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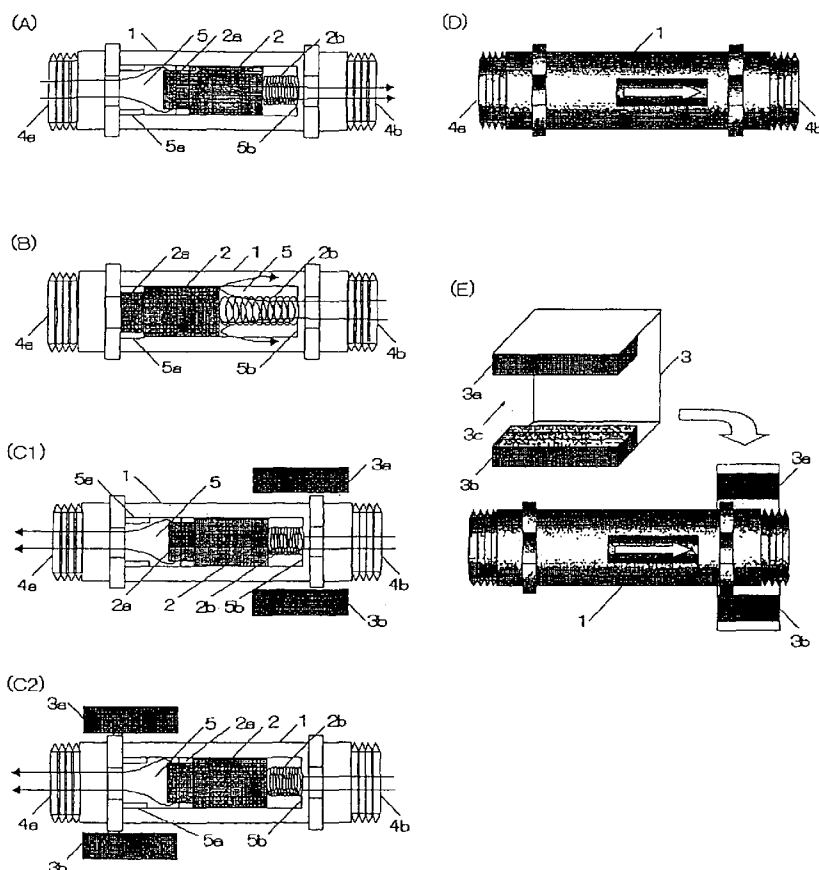
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[Continued on next page]

(54) Title: A CHECK VALVE AND A FLUID SUPPLY DEVICE THAT USES THE CHECK VALVE



(57) Abstract: To provide highly versatile check valves, to be installed in fluid supply flow paths, that allow supply of fluid from the downstream side while maintaining sealing characteristic against outside, and fulfill functions as check valves during normal operation, and to provide fluid supply devices that use the check valves. A check valve characterized by having (1) a main section that forms a flow path with tie-in points at both ends and a middle hollow section, (2) a valve body positioned in said middle hollow section, made of movable paramagnetic material, and having one end that seals the above mentioned flow path and the other end that is biasing-possible, and (3) an outer casing around the outer circumference of the above mentioned main section, with magnetic poles that are arranged in a manner so that they sandwich said valve body, and said magnetic poles are mountable and removable, or allow change of mounting locations.



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A check valve and a fluid supply device that uses the check valve

This invention concerns a check valve and a fluid supply device that uses the check valve, that are particularly useful as check valves and gas supply devices that are
5 installed in specialty gas supply piping systems used in semiconductor manufacturing plants.

Since the degree of purity of and intrusion of impurity in specialty material gas, used in semiconductor manufacturing processes, have a considerable influence on the characteristics of electronic devices, an extremely strict management is required for the
10 gas supply flow path. Specifically, many of such specialty material gases used in semiconductor manufacturing as represented by NH_3 , BCL_3 , CL_2 , SiH_2CL_2 , Si_2H_6 , HBr , HF , N_2O , C_3F_8 , SF_6 and WF_6 , are susceptible to contamination and have the characteristics of reacting to such elements as moisture and forming corrosive substances. Therefore, for the purpose of preventing intrusion of atmospheric gasses into the piping
15 system when conducting maintenance work and inspection of the piping system that comprises such gas supply flow paths of specialty material gas supply devices or changing parts mounted in the gas supply flow paths, a method of pre-installing check valves in each piping section has been implemented to allow maintenance and change of parts at the smallest levels of units in the flow paths. Moreover, since the check valve
20 does not have any control parts, and is composed by combining simple parts such as springs that are smaller than parts of other valves, it saves space on the piping panel, and since it does not have any parts that require any mechanically forced resetting and eliminates the risk of the operator forgetting to reset it, it can be manufactured at low cost, and hence it is frequently used for the purpose of preventing regurgitation from the
25 downstream side in various processes not limited to semiconductor manufacturing processes.

Check valves generally used for the above purposes, for example, have a structure as shown in Figure 8 (a) and (b) (e.g. refer to patent document 1). Figure 8 (a) shows a state in which the flow path in the check valve is closed. This check valve is
30 composed of intake section 32a from which fluid flows in, intake section 32c with a larger diameter than intake section 32a, valve case 32 equipped with valve seat 32b that is mounted at the step between intake section 32a and intake section 32c, pressure spring 34 that prevents regurgitation of fluid by pressing valve body 33 against valve seat 32b, and fitting 35 that is fixed to valve case 32 at screw section 32d and fixes pressure spring 34

that presses valve body 33 against valve seat 32b. When highly pressurized fluid is supplied from intake section 32a of the check valve, valve body 33 is pushed down by the supplied pressure as shown in Figure 8 (b), and the fluid flows out from the gap created between valve seat 32b and valve body 33.

5 There are also check valves with structures that do not use reaction force that accompany biasing means such as the pressure spring, as shown in Figure 9 (a) and (b) (e.g. refer to patent document 2). This type, as a check valve that maintains the effect of preventing back-flow using magnetic bodies at both the valve seat and valve body, is equipped with intake 43 at one end as well as hollow conduit tube 41 with intake 45 at the
10 other end, poppet 47 that can move freely within conduit tube 41, external magnet 49 positioned at conduit tube 41, and internal magnet 45 positioned inside poppet 47, and has a function that heightens the capability for determining whether poppet 47 should move and the direction of its movement from the relationship between the pressure difference between pressure B at the outflow side, pressure A at the intake side and magnetic force
15 M of inner and outer magnets 45 and 49.

[Patent document 1] Japanese patent application publication number 2003-247659

[Patent document 2] Japanese patent application publication number 2000-337539

20 It is, however, desirable to implement a method of maintenance and parts exchange while regurgitating purge gas such as nitrogen gas from the downstream side of the check valve since there is necessity to further strictly prevent intrusion of atmosphere into the piping system when conducting maintenance of the piping system and changing devices connected at the upstream side of the check valve for gas supply flow paths in
25 specialty material gas supply devices for semiconductor manufacturing, and there is strong demand for this. At this time with regular check valves, it is possible to feed purge gas from upstream as shown in Figure 10 (A), but it is not possible to feed purge gas from downstream as shown in Figure 10 (B). Moreover, since, in general, there is no special control mechanism it is very difficult to feed gas in the reverse direction into the piping
30 line once it is installed, and if this becomes necessary, there will be no other choice but to open up the piping system. At this time, if the piping system is opened for nitrogen purging even temporarily, there will be risk of contaminating inside the piping with atmosphere, and intrusion of atmosphere can cause contamination and corrosion.

Although it is possible to take a method of adding bypass line 53 equipped with valve 52 in parallel with check valve 51 to bypass the check valve and avoid the above mentioned problem as shown in Figure 10 (C), there is increased risk of gas leakage since there are additional connection joints for the portion of bypass line 53 that is not normally
5 in use. It is also not desirable from the points of view of costs and space conservation or reducing dead volume. Moreover, there is such risk as the back-flow prevention function of the check valve being nullified if the operator forgets to close the bypass line valve after completion of maintenance.

As securing airtightness is important in such gas supply devices, airtightness
10 tests by applying pressure inside the flow path and detecting the rate of leak are conducted regularly or during maintenance and inspection work. At this time, as shown in Figure 10 (D) pressure tests at upstream side piping section 54 of check valve 51 can not be conducted due to the back-flow prevention function as stated above, and as shown in Figure 10 (E), checking the airtightness is difficult since mounting the pressure sensor 55
15 to said piping section 54 is also difficult.

Although there is no problem with the essential function of the check valve concerning the sealing characteristic in the method of using magnets to move the valve body as stated above since it has an integral structure with the external magnet mounted onto the check valve main section, it is still impossible to purge the upstream side, as in
20 conventional methods, due to the back-flow prevention function when the downstream side pressure is larger than the upstream side, it is impossible with a fixed external magnet with a fixed magnetic power to open the valve body in accordance with the change in the purge gas pressure from the downstream side during maintenance.

As stated above, in cases of using conventional check valves,
25 (1) it is difficult to conduct maintenance work such as changing valves since it is impossible to freely nullify the effect of the check valve.

(2) with devices that can be adjusted freely, forgetting to restore the original state after maintenance work can lead to serious accidents.

(3) since the structure of devices that can be adjusted freely become complex, the
30 devices themselves become large and necessitate alteration in piping layout. At the same time it leads to drastic cost increase since the structure of the check valve becomes complicated.

The objective of this invention is to provide highly versatile check valves, to be installed at fluid supply flow paths, that fulfill a function as check valves during normal

operation and at the same time allow supply of fluid from the downstream side while maintaining the sealing characteristic against the outside. Another objective of this invention is to provide fluid supply devices that excel in maintainability of the piping and prevent contamination inside the flow paths from external air, by using such check valves
5 in fluid supply devices for piping systems for specialty gas supply used, for example, in semiconductor manufacturing plants.

Inventors of this invention, as a result of committed accumulative research to solve the above problems, found that the above objectives can be achieved by a check valve and fluid supply device that uses the check valve described below and reached
10 completion of this invention. The word "fluid" used herein does not merely represent gases and liquids but also widely includes substances with fluidity such as powders.

This invention concerns a check valve characterized by having (1) a main section that forms a flow path with tie-in points at both ends and a middle hollow section, (2) a valve body positioned in said middle hollow section, made of movable paramagnetic
15 material, and having one end that seals the above mentioned flow path and the other end that is biasing-possible, and (3) an outer casing around the outer circumference of the above mentioned main section, with magnetic poles that are arranged in a manner so that they sandwich said valve body, and said magnetic poles are mountable and removable, or allow change of mounting locations.

With the above structure it is possible to supply fluid such as purge gas in the reverse direction due to the function (hereafter referred to as "back-flow prevention regulating function") of forcibly terminating or limiting the check valve function externally, while fulfilling the function as a check valve during normal operation. Moreover, as the characteristics of this invention, it is an extremely effective means in
20 devices, such as specialty material gas supply devices for semiconductors, that require utmost attention against intrusion of external air since the above functions can be controlled while maintaining the sealing characteristic against the outside. In addition, by having an outer casing with magnetic poles that are arranged in a manner so that they sandwich the valve body, that is mountable and removable, or allow change of mounting
25 locations, as a part to control the valve body externally, it becomes possible to adjust the back-flow prevention function and back-flow prevention regulating function in accordance with the operational condition of the check valve to provide a highly versatile
30 check valve.

This invention is the check valve stated above and is characterized by the above

mentioned magnetic poles made of electromagnets that allow switching between attracting and repelling magnetism generated between them and the above mentioned valve body.

In such devices as the specialty material gas supply device for semiconductors, capability of changing conditions such as gas pressure and supply flow rate and at the same time precision controllability are required. Therefore, a back-flow prevention function and a back-flow prevention regulating function that correspond to the internal pressure and flow rate conditions of the gas supply flow path are required also for the check valves used in these devices. This invention is composed to allow adjustment of both of these functions by having an outer casing that can be mounted and removed, or allows changing the location it is mounted as mentioned above. Moreover, by making the polarity and magnetic strength of the magnetic poles variable, it became possible to control the coercion to the valve body and hence even finer adjustments of the back-flow prevention function and back-flow prevention regulating function became possible.

This invention is the above mentioned check valve characterized by the above mentioned outer casing having a notch to a section of the outer side of the above mentioned main section, and a structure that allows mounting and removing the outer case using the notch, or a structure that allows changing the mounting locations of the magnetic poles.

By having a structure that allows mounting and removing, or changing the mounting position of the magnetic poles, the above mentioned check valve is highly versatile. Since actual fluid supply devices have multiple flow paths and check valves are placed in various positions and directions depending on the flow path, it is desirable that mounting and removing them, or changing the positions of their magnetic poles can be made easily and securely. This invention realizes a composition that meets these requirements by employing a structure (herein and hereafter referred to as "yoke") where the outer casing has a sideways U-shaped cross section with magnets at the top and bottom. In cases of mounting the yoke only when purging the flow path, it is possible to check the progress of the maintenance visually and since restoration can be made easily by the removal operation after the purging is completed, checking the restoration can also be made visually and securely, and operational oversights such as forgetting to restore it to the original setup can be reduced. Furthermore, due to the arrangement of the magnetic poles using such structures as the yoke, it is possible to apply uniform magnetic force to the valve body and move the valve body smoothly.

This invention is the above mentioned check valve characterized by having either a composition with (1) an axis, made of paramagnetic material, at the inner circumference of the above mentioned main section by making a groove at a section of the outer circumference of the above mentioned valve body, that can be moved vertically to the central axis of the middle hollow section, or (2) an axis, made of paramagnetic material, at the outer circumference of the above mentioned valve body by making a groove at a section of the inner circumference of the above mentioned main section, that can be moved vertically to the central axis of the middle hollow section, and at the same time one end of said axis can be latched to the above mentioned groove.

The above mentioned check valve has a gas distribution function, back-flow prevention function and back-flow prevention regulating function made available by the balance between the gas pressure relationship between the upstream side and downstream side, elasticity of other bias-possible parts that comprise the valve body, and magnetic attracting and repelling forces. However, since when the balance is greatly disrupted by, for example, pressure rise at the downstream side, the back-flow prevention regulating function is affected greatly, it is desirable to secure a back-flow prevention regulating function as a preventive means. This invention, by having either one of the above compositions, secures the function of maintaining the state after forcibly moving the valve body using the attracting or repelling force of the magnetic poles. Due to this composition it is possible to provide highly versatile check valves that fulfill a function as check valves during normal operation and at the same time assuredly secure the function of supplying fluid from the downstream side while maintaining the sealing characteristic against the outside.

This invention is a fluid supply device that uses either one of the check valves mentioned above, characterized by one end of the valve body, located inside said check valve, positioned at the upstream side of the fluid supply device flow path to allow purging of the upstream side from said check valve of the fluid supply device flow path while securing the sealing characteristic of the fluid supply device flow path, by moving the valve body to the downstream side using the magnetic poles positioned at the outer circumference of the check valve main section.

The above mentioned check valve, to be installed at a fluid supply flow path, has a composition that allows fulfilling a function as a check valve during normal operation and at the same time allows supply of fluid from the downstream side while maintaining the sealing characteristic against the outside. Therefore, by using this check valve in a

fluid supply device such as a specialty material gas supply device for semiconductors, positioning one end of it at the upstream side of the fluid supply device flow path, and moving the valve body to the downstream side using the above mentioned magnetic poles, it is possible to purge the upstream side of the fluid supply device flow path while
5 securing the sealing characteristic of the fluid supply device flow path, and provide a fluid supply device that excels in maintainability of the piping.

This invention is the above mentioned fluid supply device characterized by its controllability of purge pressure or purge flow rate while securing the sealing characteristic of the fluid supply device flow path by adjusting the magnetic power
10 between the magnetic poles and the valve body by changing the position or magnetic field strength of the above mentioned magnetic poles.

While the back-flow prevention function of the check valve allows assurance of stable characteristics with specific setting of conditions without being affected relatively by such factors as gas pressure and supply flow rate, it is necessary to adjust the repelling
15 force from biasing or attracting and repelling forces from the magnetic poles considering the balance with such factors as the gas pressure and supply flow rate to feed a designated amount of gas for purging by nullifying the back-flow prevention function. This invention that uses electromagnets as magnetic poles allows adjustment of the magnetic strength between the magnetic poles and valve body and hence adjustment of the
20 back-flow prevention function and the back-flow prevention regulating function by changing the positions of the magnetic poles or the magnetic field strength of the magnetic poles. Therefore, it is possible to provide a fluid supply device that excels in maintainability of the piping while maintaining the sealing characteristic against the outside.

25 As described above, with this invention, it is possible to provide highly versatile check valves, to be mounted on fluid supply devices, that fulfill a function as check valves during normal operation and at the same time assuredly secure the function of supplying fluid from the downstream side while maintaining the sealing characteristic against the outside. Moreover, it is possible to provide fluid supply devices that excel in
30 maintainability of the piping by using such check valves in the fluid supply devices in piping systems for specialty gas supply used, for example, in semiconductor manufacturing plants.

The implementation configuration of this invention is described below while referring to figures.

Figure 1 (A) ~ (E) are schematic diagrams that show the basic composition (composition example 1) of the check valve pertaining to this invention and its actions. In Figure 1 (A) ~ (E), the check valve is characterized by being composed of main section 1, valve body 2 and outer casing 3, where (1) main section 1 forms a flow path with tie-in points 4a and 4b at both ends, and middle hollow section 5, (2) valve body 2 positioned in middle hollow section 5, made of movable paramagnetic material, and having one end 2a that seals the flow path and the other end 2b that is biasing-possible, and (3) outer casing 3 around the outer circumference of main section 1, with magnetic poles 3a and 3b that are arranged in a manner so that they sandwich valve body 2, and magnetic poles 3a and 3b are mountable and removable, or allow change of mounting locations.

A typical example of main section 1 has an internal structure as shown in Figure 1 (A) and external structure as shown in Figure 1 (D), tie-in points 4a and 4b at its both ends, and a cylindrical body that forms hollow section 5. While the material is not limited in particular as long as it is capable of forming a durable structure, in cases it is used in such devices as special material gas supply devices for semiconductors such materials as stainless steel (SUS-316L, etc.) are desirable as it requires corrosion resistance. As to tie-in points 4a and 4b, it is desirable that they have the prescribed pressure resistance and sealing characteristic, and a screw shape as shown in Figure 1 so that they are easy to connect with the piping inside the device in which the check valve is used. At one end (tie-in points 4a side in Figure 1) of hollow section 5, sealing protrusion section 5a that forms a seal when connected or fitted with one end 2a of valve body 2 is attached, and at the other end (tie-in points 4b side in Figure 1) latch section 5b where the other end 2b of valve body 2 latches and enables biasing is attached.

Valve body 2, partly or entirely made of paramagnetic material, is positioned at hollow section 5 of main section 1 in a manner allowing it to slide. For gas flow from tie-in points 4a side in Figure 1 (A), valve body 2 moves along hollow section 5 due to the gas pressure to create a desired gap between one end 2a and sealing protrusion section 5a, and the other end 2b latches to latch section 5b to form a condition that allows biasing. For gas flow from tie-in point 4b side in Figure 1 (A), valve body 2 moves along hollow section 5 due to the gas pressure and repelling force of the other end 2b to form a sealed condition to close or fit the gap between one end 2a and sealing protrusion section 5a.

While Figure 1 (A) ~ (C2) shows a composition where one end 2a forms a part of valve body 2, and the other end 2b forms a spring 2b as a separate body, the composition is not limited to this in particular as long as it has the above mentioned functions. For

example, if the other end 2b is made of resin compound with elasticity, the same function can be achieved, and if the entire valve body 2 is made of resin compound with elasticity, it is possible to place a magnetic body inside it and mold them together as a single-piece body. For the contact surface of one end 2a that connects tightly with sealing protrusion
5 section 5a, it is desirable to use a flexible sealing sheet so that sufficient sealing characteristic can be maintained after repeated closure and separation, or it is desirable that the entire one end 2a is made of resin compound with flexibility and elasticity.

The materials of valve body 2 are not limited in particular as long as they enable it to slide along the inner circumference of hollow section 5, and that they provide sealing
10 characteristic for one end 2a and elasticity for the other end 2b, but in cases it is used in devices such as specialty material gas supply devices for semiconductors, corrosion resistance is required, and hence it is desirable to use resin materials such, for example, as PCTFE and Kalrez. For the formation of valve body 2 with paramagnetic characteristic, for the part excluding one end 2a, a method of using paramagnetic materials such as
15 nickel (Ni) that have low reactivity to corrosive or specialty gases, a method of encasing paramagnetic material such as iron (Fe) or Ni inside valve body 2, or a method of forming valve body 2 with material that has powdered paramagnetic material mixed in, can also be suggested.

Outer casing 3 has magnetic poles 3a and 3b positioned in a manner sandwiching
20 valve body 2, and is mounted at outer circumference of main section 1 as shown in Figure 1 (C). It is desirable that outer casing 3 has a notch 3c to a section of the outside of main section 1, and that it can be mounted and removed using this notch 3c, or that it has a structure that allows changing the mounting positions of magnetic poles 3a and 3b. More specifically, a structure such as yoke 3 as shown in Figure 1 (E) can be suggested. When
25 yoke 3 that has magnetic poles 3a and 3b that attract valve body 2 is positioned at main section 1 as shown in Figure 1 (E), valve body 2 made of paramagnetic material is attracted by the magnetism of magnetic poles 3a and 3b, and by that force that exceeds the repelling power of the gas pressure and spring 2b (equivalent to other end 2b), it is possible to separate sealing protrusion section 5a and one end 2a. Moreover, when
30 magnetic poles 3a and 3b are positioned at main section 1 at approximately equal distances from valve body 2 using yoke 3, equal magnetic forces are applied to valve body 2 to enable smooth movement of valve body 2. In this case, there is also no effect on stability of positioning due to the mutual attracting force between magnetic poles 3a and 3b that is a problem when multiple magnetic poles are used.

When magnetic poles 3a and 3b have magnetism that repels against valve body 2, it is possible to attain the same effect by mounting yoke 3 to face the flow path as shown in Figure 1 (C1). At this time it is possible to adjust the degree of separation between sealing protrusion section 5a and one end 2a by changing the mounting positions of magnetic poles 3a and 3b, and change the distance between them and valve body 2 in the flow path direction or in the direction perpendicular to the flow path. Moreover, it is also desirable to use magnetic poles 3a and 3b made of electromagnets to allow switching between attracting and repelling magnetism between them and valve body 2. By switching to magnetism that generates attracting force, sealing protrusion section 5a and one end 2a can be separated, and by switching to magnetism that generates repelling force, the sealing characteristic between sealing protrusion section 5a and one end 2a is reinforced to strengthen the back-flow prevention effect. The number of magnetic poles is not limited to two and can be three or more, or can be an integrated single-body magnetic pole in a shape of a cylinder or semi-cylinder.

Next, the functions of this check valve are explained through its relationship with the force of feeding the gas, as shown in Figure 1 (A) ~ (E). Here, the flow of gas from the upstream side of the check valve (herein and hereafter, this refers not to the upstream of the gas flow but the tie-in point 4a side of the check valve), as shown in Figure 1 (A), is referred to as “forward flow,” the flow of gas from the downstream side of the check valve (herein and hereafter, this refers not to the downstream of the gas flow but the tie-in point 4b side of the check valve), as shown in Figure 1 (B), is referred to as “reverse flow,” and the state in which there is no gas flow from either side, that is the pressure in the flow path at the upstream side (hereafter referred to as “upstream side pressure P_u ”) and the pressure in the flow path at the downstream side (hereafter referred to as “downstream side pressure P_d ”) are equal, is referred to as the “static state.” At the static state, valve 2 is pushed against the upstream of hollow section 5 by the repelling force of spring 2b, and creates a sealed state between sealing protrusion section 5a and one end section 2a.

(1) Functions with forward flow

When upstream side pressure P_u exceeds downstream side pressure P_d and, at the same time, exceeds repelling force K of spring 2b, the forward flow occurs. That is, when the relationship of the initial upstream side pressure P_{uo} with downstream side pressure P_d and repelling force K is has pressure condition “ $P_{uo} \geq P_d + K$,” valve body 2

moves along hollow section 5 from the upstream side to downstream side to create a desired gap between one end section 2a and sealing protrusion section 5a and create a forward gas flow, and then valve body stabilizes at a position where pressure condition becomes " $P_u = P_d + K$." At this time, the gas forms a flow as shown in Figure 1 (A) and
5 spring 2b of valve body 2 latches to latch section 5b and forms a state of biasing by repelling force K.

(2) Functions with reverse flow

Inversely to (1) above, when the relationship of the initial upstream side pressure
10 P_{uo} with downstream side pressure P_d and repelling force K has pressure condition " $P_{uo} < P_d + K_o$," the back-flow prevention function of the check valve activates and the gas flow stops. That is, when activating the check valve or when the upstream pressure P_u drops from the above state in (1) to pressure condition " $P_u = P_d + K$," valve body 2 moves along hollow section 5 from the downstream side to upstream side to close the gap
15 between one end section 2a and sealing protrusion section 5a, and the forward gas flow stops or a state in which a reverse flow does not occur is made. At this time, the gas from the downstream side stops as shown in Figure 1 (B) and valve body 2 presses one end section 2a against sealing protrusion section 5a to connect or fit them together and valve body 2 forms a sealed state due to the downstream side pressure P_d and repelling force K.

20

(3) Functions that regulates back-flow prevention function

At the state in (2), if yoke 3 having magnetic poles 3a and 3b is mounted to main section 1 as shown in Figure 1 (E), valve body 2, made of paramagnetic material, is attracted by magnetic force M of magnetic poles 3a and 3b, and the back-flow prevention
25 function of the check valve is regulated. That is, when the combined force of upstream side pressure P_u and magnetic force M exceeds downstream side pressure P_d , and at the same time exceeds repelling force K of spring 2b, a forward flow occurs. More specifically, when upstream side pressure P_u , in relation to downstream side pressure P_d and repelling force K_o , has pressure condition " $P_{uo} + M \geq P_d + K_o$," valve 2 moves along
30 hollow section 5 from the upstream side to downstream side to create a desired gap between one end section 2a and sealing protrusion section 5a and creates a forward gas flow, and then valve body 2 stabilizes at a position where the pressure condition becomes " $P_u + M = P_d + K$." At this time, the positional relationship of valve body 2 to main section 1 is the same as that shown in Figure 1 (A), but the gas forms a flow as shown in Figure 1

(C1), and spring 2b of valve body 2 latches to latch section 5b and forms a state of biasing by repelling force K.

Furthermore, the following functions are made available by making magnetic poles 3a and 3b with electromagnets to allow switching between attracting and repelling magnetism that is generated between them and valve body 2.

(a) By switching the magnetism between magnetic poles 3a and 3b and valve body 2 to generate attracting force, it becomes possible to activate, terminate and control the back-flow prevention regulating function while keeping yoke 3 at fixed state.

(b) By adjusting the magnetic force of magnetic poles 3a and 3b at the state in (1), it is possible to change the degree of opening between one end section 2a and sealing protrusion section 5a. By being able to adjust the degree of opening, it is possible to adjust the upstream side pressure or flow rate.

(c) By fixing yoke 3 in the same state in (1) or (2) and switching the magnetism between magnetic poles 3a and 3b, and valve body 2 to generate repelling force, it is possible to apply resistance to the forward flow. That is, it is possible to apply the force of spring 2b in the same direction to valve body 2 and reinforce the back-flow prevention function.

(d) Moreover, by adjusting the magnetic force in the state of (3), it is possible to change the degree of opening the gap between one end section 2a and sealing protrusion section 5a. By being able to adjust the degree of opening, it becomes possible to adjust the downstream side pressure or flow rate.

A function checkout test and yoke function test under actual operating conditions were conducted on the check valve having the above mentioned compositions.

(1) Check valve function checkout test

(1-1) Experiment conditions

Using a check valve having the composition as shown in Figure 1 (C), verification was made using the attracting force of the magnetic poles that yields the back-flow prevention regulating function, with pressure of 0.05MPa, which is the leak purge pressure, or less. Verification using the attracting force enables highly objective evaluation even under a condition with many variable factors such as the positions of magnetic bodies and distances between magnetic bodies, by using the mutual attracting forces among the magnetic bodies.

(1-2) Experiment results

As a result of experimenting by changing the attracting force by setting the leak purge pressure at 0.05MPa, flow in the reverse direction of the purge gas occurred at attracting force of 0.75kg. That is, this confirms that by using a yoke mounted with a cylindrical magnet of attracting force of 0.75kg or larger, it is possible to obtain the back-flow prevention regulating function at leak purge pressure of 0.05MPa and below.

(2) Yoke function test

(2-1) Experiment conditions

(1) Using the same check valve used in (1), the release pressure of gas sealed inside a piping system that uses the check valve was obtained using the experiment flow as shown in Figure 2 (A). This pressure becomes the reference point for the back-flow prevention regulating function to work with the check valve of this invention. As to the mounting methods of the magnetic poles, tests were made both by using the yoke and without using it. The experiment flow allows gas from supply source 11 to be fed to test subject check valve 10 via pressure regulator 12 and choke piece 13. The pressure condition is adjusted by pressure regulator 12, and the pressure at the time is measured with pressure gauge 14. In the case of not using the yoke, magnetic poles 3a and 3b were mounted directly onto main section 1 as shown in Figure 2 (B).

(2-2) Experiment results

By mounting a yoke with a cylindrical magnet with attracting force of 11.5kg or larger, unlocking effect was obtained at normal purge pressure of 0.7MPa or smaller as shown in Table 1 below and Figure 3. It was also verified that more uniform attracting force effect was obtained by using the yoke compared to not using it.

Table 1

Attracting force (kg)	Release pressure with yoke (MPa)	Release pressure without yoke (MPa)	Shape of magnetic poles
11.50	0.7	0.56	Cylindrical magnet
8.35	0.63	0.52	Cylindrical magnet
7.86	0.5	0.43	Rectangular column magnet
4.62	0.35	0.28	Rectangular column magnet
3.00	0.25	0.2	Cylindrical magnet

(3) Conclusion

As the results of the experiments above, it is possible to provide a check valve that allows adjustment of attracting force corresponding to the normally used leak purge pressure and purge pressure in such devices as specialty material gas supply devices for
5 semiconductors. As to the arrangement of the magnetic poles, it was also verified that more stable back-flow prevention regulating function of the check valve can be realized with lower attracting force by using the yoke.

In composition example 1 mentioned above, the back-flow prevention function
10 is regulated by forcibly moving valve body 2 against a "reverse flow" using the attracting force of magnetic poles 3a and 3b. In case, however, a pressure condition " $P_{uo}+M \geq P_d+K_o$ " can not be maintained, that is, in case the downstream pressure is strong to make the pressure condition to be " $P_{uo}+M > P_d+K_o$," it is necessary to strengthen the attracting force of magnetic poles 3a and 3b to respond to this to regulate the back-flow prevention
15 function. In this invention, with a composition (composition example 2) as shown in Figure 4 (A) ~ (E), after valve body 2 is forcibly moved using the attracting or repelling force of magnetic poles 3a and 3b, a function to maintain the state is secured.

In specific terms, a composition, as shown in Figure 4 (A) ~ (D), can be suggested where axial bodies 6a and 6b that can travel in the vertical direction to the
20 central axis of hollow section 5 and have the same magnetism as valve body 2, are mounted inside main section 1, and where groove 2c is made at the outer circumference of valve body 2 to which each end of axial bodies 6a and 6b can be latched. Here, the material of axial bodies 6a and 6b are not limited in particular as long as they are made of paramagnetic material and have the durability against the pressure of the fluid, including
25 the ends.

(1) Figure 4 (A) shows the state of each section during forward flow. It is basically the same as Figure 1 (A) in the composition example 1, including the positional relationship of valve body 2 and main section 1. Here, axial bodies 6a and 6b are pushed
30 towards the outer circumference side of main section 1 of its inner side sections 1a and 1b due to the repelling force against valve body 2, and there is no contact with valve body 2. That is, by making axial bodies 6a and 6b have the same magnetism as valve body 2, it is possible to secure a state that does not apply load on the movement of valve body 2.

(2) Figure 4 (B) shows the state of each section during reverse flow. It is basically the same as Figure 1 (B) in the composition example 1, including the positional relationship of valve body 2 and main section 1. Here, as in Figure 4 (A), axial bodies 6a and 6b are pushed towards the outer circumference side of main section 1 of its inner side
5 section 1a due to the repelling force against valve body 2, and there is no contact with valve body 2.

(3) By mounting magnetic poles 3a and 3b to main section 1 and apply repelling force to valve body 2, valve body 2 moves towards the downstream side to create a gap
10 between one end section 2a and sealing protrusion section 5a as shown in Figure 4 (C). Here, axial bodies 6a and 6b, while repelling against valve body 2 and by having the same magnetism as magnetic poles 3a and 3b, are at a state of being contiguous to the outer surface of valve body 2 due to the strong repelling force from magnetic poles 3a and 3b.

(4) After valve body 2 move towards the downstream side for a certain distance, it forms a temporary static state where the above mentioned pressure condition is balanced at " $P_{uo}+M=P_d+K_o$." By pre-setting groove 2c made on valve 2 so that it will be at a position close to inner sections 1a and 1b under this condition, they form a static state, and, at the same time, the tips of axial bodies 6a and 6b positioned in inner sections 1a and 1b
20 are inserted into groove 2c of valve body 2 to be in a latched state due to the repelling force from magnetic poles 3a and 3b. At this time, the repelling force from valve body 2 and magnetic poles 3a and 3b is applied to axial bodies 6a and 6b in a vertical direction to the central axis of hollow section 5, and, at the same time, while the direction of movement is restricted by inner sections 1a and 1b, there is almost no force applied to the
25 direction of the central axis of hollow section 5. Therefore, the tips of axial bodies 6a and 6b that are inserted into groove 2c of valve body 2 in a latched state, are not affected by the upstream side and downstream side pressure conditions that are applied in the direction of the central axis of hollow section 5. This means that it has superb functions that does not allow reduction in back-flow prevention regulating function even if the
30 pressure at the downstream side rises during purging.

Although in the structure shown in Figure 4 (A) ~ (D), the positions of inner side sections 1a and 1b are fixed, it is also possible to make them adjustable when desired by allowing their mounting positions to be changed or giving main section 1 a structure so

that it can be divided into multiple parts.

In (1) ~ (4) above, explanation is given in cases where groove 2c is made in valve 2, axial bodies 6a and 6b are mounted at its main section 1 side, and the magnetism of axial bodies 6a and 6b, and magnetic poles 3a and 3b are all the same, but groove 2c and the magnetism of axial bodies 6a and 6b, and magnetic poles 3a and 3b are not limited in particular to the above specifications. For example, it is also possible to obtain a similar function by mounting axial bodies 6a and 6b on the inside of the outer circumference sections 2d and 2e of valve body 2 and making groove 1c in main section 1 as shown in Figure 4 (E). Moreover, at this time, it is also possible to obtain a similar function by making the magnetism of axial bodies 6a and 6b different from that of valve body 2 and magnetic poles 3a and 3b. Furthermore, it is also possible to obtain the same effect by composing magnetic poles 3a and 3b with electromagnets to allow addition of or change in magnetism.

Next, a composition example of a gas supply device (hereafter referred to as “this device”) using the check valve pertaining to this invention is explained. In specific terms, it is characterized by making use of the characteristics of the above mentioned check valve, having one end of the valve body installed inside at the upstream side of the fluid supply flow path, and moving the valve body towards the downstream side using the magnetic poles mounted at the outer circumference of the check valve main section, to allow purging of the upstream side of the fluid supply flow path of said check valve while securely maintaining the sealing characteristic of the fluid supply flow path. It is described below in detail based on Figure 5.

The specialty gas supply device that is the representative example of this device is composed of supply systems 20a and 20b that have almost identical flow paths as shown in Figure 5. That is, at one supply system 20a, specialty gas is supplied from high-pressure container 21a filled with the gas to specified pressure, through piping 22a connected to the container, and flow path Aa, and after it is adjusted to specified pressure and flow rate at pressure regulator 23a, it is fed from outlet 24 to such processing systems as, for example, semiconductor manufacturing devices. Supply system 20b also has the same composition, and normally only one of the two systems 20a and 20b is used in turns while the remaining one is reserved as a backup supply system. In cases a large amount of gas supply is required, both systems 20a and 20b are used simultaneously to secure ample supply volume. Figure 4 shows a case in which supply system 20b is used while maintenance work is to be conducted on supply system 20a.

This device is equipped with water spray supply path W for preventing temperature drop of high-pressure containers 21a and 21b, that is caused by supplying large amount of gas with low boiling point such as specialty gas, purge supply path P for use when changing parts used in high-pressure containers 21a and 21b, and flow paths, as well as parts that comprise the flow paths, leak check gas supply path L, and line nitrogen (Nz) supply path. It is also equipped with purge valve 25a so that purge gas can be supplied as a precautionary means. These flow paths and flow paths Aa and Ab are connected via switch valves (electromagnetic valves) 26a and 27a, or 26b and 27b, so that purging and leak check of flow paths Aa and Ab can be conducted. Supply path N is connected to a vent (not shown in figure) and is returned to the vent along with the N2 used via outlet V.

As shown in Figure 5, in this device check valves are installed in main supply paths P, L and N, except water spray supply path W, to prevent intrusion of outside air during maintenance and inspection. More specifically, in supply path L check valve 10a, in supply path P check valves 10b and 10e, in supply path N check valves 10c and 10f, and in flow paths Ba and Bb that connects each supply path check valves 10d and 10g are installed. Since specialty gas flows through flow paths Aa and Ab in this device, purging at the time of changing the parts in flow paths Aa and Ab, and the functions of check valves 10d and 10g installed in flow paths Ba and Bb that are related to this purging are important. More specifically, check valve 10d pertaining to this invention achieves a superb function during maintenance work such as changing or disassembling and cleaning pressure regulator 23a and electromagnetic valve 26a that are shown inside the circle in Figure 6.

Figure 6 (A) ~ (E) shows the function of check valve 10d when electromagnetic valve 26a is removed from flow path Aa. Figure 6 (B) shows the state of this device at the time of or after removing electromagnetic valve 26a, shown inside the circle in Figure 6 (A), and Figure 6 (C) shows the state of a conventional device at the time of or after removing it. That is, in case a conventional check valve is used, it is possible to feed purge gas introduced from purge gas intake P to check valve 10d via flow paths a and b, and then through flow paths c and d, as shown in Figure 6 (C), but it is impossible to feed it to flow paths f and e that are beyond check valve 10d. At this time, it is possible to purge flow path e by introducing the purge gas from purge gas supply valve 25a. It is, however, difficult to purge flow path f while preventing intrusion of outside air into the gas supply flow path, and hence the maintenance work becomes troublesome. On the other hand, in

this device, as shown in Figure 6 (A), by using check valve 10d pertaining to this invention, it is possible to regulate the back-flow prevention function and purge flow path f without intrusion of outside air into the gas supply flow paths, and no special maintenance work is necessary.

5 Figure 6 (D) shows the state of this device at the time of or after removing electromagnetic valve 26a, provided that electromagnetic valve 26a shown in the circle in Figure 6 (A) is removable while flow path d and flow path e are still connected, and Figure 6 (E) shows the state of a conventional device at the time or after removing it. That is, in case a conventional check valve is used, it is possible to feed purge gas introduced from purge gas intake P to check valve 10d via flow paths a and b, and then through flow paths c, d and e, as shown in Figure 6 (E), but it is impossible to feed it to flow path f that is beyond check valve 10d. On the other hand, in this device, as shown in Figure 6 (D), by using check valve 10d pertaining to this invention, it is possible to regulate the back-flow prevention function and purge flow path f without intrusion of outside air into the gas supply flow paths. Moreover, in this case it is not necessary to introduce purge gas from purge gas supply valve 25a and no other special maintenance work is necessary.

 Figure 7 (A) and (B) shows the function of check valve 10d when pressure regulator 23a is removed from flow path Aa. Figure 7 (A) shows the state of this device at the time of or after removing it, and Figure 7 (B) shows the state of a conventional device at the time of or after removing it. That is, in case a conventional check valve is used, it is possible to feed purge gas introduced from purge gas intake P to check valve 10d through flow paths a, b, and c, as shown in Figure 7 (B), but the purge gas accumulates in flow path a and it is impossible to feed it to flow paths f and d that are beyond check valve 10d. At this time, it is possible to purge flow path d by introducing the purge gas from purge gas supply valve 25a. It is, however, difficult to purge flow path f while preventing intrusion of outside air into the gas supply flow path, and hence the maintenance work becomes troublesome. On the other hand, in this device, as shown in Figure 7 (A), by using check valve 10d pertaining to this invention, it is possible to regulate the back-flow prevention function and purge flow paths a, f, d and even e. Therefore, there is no intrusion of outside air into the gas supply flow paths, and it is not necessary to introduce purge gas from purge gas supply valve 25a, or conduct other special maintenance work.

 At this time, it is desirable to control the purge pressure or purge flow rate while securing the sealing characteristic of the fluid supply flow path by adjusting the magnetic force between the valve body and magnetic poles by changing the positions of the

magnetic poles of the check valve or changing the magnetic field strength of the magnetic poles. That is, in the example of Figure 7 (A) described above, it is ideal when the supply flow rate of purge gas to flow paths b and c, and the supply flow rate of flow paths a (f) and d are approximately equal, but since the balance is disturbed by the flow resistance
5 caused by the parts installed in each flow path, it is possible to balance the two flow rates by adjusting the degree of opening of the check valves.

As described above, it is possible to provide a gas supply device that excels in maintainability of the piping by using this device in such specialty gas supply piping systems as, for example, used in semiconductor manufacturing plants.

10 As stated above, this invention gives birth to unprecedented superb functions by allowing a check valve to have a function that restricts its primary innate function as a check valve, and the technology that easily enables creation of non-stationary state only during maintenance work using such forces as magnetic force of non-contact jigs can also be used in such valves as the electromagnetic valve that are normally in a closed state so
15 that they can be changed to have a normally open state.

Brief explanation of figures

Figure 1: Schematic diagram illustrating basic composition and operation of check valve pertaining to this invention

20 Figure 2: Explanatory diagram illustrating experiment flow for function test of check valve pertaining to this invention

Figure 3: Explanatory diagram illustrating the results of function test of check valve pertaining to this invention

Figure 4: Schematic diagram illustrating other compositions and their operation of check
25 valve pertaining to this invention

Figure 5: Schematic diagram illustrating gas supply device using check valve pertaining to this invention

Figure 6: Schematic diagram illustrating functions of check valve during maintenance of switch valves that compose this device

30 Figure 7: Schematic diagram illustrating functions of check valve during maintenance of pressure regulator that composes this device

Figure 8: Schematic diagram illustrating one example of check valve pertaining to conventional technology

Figure 9: Schematic diagram illustrating other examples of check valves pertaining to

conventional technology

Figure 10: Explanatory diagram illustrating functions of check valve in gas supply flow path using check valve pertaining to conventional technology

- | | | |
|----|-------------------------------------|--------------------------------------|
| 5 | Explanation of codes | |
| | 1 | Main section |
| | 2 | Valve body |
| | 2a | One end section |
| | 2b | Other end section (spring) |
| 10 | 3 | Outer casing (yoke) |
| | 3a, 3b | Magnetic poles |
| | 4a, 4b | Tie-in points |
| | 5a | Sealing protrusion section |
| | 5b | Latch section |
| 15 | 10, 10a ~ 10g | Check valves |
| | 20a, 20b | Supply system |
| | 21a, 21b | High-pressure container |
| | 22a, 22b | Piping |
| | 23a, 23b | Pressure regulator |
| 20 | 25a | Purge gas supply valve |
| | 26a | Electromagnetic valve (switch valve) |
| | A, Aa, Ab, Ba, Bb, a ~ f Flow paths | |

CLAIMS

5 1 - A check valve characterized by having (1) a main section that forms a flow path with tie-in points at both ends and a middle hollow section, (2) a valve body positioned in said middle hollow section, made of movable paramagnetic material, and having one end that seals the above mentioned flow path and the other end that is biasing-possible, and
10 (3) an outer casing around the outer circumference of the above mentioned main section, with magnetic poles that are arranged in a manner so that they sandwich said valve body, and said magnetic poles are mountable and removable, or allow change of mounting locations.

15 2- The check valve, stated in Claim 1, characterized by the above mentioned magnetic poles made of electromagnets that allow switching between attracting and repelling magnetism generated between them and the above mentioned valve body.

20 3 - The check valve, stated in Claim 1 or 2, characterized by the above mentioned outer casing having a notch to a section of the outer side of the above mentioned main section, and a structure that allows mounting and removing the outer case using the notch, or a structure that allows changing the mounting locations of the magnetic poles.

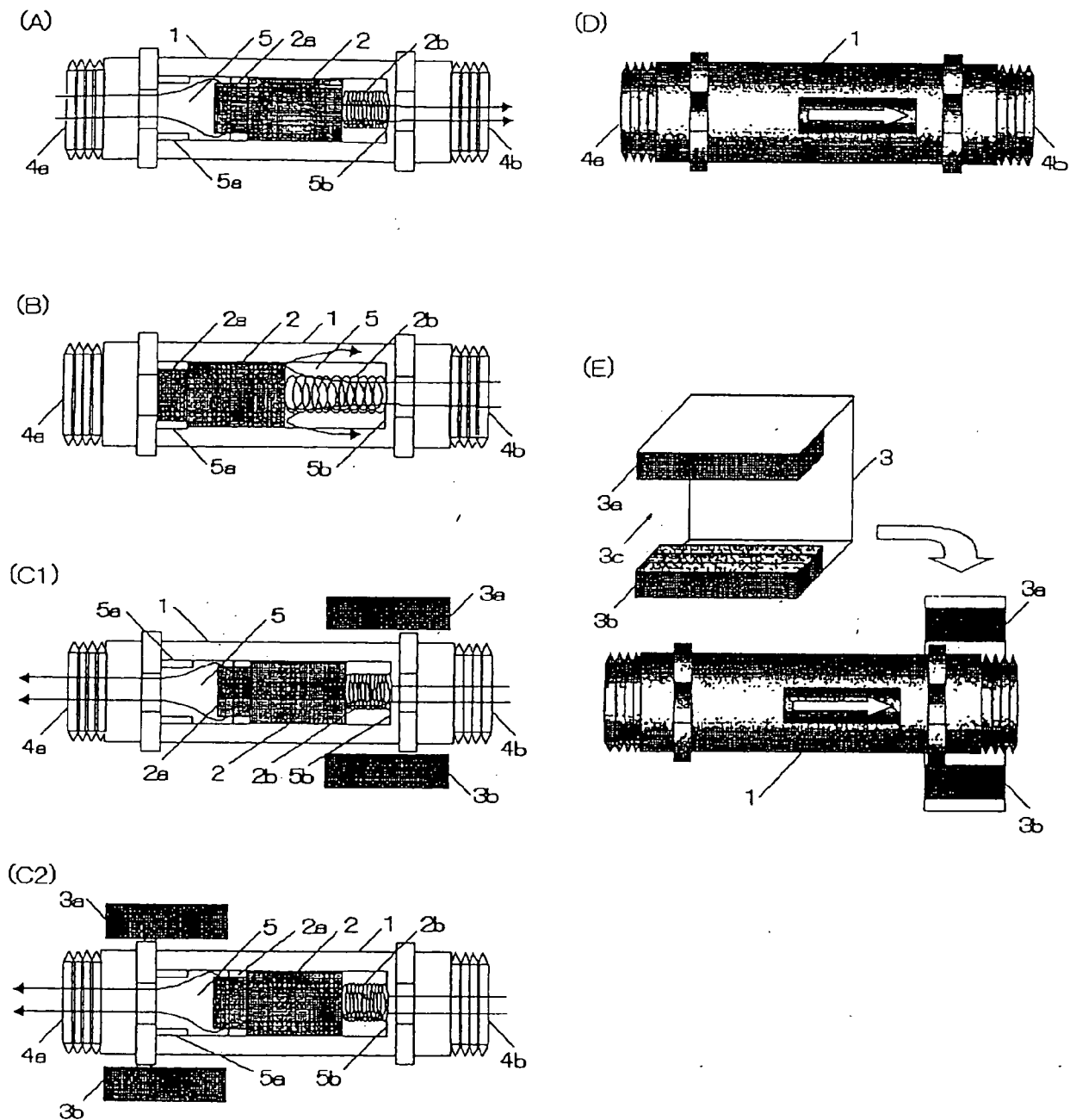
25 4 - The check valve, stated in Claim 1, 2 or 3, characterized by having either a composition with (1) an axis, made of paramagnetic material, at the inner circumference of the above mentioned main section by making a groove at a section of the outer circumference of the above mentioned valve body, that can be moved vertically to the central axis of the middle hollow section, or (2) an axis, made of paramagnetic material, at the outer circumference of the above mentioned valve body by making a groove at a section of the inner circumference of the above mentioned main section, that can be
30 moved vertically to the central axis of the middle hollow section, and at the same time one end of said axis can be latched to the above mentioned groove.

5 - A fluid supply device that uses the check valve, stated in Claim 1, 2, 3 or 4, characterized by one end of the valve body, located inside said check valve, positioned at

the upstream side of the fluid supply device flow path to allow purging of the upstream side from said check valve of the fluid supply device flow path while securing the sealing characteristic of the fluid supply device flow path, by moving the valve body to the downstream side using the magnetic poles positioned at the outer circumference of the
5 check valve main section.

6 - The fluid supply device, stated in Claim 5, characterized by its controllability of purge pressure or purge flow rate while securing the sealing characteristic of the fluid supply device flow path by adjusting the magnetic power between the magnetic poles and
10 the valve body by changing the position or magnetic field strength of the above mentioned magnetic poles.

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**FIGURE 1**

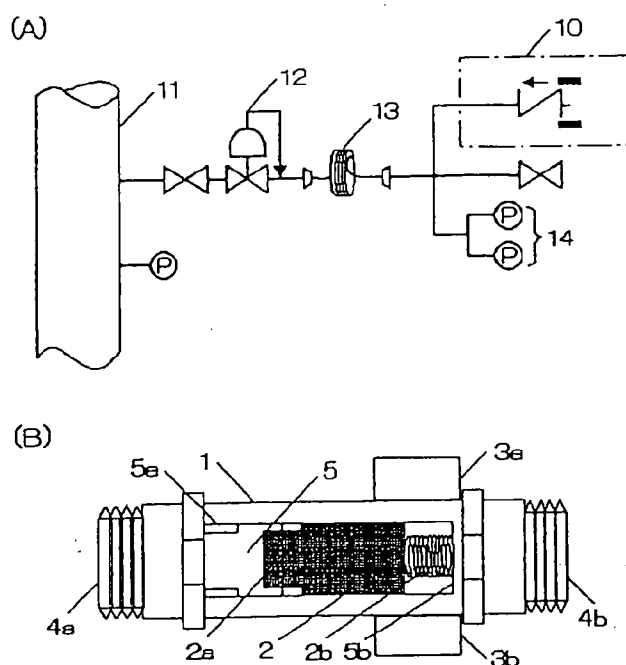


FIGURE 2

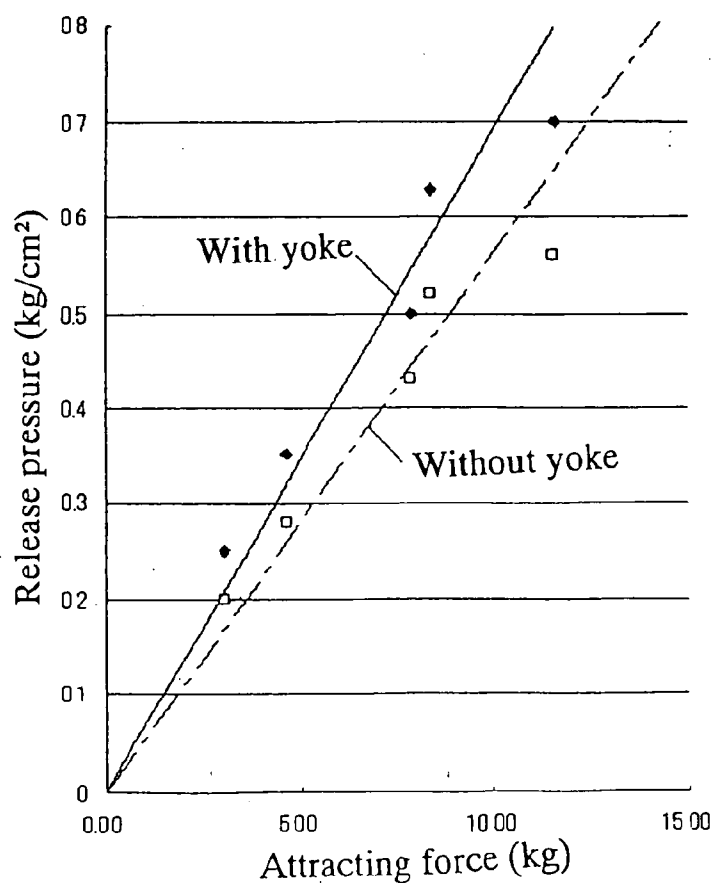
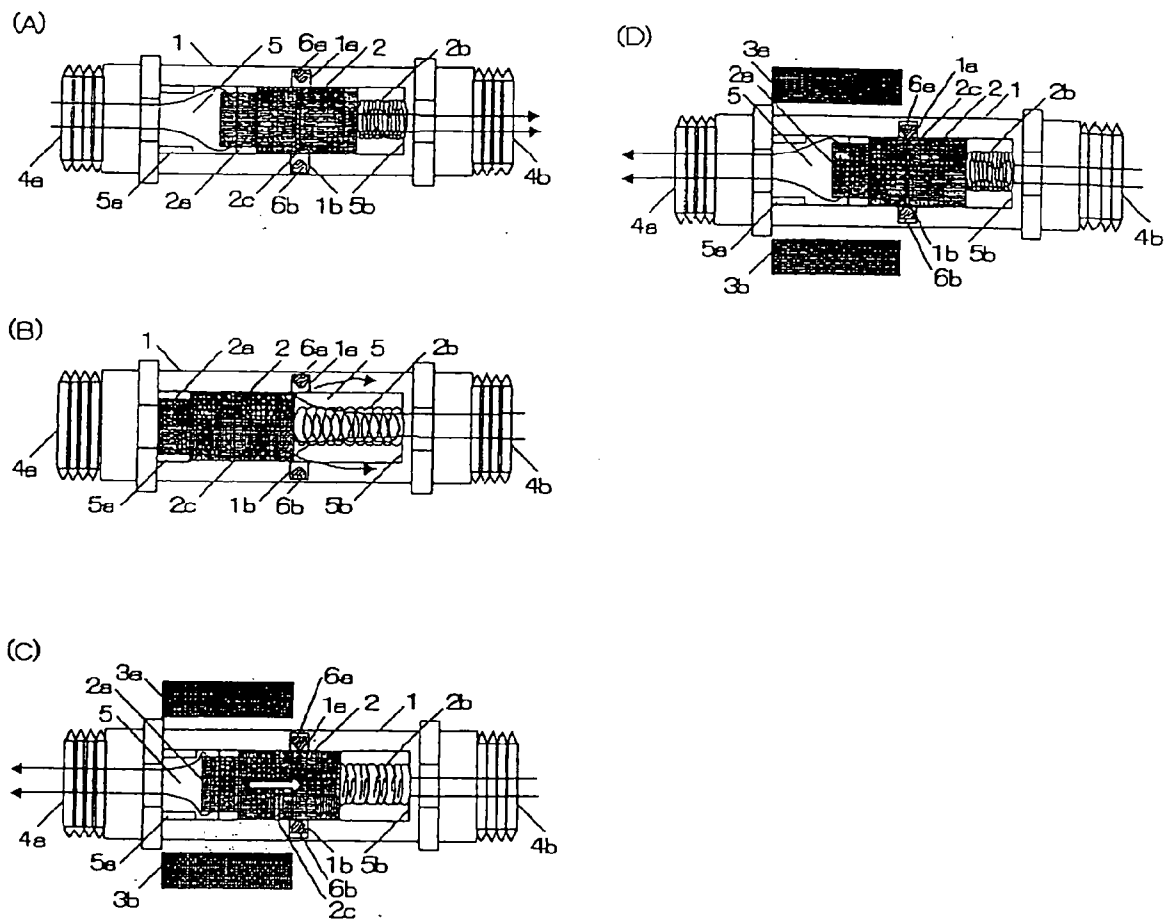
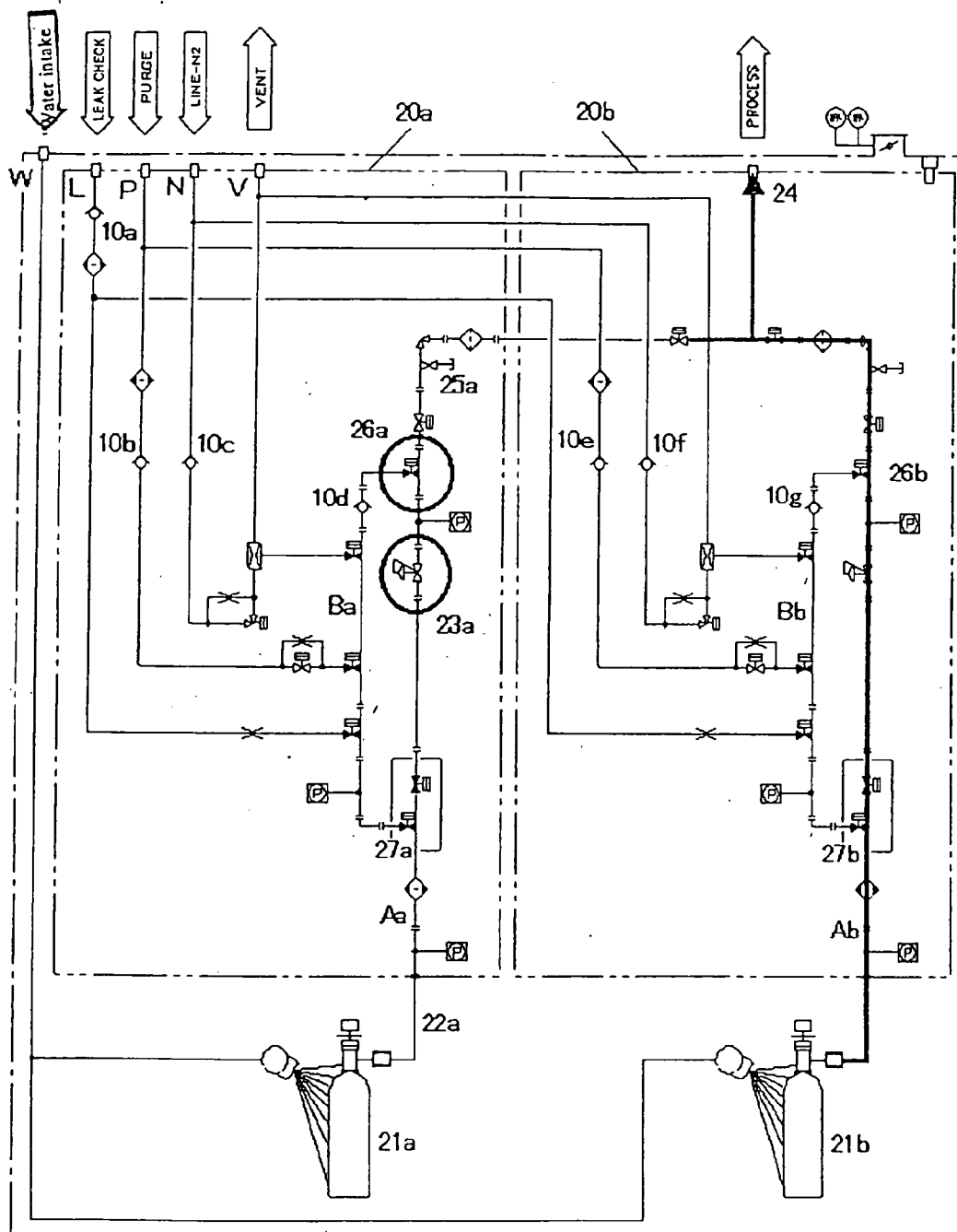


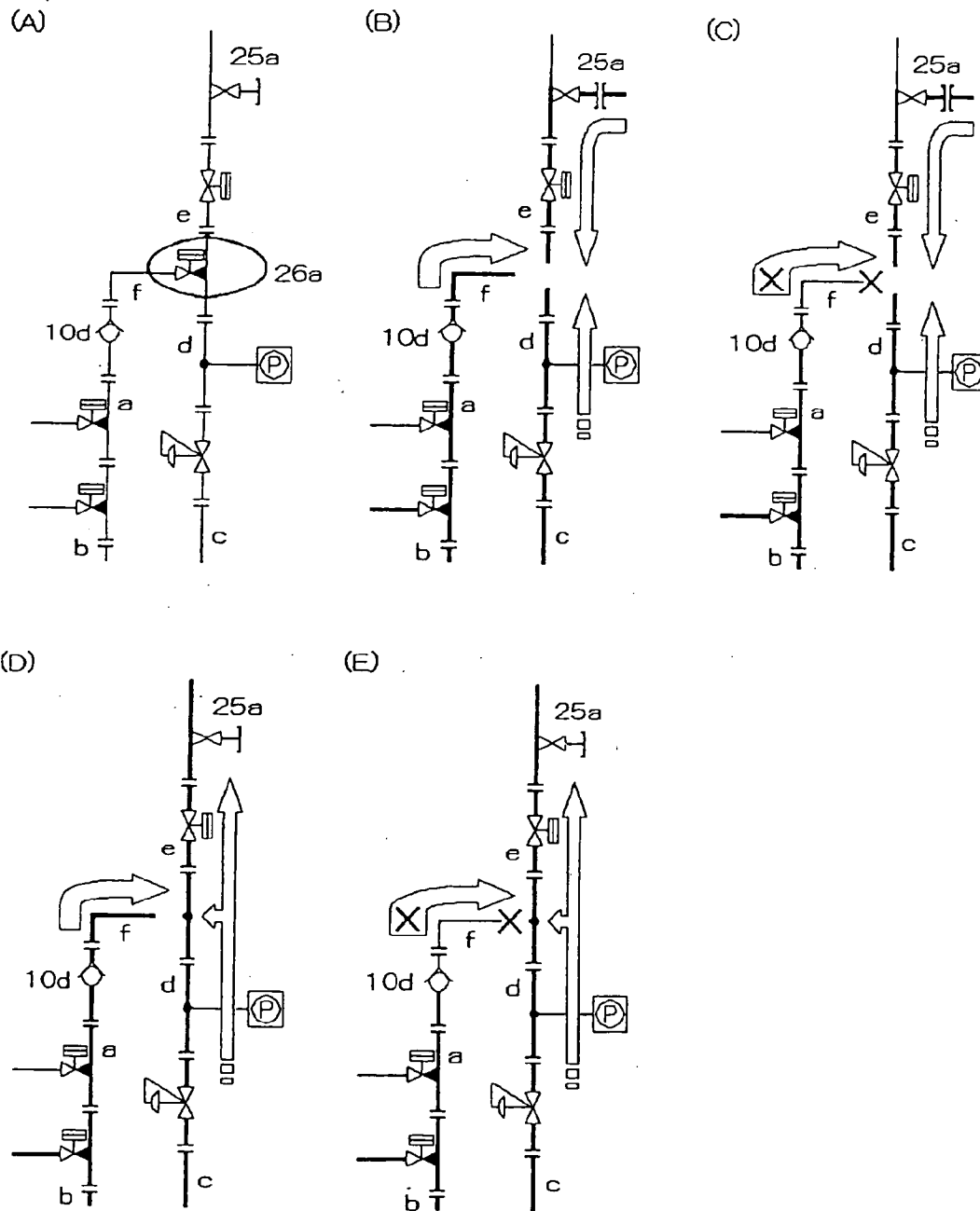
FIGURE 3

**FIGURE 4**

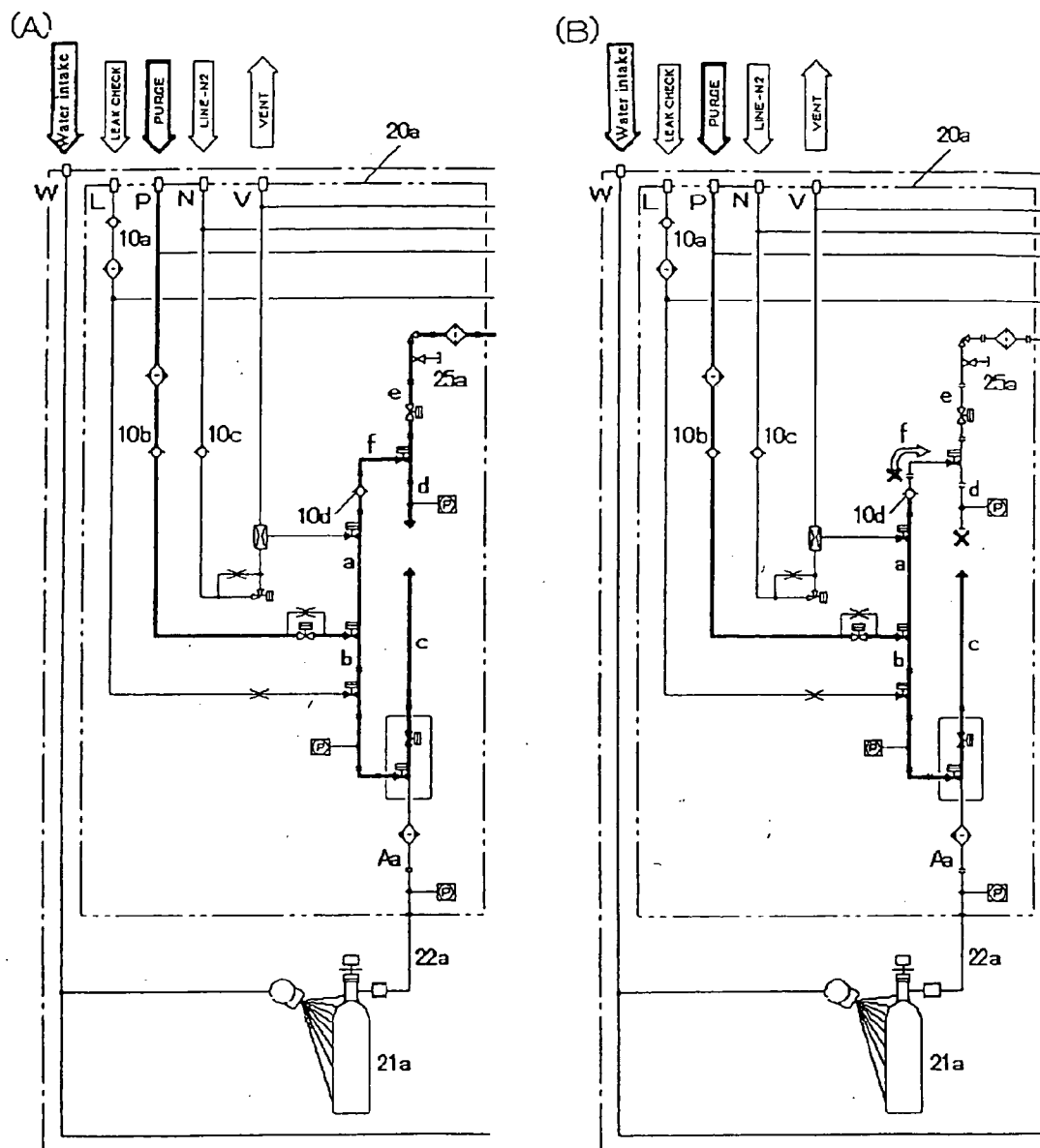
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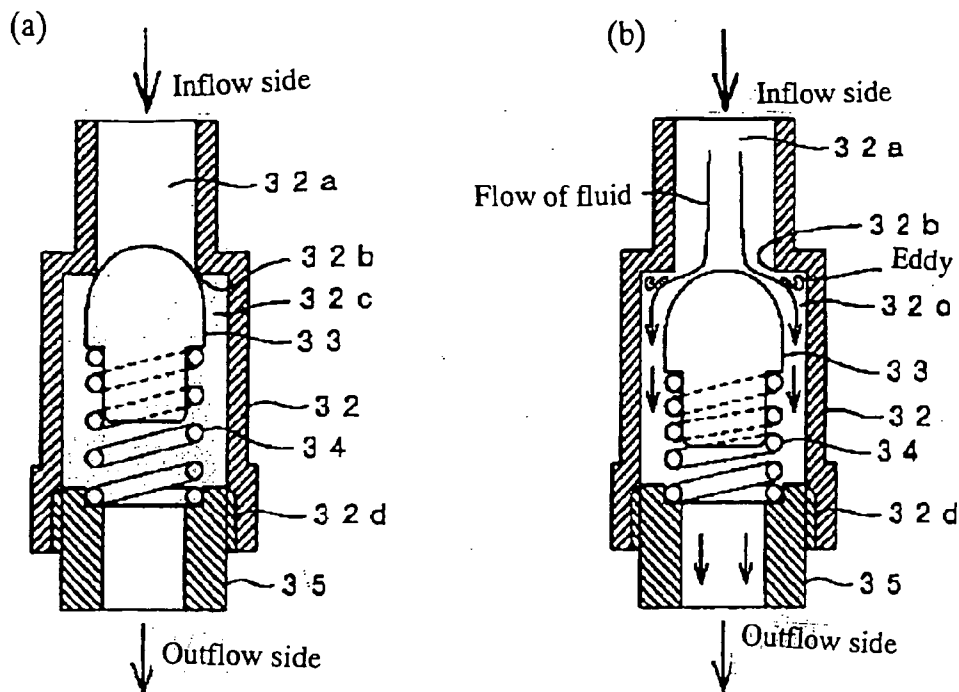
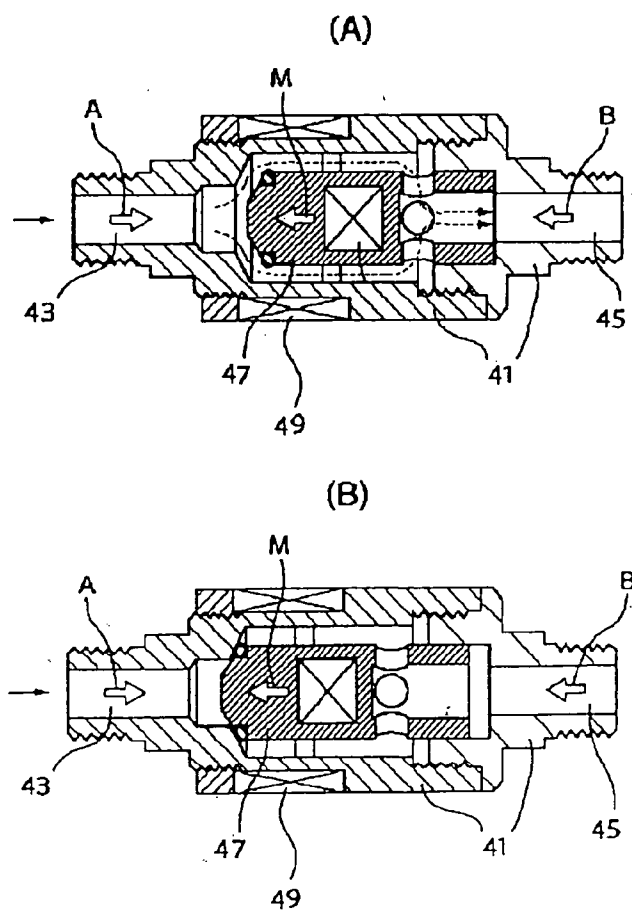
**FIGURE 5**

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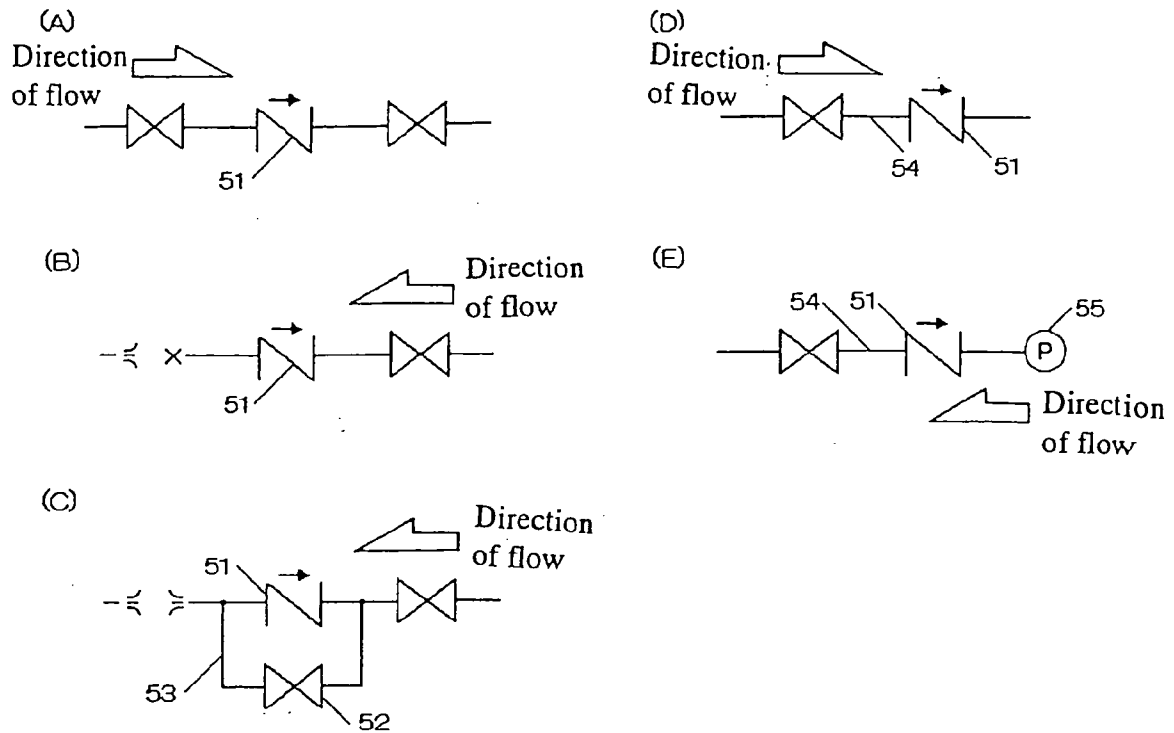
**FIGURE 6**

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**FIGURE 7**

**FIGURE 8****FIGURE 9**

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**FIGURE 10**

INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2007/052307

A. CLASSIFICATION OF SUBJECT MATTER
INV. F16K31/08

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)
F16K

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

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

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 30 27 351 A1 (IMAI TETSUICHI) 12 February 1981 (1981-02-12) page 29 - page 30; figures 9a-9e -----	1
X	JP 53 004212 A (MIYATA IND) 14 January 1978 (1978-01-14) abstract; figures 1-3 -----	1,5
X	JP 56 066575 A (SHIMIZU MITSURU) 5 June 1981 (1981-06-05) abstract; figures 1-8 -----	1,5

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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Date of the actual completion of the international search

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20/07/2007

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2007/052307

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