US 20060037310A1

(19) **United States**

(12) **Patent Application Publication** (10) **Pub. No.: US 2006/0037310 A1**

Sakata et al. (43) **Pub. Date: Feb. 23, 2006**

(54) **AIRFLOW CONTROL VALVE FOR USE IN AN INTERNAL COMBUSTION ENGINE**

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(21) Appl. No.: **11/175,433**

(22) Filed: **Jul. 7, 2005**

(30) **Foreign Application Priority Data**

Aug. 20, 2004 (JP) 2004-240955

Publication Classification

(51) **Int. Cl.**
F01N 3/00 (2006.01)

(52) **U.S. Cl.** **60/289**

(57) **ABSTRACT**

An airflow control valve is composed of a housing forming an air passage therein and an electromagnetically driven valve disposed in the air passage. The valve divides the air passage into an upstream passage having an air inlet port and a downstream passage having an outlet port open to an exhaust pipe. A barrier facing an exhaust gas blown back from the exhaust pipe is formed in the downstream passage in order to reduce an amount of deposits accumulating on and around the valve due to foreign particles contained in the exhaust gas. The barrier may be a dead end space in which the exhaust gas stagnates or a wall interfering with a flow of the exhaust gas. A one-way valve may be disposed immediately downstream of the valve to prevent the exhaust gas from flowing toward the valve.

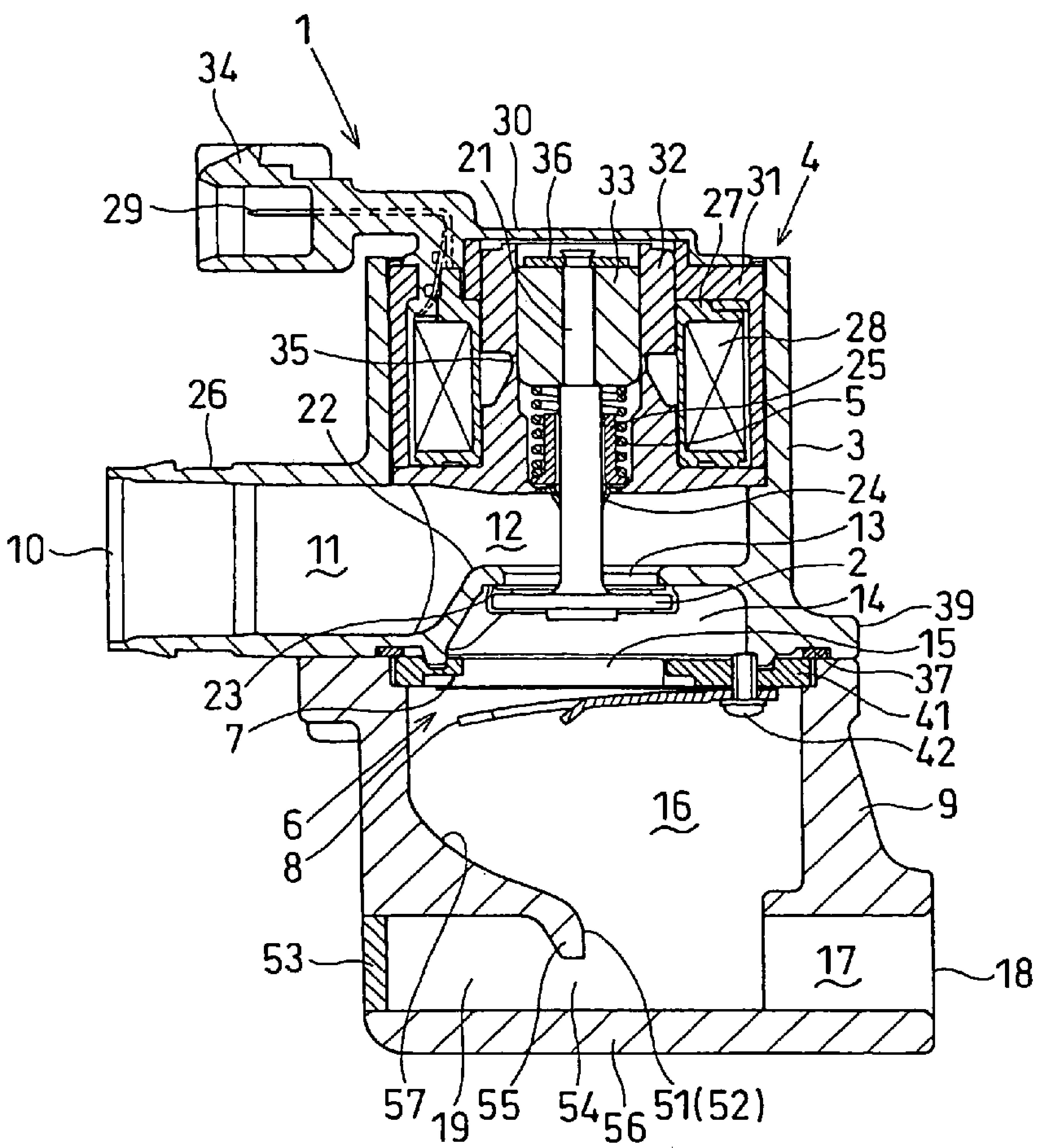
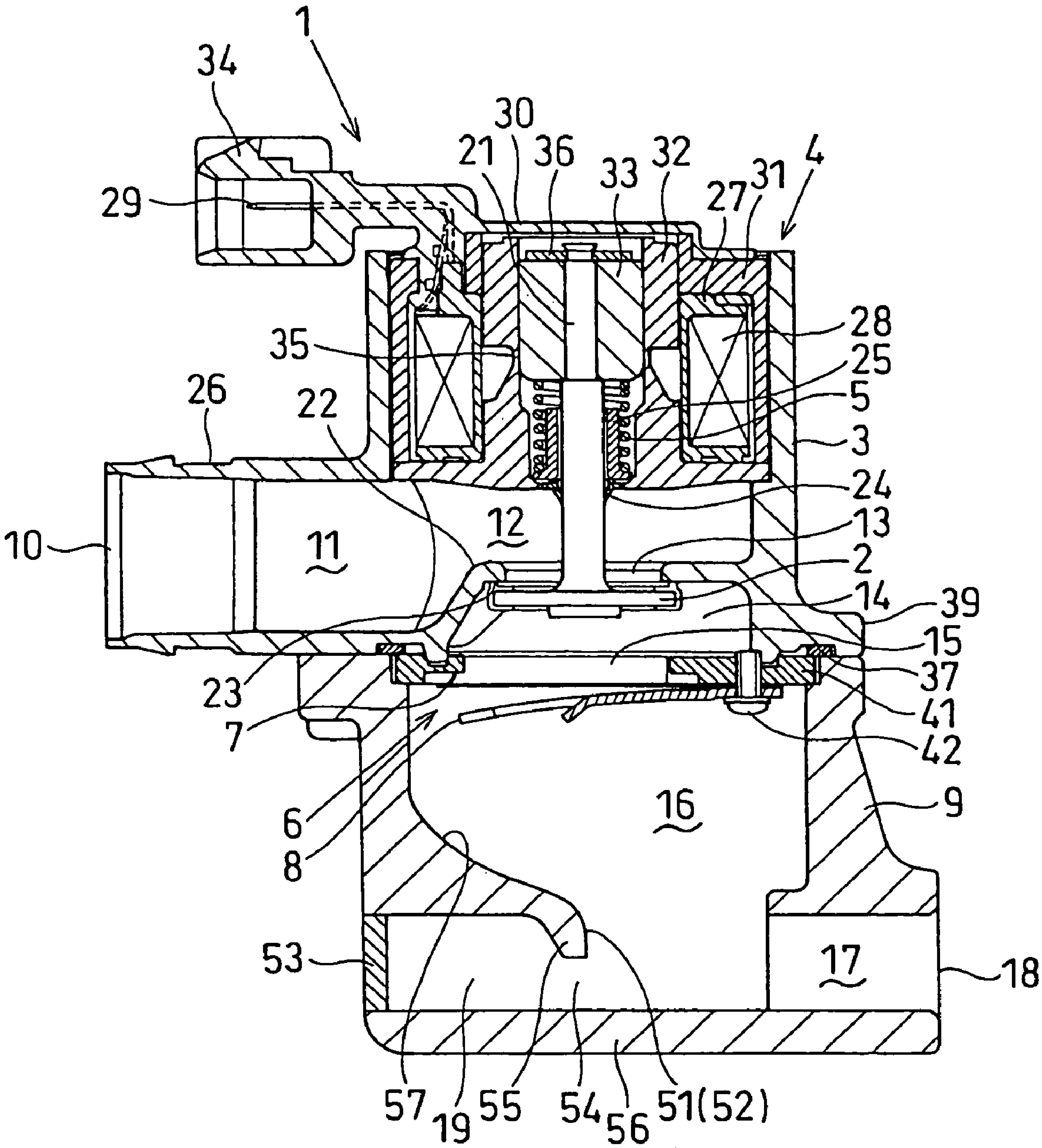


FIG. 1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51(52)

FIG. 2

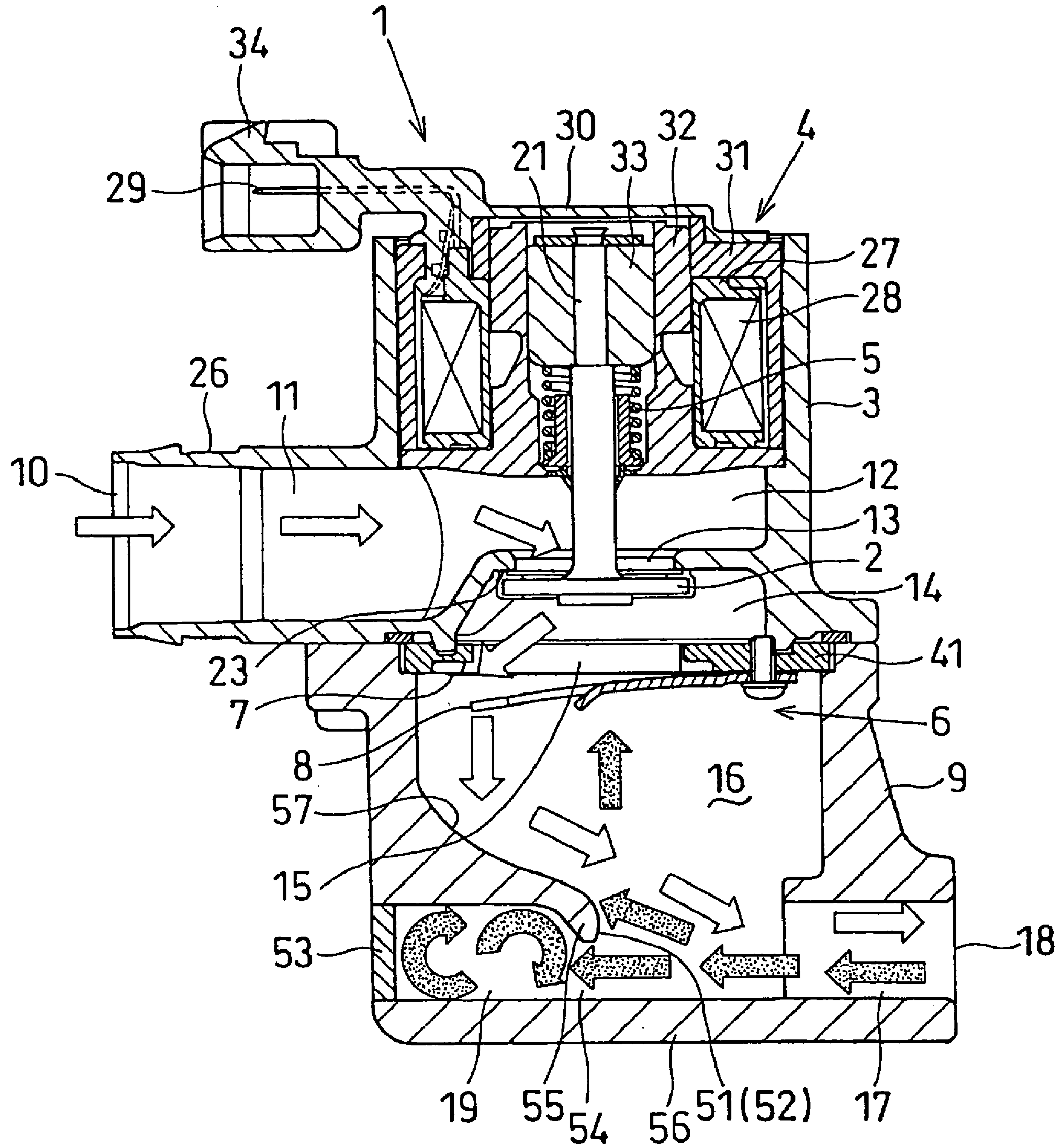

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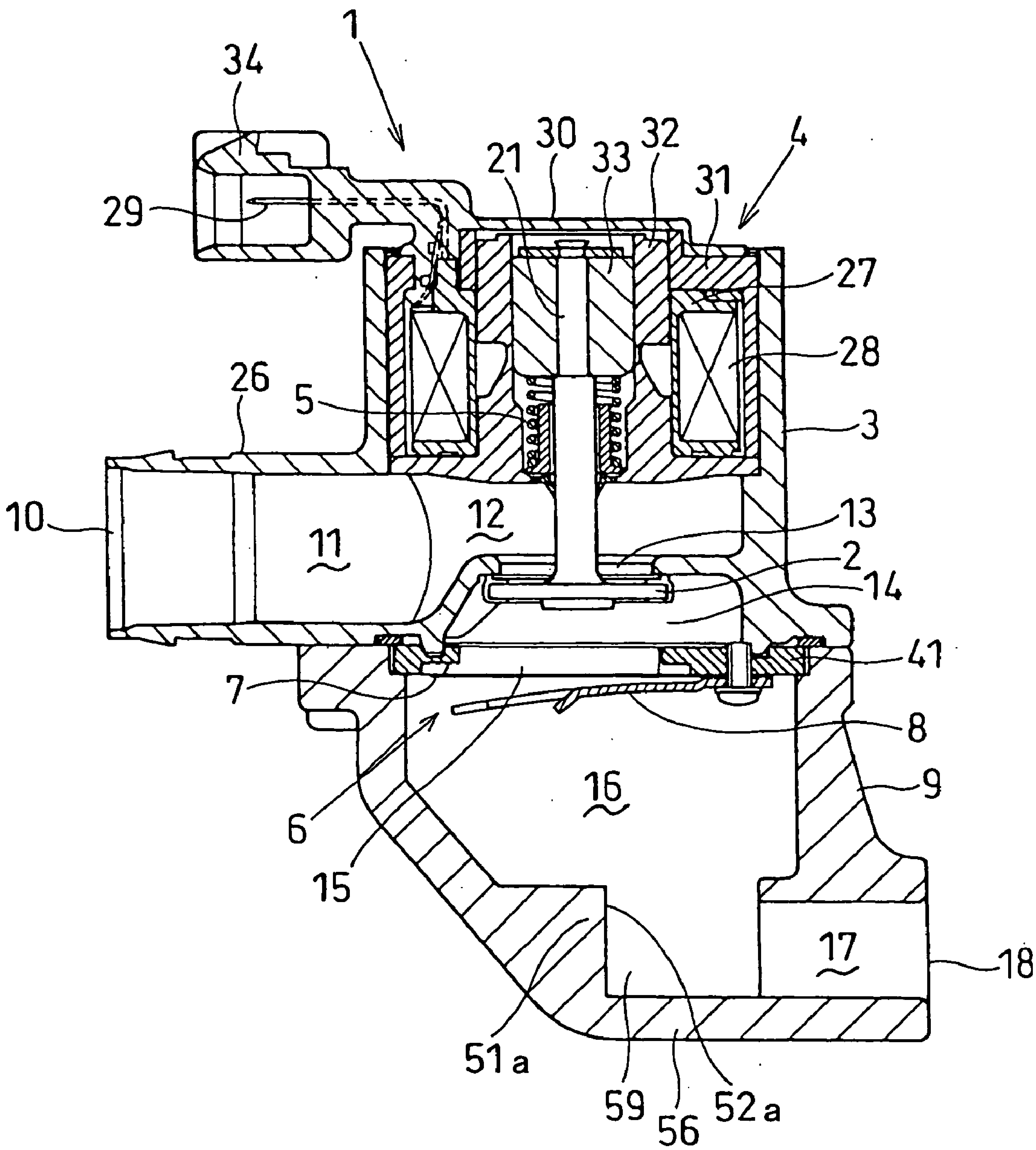
FIG. 3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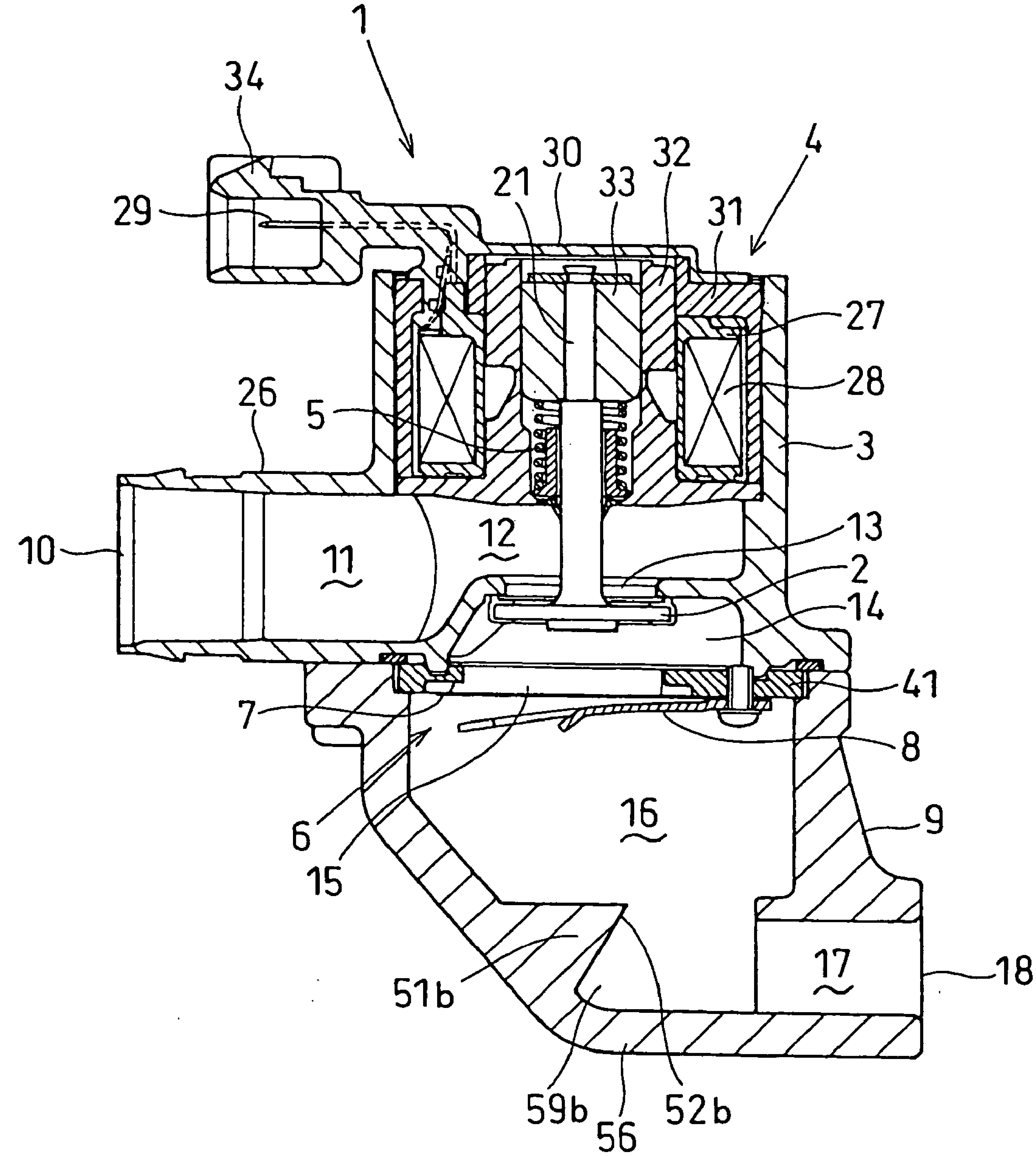
52a

FIG. 4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59b
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52b

FIG. 5

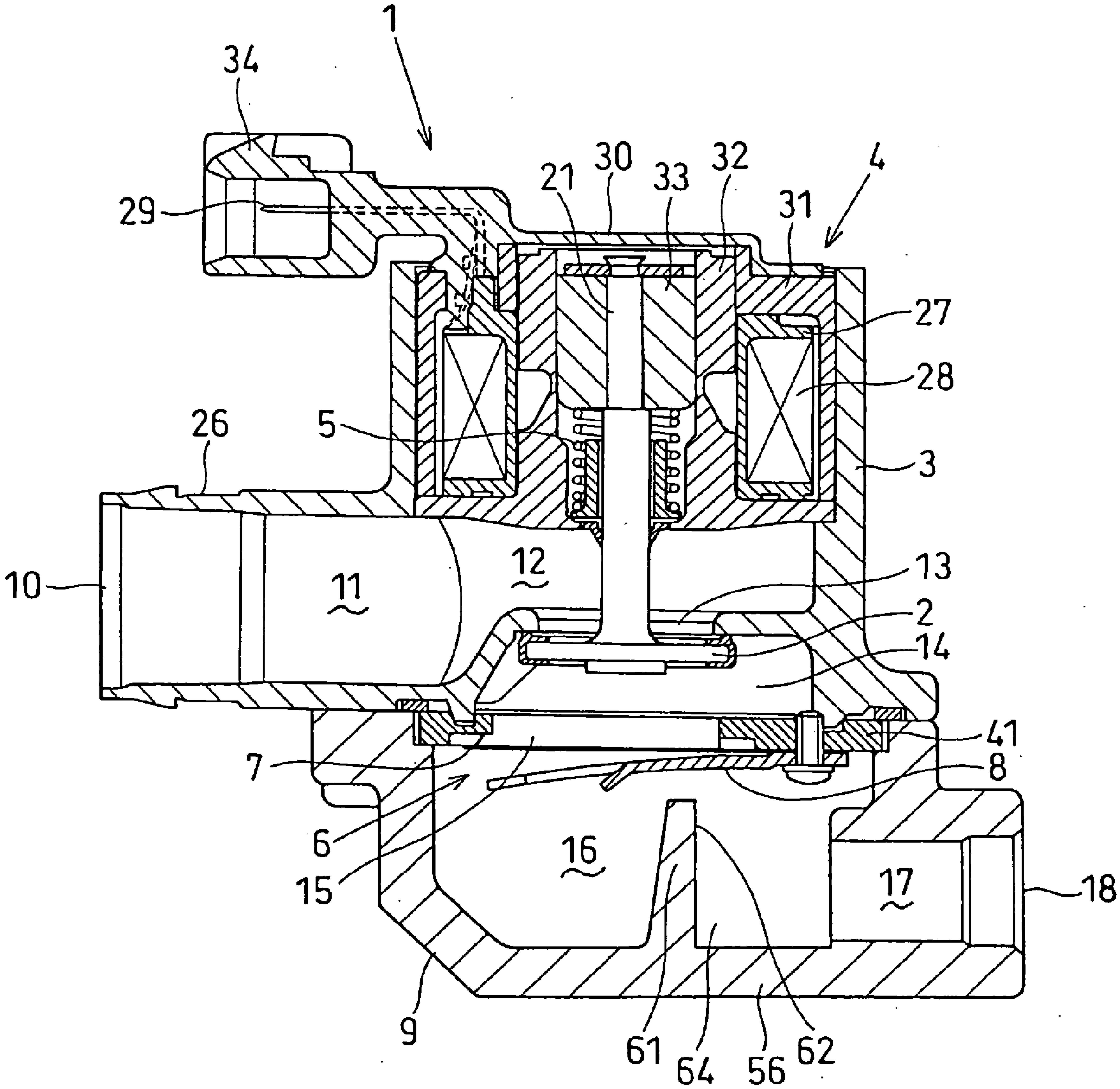
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FIG. 6

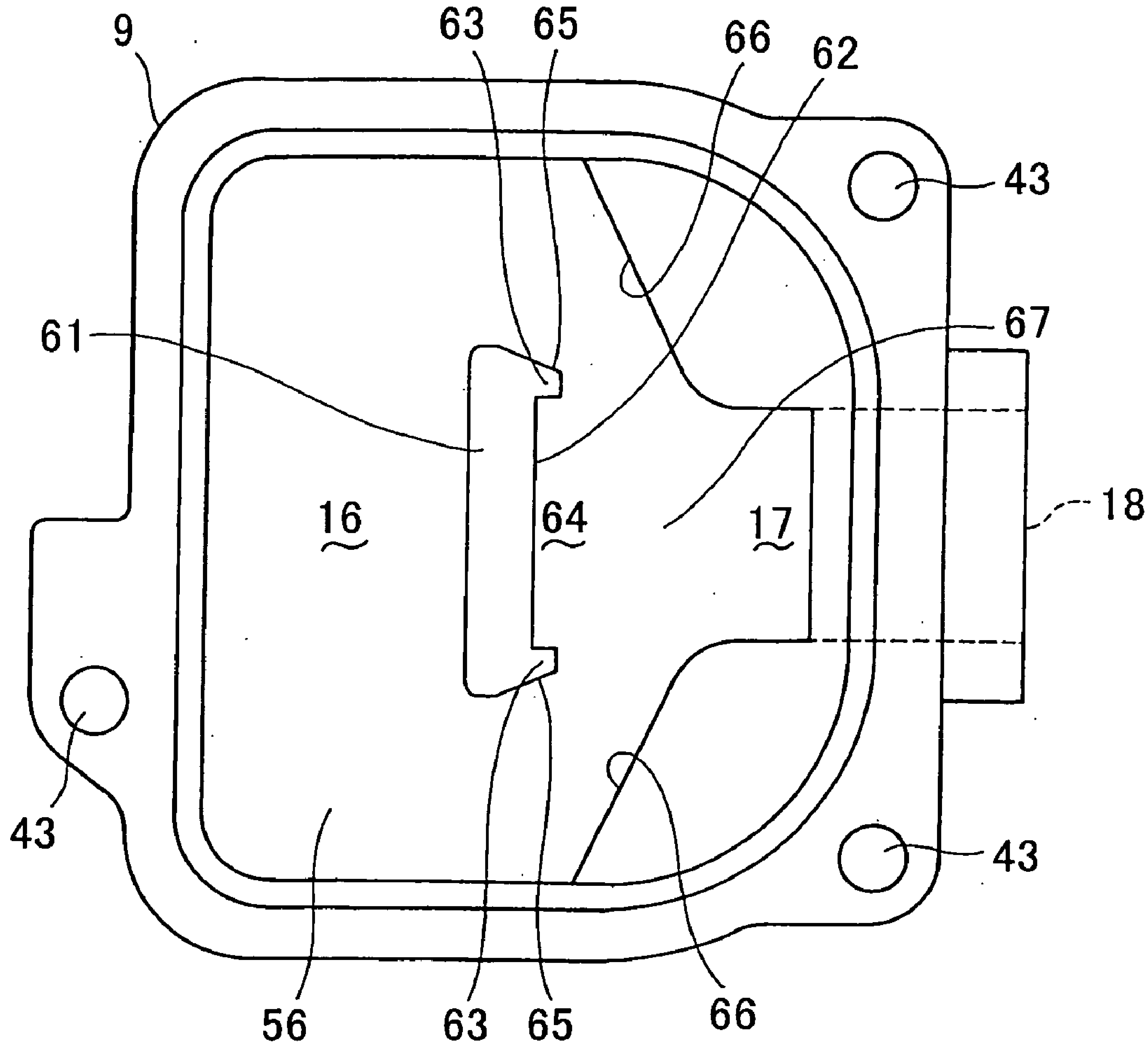

FIG. 7

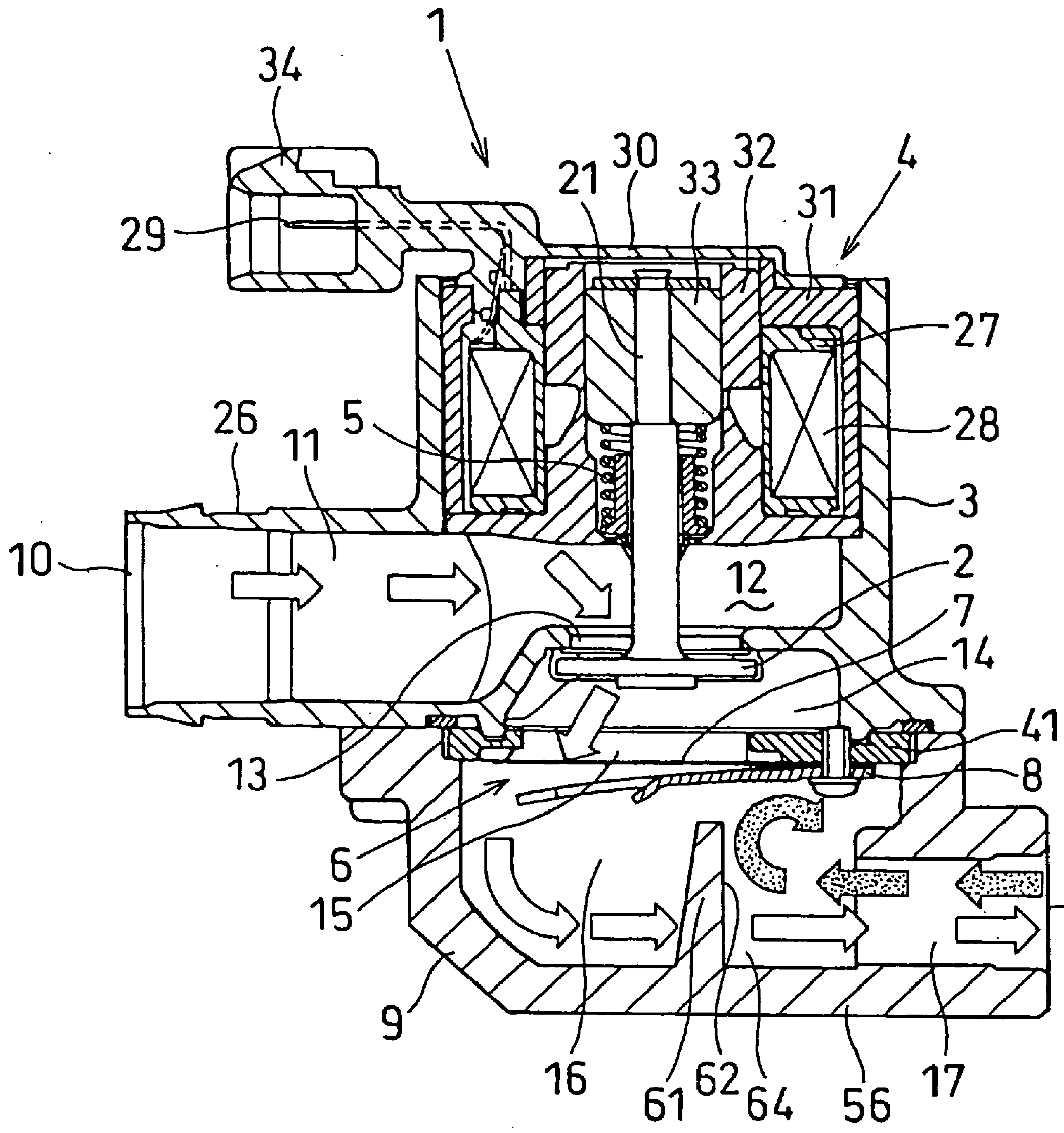

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FIG. 8A

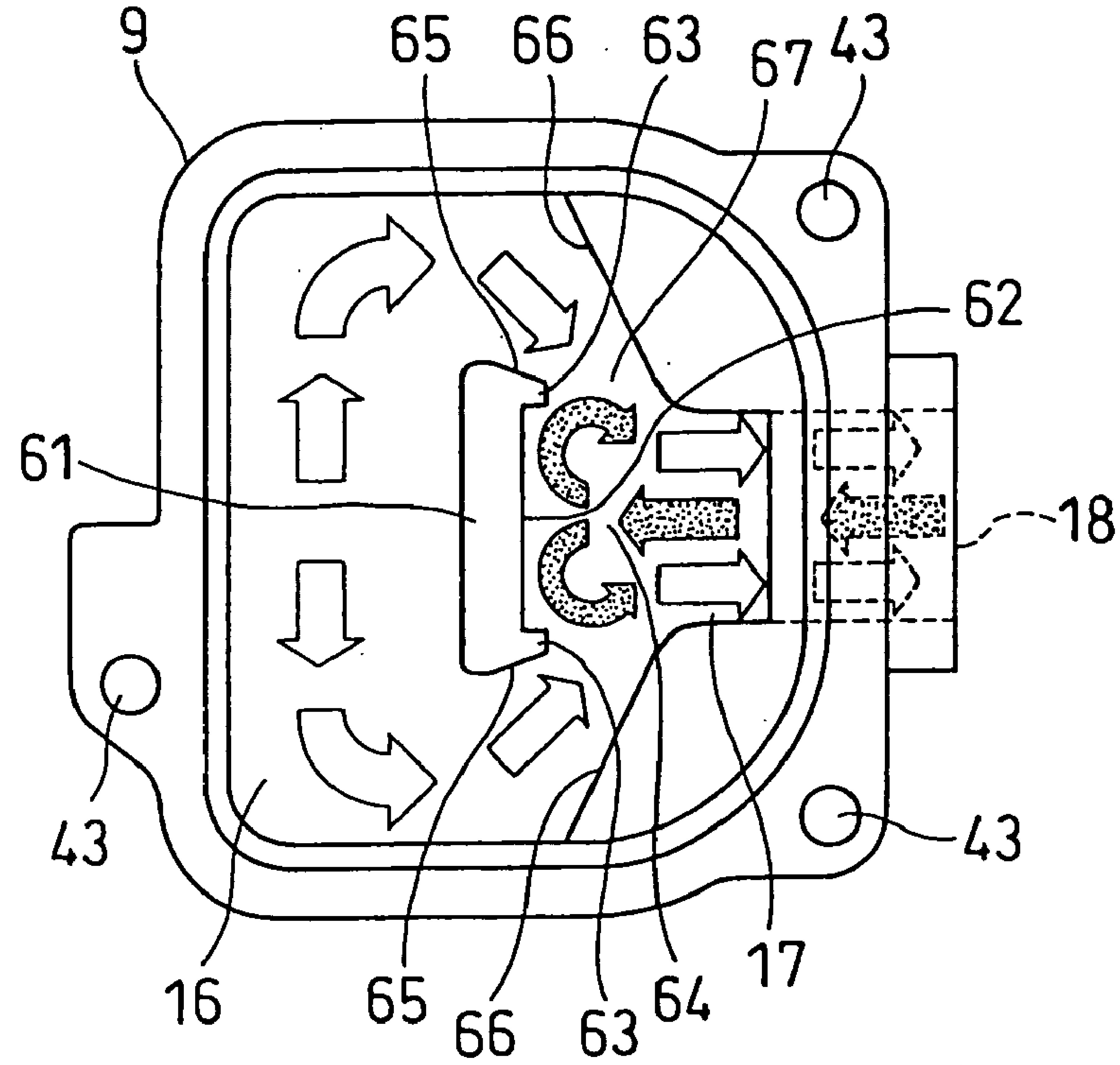
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FIG. 8B

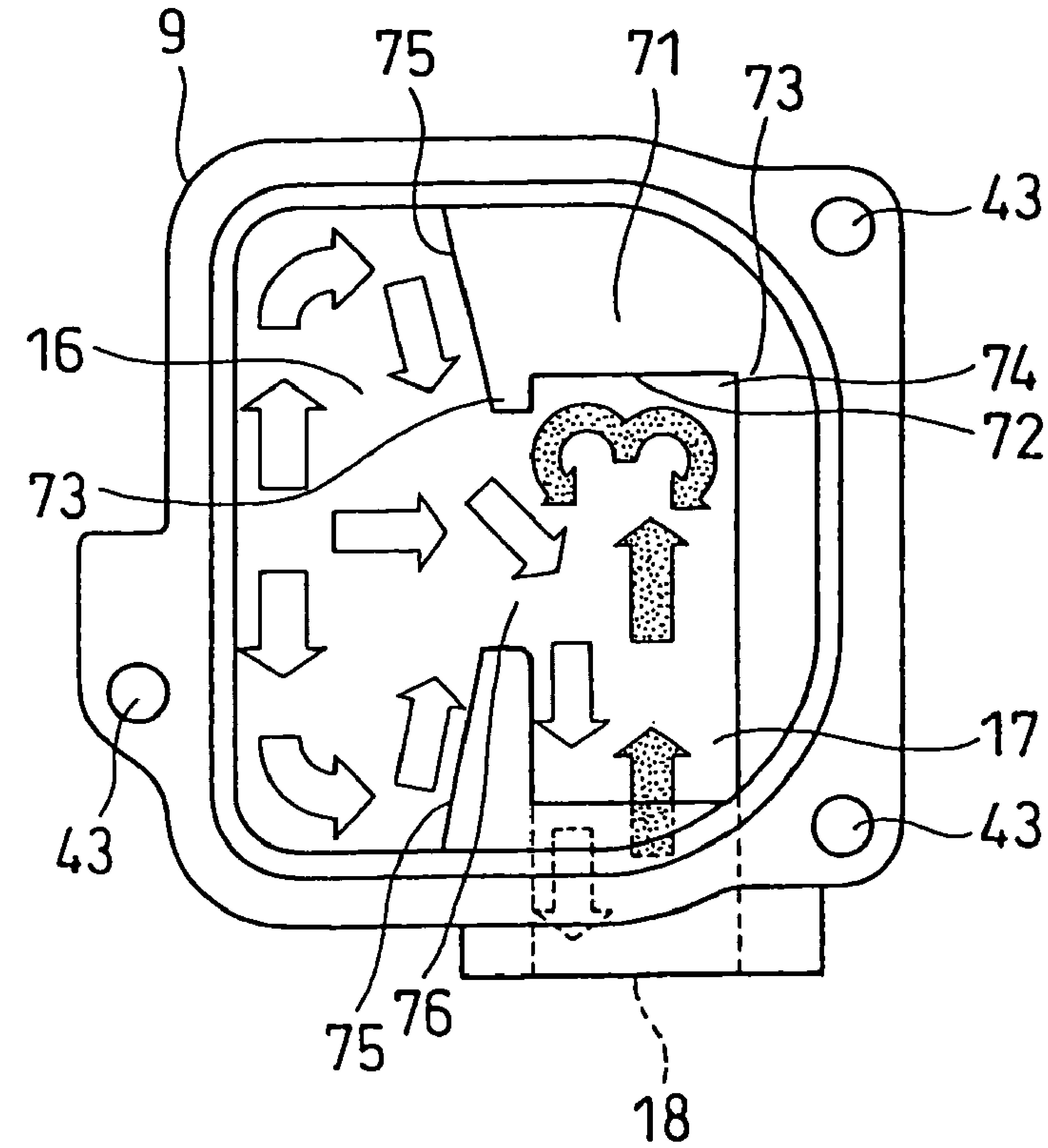
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FIG. 9

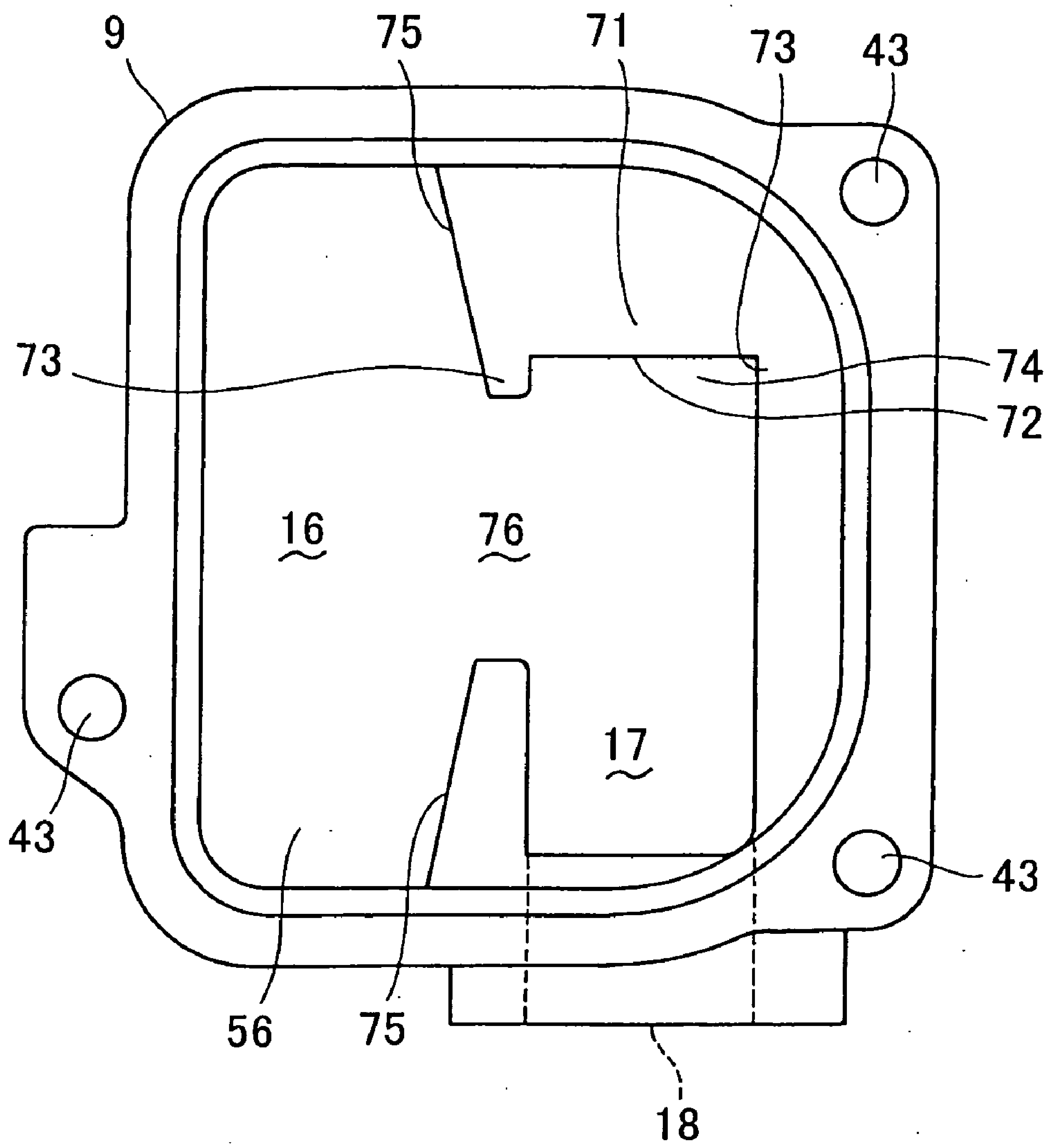
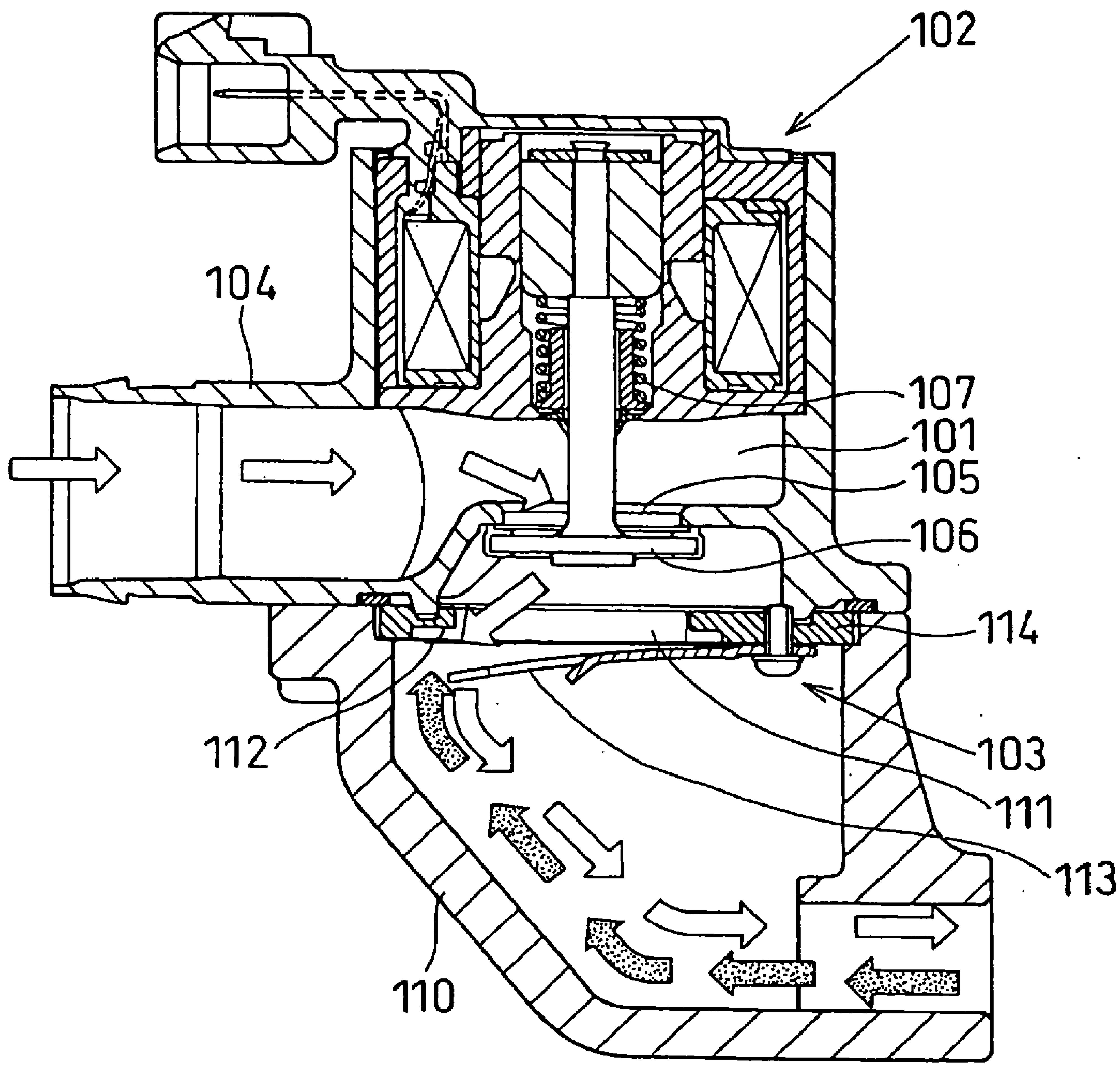


FIG. 10
PRIOR ART



AIRFLOW CONTROL VALVE FOR USE IN AN INTERNAL COMBUSTION ENGINE

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application is based upon and claims benefit of priority of Japanese Patent Application No. 2004-240955 filed on Aug. 20, 2004, the content of which is incorporated herein by reference.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The present invention relates to an airflow control valve for opening or closing an air passage communicating with an exhaust gas passage in an internal combustion engine, and more particularly to an airflow control valve for controlling an amount of secondary air supplied from an air pump to an exhaust pipe.

[0004] 2. Description of Related Art

[0005] Examples of an airflow control valve for supplying secondary air to a three-way catalyzer in an exhaust pipe for raising temperature of the three-way catalyzer when an engine is being started are disclosed in JP-A-2002-272080 and JP-A-2002-260919. The airflow control valve disclosed therein includes an electromagnetic valve and a one-way valve. An essential portion of the airflow control valve is shown in **FIG. 10** attached hereto.

[0006] As shown in **FIG. 10**, the electromagnetic valve **102** contained in a valve housing **104** is composed of a valve **106** for opening or closing an opening **105** formed in the valve housing, a solenoid actuator for driving the valve **106** in a direction to open the opening **105**, and a coil spring **107** for biasing the valve **106** in a direction to close the opening **105**. The one-way valve **103** is disposed at a boundary portion connecting the valve housing **104** and an outlet casing **110**. The one-way valve **103** is composed of a reed valve **112** for opening or closing an opening **111** formed in a metal plate **114** and a reed stopper **113** for protecting the reed valve **112**.

[0007] Air pressurized by an air pump (not shown) is introduced into the valve housing **104**, and the introduced air is supplied to a three-way catalyzer (not shown) in an exhaust pipe through an air passage shown with white arrows when the valve **106** opens the opening **105**. The one-way valve **103** is opened by the air passing through the air passage and is closed by exhaust gas (shown with dotted arrows in **FIG. 10**) blown back from the exhaust pipe. The blown back exhaust gas that includes unburned gas, carbon particles and other small particles is prevented from entering into the valve housing **104** by the one-way valve **103**.

[0008] In the conventional airflow control valve, however, following problems are involved. When the valve **106** is closed, exhaust gas is blown back due to pulsating pressure of the engine and enters into the outlet casing **110** as shown with dotted arrows in **FIG. 10**. Small particles contained in the exhaust gas adhere to the reed valve **112**, forming deposits thereon. If the deposits are formed between the metal plate **114** and the reed valve **112**, the reed valve **112** becomes unable to close, and the exhaust gas enters into valve housing **104** containing the valve **106** therein. In other words, the reed valve **112** becomes unable to function as the one-way valve for preventing the exhaust gas from being blown back into the valve housing **104**. The deposits may be formed on the valve **106** and the valve seat. If this happens, movement of the valve **106** is hindered, and the valve **106** may not be smoothly opened. As a result, the secondary air cannot be sufficiently supplied to the three-way catalyzer.

[0009] An exhaust gas control valve is conventionally used in an exhaust gas re-circulation system. In this system, part of the exhaust gas is introduced into an air-intake pipe of an engine to reduce an amount of nitrogen-oxides formulated in combustion by lowering a combustion temperature. The re-circulating exhaust gas is supplied to the intake pipe through the exhaust gas control valve. The exhaust gas control valve is composed of a housing forming an exhaust gas passage therein, a valve for closing or opening the exhaust gas passage, and a coil spring biasing the valve in the closing direction. The valve is driven by a motor actuator in the opening direction.

[0010] Small particles contained in the exhaust gas adhere to the valve and the valve seat in the exhaust gas control valve, forming deposits around the valve. To reduce an amount of deposits accumulated around the valve, an exhaust gas recirculation valve having a side hole in the passage for accumulating the deposits therein is proposed in JP-A-2002-339811. However, the small particles in the exhaust gas once entered into the side hole are highly possible to bounce out into the passage. Therefore, much effect cannot be expected for the proposed side hole.

SUMMARY OF THE INVENTION

[0011] The present invention has been made in view of the above-mentioned problem, and an object of the present invention is to provide an improved airflow control valve, in which an amount of deposits accumulating on a control valve and a one-way valve is reduced.

[0012] The airflow control valve has an air passage and an electromagnetically driven valve disposed in the air passage. The air passage is divided into two passages by the valve, i.e., an upstream passage having an inlet port and a downstream passage having an outlet port. Secondary air compressed by an air pump is introduced into the upstream passage through the inlet port and supplied from the downstream passage to an exhaust pipe of an internal combustion engine through the outlet port. An amount of air supplied to the exhaust pipe is controlled by opening or closing the valve. The outlet port is open to the exhaust pipe, and exhaust gas is blown back into the downstream passage.

[0013] A barrier facing the outlet port from which the exhaust gas enters into the airflow control valve is disposed in the downstream passage to reduce an amount of the exhaust gas directly hitting the valve. Thus, an amount of deposits accumulating on and around the valve due to foreign particles contained in the exhaust gas is reduced. The barrier may be made in a form of a dead end space having a small opening facing the outlet port. The exhaust gas entering into the airflow control valve stagnates in the dead end space, and some foreign particles are kept therein. To prevent the foreign particles once kept in the dead end space from bouncing out of the dead end space toward the valve, bent portions may be made at the opening of the dead end space. An interfering wall directly facing the outlet port may be made in the downstream passage to form a stagnating space between the interfering wall and the outlet port.

[0014] Preferably, one-way valve for preventing the exhaust gas from entering into the upstream passage while permitting the secondary air to flow therethrough is disposed immediately downstream of the valve. The valve is prevented from being directly hit by the exhaust gas blown back from the exhaust pipe. The one-way valve is also protected from being directly hit by a large amount of the exhaust gas by the barrier, the dead end space or the interfering wall disposed in the downstream passage.

[0015] The airflow control valve may be used as a valve for controlling an amount of exhaust gas to be re-circulated from an exhaust pipe into an intake pipe of an engine. In this case, the exhaust gas is introduced from the outlet port, and the inlet port is connected to the intake pipe of the engine.

[0016] According to the present invention, an amount of exhaust gas directly hitting the valve and the one-way valve is reduced and an amount of deposits accumulating on and around the valve and the one-way valve is reduced. Accordingly, the airflow control valve can be operated without being hindered by accumulation of deposits. Other objects and features of the present invention will become more readily apparent from a better understanding of the preferred embodiments described below with reference to the following drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] **FIG. 1** is a cross-sectional view showing an airflow control valve as a first embodiment of the present invention;

[0018] **FIG. 2** is a cross-sectional view showing the same airflow control valve as shown in **FIG. 1**, including arrows showing flow directions of air and exhaust gas;

[0019] **FIG. 3** is a cross-sectional view showing an airflow control valve as a second embodiment of the present invention;

[0020] **FIG. 4** is a cross-sectional view showing an airflow control valve as a third embodiment of the present invention;

[0021] **FIG. 5** is a cross-sectional view showing an airflow control valve as a fourth embodiment of the present invention;

[0022] **FIG. 6** is a plan view showing an outlet casing used in the fourth embodiment shown in **FIG. 5**;

[0023] **FIG. 7** is a cross-sectional view showing the same airflow control valve as shown in **FIG. 5**, including arrows showing flow directions of air and exhaust gas;

[0024] **FIG. 8A** is a plan view showing an outlet casing used in the airflow control valve shown in **FIG. 5**, viewed from its topside;

[0025] **FIG. 8B** is a plan view showing a modified form of the outlet casing shown in **FIG. 8A**;

[0026] **FIG. 9** is a plan view showing the same outlet casing as shown in **FIG. 8B**, in an enlarged scale; and

[0027] **FIG. 10** is a cross-sectional view showing a conventional airflow control valve.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0028] A first embodiment of the present invention will be described with reference to **FIGS. 1 and 2**. In this embodiment, a stagnating space in which exhaust gas blown back from an exhaust pipe stagnates is provided in an outlet casing of an airflow control valve in order to reduce accumulation of deposits on a control valve. The airflow control valve is disposed in an air passage for supplying secondary air to a three-way catalyzer in an exhaust pipe. The secondary air is sent from a motor-driven air pump to the airflow control valve that includes an electromagnetic valve for controlling an amount of the secondary air supplied to the three-way catalyzer. Operation of the motor for driving the air pump and the electromagnetic valve is controlled by an electronic control unit (ECU). The secondary air is supplied to the three-way catalyzer to activate the catalyzer when an engine is being started and an exhaust gas temperature is low.

[0029] As shown in **FIG. 1**, the airflow control valve is composed of a valve housing **3** containing an electromagnetic valve **1** having a poppet-type valve **2** therein, an outlet casing **9** having a one-way valve **6** and other associated components. An air passage (**11**, **12**, **14**, **16**, **17**) for supplying the secondary air to the three-way catalyzer is formed in the valve housing **3** and the outlet casing **9**.

[0030] The electromagnetic valve **1** includes the poppet-type valve **2**, a solenoid actuator **4** for driving the valve **2** in the opening direction and a coil spring **5** for biasing the valve **2** in the closing direction. The valve **2** is formed in a disc shape having a resilient rubber ring disposed around its outer periphery. The valve **2** is connected to a valve shaft **21** that is reciprocated in the vertical direction. The valve **2** is seated on a valve seat **23** formed on a valve sheet frame **22** of the valve housing **3** to close an opening **13**. When the valve **2** is driven, the valve **2** is lifted from the valve seat **23** to open the opening **13**. The valve shaft **21** is slidably inserted into a sleeve **25**, and a seal rubber **24** is disposed to close a small sliding gap between the sleeve **25** and the valve shaft **21** to thereby prevent small particles from entering into the sliding gap.

[0031] The valve housing **3** is made of aluminum by die-casting, and includes a inner space for accommodating the solenoid actuator **4** and a connecting pipe **26** having an inlet port **10** for introducing the secondary air supplied from the air pump. The outlet casing **9** is also made of aluminum by die-casting, and includes air passages **16**, **17**, an outlet port **18** to be connected to the exhaust pipe and a dead end space **19** (described later in detail). An upper end of the outlet casing **9** is connected to a flange **39** formed at a lower end of the valve housing **3**, and a one-way valve **6** is positioned at the upper end portion of the outlet casing **9**. A circular seal rubber **37** is disposed between the valve housing **3** and the outlet casing **9** for hermetically seal the connecting portion. The air passage formed in the valve housing **3** and the outlet casing **9** is separated by the valve **2** into an upstream passage **11**, **12** and a downstream passage **14**, **16**, **17**.

[0032] The solenoid actuator **4** for driving the valve **2** is composed of a solenoid coil **28** wound around a coil bobbin **27**, a pair of terminals **29** for supplying electric power to the solenoid coil **28**, a housing cover **30** supporting the terminals

29, a cylindrical yoke **31**, a cylindrical stator core **32** connected to the yoke **31** forming a space for accommodating the solenoid coil **28** therebetween, and a moving core **33** connected to the valve shaft **21**. The coil bobbin **27** is made of a resin material such as polybutylene terephthalate (PBT) and fixedly positioned in a cylindrical space between the yoke **31** and the stator core **32**.

[**0033**] Upon supplying electric power to the solenoid coil **28** from the terminals **29**, the moving core **33** connected to the valve shaft **21** is driven downward by magnetic field generated in the yoke **31** and the stator core **32** thereby to open the valve **12** against the biasing force of the coil spring **5**. The terminals **29** are connected to the ECU through a wire harness, and the operation of the electromagnetic valve **1** is controlled by the ECU.

[**0034**] At the bottom end of the stator core **32**, a flange portion forming the air passage **12** is provided, and at a center portion of the stator core **32**, a thin wall portion **35** is formed to provide a high magnetic resistance in the magnetic circuit. The moving core **33** moves downward to open the valve **2** when the magnetic field is generated by the solenoid coil **28**. The valve shaft **21** is inserted into a center hole of the moving core **33** and a center hole of a washer **36** so that a step formed on the valve shaft **21** abuts the bottom end of the moving core **33**, and the upper end of the valve shaft **21** is staked to fixedly connect the valve shaft **21** to the moving core **33**. The coil spring **5** is disposed outside of the sleeve **25**, and its upper end is connected to the bottom of the moving core **33** and its lower end is connected to a flange portion of the sleeve **25**, so that a biasing force of the coil spring **5** is given to the valve **2** in the closing direction.

[**0035**] The one-way valve **6** is a valve for preventing the exhaust gas blown back from the exhaust pipe from entering into the valve housing **3** while allowing the secondary air to flow therethrough. The one-way valve **6** is composed of a metal plate **41** that has plural openings **15**, a reed valve **7** for opening or closing the openings **15**, and a reed valve stopper **8** for limiting the reed valve **7** at its maximum open position. The metal plate **41** is made of a metallic material such as aluminum and includes plural openings **15** formed in a mesh-like shape. The reed valve **7** is made of a metallic material such as a spring plate. One end of the reed valve **7** is supported on the metal plate **41** with screws **42** or the like, and the other end of the reed valve **7** is shaped in double tongues or triple tongues. On the surface of the mesh-like openings **15** of the metal plate **41**, a rubber seal is formed by baking. The reed stopper **8** is made of a metallic material. One end of the reed stopper **8** is connected to the metal plate **41**, and the other end thereof is a free end having double or triple tongues.

[**0036**] Now, the structure of the outlet casing **9** having the dead end space **19** will be described in detail. The exhaust gas may be blown back from the exhaust pipe into the air passage **16**, **17** through the outlet **18** due to a pressure pulsation generated in the exhaust pipe. The exhaust gas includes small particles consisting of unburned gas, carbon particles or the like. These small particles accumulate on the reed valve **7** forming deposits thereon. When the deposits are formed on the reed valve **7**, the reed valve **7** may become impossible to close to prevent the exhaust gas from entering into the valve housing **3**. To decrease the amount of exhaust gas hitting the reed valve **7**, barrier **51** is formed so that a passage surface **52** of the barrier **51** faces the outlet **18**.

[**0037**] A dead end space **19** is formed inside of the barrier **51**. One end of the dead end space **19** is an opening **54** facing the outlet **18**, and the other end thereof is closed with a hermetic plug **53**. A center line of the head end space **19** is substantially directed to a center line of the outlet port **18**. The dead end space **19** is positioned in the downstream passage, i.e., downstream of the valve **2** and the one-way valve **6**. The dead end space **19** functions as a stagnating space in which the blown back exhaust gas stagnates, thereby reducing an amount of the exhaust gas directly hitting the reed valve **7**. The dead end space **19** is positioned at a far most position from the electromagnetic valve **1** to suppress a temperature rise due to the exhaust gas in a space around the electromagnetic valve **1**.

[**0038**] The barrier **51** includes a bent portion **55** for preventing foreign particles once entered into the dead end space **19** from bouncing out again into the air passage **16**. The bent portion **55** is bent downwardly so that the opening **54** becomes narrower than an inside space of the dead end space **19**. A curved surface **57** is formed above the dead end space **19**. The curved surface **57** facilitates a smooth flow of the secondary air flowing out through the plural openings **15** of the metal plate **41**.

[**0039**] Now, operation of the airflow control valve described above will be explained. A three-way catalyzer for converting CO, HC and NOx contained in the exhaust gas into harmless components is installed in an exhaust pipe of an automobile. To realize a good conversion reaction in the three-way catalyzer, it is required to keep air-fuel mixture supplied to an internal combustion engine at a stoichiometric ratio (15:1) and to raise the exhaust gas temperature above a certain level, e.g., 350° C. When the exhaust gas temperature is low, e.g., when the engine is being started, secondary air is supplied from an air pump to the three-way catalyzer to raise its temperature. By supplying air to the three-way catalyzer, the catalyzer is activated by heat generated by burning hydrocarbons contained in the exhaust gas.

[**0040**] The secondary air is supplied from the air pump to the three-way catalyzer through the airflow control valve. When the secondary air is required, the valve **2** is opened under the control of the ECU, and the secondary air is sent through the upstream passage **11**, **12**, the opening **13**, the passage **14**, the opening **15** and the downstream passage **16**, **17**, as shown with white arrows in **FIG. 2**. In this case, the one-way valve **6** is opened by the pressure of the secondary air. The secondary air smoothly flows along the curved surface **57** toward the outlet port **18**. Thus, the three-way catalyzer is activated to convert harmful components in the exhaust gas into harmless components.

[**0041**] When the valve **2** is closed, the blown back exhaust gas enters into the air passage **16**, **17**. Particles contained in the exhaust gas form deposits on and around the reed valve **7** of the one-way valve **6**. When a certain amount of the deposits is accumulated on and around the reed valve **7**, the reed valve **7** becomes unable to close. If the one-way valve **6** does not function as a one-way valve, the exhaust gas entered the air passage **16** further proceeds to the air passage **14** through the opening **15** of the one-way valve **6**. If this happens, it is highly possible that deposits are formed on and around the valve **2**, making the valve **2** unable to work properly. If the valve **2** does not work properly, a sufficient amount of the secondary air will not be supplied to the three-way catalyzer.

[0042] In order to avoid the trouble mentioned above, the dead end space **19** is formed in the outlet casing **9** according to the present invention. As shown in **FIG. 2** with dotted arrows, the exhaust gas blown back from the exhaust pipe enters into the air passage **16, 17** along a bottom wall **56** and proceeds to the dead end space **19** through the opening **54**. The exhaust gas entered into the dead end space **19** hits the wall of the dead end space **19** and stagnates therein. Therefore, an amount of the exhaust gas directly hitting the one-way valve **6** is reduced. Accordingly, formation of the deposits on and around the reed valve **7** is suppressed. Further, the opening **54** of the dead end space **19** is made narrower than the inside space, and the bent portion **55** is formed at the opening **54**. Therefore, the exhaust gas once entered into the dead end space circulates therein, keeping the foreign particles contained in the exhaust gas in the dead end space.

[0043] Thus, formation of the deposits on and around the one-way valve **6** and the valve **2** is suppressed, thereby securing proper operation of the airflow control valve. Further, since the dead end space **19** is formed at the position far from the valve **2**, a temperature rise in the electromagnetic valve **1** due to the exhaust gas is suppressed. Since the curved surface **57** is formed above the dead end space **19**, the secondary air smoothly flows through the air passage **16, 17** when the valve **2** is opened. The foreign particles accumulated in the dead end space **19** when the valve **2** is closed are sucked back again into the exhaust pipe together with the secondary air when the valve **2** is opened. Accordingly, it is not necessary to provide a dead end space **19** with a large size or to provide additional means for scavenging the dead end space **19**.

[0044] A second embodiment of the present invention will be described with reference to **FIG. 3**. In this embodiment, a shape of the barrier **51** in the first embodiment is modified to a barrier **51***a* shown in **FIG. 3**. The barrier **51***a* includes a passage surface **52***a* standing up from the bottom wall **56** at a right angle. A stagnating space **59** is formed between the air passage **17** and the passage surface **52***a*.

[0045] The exhaust gas blown back from the exhaust pipe and entering into the outlet casing **9** from the outlet port **18** hits the passage surface **52***a*. An amount of exhaust gas directly hitting the one-way valve **6** is reduced, and the exhaust gas stagnates in the stagnating space **59**. Foreign particles included in the exhaust gas form deposits in the stagnating space **59** or accumulates therein. Thus, an amount of deposits formed on and around the reed valve **7** is reduced. In this manner, the barrier **51***a* in the second embodiment functions similarly to the barrier **51** in the first embodiment.

[0046] A third embodiment of the present invention is shown in **FIG. 4**. In this embodiment, a barrier **51***b* is further modified from the barrier **51***a* of the second embodiment. The barrier **51***b* includes a passage surface **52***b* standing up from the bottom wall **56** forming an acute angle. A stagnating space **59***b* is formed between the air passage **17** and the passage surface **52***b*. The amount of exhaust gas directly hitting the one-way valve **6** is reduced in the same manner as in the second embodiment. Further, in this third embodiment, the foreign particles in the exhaust gas once kept in the stagnating space **59***b* are prevented from bouncing out of the stagnating space **59***b* by the passage surface **52***b* forming an acute angle between itself and the bottom wall **56**.

[0047] A fourth embodiment of the present invention will be described with reference to **FIGS. 5-9**. In this embodiment, as shown in **FIGS. 5 and 6**, an interfering wall **61** standing up from the bottom wall **56** at a right angle is formed in the inner space of the outlet casing **9**. The interfering wall **61** has a wall surface **62** directly facing the outlet port **18**, and a stagnating space **64** is formed between the air passage **17** and the wall surface **62**. As shown in **FIG. 6** the interfering wall **61** further includes a pair of bent portions **63** bent toward the outlet port **18**. Further, passage surfaces **66** having an inclination as shown in **FIG. 6** are formed on an inner wall of the outlet casing **9** for smoothly guiding the secondary airflow sent through the valve **2** to the outlet **18**. An air passage **67** converging to the outlet port **18** is formed by the passage surfaces **66**. Holes **43** (shown in **FIG. 6**) are holes for connecting the outlet casing **9** to the valve housing **3** with screws or the like.

[0048] As shown in **FIGS. 7 and** 8A (an exhaust gas flow is shown with dotted arrows and a secondary airflow is shown with white arrows), the exhaust gas entering into the air passage **17** from the outlet port **18** hits the interfering wall **61** and stagnates in the stagnating space **64**. A certain amount of foreign particles included in the exhaust gas is kept in the stagnating space **64**, and an amount of exhaust gas hitting the one-way valve **6** is reduced. The foreign particles once kept in the stagnating space **64** are prevented from bouncing out of the stagnating space **64** toward the one-way valve **6** by the pair of bent portions **63**. In this manner, an amount of deposits formed on and around the reed valve **7** is reduced.

[0049] The interfering wall **61** could be an obstacle to the secondary airflow supplied from the air pump through the valve **2**. To avoid the interfering wall **61** from becoming an obstacle to the secondary airflow, as shown in **FIG. 8A**, the inclined passage surfaces **66** are formed on the inner wall of the outlet casing **9**, and inclined surfaces **65** along the secondary airflow are formed on the bent portions **63**. A smooth air passage **67** for the secondary airflow is formed by the inclined passage surfaces **65, 66**. Therefore, the secondary air smoothly flows through the air passage **67** without generating a high amount of pressure loss.

[0050] The outlet casing **9** in the fourth embodiment may be further modified to a form shown in **FIGS. 8B and 9**. In this modified form, a barrier **71** is formed in the outlet casing **9**. The barrier **71** includes a passage surface **72** directly facing the outlet **18** so that the exhaust gas entering into the outlet casing **9** hits the passage surface **72**. The passage surface **72** stands up from the bottom wall **56** at a right angle, and a stagnating space **74** is formed between the barrier **71** and the outlet port **18**. Bent portions **73** for preventing the foreign particles once trapped in the stagnating space **74** from easily bouncing out of the stagnating space **74** are formed on the passage surface **72**. Further, inclined passage surfaces **75** for smoothly guiding the airflow **76** of the secondary air toward the outlet port **18** are formed.

[0051] The exhaust gas entering into the air passage **17** from the outlet port **18** hits the passage wall **72** and stagnates in the stagnating space **74**. Foreign particles in the exhaust gas are accumulated or deposited in the stagnating space **74**. An amount of the exhaust gas directly hitting the one-way valve **6** is reduced, and an amount of foreign particles deposited on and around the reed valve **7** is reduced. The secondary air supplied from the air pump through the valve **2** is smoothly led to the outlet port **18** along the inclined passage walls **75**.

[**0052**] The present invention is not limited to the embodiments described above, but it may be variously modified. The barrier and/or the stagnating space for the exhaust gas according to the present invention may be applied to various valves such as a swirl control valve, an intake-air control valve in a swirl control valve, a tumble control valve, an intake-air control valve in a tumble control valve, or a throttle valve for controlling amount of intake-air. The present invention may be applied also to an exhaust gas re-circulating valve for supplying a certain amount of exhaust gas into an air-intake pipe of an internal combustion engine.

[**0053**] While the present invention has been shown and described with reference to the foregoing preferred embodiments, it will be apparent to those skilled in the art that changes in form and detail may be made therein without departing from the scope of the invention as defined in the appended claims.

1. An airflow control valve for use in an internal combustion engine, the airflow control valve comprising:

a housing forming an air passage therein;

a valve disposed in the air passage for opening or closing the air passage, the air passage being separated by the valve into an upstream passage having an inlet port and a downstream passage having an outlet port from which air is blown out, the outlet port being open to a source of exhaust gas exhausted from the internal combustion engine; and

a barrier disposed in the down stream passage to face the outlet port for reducing an amount of the exhaust gas directly hitting the valve when the exhaust gas enters the downstream passage from the outlet port.

2. The airflow control valve as in claim 1, wherein:

the barrier includes a passage surface facing the outlet port; and

a stagnating space for stagnating the exhaust gas flow is formed in the vicinity of the passage surface.

3. An airflow control valve for use in an internal combustion engine, the airflow control valve comprising:

a housing forming an air passage therein;

a valve disposed in the air passage for opening or closing the air passage, the air passage being separated by the valve into an upstream passage having an inlet port and a downstream passage having an outlet port from which air is blown out, the outlet port being open to a source of exhaust gas exhausted from the internal combustion engine; and

a dead end space disposed in the downstream passage to face the outlet port for stagnating the exhaust gas entering into the downstream passage from the outlet port, the dead end space having an opening from which the exhaust gas enters.

4. The airflow control valve as in claim 3, wherein:

the dead end space includes a passage surface facing the outlet port, and the opening of the dead end space open to the passage surface.

5. The airflow control valve as in claim 3, wherein:

the opening of the dead end space is smaller than an inside of the dead end space.

6. The airflow control valve as in claim 3, wherein:

a bent portion for preventing foreign particles, contained in the exhaust gas, once entered into the dead end space from bouncing out of the dead end space is formed at the opening of the dead end space.

7. The airflow control valve as in claim 6, wherein:

the bent portion is formed at a portion of the opening close to the valve.

8. An airflow control valve for use in an internal combustion engine, the airflow control valve comprising:

a housing forming an air passage therein;

a valve disposed in the air passage for opening or closing the air passage, the air passage being separated by the valve into an upstream passage having an inlet port and a downstream passage having an outlet port from which air is blown out, the outlet port being open to a source of exhaust gas exhausted from the internal combustion engine; and

an interfering wall disposed in the downstream passage for interfering with a flow of the exhaust gas entering into the downstream passage from the outlet port.

9. The airflow control valve as in claim 8, wherein:

the interfering wall includes a wall surface directly facing the outlet port; and

a stagnating space for stagnating the exhaust gas therein is formed between the wall surface and the outlet port.

10. The airflow control valve as in claim 9, wherein:

the downstream passage includes passage surfaces inclined along a flow direction of the air to be blown out from the outlet port so that the air smoothly flows through the downstream passage.

11. The airflow control valve as in claim 1, wherein:

the upstream passage is a passage for introducing compressed secondary air to be supplied to an exhaust pipe of the internal combustion engine;

the downstream passage is a passage for supplying the air to the exhaust pipe of internal combustion engine; and

the valve is a valve for controlling an amount of the secondary air to be supplied to the exhaust pipe of the engine by opening or closing the air passage.

12. The airflow control valve as in claim 11, wherein:

a one-way valve for preventing the exhaust gas from entering into the upstream passage is provided in the downstream passage.

13. The airflow control valve as in claim 12, wherein:

the one-way valve includes a metal plate having air passages through which the secondary air flows, a reed valve for opening or closing the air passages, and a reed valve stopper for limiting an opening degree of the reed valve; and the one-way valve is positioned in the vicinity of the valve.

14. The airflow control valve as in claim 1, wherein:

the air passage is a passage for connecting an exhaust pipe to an intake pipe of the internal combustion engine for re-circulating part of the exhaust gas to the engine for decreasing a combustion temperature in the engine, and an amount of the exhaust gas to be re-circulated is controlled by the valve.

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