	JP 7-139463 A (Toyoda Automatic Loom Works, Ltd.), 30 May, 1995 (30.05.95), Full text; Figs. 1 to 6 & US 5556260 A & DE 4415088 A	1-9
☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.		
* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
Date of the actual completion of the international search 25 September, 2001 (25.09.01)		Date of mailing of the international search report 09 October, 2001 (09.10.01)
Name and mailing address of the ISA/ Japanese Patent Office		Authorized officer
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