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(54) Title: PCV VALVE AND POLLUTION CONTROL SYSTEM

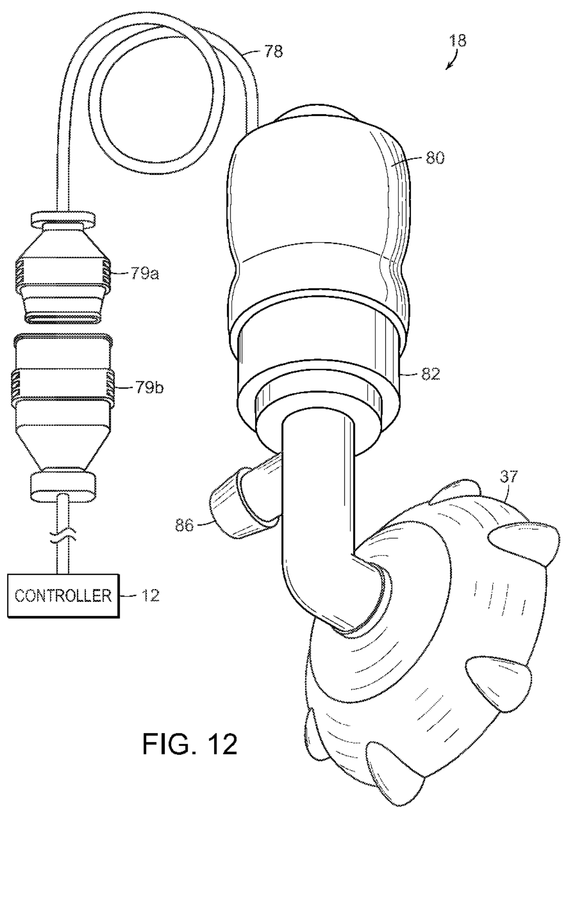

FIG. 12

(57) Abstract: A PCV valve and pollution control system for combustion engines. The PCV valve has an inlet and an outlet adapted to vent blow-by gasses from the crank case of a combustion engine. The inlet of the PCV valve is in fluid communication with a port on an engine oil cap on an engine oil inlet tube. The PCV valve may be integral with the engine oil cap or connected thereto by a hose. The outlet of the PCV valve directs vented blow-by gasses to a fuel/air inlet to the combustion chamber of the engine. The combination of the PCV valve with the engine oil cap facilitates installation of the system on a combustion engine.

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PCV VALVE AND POLLUTION CONTROL SYSTEM

DESCRIPTION

FIELD OF THE INVENTION

[Para 1] The present invention generally relates to a system for controlling pollution. More particularly, the present invention relates to a system that filters engine fuel by-products for recycling through a PCV valve assembly in order to reduce emissions and improve engine performance.

BACKGROUND OF THE INVENTION

[Para 2] The basic operation of standard internal combustion engines vary somewhat based on the type of combustion process, the quantity of cylinders and the desired use/functionality. For instance, in a traditional two-stroke engine, oil is pre-mixed with fuel and air before entry into the crankcase. The oil/fuel/air mixture is drawn into the crankcase by a vacuum created by the piston during intake. The oil/fuel mixture provides lubrication for the cylinder walls, crankshaft and connecting rod bearing in the crankcase. In a standard gasoline engine, the fuel is then compressed in the combustion chamber and ignited by a spark plug that causes the fuel to burn. There are no spark plugs in a diesel engine, so combustion in a diesel engine occurs only as a result of the heat and compression in the combustion chamber. The piston is then pushed downwardly and the exhaust fumes are allowed to exit the cylinder when the piston exposes the exhaust port. The movement of the piston pressurizes the remaining oil/fuel in the crankcase and allows additional fresh oil/fuel/air to rush into the cylinder, thereby simultaneously pushing the remaining exhaust out the exhaust port. Momentum drives the piston back into the compression stroke as the process repeats itself.

[Para 3] Alternatively, in a four-stroke engine, oil lubrication of the crankshaft and connecting rod bearing is separate from the fuel/air mixture. Here, the crankcase is filled mainly with air and oil. It is the intake manifold that receives and mixes fuel and air from separate sources. The fuel/air mixture in the intake manifold is drawn into the combustion chamber where it is ignited by the spark plugs (in a standard gasoline engine) and burned. In a diesel engine, the fuel/air mixture is ignited by heat and pressure in the combustion chamber. The combustion chamber is largely sealed off from the crankcase by a set of piston rings that are disposed around an outer diameter of the pistons within the piston cylinder. This keeps the oil in the crankcase rather than allowing it to burn as part of the combustion stroke, as in a two-stroke engine. Unfortunately, the piston rings are unable to completely seal off the piston cylinder. Consequently, crankcase oil intended to lubricate the cylinder is, instead, drawn into the combustion chamber and burned during the combustion process. Additionally, combustion waste gases comprising unburned fuel and exhaust gases in the cylinder simultaneously pass the piston rings and enter the crankcase. The waste gas entering the crankcase is commonly called “blow-by” or “blow-by gas”.

[Para 4] Blow-by gases mainly consist of contaminants such as hydrocarbons (unburned fuel), carbon dioxide or water vapor, all of which are harmful to the engine crankcase. The quantity of blow-by gas in the crankcase can be several times that of the concentration of hydrocarbons in the intake manifold. Simply venting these gases to the atmosphere increases air pollution. Although trapping the blow-by gases in the crankcase allows the contaminants to condense out of air and accumulate therein over time. Condensed contaminants form corrosive acids and sludge in the interior of the crankcase that dilutes the lubricating oil. This decreases the ability of the oil to lubricate the cylinder and the crankshaft. Degraded oil that fails to properly lubricate the crankcase components (e.g. the crankshaft and connecting rods) can be a factor in poor engine performance. Inadequate crankcase lubrication contributes to unnecessary wear on the piston rings which simultaneously reduces the quality of the seal between the combustion chamber and the crankcase. As the engine ages, the gaps between the piston rings and cylinder walls increase resulting in larger quantities of blow-by gases entering the crankcase. Too much blow-by gases entering the crankcase can cause power loss and even engine failure. Moreover, condensed water in the blow-by gases can cause engine parts to rust.

[Para 5] These issues are especially problematic in diesel engines. Diesel engines burn diesel fuel which is much more oily and heavy than gasoline. As it burns, diesel fuel produces carcinogens, particulate matter (soot), and NOx (nitrogen contaminants). This is why most diesel engines are associated with the images of a big rig truck belching black smog from its exhaust pipes. Similarly, the blow-by gas produced in the crankcase of a diesel engine is much more oily and heavy than gasoline blow-by gas. Hence, crankcase ventilation systems for diesel engines were developed to remedy the existence of blow-by gases in the crankcase. In general, crankcase ventilation systems expel blow-by gases out of a positive crankcase ventilation (PCV) valve and into the intake manifold to be re-burned. In a diesel engine, the diesel blow-by gases are much heavier and oilier than in a gasoline engine. As such, the diesel blow-by gases must be filtered before they can be recycled through the intake manifold.

[Para 6] PCV valves recirculate (i.e. vent) blow-by gases from the crankcase back into the intake manifold to be burned again with a fresh supply of air/fuel during combustion. This is particularly desirable as the harmful blow-by gases are not simply vented to the atmosphere. A crankcase ventilation system should also be designed to limit, or ideally eliminate, blow-by gas in the crankcase to keep the crankcase as clean as possible. Early PCV valve comprised simple one-way check valves. These PCV valves relied solely on pressure differentials between the crankcase and intake manifold to function correctly. When a piston travels downward during intake, the air pressure in the intake manifold becomes lower than the surrounding ambient atmosphere. This result is commonly called “engine vacuum”. The vacuum draws air toward the intake manifold. Accordingly, air is capable of being drawn from the crankcase and into the intake manifold through a PCV valve that provides a conduit therebetween. The PCV valve basically opens a one-way path for blow-by gases to vent from the crankcase back into the intake manifold. In the event the pressure difference changes (i.e. the pressure in the intake manifold becomes relatively higher than the pressure in the crankcase), the PCV valve closes and prevents gases from exiting the intake manifold and entering the crankcase. Hence, the PCV valve is a "positive" crankcase ventilation system, wherein gases are only allowed to flow in one direction – out from the crankcase and into the intake manifold. The one-way check valve is basically an all-or-nothing valve. That is, the valve is completely open during periods when the pressure in the intake manifold is relatively less than the pressure in the crankcase. Alternatively, the valve is completely closed when the pressure in the crankcase is relatively lower than the pressure in the intake manifold. One-way check valve-based PCV valves are unable to account for changes in the quantity of blow-by gases that exist in the crankcase at any given time. The quantity of blow-by gases in the crankcase varies under different driving conditions and by engine make and model.

[Para 7] PCV valve designs have been improved over the basic one-way check valve and can better regulate the quantity of blow-by gases vented from the crankcase to the intake manifold. One PCV valve design uses a spring to position an internal restrictor, such as a cone or disk, relative to a vent through which the blow-by gases flow from the crankcase to the intake manifold. The internal restrictor is positioned proximate to the vent at a distance proportionate to the level of engine vacuum relative to spring tension. The purpose of the spring is to respond to vacuum pressure variations between the crankcase and intake manifold. This design is intended to improve on the all-or-nothing one-way check valve. For example, at idle, engine vacuum is high. The spring-biased restrictor is set to vent a large quantity of blow-by gases in view of the large pressure differential, even though the engine is producing a relatively small quantity of blow-by gases. The spring positions the internal restrictor to substantially allow air flow from the crankcase to the intake manifold. During acceleration, the engine vacuum decreases due to an increase in engine load. Consequently, the spring is able to push the internal restrictor back down to reduce the air flow from the crankcase to the intake manifold, even though the engine is producing more blow-by gases. Vacuum pressure then increases as the acceleration decreases (i.e. engine load decreases) as the vehicle moves toward a constant cruising speed. Again, the spring draws the internal restrictor back away from the vent to a position that substantially allows air flow from the crankcase to the intake manifold. In this situation, it is desirable to increase air flow from the crankcase to the intake manifold, based on the pressure differential, because the engine creates more blow-by gases at cruising speeds due to higher engine RPMs. Hence, such an improved PCV valve that solely relies on engine vacuum and spring-biased restrictor does not optimize the ventilation of blow-by gases from the crankcase to the intake manifold, especially in situations where the vehicle is constantly changing speeds (e.g. city driving or stop and go highway traffic).

[Para 8] One key aspect of crankcase ventilation is that engine vacuum varies as a function of engine load, rather than engine speed, and the quantity of blow-by gases varies, in part, as a function of engine speed, rather than engine load. For example, engine vacuum is higher when engine speeds remain relatively constant (e.g. idling or driving at a constant velocity). Thus, the amount of engine vacuum present when an engine is idling (perhaps 900 rotations per minute (rpm)) is essentially the same as the amount of vacuum present when the engine is cruising at a constant speed on a highway (for example between 2,500 to 2,800 rpm). The rate at which blow-by gases are produced is much higher at 2,500 rpm than at 900 rpm. But, a spring-based PCV valve is unable to account for the difference in blow-by gas production between 2,500 rpm and 900 rpm because the spring-based PCV valve experiences a similar pressure differential between the intake manifold and the crank case at these different engine speeds. The spring is only responsive to changes in air pressure, which is a function of engine load rather than engine speed. Engine load typically increases when accelerating or when climbing a hill, for example. As the vehicle accelerates blow-by gas production increases, but the engine vacuum decreases due to the increased engine load. Thus, the spring-based PCV valve may vent an inadequate quantity of blow-by gases from the crankcase during acceleration. Such a spring-based PCV valve system is incapable of venting blow-by gases based on blow-by gas production because the spring is only responsive to engine vacuum.

[Para 9] U.S. Patent No. 5,228,424 to Collins, the contents of which are herein incorporated by reference, is an example of a two-stage spring-based PCV valve that regulates the ventilation of blow-by gases from the crankcase to the intake manifold. Specifically, Collins discloses a PCV valve having two disks therein to regulate air flow between the crankcase and the intake manifold. The first disk has a set of apertures therein and is disposed between a vent and the second disk. The second disk is sized to cover the apertures in the first disk. When little or no vacuum is present, the second disk is held against the first disk, resulting in both disks being held against the vent. The new result is that little air flow is permitted through the PCV valve. Increased engine vacuum pushes the disks against a spring and away from the vent, thereby allowing more blow-by gases to flow from the crankcase, through the PCV valve and back into the intake manifold. The mere presence of an engine vacuum causes at least the second disk to unseat from the first disk such that small quantities of blow-by gases vent from the engine crankcase through the aforementioned apertures in the first disk. The first disk typically substantially covers the vent whenever the throttle position indicates that the engine is operating at a low, constant speed (e.g. idling). Upon vehicle acceleration, the first disk may move away from the vent to increase the rate at which the blow-by gases exit the crankcase. The first disk may also unseat from the vent when the throttle position indicates the engine is accelerating or operating at a constant yet higher speed. The positioning of the first disk is based mostly on throttle position and the positioning of the second disk is based mostly on vacuum pressure between the intake manifold and crankcase. But, blow-by gas production is not based solely on vacuum pressure, throttle position, or a combination. Instead, blow-by gas production is based on a plurality of different factors, including engine load. Hence, the Collin's PCV valve also inadequately vents blow-by gases from the crankcase to the intake manifold when the engine load varies at similar throttle positions.

[Para 10] Maintenance of a PCV valve system is important and relatively simple. The lubricating oil must be changed periodically to remove the harmful contaminants trapped therein over time. Failure to change the lubricating oil at adequate intervals (typically every 3,000 to 6,000 miles) can lead to a PCV valve system contaminated with sludge. A plugged PCV valve system will eventually damage the engine. The PCV valve system should remain clear for the life of the engine assuming the lubricating oil is changed at an adequate frequency.

[Para 11] Prior art pollution control systems have required tapping or drilling into the crankcase or similar engine compartment that contains the blow-by gasses in order to recycle the same. Such tapping or drilling into the crankcase runs the risk of damaging the engine block or otherwise harming the integrity of the engine. In addition, the act of installing a PCV valve on an engine, whether OEM or aftermarket, could be an involved or time consuming process because of the difficulty with attaching a new PCV valve in the engine compartment or accessing an existing PCV valve for removal and replacement.

[Para 12] Accordingly, there is a need for a pollution control system or corresponding PCV valve that is easier, more convenient, and less costly to install. The present invention fulfills these needs and provides other related advantages.

SUMMARY OF THE INVENTION

[Para 13] The present invention is directed to a PCV valve adapted to vent blow-by gasses from a crankcase of a combustion engine. An inlet on the inventive PCV valve is in fluid communication with a port on an engine oil cap, the engine oil cap being configured for attachment to an oil filler tube to the crankcase. An outlet on the inventive PCV valve is configured for fluid communication with a fuel/air inlet of the combustion engine. The inventive PCV valve includes a two-stage check valve between the inlet and the outlet. The first stage of the check valve is configured to be opened or closed by a solenoid mechanism responsive to a controller. The second stage of the check valve is biased in a closed position so as to open only under vacuum pressure in the combustion engine greater than a predetermined threshold.

[Para 14] The inlet of the PCV valve may be fluidly connected to the port on the engine oil cap by a hose. Alternatively, the inlet of the PCV valve may be co-extensive with the port on the engine oil cap, such that the engine oil cap is integrally formed with the PCV valve and the inlet of the PCV valve is the port on the engine oil cap. A filter screen preferably covers the port in the engine oil cap.

[Para 15] In a pollution control system, the PCV valve is again adapted to vent blow-by gasses from a crankcase of the combustion engine. The inlet of the PCV valve is in fluid communication with a port on the engine oil cap of the combustion engine such that the blow-by gasses are vented through the oil filler tube of the crankcase. An outlet of the PCV valve is in fluid communication with a fuel/air inlet of the combustion engine. The PCV valve again comprises a two-stage check valve, where the first stage is directed by the controller, and the second stage is compatible with OEM settings such that the check valve opens only under sufficient vacuum pressure in the event the controller fails. The controller is coupled to a sensor for monitoring an operational characteristic of the combustion engine. The controller is configured to selectively modulate engine vacuum pressure to adjustably increase or decrease a fluid flow rate of blow-by gasses venting from the combustion engine.

[Para 16] The inlet of the PCV valve may be co-extensive with the port on the engine oil cap, such that the PCV valve is integrally formed with the engine oil cap and the inlet of the PCV valve is the port on the engine oil cap. A filter screen may be included over the port in the engine oil cap.

[Para 17] The outlet of the PCV valve may be in fluid communication with a recycle line on an OEM pollution control system, wherein the OEM pollution control system vents directly from the crankcase and the recycle line feeds into the fuel/air inlet. The fuel/air inlet may be an intake manifold, a fuel line, an air line, or a fresh air intake. The fuel/air inlet may be a fresh air intake for an air filter that feeds into a supercharger on the combustion engine.

[Para 18] The system may also include an oil separator in fluid communication with the outlet from the PCV valve. An oil outlet from the oil separator is in fluid communication with the crankcase of the combustion engine. A gas outlet from the oil separator is in fluid communication with the fuel/air inlet of the combustion engine.

[Para 19] The combustion engine may operate on gasoline, methanol, diesel, ethanol, compressed natural gas, liquid propane gas, hydrogen, or an alcohol-based fuel.

[Para 20] The controller may decrease the engine vacuum pressure during periods of decreased production of blow-by gasses to decrease the fluid flow rate through the PCV valve, and increase the engine vacuum pressure during periods of increased production of blow-by gasses to increase the fluid flow rate through the PCV valve. The controller preferably includes a pre-programmed software program, a flash-updatable software program, or a behavior-learning software program. The controller may also include a wireless transmitter or a wireless receiver. The controller may further include a window switch coupled to an engine RPM sensor, wherein the engine vacuum pressure is modulated based on a predetermined engine RPM or multiple engine RPMs set by the window switch.

[Para 21] The controller can also include an on-delay timer so as to preclude fluid flow of blow-by gasses for a predetermined duration after activation of the combustion engine. The predetermined duration of the on-delay timer may be a function of time, engine temperature, or engine RPM. The sensor comprises an engine temperature sensor, a spark plug sensor, an accelerometer sensor, a PCV valve sensor, or an exhaust sensor. In addition, the operational characteristic comprises an engine temperature, a quantity of engine cylinders, a real-time acceleration calculation, or an engine RPM.

[Para 22] Other features and advantages of the present invention will become apparent from the following more detailed description, taken in conjunction with the accompanying drawings, which illustrate, by way of example, the principles of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[Para 23] The accompanying drawings illustrate the invention. In such drawings:

[Para 24] FIGURE 1 is a schematic illustrating a pollution control device for diesel engines having a controller operationally coupled to numerous sensors and a PCV valve;

[Para 25] FIGURE 2 is a schematic illustrating the general functionality of the PCV valve system in a combustion-based engine;

[Para 26] FIGURE 3 is a schematic illustrating the general functionality of an alternate embodiment of the PCV valve system in a combustion-based engine;

[Para 27] FIGURE 4 is a schematic illustrating the general functionality of another alternate embodiment of the PCV valve system in a combustion-based engine;

[Para 28] FIGURE 5 is a perspective view of a PCV valve integral with an oil cap for use with the inventive system;

[Para 29] FIGURE 6 is an exploded perspective view of the PCV valve and oil cap of FIG. 5;

[Para 30] FIGURE 7 is a partially exploded perspective view of the PCV valve of FIG. 6, illustrating assembly of an air flow restrictor;

[Para 31] FIGURE 8 is a partially exploded perspective view of the PCV valve of FIG. 6, illustrating partial depression of the air flow restrictor;

[Para 32] FIGURE 9 is a cross-sectional view of the PCV valve taken along line 9-9 of FIG. 5, illustrating no air flow;

[Para 33] FIGURE 10 is a cross-sectional view of the PCV valve taken along line 10-10 of FIG. 5, illustrating restricted air flow;

[Para 34] FIGURE 11 is another cross-sectional view of the PCV valve taken along line 11-11 of FIG.5, illustrating full air flow;

[Para 35] FIGURE 12 is a perspective view of an alternate embodiment of a PCV valve integral with an oil cap for use with the inventive system;

[Para 36] FIGURE 13 is a perspective illustration of the oil separator of the present invention; and

[Para 37] FIGURE 14 is an exploded view of the oil separator of FIG. 13.

BRIEF DESCRIPTION OF THE PREFERRED EMBODIMENTS

[Para 38] As shown in the drawings for purposes of illustration, the present invention for a pollution control system for combustion engines is referred to generally by the reference number 10. In FIGURE 1, the pollution control system 10 is generally illustrated as having a controller 12 preferably mounted under a hood 14 of an automobile 16. The controller 12 is electrically coupled to any one of a plurality of sensors that monitor and measure the real-time operating conditions and performance of the automobile 16. The controller 12 regulates the flow rate of blow-by gases by regulating the engine vacuum in a combustion engine through digital control of a PCV valve 18. The controller 12 receives real-time input from sensors that might include an engine temperature sensor 20, a battery sensor 24, a PCV valve sensor 26, an engine RPM sensor 28, and accelerometer sensor 30 and an exhaust sensor 32. Data obtained from the sensors 20-32 by the controller 12 is used to regulate the PCV valve 18, as described in more detail below.

[Para 39] The controller 12 may also control other devices in the vehicle engine. The controller 12 may control the flow of oil out of an oil filter or oil separator 19. The controller 12 may also regulate engine temperatures, and an aerated conditioning chamber, which is designed to condition fuel going back into the fuel line or back into the vacuum manifold by aerating and mixing the fuel before reintroducing it. The controller 12 may also regulate a purging system in case of failure in the pollution control system 10 - the purging system triggers the engine to revert back to an OEM system, whether an OEM PCV system or other type of blow-by gas management system. Controller 12 may also provide alerts to the operator of the engine. The alerts may blink an LED readout so as to report on the actual sensed condition of the engine and receive alerts in the case of failure. Alerts such as alarms or illuminated signals can communicate the sensed conditions. The controller 12 is fully upgradable with flash memory or other similar devices. This means that the same controller 12 and system 10 could work on virtually any type of engine with all different types of fuels. The pollution control system 10 is adaptable to any internal combustion engine. For example, the pollution control system 10 may be used with gasoline, methanol, diesel, ethanol, compressed natural gas (CNG), liquid propane gas (LPG), hydrogen, alcohol-based engines, or virtually any other combustible gas and/or vapor-based engine. This includes both two and four stroke IC engines and all light medium and heavy duty configurations.

[Para 40] FIGURES 2-4 depict schematic illustrations of the pollution control system 10 for combustion engines 36. As shown in these figures, the PCV valve 18 (and optionally oil separator 19) are disposed between a crank case 35, of an engine 36, and an intake manifold 38. In operation, the intake manifold 38 receives air via an air line 42. An air filter 44 may be disposed between the air line 42 and an air intake line 46 to filter fresh air entering the pollution control system 10. The air in the intake manifold 38 is delivered to a piston cylinder 48 as a piston 50 descends downward within the cylinder 48 from the top dead center. As the piston 50 descends downward, a vacuum is created within a combustion chamber 52. Accordingly, an input camshaft 54 rotating at half the speed of the crankshaft 34 is designed to open an input valve 56 thereby subjecting the intake manifold 38 to the engine vacuum. Thus, air is drawn into the combustion chamber 52 from the intake manifold 38.

[Para 41] Once the piston 50 is at the bottom of the piston cylinder 48, the vacuum effect ends and air is no longer drawn into the combustion chamber 52 from the intake manifold 38. At this point, the piston 50 begins to move back up the piston cylinder 48, and the air in the combustion chamber 52 becomes compressed. Next, fuel is injected directly into the combustion chamber 52 from the fuel line 40. This injection may be further aided by compressed air from a compressed air line. Depending upon the type of fuel, combustion may be generated be a spark, compression, heating, or other known methods. The fuel ignites after it is injected into the combustion chamber.

[Para 42] The rapid expansion of the ignited fuel/air in the combustion chamber 52 causes depression of the piston 50 within the cylinder 48. After combustion, an exhaust camshaft 60 opens an exhaust valve 62 to allow escape of the combustion gases from the combustion chamber 52 out an exhaust line 64. Typically, during the combustion cycle, an excess portion of exhaust gases - "blow-by gasses" - slip by a pair of piston rings 66 mounted in a head 68 of the piston 50.

[Para 43] These blow-by gases enter the crankcase 35 as high pressure and temperature gases. Over time, harmful exhaust gases such as hydrocarbons, carbon monoxide, nitrous oxide and carbon dioxide, as well as particulates, in these blow-by gasses can condense or settle out of the gaseous state and coat the interior of the crankcase 35 and mix with the oil 70 that lubricates the mechanics within the crankcase 35. The diesel pollution control system 10 is designed to recycle the contents of these blow-by gases from the crankcase 35 back to the combustion intake so as to be burned by the engine 36. This is accomplished by using the pressure differential between the crankcase 35 and intake manifold 38.

[Para 44] FIGURE 2 illustrates an embodiment wherein the PCV valve 18 is in communication with the crankcase 35 through an engine oil cap 37. The engine oil cap 37 is mounted on an oil inlet of filler tube 39 into the crankcase 35. The oil inlet tube 39 is preferably the same port through which oil is added to the engine 36. In this embodiment, the PCV valve 18 is integral with the engine oil cap 37, such that the inlet port 84 of the PCV valve 18 passes through the cap 37 and is open to the inlet tube 39. In this way, blow-by gasses are drawn from the crankcase 35, up the inlet tube 39, and through the cap 37. A filter screen 85 (FIG. 5) may be included in the interior of the cap 37 so as to trap and remove at least a portion of the oil from the blow-by gasses as they pass through the screen 85. An outlet 86 from the PCV valve 18 is in fluid communication with the intake manifold 38 so as to return the blow-by gasses to the combustion chamber 52. The blow-by gasses may be fed directly into the intake manifold 38, the air line 42, the fresh air line 46, or the fuel line 40. In certain types of engines 36, particularly those with a supercharger 45 that alternate operational states between a vacuum and positive pressure, the blow-by gasses are preferably fed into an air filter 44, prior to the supercharger 45. The PCV valve 18 is electrically connected to the controller 12 so as to be controlled as described elsewhere herein.

[Para 45] FIGURE 3 illustrates an alternate embodiment wherein the PCV valve 18 is again in communication with the crankcase 35 through the engine oil cap 37. However, in this embodiment, the PCV valve 18 is connected to the engine oil cap 37 by a hose 43. The hose 43 is connected the inlet port 84 of the PCV valve 18 with a matching port 87 through the cap 37. Similar to the earlier embodiment, blow-by gasses are drawn from the crankcase 35, up the inlet tube 39, through the cap 37 and hose 43, and into the PCV valve 18. A filter screen 85 may be included in the interior of the cap 37. The outlet 86 from the PCV valve 18 is in fluid communication with the intake manifold 38 so as to return the blow-by gasses to the combustion chamber 52. However, the outlet 86 from the PCV valve 18 may first pass through an oil separator 19, as described below. The blow-by gasses from the outlet 174 of the oil separator 19 may be fed directly into the intake manifold 38, the air line 42, the fresh air line 46, or the fuel line 40. The PCV valve 18 is electrically connected to the controller 12 so as to be controlled as described elsewhere herein.

[Para 46] FIGURE 4 illustrates another alternate embodiment wherein the PCV valve 18 is again in communication with the crankcase 35 through the engine oil cap 37. In this embodiment, the PCV valve 18 is again integral with the engine oil cap 37, but may be configured as shown in FIG. 3. As with the other embodiments, the blow-by gasses are drawn from the crankcase 35, up the inlet tube 39, and through the cap 37. Again a filter screen 85 may be included in the interior of the cap 37. In this embodiment, the PCV valve 18 is installed in conjunction with an OEM PCV valve system that is connected to an outlet port

72 on the crankcase 35. A vent line 74 connects the outlet port 72 to the OEM PCV valve 21, which is in turn connected to the intake manifold 38 or other engine inlet by a return line 76. The outlet 86 from the PCV valve 18 is in fluid communication with the return line 76 of the OEM PCV system so as to return the blow-by gasses to the combustion chamber 52 by the same means. The PCV valve 18 is electrically connected to the controller 12 so as to be controlled as described elsewhere herein. In this embodiment, the blow-by gasses will mostly pass through the PCV valve 18 of the inventive system as the path of least resistance. OEM PCV systems tend to have smaller orifices or ports than those that are found in the inventive PCV valve system 10. Since the flow rate of blow-by gasses depends upon pressure differentials, i.e., a vacuum generated during the piston cycle, the blow-by gasses will follow the least restrictive path.

[Para 47] In operation, the blow-by gases exit the relatively higher pressure crankcase 35 through the PCV valve 18 and then return to the combustion chamber 52 of the engine 36 as described. The fuel line 40 may receive fuel vapors that are more pure, while the less pure blow-by gases may be vented from the crankcase 35 to the intake manifold 38 via the blow-by line 41. This process is digitally regulated by the controller 12 shown in FIG. 1. The fuel vapors to the fuel line 40 may be passed through the fuel filter before being reintroduced to the engine 36.

[Para 48] The PCV valve 18 in FIGURE 5 is generally electrically coupled to the controller 12 via a pair of electrical connections 78. The controller 12 at least partly regulates the quantity of blow-by gases flowing through the PCV valve 18 via the electrical connections 78. In FIG. 5, the PCV valve 18 includes a rubber housing 80 that encompasses a portion of a rigid outer housing 82. The connector wires 78 extend out from the outer housing 82 via an aperture therein (not shown). Preferably, the outer housing 82 is unitary and comprises an intake orifice 84 and an exhaust orifice 86. In general, the controller 12 operates a restrictor internal to the outer housing 82 for regulating the rate of blow-by gases entering the intake orifice 84 and exiting the exhaust orifice 86.

[Para 49] FIGURE 6 illustrates the PCV valve 18 in an exploded perspective view. The rubber housing 80 covers an end cap 88 that substantially seals to the outer housing 82 thereby encasing a solenoid mechanism 90 and an air flow restrictor 92. The solenoid mechanism 90 includes a plunger 94 disposed within a solenoid 96. The connector wires 78 operate the solenoid 96 and extend through the end cap 88 through an aperture 98 therein. Similarly, the rubber housing 80 includes an aperture (not shown) to allow the connector wires 78 to be electrically coupled to the controller 12.

[Para 50] In general, engine vacuum present in the intake manifold 38 causes blow-by gases to be drawn from the crankcase 35, through the intake orifice 84 and out the exhaust orifice 86 in the PCV valve 18. The air flow restrictor 92 shown in FIG. 6 is one mechanism that regulates the quantity of blow-by gases that vent from the crankcase 35 to the intake manifold 38. Regulating blow-by gas air flow rate is particularly advantageous as the pollution control system 10 is capable of increasing the rate blow-by gases vent from the crankcase 35 during times of higher blow-by gas production and decreasing the rate blow-by gases vent from the crankcase 35 during times of lower blow-by gas production. The controller 12 is coupled to the plurality of sensors 20-32 to monitor the overall efficiency and operation of the automobile 16 and operates the PCV valve 18 in real-time to maximize recycling of blow-by gases according to the measurements taken by the sensors 20-32.

[Para 51] The operational characteristics and production of blow-by is unique for each engine and each automobile in which individual engines are installed. The pollution control system 10 is capable of being installed in the factory or post production to maximize automobile fuel efficiency, reduce harmful exhaust emissions, recycle oil and other gas and eliminate contaminants within the crankcase. The purpose of the pollution control system 10 is to strategically vent the blow-by gases from the crankcase 35 based on blow-by gas production, filter the blow-by gas, and recycle any oil and fuel that may come out of the blow-by gas. Accordingly, the controller 12 digitally regulates and controls the PCV valve 18 based on engine speed and other operating characteristics and real-time measurements taken by the sensors 20-32. The pollution control system 10 may be integrated into immobile engines used to produce energy or used for industrial purposes.

[Para 52] In particular, venting blow-by gases based on engine speed and other operating characteristics of an automobile decreases the overall quantity of hydrocarbons, carbon monoxide, nitrogen oxide, carbon dioxide, and particulate emissions. The pollution control system 10 recycles these gases and particulates by burning them in the combustion cycle. No longer are large quantities of the contaminants expelled from the engine via the exhaust. Hence, the pollution control system 10 is capable of reducing air pollution by as much as forty to fifty percent for each engine, increasing output per gallon by as much as twenty to thirty percent, increasing horsepower performance, reducing engine wear (due to low carbon retention therein) and reducing the frequency of oil changes by approximately a factor of ten. Considering that the United States consumes approximately 870 million gallons of petroleum a day, a fifteen percent reduction through the recycling of blow-by gases with the pollution control system 10 translates into a savings of approximately 130 million gallons of petroleum a day in the United States alone. Worldwide, nearly 3.3 billion gallons of petroleum are consumed per day, which would result in approximately 500 million gallons of petroleum saved every day.

[Para 53] In one embodiment, the quantity of blow-by gases entering the intake orifice 84 of the PCV valve 18 is regulated by the air flow restrictor 92 as generally shown in FIG. 6. The air flow restrictor 92 includes a rod 100 having a rear portion 102, an intermediate portion 104, and a front portion 106. The front portion 106 has a diameter slightly less than the rear portion 102 and the intermediate portion 104. A front spring 108 is disposed concentrically over the intermediate portion 104 and the front portion 106, including over a front surface 110 of the rod 100. The front spring 108 is preferably a coil spring that decreases in diameter from the intake orifice 84 toward the front surface 110. An indent collar 112 separates the rear portion 102 from the intermediate portion 104 and provides a point where a rear snap ring 114 may attach to the rod 100. The diameter of the front spring 108 should be approximately or slightly less than the diameter of the rear snap ring 114. The rear snap ring 114 engages the front spring 108 on one side and a rear spring 116 tapers from a wider diameter near the solenoid 96 to a diameter approximately the size of or slightly smaller than the diameter of the rear snap ring 114. The rear spring 116 is preferably a coil spring and is wedged between a front surface 118 of the solenoid 96 and the rear snap ring 114. The front portion 106 also includes an indented collar 120 providing a point of attachment for a front snap ring 122. The diameter of the front snap ring 122 is smaller than that of the tapered front spring 108. The front snap ring 122 fixedly retains a front disk 124 on the front portion 106 of the rod 100. Accordingly, the front disk 124 is fixedly wedged between the front snap ring 122 and the front surface 110. The front disk 124 has an inner diameter configured to slidably engage the front portion 106 of the rod 100. The front spring 108 is sized to engage a rear disk 126 as described below.

[Para 54] The disks 124, 126 govern the quantity of blow-by gases entering the intake orifice 84 and exiting the exhaust orifice 86. FIGS. 7 and 8 illustrate the air flow restrictor 92 assembled to the solenoid mechanism 90 and external to the rubber housing 80 and the outer housing 82. Accordingly, the plunger 94 fits within a rear portion of the solenoid 96 as shown therein. The connector wires 78 are coupled to solenoid 96 and govern the position of the plunger 94 within the solenoid 96 by regulating the current delivered to the solenoid 96. Increasing or decreasing the electrical current through the solenoid 96 correspondingly increases or decreases the magnetic field produced therein. The magnetized plunger 94 responds to the change in magnetic field by sliding into or out from within the solenoid 96. Increasing the electrical current delivered to the solenoid 96 through the connector wires 78 increases the magnetic field in the solenoid 96 and causes the magnetized plunger 94 to depress further within the solenoid 96. Conversely, reducing the electrical current supplied to the solenoid 96 via the connector wires 78 reduces the magnetic field therein and causes the magnetized plunger 94 to slide out from within the interior of the solenoid 96. As will be shown in more detail herein, the positioning of the plunger 94 within the solenoid 96 at least partially determines the quantity of blow-by gases that may enter the intake orifice 84 at any given time. This is accomplished by the interaction of the plunger 94 with the rod 100 and the corresponding front disk 124 secured thereto.

[Para 55] FIGURE 7 specifically illustrates the air flow restrictor 92 in a closed position. The rear portion 102 of the rod 100 has an outer diameter approximately the size of the inner diameter of the solenoid 96. Accordingly, the rod 100 can slide within the solenoid 96. The position of the rod 100 in the outer housing 82 depends upon the position of the plunger 94 due to the engagement of the rear portion 106 with the plunger 94 as shown more specifically in FIGURES 9-11. As shown in FIG. 7, the rear spring 116 is compressed between the front surface 118 of the solenoid 96 and the rear snap ring 114. This in turn compresses the rear disk 126 against the front disk 124. Similarly, the front spring 108 is compressed between the rear snap spring 114 and the rear disk 126. This allows for the rear disk 126 to be separated from the front disk 124, as shown in FIGURE 8.

[Para 56] As better shown in FIGS. 9-11 (taken along lines 9-9, 10-10, and 11-11 of FIG.5), the front disk 124 includes an extension 130 having a diameter less than that of a foot 132. The foot 132 of the rear disk 126 is approximately the diameter of the tapered front spring 108. In this manner, the front spring 108 fits over an extension 130 of the rear disk 126 to engage the planar surface of the diametrically larger foot 132 thereof. The inside diameter of the rear disk 126 is approximately the size of the external diameter of the intermediate portion 104 of the rod 100, which is smaller in diameter than either the intermediate portion 104 or the rear portion 102. In this regard, the front disk 124 locks in place on the front portion 106 of the rod 100 between the front surface 110 and the front snap ring 122. Accordingly, the position of the front disk 124 is dependent upon the position of the rod 100 as coupled to the plunger 94. The plunger 94 slides into or out from within the solenoid 96 depending on the amount of current delivered by the connecting wires 78, as described above.

[Para 57] FIG. 8 illustrates the PCV valve 18 wherein increased vacuum created between the crankcase 35 and the intake manifold 38 causes the rear disk 126 to retract away from the intake orifice 84 thereby allowing air to flow therethrough. In this situation the engine vacuum pressure exerted upon the disk 126 must overcome the opposite force exerted by the front spring 108. Here, small quantities of blow-by gases may pass through the PCV valve 18 through a pair of apertures 134 in the front disk 124.

[Para 58] FIGS. 9-11 more specifically illustrate the functionality of the PCV valve 18 in accordance with the pollution control system 10. FIG. 9 illustrates the PCV valve 18 in a closed position. Here, no blow-by gas may enter the intake orifice 84. As shown, the front disk 124 is flush against a flange 136 defined in the intake orifice 84. The diameter of the foot 132 of the rear disk 126 extends over and encompasses the apertures 134 in the front disk 124 to prevent any air flow through the intake orifice 84. In this position, the plunger 94 is disposed within the solenoid 96 thereby pressing the rod 100 toward the intake orifice 84. The rear spring 116 is thereby compressed between the front surface 118 of the solenoid 96 and the rear snap ring 114. Likewise, the front spring 108 compresses between the rear snap ring 114 and the foot 132 of the rear disk 126.

[Para 59] FIG. 10 is an embodiment illustrating a condition wherein the vacuum pressure exerted by the intake manifold relative to the crankcase is greater than the pressure exerted by the front spring 108 to position the rear disk 126 flush against the front disk 124. In this case, the rear disk 126 is able to slide along the outer diameter of the rod 100 thereby opening the apertures 134 in the front disk 124. Limited quantities of blow-by gases are allowed to enter the PCV valve 18 through the intake orifice 84 as noted by the directional arrows therein. Of course, the blow-by gases exit the PCV valve 18 through the exhaust orifice 86 as noted by the directional arrows therein. In the position shown in FIG. 10, blow-by gas air flow is still restricted as the front disk 124 remains seated against the flanges 136. Thus, only limited air flow is possible through the apertures 134. Increasing the engine vacuum consequently increases the air pressure exerted against the rear disk 126. Accordingly, the front spring 108 is further compressed such that the rear disk 126 continues to move away from the front disk 124 thereby creating larger air flow path to allow escape of the additional blow-by gases. Moreover, the plunger 94 in the solenoid 96 may position the rod 100 within the PCV valve 18 to exert more or less pressure on the springs 108, 116 to restrict or permit air flow through the intake orifice 84, as determined by the controller 12.

[Para 60] FIG. 11 illustrates another condition wherein additional air flow is permitted to flow through the intake orifice 84 by retracting the plunger 94 out from within the solenoid 96 by altering the electric current through the connector wires 78. Reducing the electrical current flowing through the solenoid 96 reduces the corresponding magnetic field generated therein and allows the magnetic plunger 94 to retract. Accordingly, the rod 100 retracts away from the intake orifice 84 with the plunger 94. This allows the front disk 124 to unseat from the flanges 136 thereby allowing additional air flow to enter the intake orifice 84 around the outer diameter of the front disk 124. Of course, the increase in air flow through the intake orifice 84 and out through the exhaust orifice 86 allows increased venting of blow-by gases from the crankcase 35 to the intake manifold 38. In one embodiment, the plunger 94 allows the rod 100 to retract all the way out from within the outer housing 82 such that the front disk 124 and the rear disk 126 no longer restrict air flow through the intake orifice 84 and out through the exhaust orifice 86. This is particularly desirable at high engine RPMs and high engine loads, where increased amounts of blow-by gases are produced by the engine. Engine load is a more reliable indicator of the quantity of blow-by gasses being produced than RPMs. In addition, immobile engines, i.e., generators, or those not geared to a transmission run at a constant RPM. Thus, the system 10 or PCV valve 18 is preferably controlled based on sensed load conditions or in a periodic on/off cycle, i.e., 2 minutes on - 2 minutes off. Of course, the springs 108, 116 may be rated differently according to the specific automobile with which the PCV valve 18 is to be incorporated in a pollution control system 10.

[Para 61] The controller 12 effectively governs the placement of the plunger 94 within the solenoid 96 by increasing or decreasing the electrical current therein via the connector wires 78. The controller 12 itself may include any one of a variety of electronic circuitry that include switches, timers, interval timers, timers with relay or other vehicle control modules known in the art. The controller 12 operates the PCV valve 18 in response to the operation of one or more of these control modules. For example, the controller 12 could include an RWS window switch module provided by Baker Electronix of Beckly, W. VA. The RWS module is an electric switch that activates above a pre-selected engine RPM and deactivates above a higher pre-selected engine RPM. The RWS module is considered a “window switch” because the output is activated during a window of RPMs. The RWS module could work, for example, in conjunction with the engine RPM sensor 28 to modulate the air flow rate of blow-by gases vented from the crankcase 35.

[Para 62] Preferably, the RWS module works with a standard coil signal used by most tachometers when setting the position of the plunger 94 within the solenoid 96. An automobile tachometer is a device that measures real-time engine RPMs. In one embodiment, the RWS module may activate the plunger 94 within the solenoid 96 at low engine RPMs, when blow-by gas production is minimal. Here, the plunger 94 pushes the rod 100 toward the intake orifice 84 such that the front disk 124 seats against the flanges 136 as generally shown in FIG. 9. In this regard, the PCV valve 18 vents small amounts of blow-by gases from the crankcase to the intake manifold via the apertures 134 in the front disk 124 even though engine vacuum is high. The high engine vacuum forces blow-by gases through the apertures 134 thereby forcing the rear disk 126 away from the front disk 124, compressing the front spring 108. At idle, the RWS module activates the solenoid 96 to prevent the front disk 124 from unseating from the flanges 136, thereby preventing large quantities of air from flowing between the engine crankcase and the intake manifold. This is particularly desirable at low engine RPMs as the quantity of blow-by gas produced within the engine is relatively low even though the engine vacuum is relatively high. Obviously, the controller 12 can regulate the PCV valve 18 simultaneously with other components of the pollution control system 10 to set the air flow rate of blow-by gases vented from the crankcase 35.

[Para 63] Blow-by gas production increases during acceleration, during increased engine load and with higher engine RPMs. Accordingly, the RWS module may turn off or reduce the electric current going to the solenoid 96 such that the plunger 94 retracts out from within the solenoid 96 thereby unseating the front disk 124 from the flanges 136 (FIG. 11) and allowing greater quantities of blow-by gas to vent from the crankcase 35 to the intake manifold 38. These functionalities may occur at a selected RPM or within a given range of selected RPMs pre-programmed into the RWS module. The RWS module may reactivate when the automobile eclipses another pre-selected RWS, such as a higher RPM, thereby re-engaging the plunger 94 within the solenoid 96. In an alternative embodiment, a variation of the RWS module may be used to selectively step the plunger 94 out from within the solenoid 96. For example, the current delivered to the solenoid 96 may initially cause the plunger 94 to engage the front disk 124 with the flanges 136 of the intake orifice 84 at 900 rpm. At 1700 rpm the RWS module may activate a first stage wherein the current delivered to the solenoid 96 is reduced by one-half. In this case, the plunger 94 retracts halfway out from within the solenoid 96 thereby partially opening the intake orifice 84 to blow-by gas flow. When the engine RPMs reach 2,500, for example, the RWS module may eliminate the current going to the solenoid 96 such that the plunger 94 retracts completely out from within the solenoid 96 to fully open the intake orifice 84. In this position, it is particularly preferred that the front disk 124 and the rear disk 126 and longer restrict air flow between the intake orifice 84 and the exhaust orifice 86. The stages may be regulated by engine RPM or other parameter and calculations made by the controller 12 and based on readings from the sensors 20-32.

[Para 64] The controller 12 can be pre-programmed, programmed after installation or otherwise updated or flashed to meet specific automobile or on-board diagnostics (OBD) specifications. In one embodiment, the controller 12 is equipped with self-learning software such that the switch (in the case of the RWS module) adapts to the best time to activate or deactivate the solenoid 96, or step the location of the plunger 94 in the solenoid 96 to optimally increase fuel efficiency and reduce air pollution. In a particularly preferred embodiment, the controller 12 optimizes the venting of blow-by gases based on real-time measurements taken by the sensors 20-32. For example, the controller 12 may determine that the automobile 16 is expelling increased amounts of harmful exhaust via feedback from the exhaust sensor 32. In this case, the controller 12 may activate withdrawal of the plunger 94 from within the solenoid 96 to vent additional blow-by gases from within the crankcase to reduce the quantity of pollutants expelled through the exhaust of the automobile 16 as measured by the exhaust sensor 32.

[Para 65] In another embodiment, the controller 12 is equipped with an LED that flashes to indicate power and that the controller 12 is waiting to receive engine speed pulses. The LED may also be used to gauge whether the controller 12 is functioning correctly. The LED flashes until the automobile reaches a specified RPM at which point the controller 12 changes the current delivered to the solenoid 96 via the connector wires 78. In a particularly preferred embodiment, the controller 12 maintains the amount of current delivered to the solenoid 96 until the engine RPMs fall ten-percent lower than the activation point. This mechanism is called hysteresis. Hysteresis is implemented into the pollution control system 10 to eliminate on/off pulsing, otherwise known as chattering, when engine RPMs jump above or below the set point in a relatively short time period. Hysteresis may also be implemented into the electronically-based step system described above.

[Para 66] The controller 12 may also be equipped with an On Delay timer, such as the KH1 Analog Series On Delay timer manufactured by Instrumentation & Control Systems, Inc. of Addison, Ill. A delay timer is particularly preferred for use during initial start up. At low engine RPMs little blow-by gases are produced. Accordingly, a delay timer may be integrated into the controller 12 to delay activation of the solenoid 96 and corresponding plunger 94. Preferably, the delay time ensures that the plunger 94 remains fully inserted within the solenoid 96 such that the front disk 124 remains flush against the flanges 136 thereby limiting the quantity of blow-by gas air flow entering the intake orifice 84. The delay timer may be set to activate release of either one of the disks 124, 126 from the intake orifice 84 after a predetermined duration (e.g. one minute). Alternatively, the delay timer may be set by the controller 12 as a function of engine temperature, measured by the engine temperature sensor 20, engine RPMs, measured by either the engine RPM sensor 28 or the accelerometer sensor 30, the battery sensor 24 or the exhaust sensor 32. The delay may include a variable range depending on any of the aforementioned readings. The variable timer may also be integrated with the RWS switch.

[Para 67] The controller 12 preferably mounts to the interior of the hood 14 of the automobile 16 as generally shown in FIG. 1. The controller 12 may be packaged with an installation kit to enable a user to attach the controller 12 as shown. Electrically, the controller 12 is powered by any suitable twelve volt circuit breaker. A kit having the controller 12 may include an adapter wherein one twelve volt circuit breaker may be removed from the circuit panel and replaced with an adapter (not shown) that connect one-way to the connector wires 78 of the PCV valve 18 so a user installing the pollution control system 10 cannot cross the wires between the controller 12 and the PCV valve 18. The controller 12 may also be accessed wirelessly via a remote control or hand-held unit to access or download real-time calculations and measurements, stored data or other information read, stored or calculated by the controller 12.

[Para 68] In another aspect of the pollution control system 10, the controller 12 regulates the PCV valve 18 based on engine operating frequency. For instance, the controller 12 may activate or deactivate the plunger 94 as the engine passes through a resonant frequency. In a preferred embodiment, the controller 12 blocks all air flow from the crankcase 35 to the intake manifold 38 until after the engine passes through the resonant frequency. The controller 12 can also be programmed to regulate the PCV valve 18 based on sensed frequencies of the engine at various operating conditions, as described above.

[Para 69] Moreover, the pollution control system 10 is usable with a wide variety of engines, including gasoline, methanol, diesel, ethanol, compressed natural gas (CNG), liquid propane gas (LPG), hydrogen, and alcohol-based engines, or virtually any other combustible gas and/or vapor-based engine. The pollution control system 10 may also be used with larger stationary engines or used with boats or other heavy machinery. Additionally, the pollution control system 10 may include one or more controllers 12 and one or more PCV valves 18 in combination with a plurality of sensors measuring the performance of the engine or vehicle. The use of the pollution control system 10 is association with an automobile, as described in detail above, is merely a preferred embodiment. Of course, the pollution control system 10 has application across a wide variety of disciplines that employ combustible materials having exhaust gas production that could be recycled and reused.

[Para 70] In another aspect of the pollution control system 10, the controller 12 may modulate control of the PCV valve 18. The primary functionality of the PCV valve 18 is to control the amount of engine vacuum between the crankcase 35 and the intake manifold 38. The positioning of the plunger 94 within the solenoid 96 largely dictates the air flow rate of blow-by gases traveling from the crankcase 35 to the intake manifold 38. In some systems, the PCV valve 18 may regulate air flow to ensure the relative pressure between the crankcase 35 and the intake manifold 38 does not fall below a certain threshold according to the original equipment manufacturer (OEM). In the event that the controller 12 fails, the pollution control system 10 defaults back to OEM settings wherein the

PCV valve 18 functions as a two-stage check valve. A particularly preferred aspect of the pollution control system 10 is the compatibility with current and future OBD standards through inclusion of a flash-updatable controller 12. Moreover, operation of the pollution control system 10 does not affect the operational conditions of current OBD and OBD-II systems. The controller 12 may be accessed and queried according to standard OBD protocols and flash-updates may modify the bios so the controller 12 remains compatible with future OBD standards. Preferably, the controller 12 operates the PCV valve 18 to regulate the engine vacuum between the crankcase 35 and the intake manifold 38, thereby governing the air flow rate therebetween to optimally vent blow-by gas within the system 10.

[Para 71] In another aspect of the pollution control system 10, the controller 12 may modulate activation and/or deactivation of the operational components, as described in detail above, with respect to, e.g., the PCV valve 18. Such modulation is accomplished through, for example, the aforementioned RWS switch, on-delay timer or other electronic circuitry and digitally activates, deactivates or selectively intermediately positions the aforementioned control components. For example, the controller 12 may selectively activate the PCV valve 18 for a period of one to two minutes and then selectively deactivate the PCV valve 18 for ten minutes. These activation/deactivation sequences may be set according to pre-determined or learned sequences based on driving style, for example. Pre-programmed timing sequences may be changed through flash-updates of the controller 12.

[Para 72] FIGURE 12 illustrates an alternate embodiment of the PCV valve 18 integral with the engine oil cap 37. Distinct from the embodiment shown in FIG. 5, this embodiment has the PCV valve 18 attached to the engine oil cap 37 by an elbow or bend connector. This elbow or bend connector orients the PCV valve 18 in a low profile, i.e., generally horizontal, position when the engine oil cap 37 is attached to the engine oil inlet 39. This low profile position of the PCV valve 18 orients the same so that it generally runs along the surface of the engine 36. This is particularly useful in engine compartments where the engine oil inlet 39 is on the top of the engine 36 and the hood 14 provides very little clearance above the engine 36. The angle or bend is preferably a ninety degree angle, but may be presented in other angles as a particular engine design may require. The PCV valve 18 functions in the same manner as the embodiment described above.

[Para 73] The wires 78 extending from the PCV valve 18 may include a waterproof connector 79a, 79b to facilitate connection to the controller 12.

[Para 74] FIGURES 13 and 14 illustrate a configuration for the oil separator 19. The oil separator 19 has a canister 134 with a top portion 166 and a bottom portion 168. Attached to the canister 134 is a handle 170 along with an inlet port 172 and an outlet port 174. FIGURE 14 shows the oil separator 19 in an exploded view with its orientation flipped from that of FIG. 13. One can see the handle 170 is attached to the top portion 166 by a screw 176 or other similar attachment means. The interior of the top portion 166 is divided into an inlet chamber 178 and an outlet chamber 180. A metal screen 182 is disposed across the openings of the inlet chamber 178 and outlet chamber 180. The screen 182 is preferably held in place by screws 184. The interior of the bottom portion 168 preferably comprises an open chamber (not shown) configured to capture oil condensed out of the blow-by gasses. The bottom portion 168 may include steel wool 186 or other similar mesh layer materials. The underside of the bottom portion 168 includes an oil drainage port 138.

[Para 75] The oil separator 19 further includes an O-ring or gasket 188 disposed between the upper portion 166 and the bottom portion 168. The O-ring 188 seals the oil separator 19 against leakage during operation under pressure. The upper portion 166 and bottom portion 168 are preferably secured together by a durable but releasable connection such as a threaded coupling, lugs and channels, or set screws. A person of ordinary skill in the art will appreciate the various means of securing the top portion 166 and bottom portion 168 together.

[Para 76] When fully assembled, the oil separator 19 brings the blow-by gasses into the inlet chamber 178 through the inlet port 172. The gasses then pass through the screen 182 into the bottom portion 168. As the blow-by gasses pass through the screen 182, a portion of the oil contained therein is condensed and drains to the bottom of the inner chamber. The blow-by gasses then pass over and through the mesh layers 186 where additional oil is further condensed out of the blow-by gasses to remain in the bottom of the inner chamber. The vacuum created by the pressure differential between the crankcase and the intake manifold then draws the blow-by gasses upward through the screen 182 into the outlet chamber 180. This second passage through the screen 182 further condenses additional oil out of the blow-by gasses. The screen 182 and mesh layers 186 also aid in filtering particulates and other contaminants in the blow-by gasses. Once drawn into the outlet chamber 180, the blow-by gasses are released through the outlet port 174 and are transported as described in the various embodiments.

[Para 77] In view of the foregoing, it is understood by one skilled in the art that the present invention for a pollution control system for diesel engines includes an oil filter and PCV valve used in conjunction with a diesel engine. In summary, during acceleration and while hauling heavy loads, the diesel engine will produce blow-by gas, which includes fuel vapor, oil, and other contaminants. This blow-by gas is vented from the crankcase to the oil filter. Here, the blow-by gas passes through a series of mesh filters where the oil and other contaminants are filtered out of the fuel vapor. The contaminants are trapped in the mesh filters, while the oil condenses to the bottom of the oil filter. The condensed oil is returned to the crankcase out of the bottom of the oil filter.

[Para 78] The purified fuel vapor is vacuumed out of the oil filter through the PCV valve to be returned to the engine for re-burning. The PCV valve is connected to a controller that allows for variable amounts of fuel vapor to pass through the valve depending on the current engine requirements. Once the fuel vapor passes through the PCV valve, it is returned to the engine either via the fuel line, or through the intake manifold.

[Para 79] Although several embodiments have been described in detail for purposes of illustration, various modifications may be made to each without departing from the scope and spirit of the invention. Accordingly, the invention is not to be limited, except as by the appended claims.

What is claimed is:

[Claim 1] A pollution control system, comprising:

a controller coupled to a sensor for monitoring an operational characteristic of a combustion engine, wherein the controller is configured to selectively modulate engine vacuum pressure to adjustably increase or decrease a fluid flow rate of blow-by gasses venting from the combustion engine; and

a PCV valve adapted to vent blow-by gasses from a crankcase of the combustion engine, an inlet of the PCV valve being in fluid communication with a port on an engine oil cap of the combustion engine such that the blow-by gasses are vented through an oil filler tube to the crankcase, and an outlet of the PCV valve being in fluid communication with a fuel/air inlet of the combustion engine, wherein the PCV valve comprises a two-stage check valve, the first stage directed by the controller, and the second stage compatible with OEM settings wherein the check valve opens only under sufficient vacuum pressure in the event the controller fails.

[Claim 2] The pollution control system of claim 1, wherein the inlet of the PCV valve is co-extensive with the port on the engine oil cap.

[Claim 3] The pollution control system of claim 2, wherein the PCV valve is integrally formed with the engine oil cap such that the inlet of the PCV valve is the port on the engine oil cap.

[Claim 4] The pollution control system of claim 1, further comprising a filter screen over the port in the engine oil cap.

[Claim 5] The pollution control system of claim 1, wherein the outlet of the PCV valve is in fluid communication with a recycle line on an OEM pollution control system, wherein the OEM pollution control system vents directly from the crankcase.

[Claim 6] The pollution control system of claim 1, wherein the fuel/air inlet comprises an intake manifold, a fuel line, an air line, or a fresh air intake.

[Claim 7] The pollution control system of claim 6, wherein the fuel/air inlet is a fresh air intake for an air filter that feeds into a supercharger on the combustion engine.

[Claim 8] The pollution control system of claim 1, further comprising an oil separator in fluid communication with the outlet from the PCV valve, an oil outlet from the oil separator in fluid communication with the crankcase of the combustion engine and a gas outlet from the oil separator in fluid communication with the fuel/air inlet of the combustion engine.

[Claim 9] The pollution control system of claim 1, wherein the combustion engine is configured to combust gasoline, methanol, diesel, ethanol, compressed natural gas, liquid propane gas, hydrogen, or an alcohol-based fuel.

[Claim 10] The pollution control system of claim 1, wherein the controller decreases the engine vacuum pressure during periods of decreased production of blow-by gasses to decrease the fluid flow rate through the PCV valve, and increases the engine vacuum pressure during periods of increased production of blow-by gasses to increase the fluid flow rate through the PCV valve.

[Claim 11] The pollution control system of claim 10, wherein the controller includes a pre-programmed software program, a flash-updatable software program, or a behavior-learning software program.

[Claim 12] The pollution control system of claim 11, wherein the controller includes a wireless transmitter or a wireless receiver.

[Claim 13] The pollution control system of claim 10, wherein the controller includes a window switch coupled to an engine RPM sensor, and wherein the engine vacuum pressure is modulated based on a predetermined engine RPM or multiple engine RPMs set by the window switch.

[Claim 14] The pollution control system of claim 1, wherein the controller includes an on-delay timer so as to preclude fluid flow of blow-by gasses for a predetermined duration after activation of the combustion engine.

[Claim 15] The pollution control system of claim 14, wherein the predetermined duration is a function of time, engine temperature, or engine RPM.

[Claim 16] The pollution control system of claim 1, wherein the sensor comprises an engine temperature sensor, a spark plug sensor, an accelerometer sensor, a PCV valve sensor, or an exhaust sensor.

[Claim 17] The pollution control system of claim 16, wherein the operational characteristic comprises an engine temperature, a quantity of engine cylinders, a real-time acceleration calculation, or an engine RPM.

[Claim 18] A PCV valve adapted to vent blow-by gasses from a crankcase of a combustion engine, the PCV valve comprising:

an inlet in fluid communication with a port on an engine oil cap, the engine oil cap configured for attachment to an oil filler tube to the crankcase;

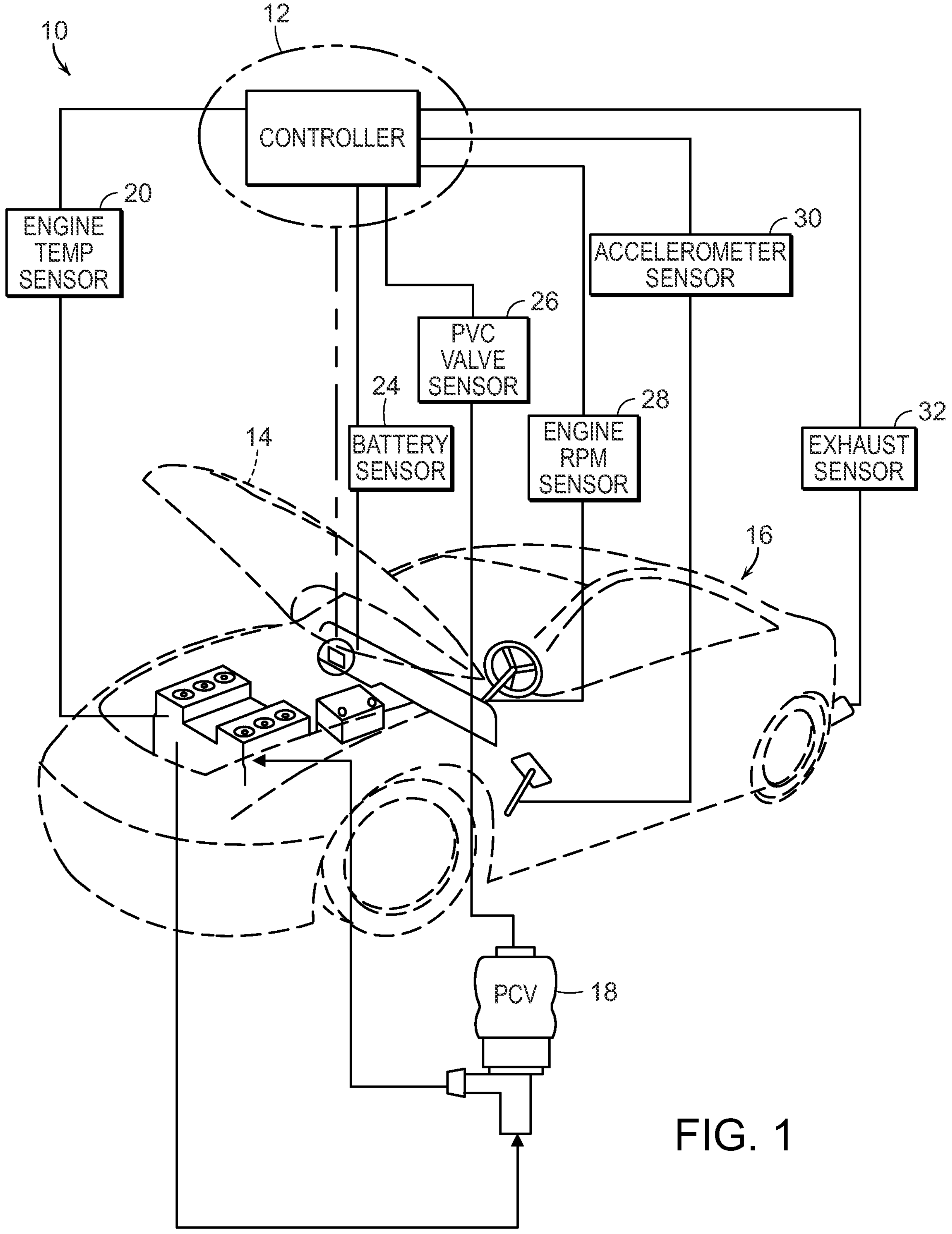
an outlet configured for fluid communication with a fuel/air inlet of the combustion engine; and a two-stage check valve between the inlet and the outlet, wherein the first stage of the check valve is configured to be opened or closed by a solenoid mechanism responsive to a controller, and the second stage of the check valve is biased in a closed position so as to open only under vacuum pressure in the combustion engine greater than a predetermined threshold.

[Claim 19] The PCV valve of claim 18, wherein the inlet of the PCV valve is fluidly connected to the port on the engine oil cap by a hose.

[Claim 20] The PCV valve of claim 18, wherein the inlet of the PCV valve is co-extensive with the port on the engine oil cap.

[Claim 21] The PCV valve of claim 20, wherein the engine oil cap is integrally formed with the PCV valve such that the inlet is the port on the engine oil cap.

[Claim 22] The PCV valve of claim 18, further comprising a filter screen covering the port in the engine oil cap.



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CONTROLLER
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ENGINE TEMP SENSOR
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ACCELEROMETER SENSOR
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PVC VALVE SENSOR
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BATTERY SENSOR
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ENGINE RPM SENSOR
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EXHAUST SENSOR
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PCV
18

FIG. 1

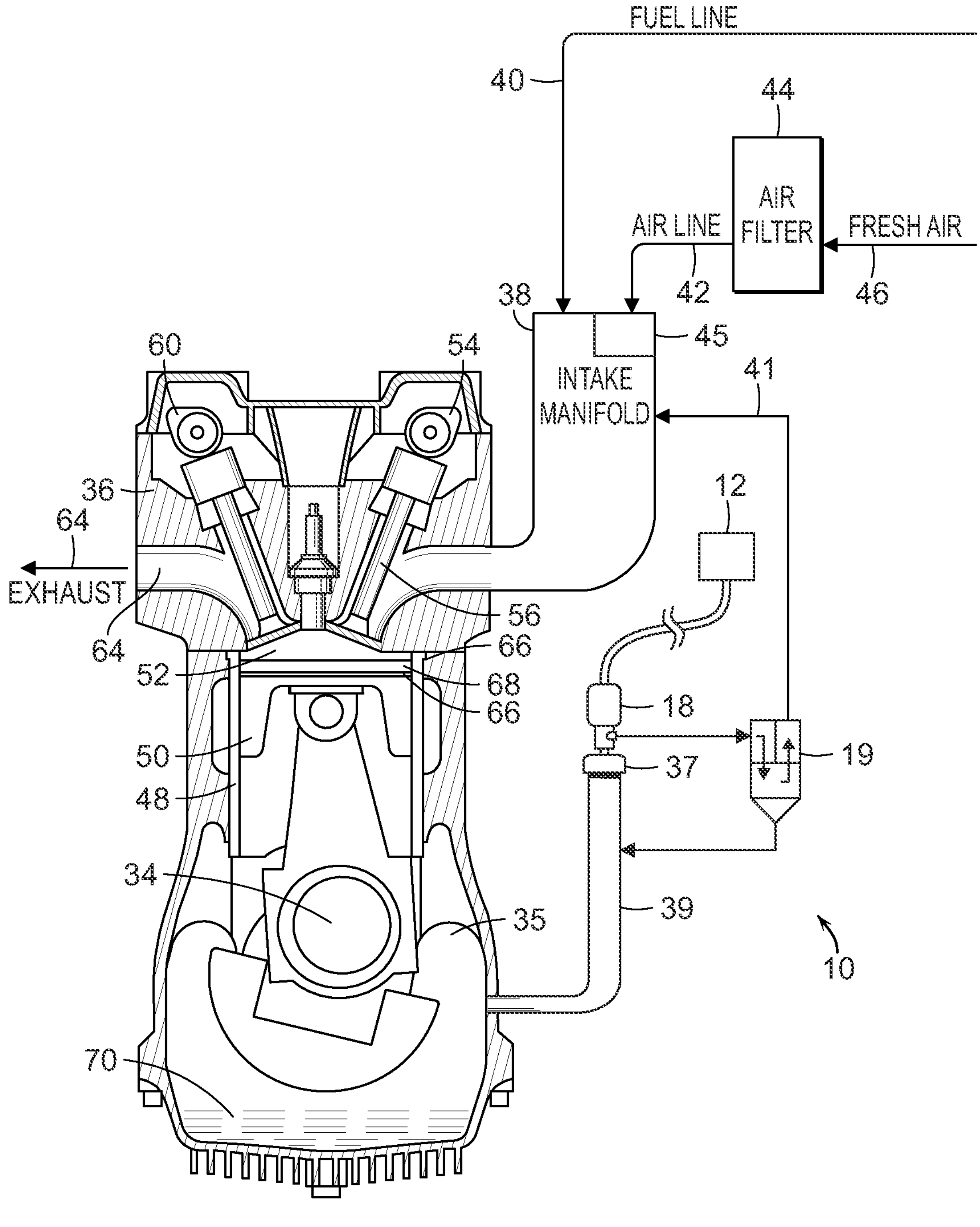
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FIG. 2

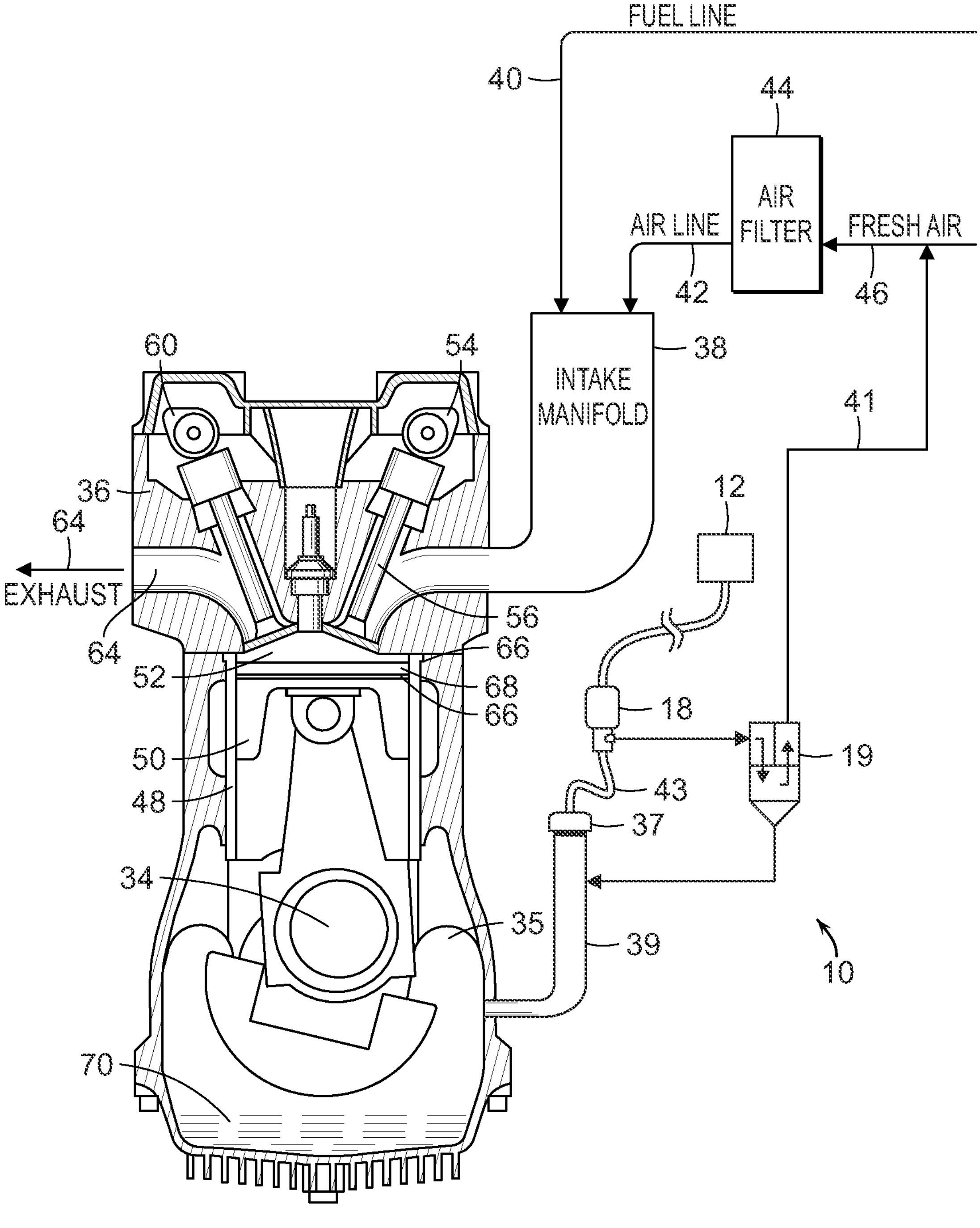
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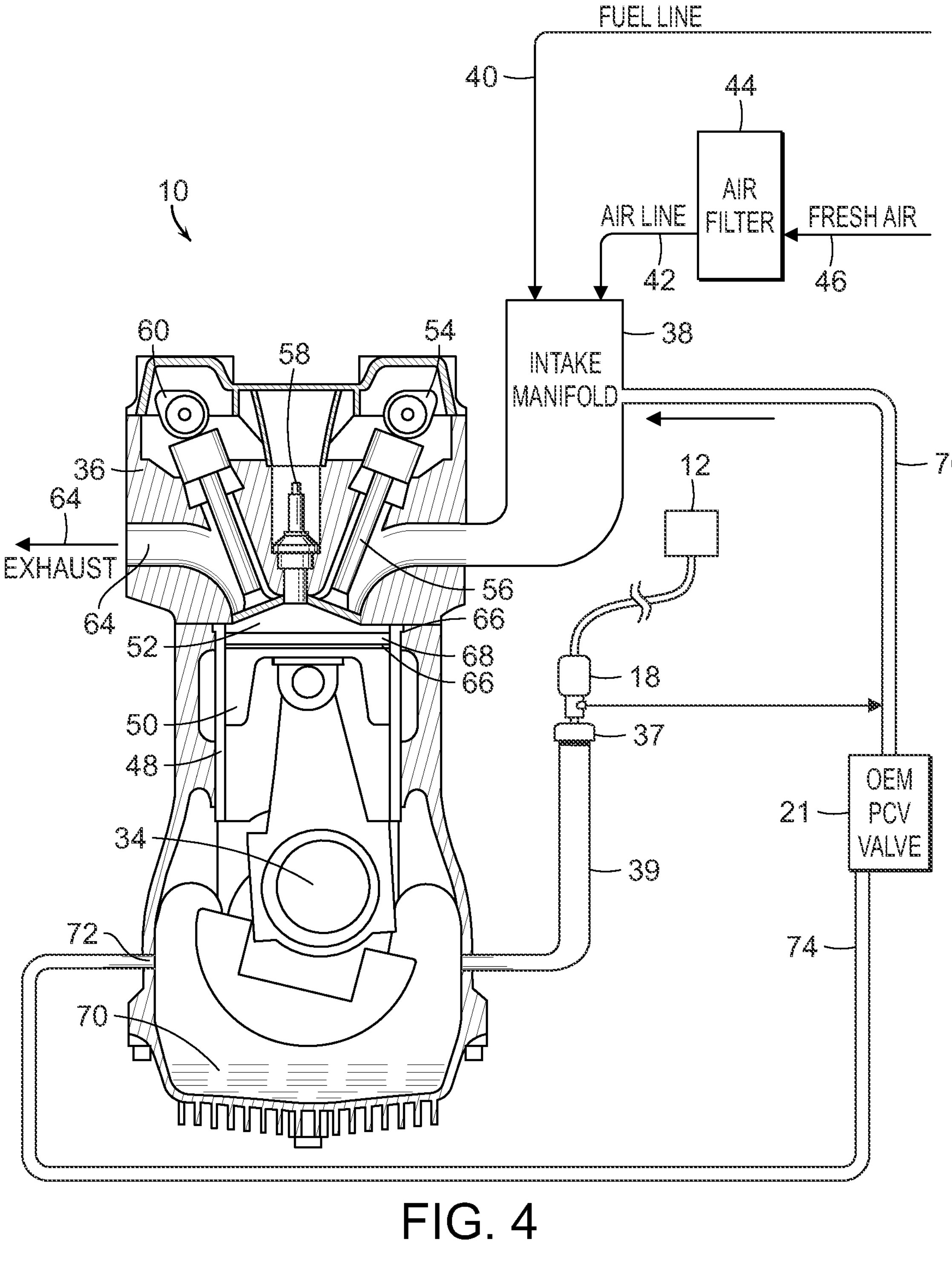
FIG. 3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OEM PCV VALVE
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FIG. 4

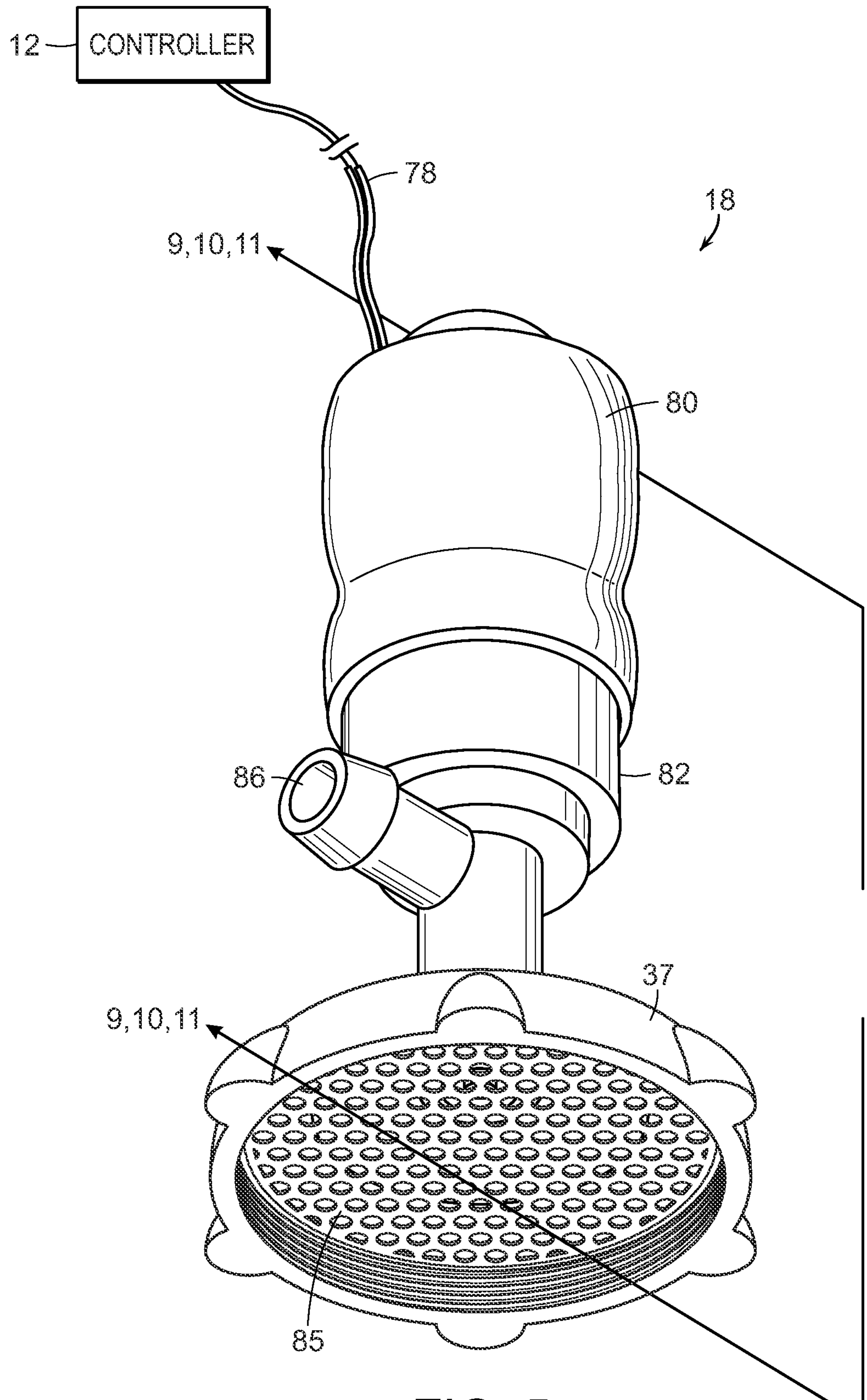

FIG. 5

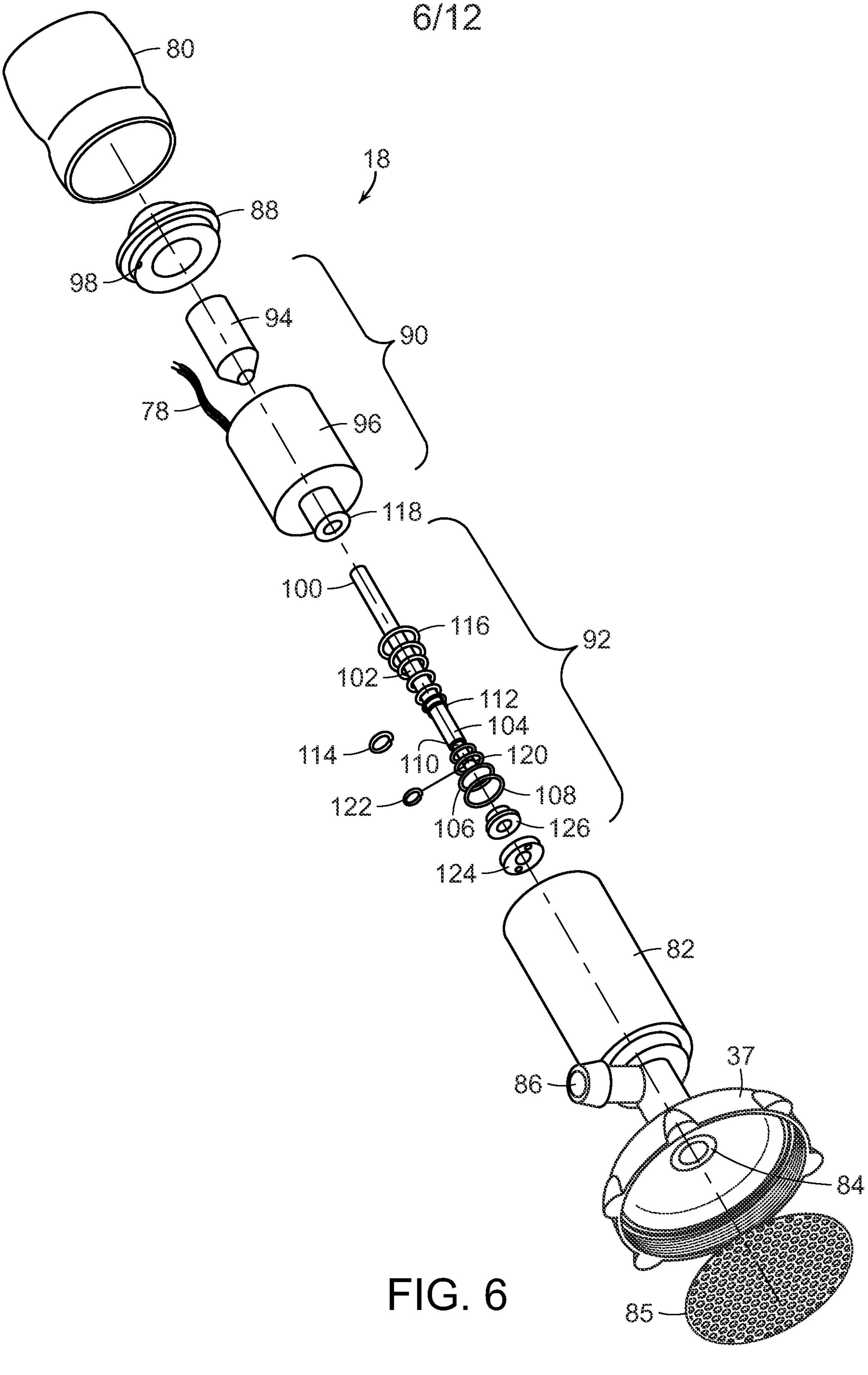
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FIG. 6

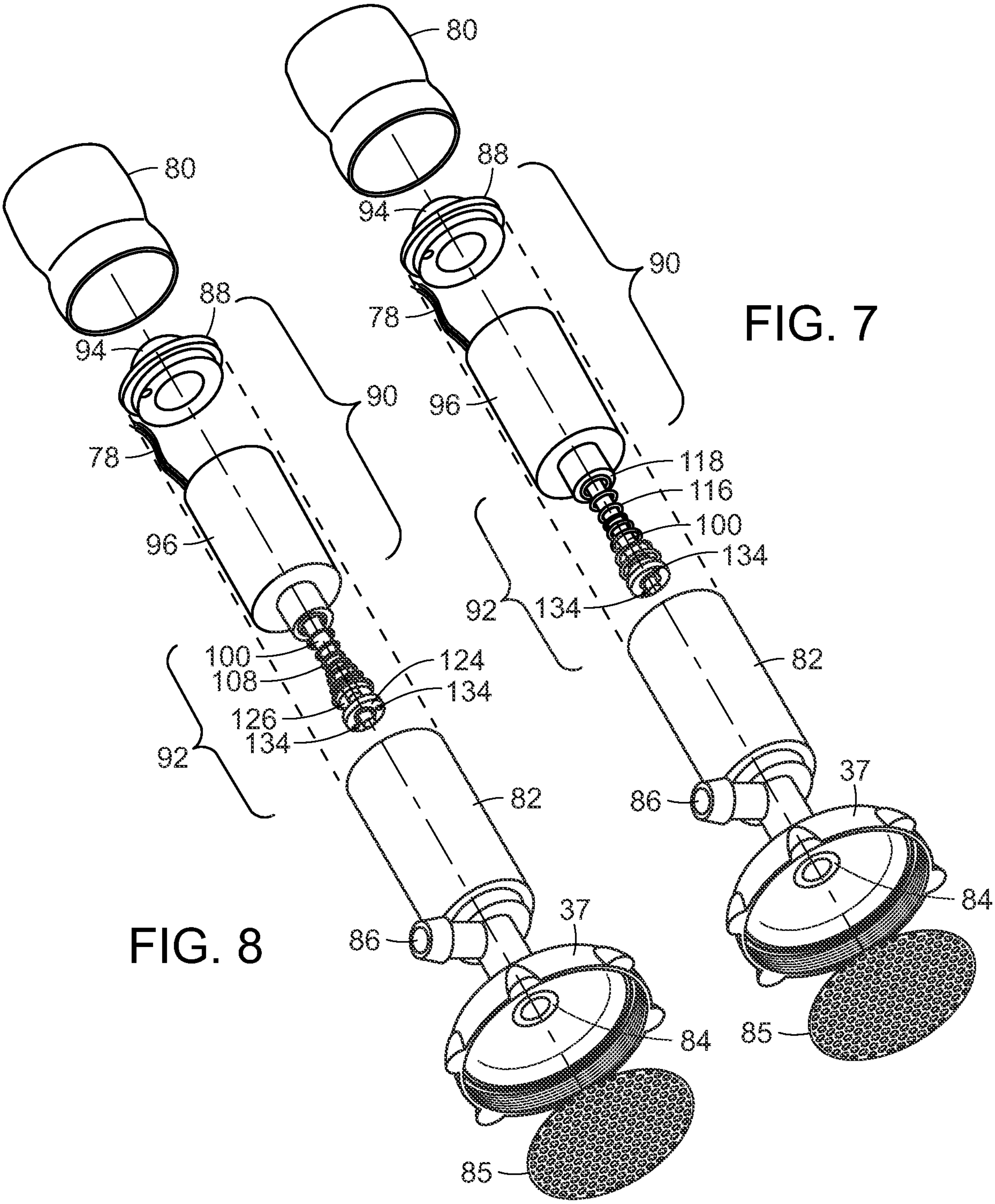
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FIG. 7

FIG. 8

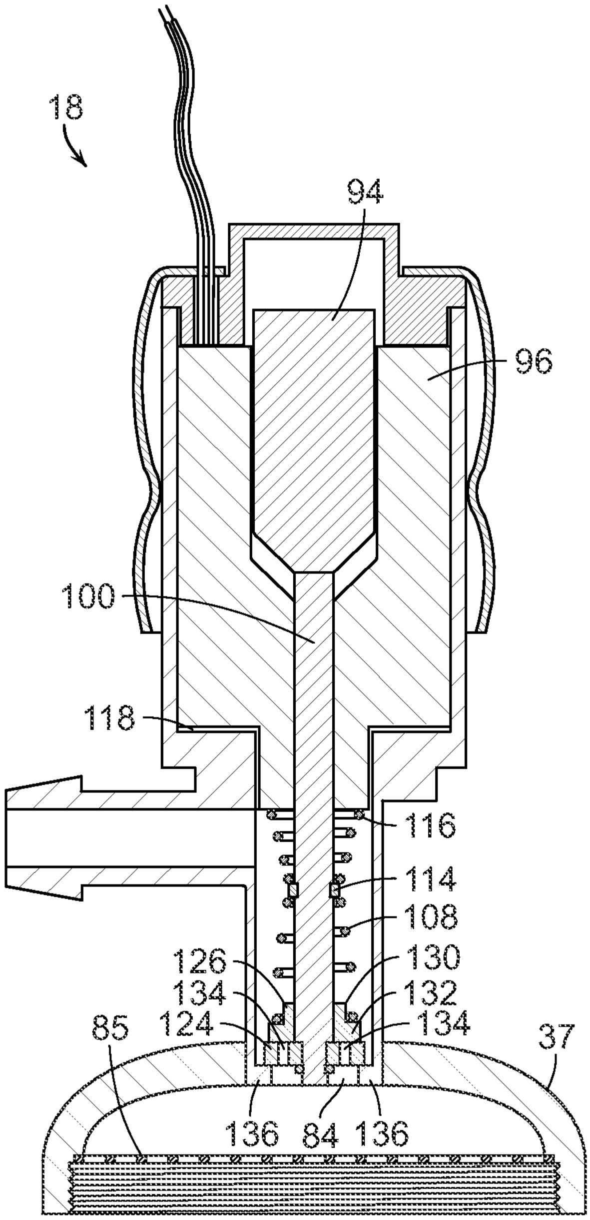
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FIG. 9

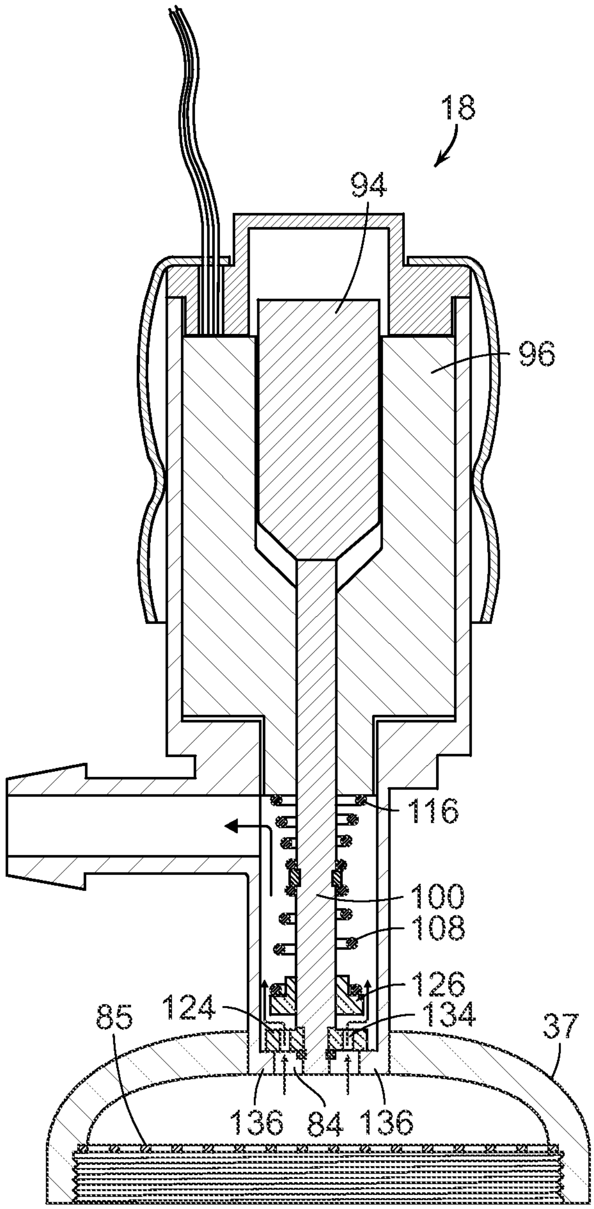
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FIG. 10

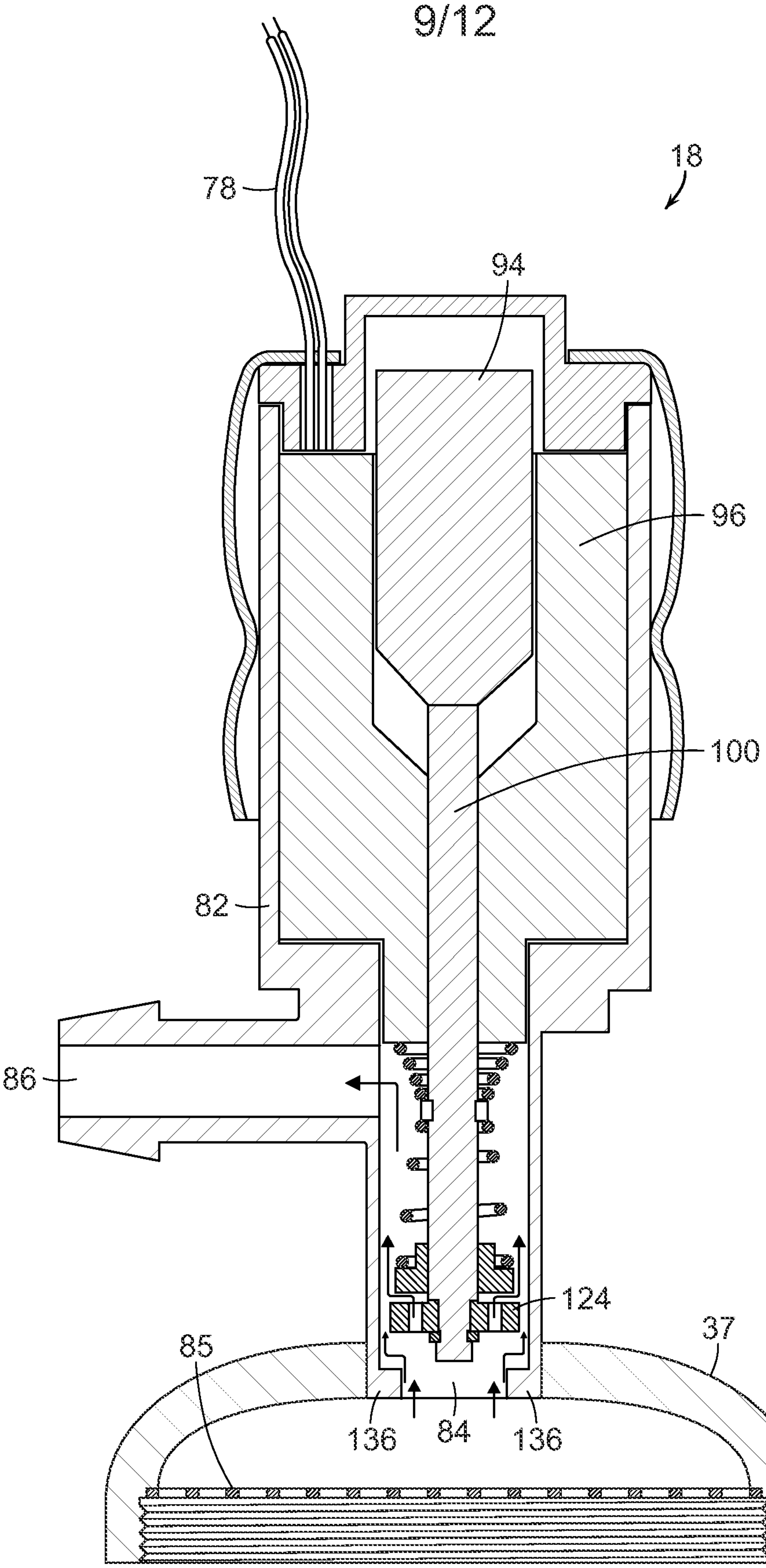

FIG. 11

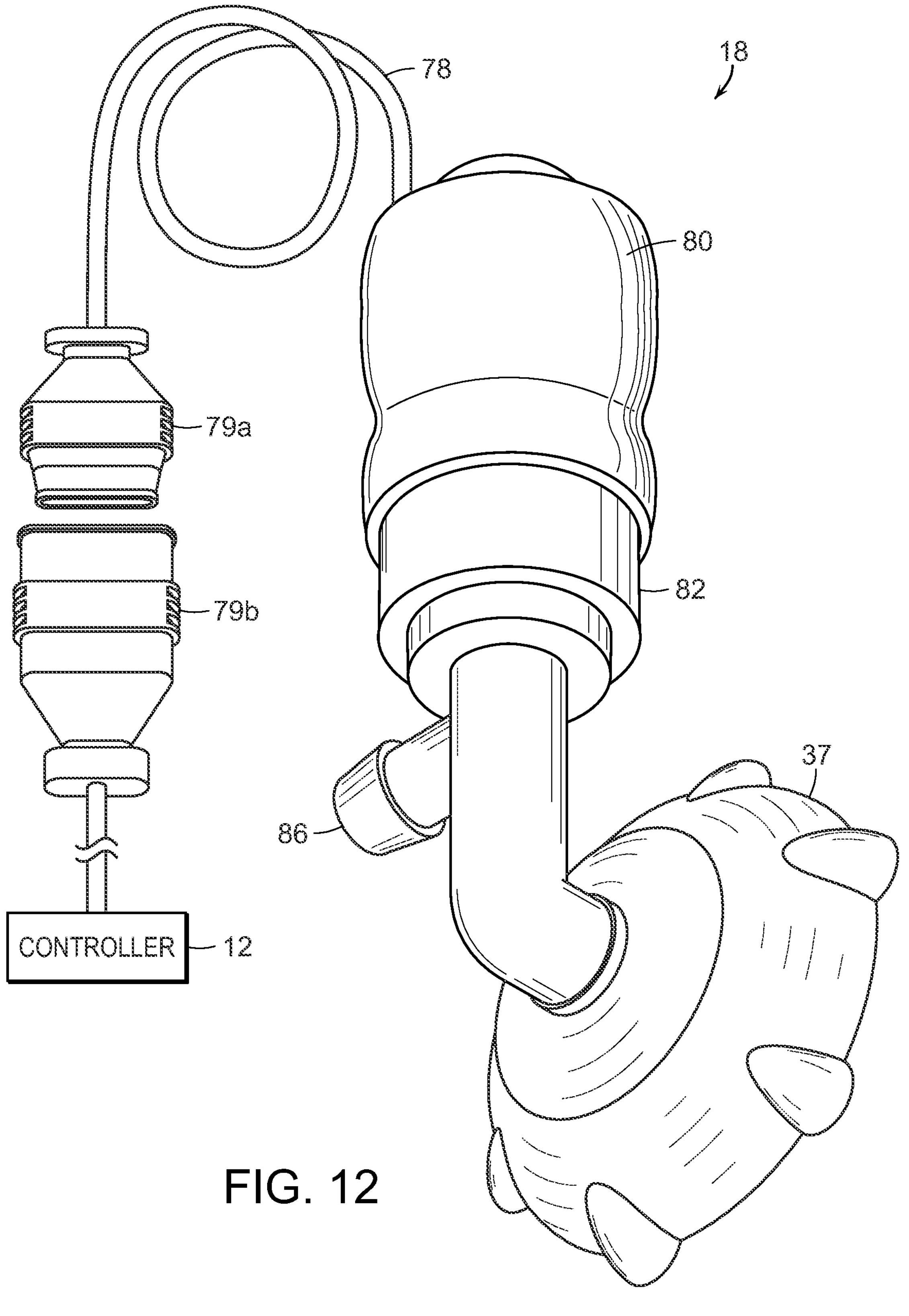

FIG. 12

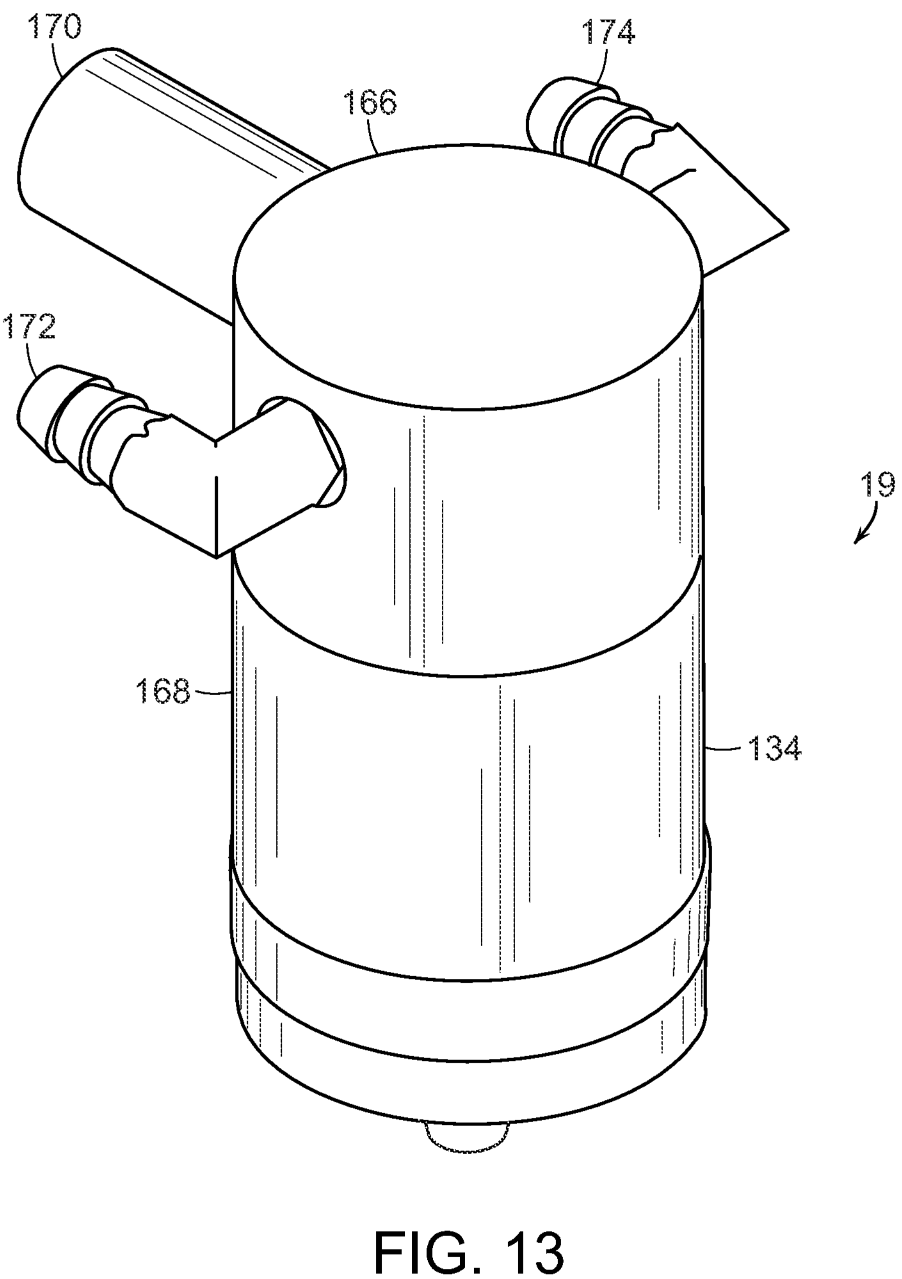

FIG. 13

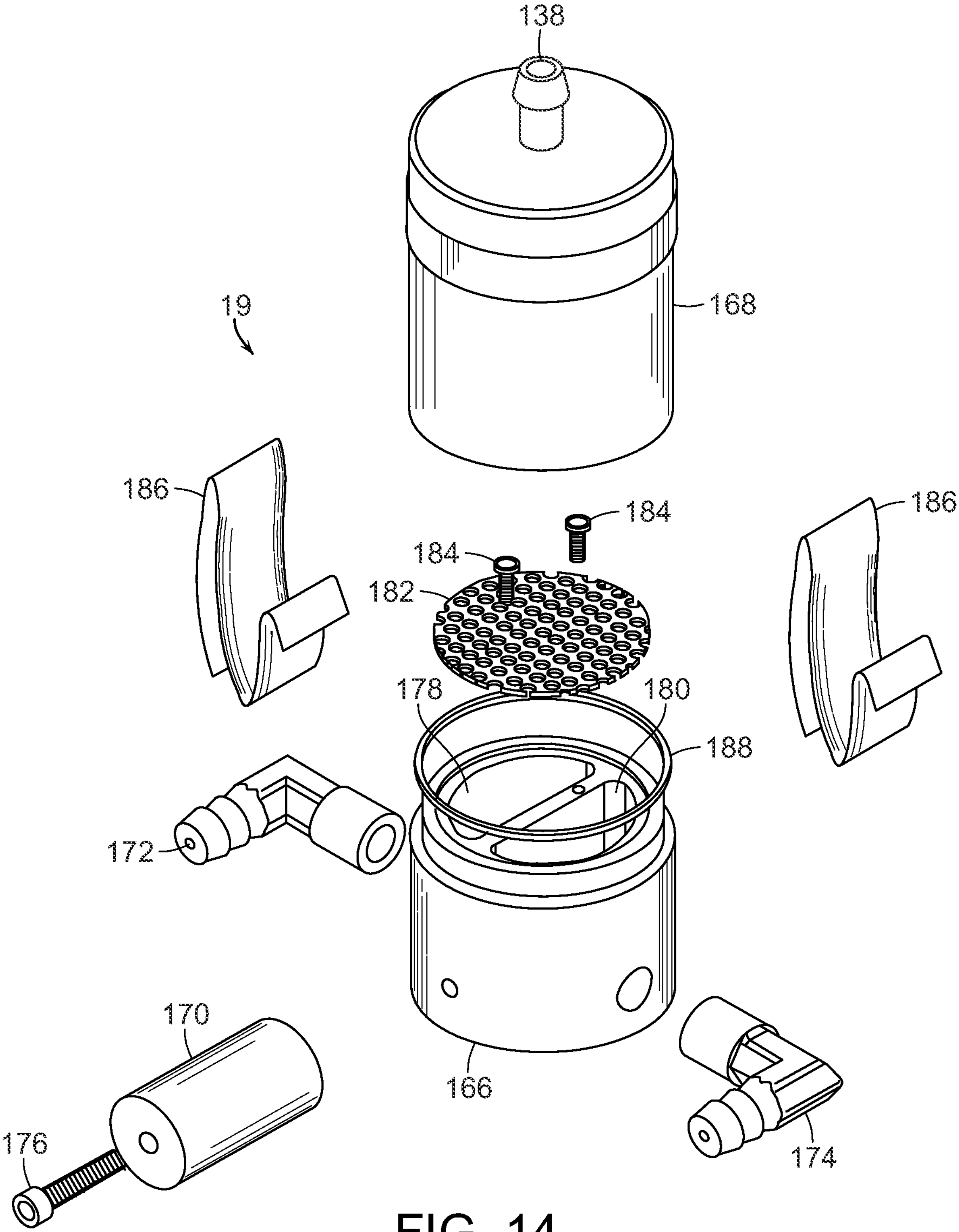

FIG. 14

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2013/063803

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - F01M 13/00 (2014.01)
USPC - 123/574
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)
IPC(8) - F02B 25/06; F01M 13/00 (2014.01)
USPC - 123/1A, 3, 41.86, 574; 701/103

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
CPC - F01M 13/0011 (2013.01)

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
Delphion, Orbit, Google

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2010/0180872 A1 (MONROS) 22 July 2010 (22.07.2010) entire document	1-7, 9-18, 20-22
Y	US 4,169,432 A (WHITE) 02 October 1979 (02.10.1979) entire document	1-7, 9-18, 20-22
Y	US 2011/0308504 A1 (KOBAYASHI et al) 22 December 2011 (22.12.2011) entire document	7

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* Special categories of cited documents:
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Date of the actual completion of the international search	Date of mailing of the international search report
10 February 2014	06 MAR 2014

Name and mailing address of the ISA/US	Authorized officer:
Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	Blaine R. Copenheaver PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

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代理人 程伟 王锦阳

(51)Int.Cl.
F01M 13/00(2006.01)

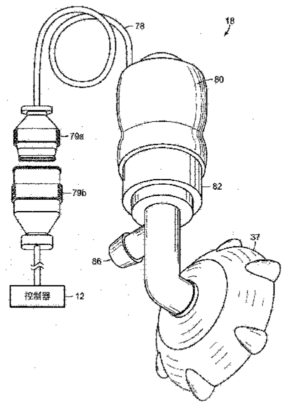
权利要求书2页 说明书13页 附图13页

(54)发明名称

PCV 阀与污染控制系统

(57)摘要

一种内燃机的PCV阀及污染控制系统。该PCV阀具有入口及出口，适用于从内燃机的曲轴箱排出漏气。该PCV阀的入口与在引擎油导入管上的引擎油盖端口流体连通。该PCV阀可以是与该引擎油盖一体成形，或是通过软管与其连接。该PCV阀的出口端将排出的漏气引导到燃料／空气入口，进入到该引擎的燃烧室。该PCV阀与该引擎油盖的结合有助于该系统安装在内燃机上。



CN 104822913 A

1.一种污染控制系统,包括 :

控制器,耦合至感测器,用以监测内燃机的运作特性,

其中该控制器用于选择性地调节引擎真空压力,以可调整的方式增加或减少从该内燃机排出的漏气的流体流速 ;以及

PCV 阀,适用于从该内燃机的曲轴箱中排放漏气,该 PCV 阀的入口与该内燃机的引擎油盖的端口流体连通,使得该漏气通过油填充管被排放到该曲轴箱,而该 PCV 阀的出口与该内燃机的燃料 / 空气入口流体连通,其中该 PCV 阀包括二阶段逆止阀,第一阶段由该控制器指引,而第二阶段与 OEM 设定相容,其中该逆止阀仅于当该控制器故障的情况下,在足够的真空压力下才打开。

2.如权利要求 1 所述的污染控制系统,其中,该 PCV 阀的该入口是与该引擎油盖上的该端口共同延伸。

3.如权利要求 2 项所述的污染控制系统,其中,该 PCV 阀是与该引擎油盖一体形成,使得该 PCV 阀的该入口是该引擎油盖上的该端口。

4.如权利要求 1 所述的污染控制系统,还包括在该引擎油盖中的该端口上方的过滤器滤网。

5.如权利要求 1 所述的污染控制系统,其中,该 PCV 阀的该出口是与 OEM 污染控制系统上的循环管线流体连通,且其中该 OEM 污染控制系统是直接从该曲轴箱排出。

6.如权利要求 1 所述的污染控制系统,其中,该燃料 / 空气入口包括进气歧管、燃料管线、空气管线、或新鲜空气进气管。

7.如权利要求 6 所述的污染控制系统,其中,该燃料 / 空气入口是新鲜空气进气管,供空气过滤器供给到该内燃机上的增压器。

8.如权利要求 1 所述的污染控制系统,还包括与该 PCV 阀的该出口流体连通的油分离器,该油分离器的油出口是与该内燃机的该曲轴箱流体连通,且该油分离器的气体出口是与该内燃机的该燃料 / 空气入口流体连通。

9.如权利要求 1 所述的污染控制系统,其中,该内燃机用于燃烧汽油、甲醇、柴油、乙醇、压缩天然气、液化丙烷气、氢气,或醇系燃料。

10.如权利要求 1 所述的污染控制系统,其中,该控制器在减少生产漏气期间,降低该引擎真空压力以降低通过该 PCV 阀的该流体流速,并在提高生产漏气期间,增加该引擎真空压力以增加通过该 PCV 阀的该流体流速。

11.如权利要求 10 所述的污染控制系统,其中,该控制器包括预编程软件程式、可闪存更新的软件程式、或是行为学习软件程式。

12.如权利要求 11 项所述的污染控制系统,其中,该控制器包括无线发送器或无线接收器。

13.如权利要求 10 所述的污染控制系统,其中,该控制器包括耦合到引擎转速感应器的窗开关,且其中该引擎真空压力是基于预定引擎转速或由该窗开关设定的多个引擎转速来调节。

14.如权利要求 1 所述的污染控制系统,其中,该控制器包括通电延迟定时器,以便阻止活化该内燃机之后的预定持续时间的漏气流动。

15.如权利要求 14 所述的污染控制系统,其中,该预定持续时间为时间、引擎温度、或

是引擎转速的函数。

16. 如权利要求 1 所述的污染控制系统，其中，该感应器包括引擎温度感应器、火星塞感应器、加速计感应器、PCV 阀感应器、或是排气感应器。

17. 如权利要求 16 所述的污染控制系统，其中，该运作特性包括引擎温度、引擎汽缸数量、即时加速度计算、或是引擎转速。

18. 一种适用于从内燃机的曲轴箱排出漏气的 PCV 阀，该 PCV 阀包括：

入口，与引擎油盖的端口流体连通，该引擎油盖用于将油填充管附接到该曲轴箱；

出口，用于与该内燃机的燃料 / 空气入口流体连通；以及

二阶段逆止阀，设置在该入口与该出口之间，其中该逆止阀的第一阶段用于通过与控制器反应的电磁圈机构来被打开或关闭，且该逆止阀的第二阶段是被偏压在关闭位置，以便仅在该内燃机内的真空压力大于预定阈值下打开。

19. 如权利要求 18 所述的 PCV 阀，其中，该 PCV 阀的该入口通过软管而流畅地连接到该引擎油盖上的该端口。

20. 如权利要求 18 所述的 PCV 阀，其中，该 PCV 阀的该入口与该引擎油盖上的该端口共同延伸。

21. 如权利要求 20 所述的 PCV 阀，其中，该引擎油盖与该 PCV 阀一体形成，使得该入口即是该引擎油盖上的该端口。

22. 如权利要求 18 所述的 PCV 阀，还包括覆盖在该引擎油盖中的该端口的过滤器滤网。

PCV 阀与污染控制系统

技术领域

[0001] 本发明一般是关于控制污染的系统。更具体而言，本发明是有关于一种系统，其过滤引擎燃料副产物以供通过 PCV 阀组件来进行循环再利用 (recycling)，以便减少废气排放及改善引擎性能。

背景技术

[0002] 标准内燃机的基本操作有些变化是基于燃烧过程的类型、汽缸的数量以及所期望的用途 / 功能性而定。例如，在传统的二冲程引擎中，油在进入曲轴箱之前，是与燃料及空气预先混合。该油 / 燃料 / 空气混合物在吸入过程中被由活塞产生的真空吸进该曲轴箱。该油 / 燃料混合物为在该曲轴箱中的汽缸壁、曲轴以及连杆轴承提供润滑作用。在标准汽油引擎中，该燃料接着在燃烧室中被压缩并且被火星塞点燃而使该燃料燃烧。在柴油引擎中没有火星塞，所以在柴油引擎中的燃烧仅为该燃烧室中的热与压缩所导致的结果。该活塞接着被向下推压，从而允许当该活塞暴露出该排气口时让排出的废气离开汽缸。该活塞运动会加压在该曲轴箱中的剩余的油 / 燃料，并且允许额外的新鲜的油 / 燃料 / 空气急速进入该汽缸中，从而同时推动该剩余的废弃排出该排气口。当该过程重复进行时，动量会驱动该活塞回到该压缩行程。

[0003] 或者，在一四冲程引擎中，该曲轴与连杆轴承之润滑油是从该燃料 / 空气混合物中分离出。在此，该曲轴箱主要填充空气和油。它是进气歧管，用以接收和混合来自不同来源的燃料和空气。在该进气歧管中的燃料 / 空气混合物被汲取到该燃烧室中，其中该燃料 / 空气混合物被火星塞点燃 (在标准汽油引擎中) 并燃烧。在柴油引擎中，该燃料 / 空气混合物被在该燃烧室中的热与压力点燃。藉由一组布置在该活塞汽缸内之活塞外径周围的活塞环，大规模地封闭该燃烧室而与曲轴箱分隔开来。这会使油保存在该曲轴箱中，而不会让它作为如在二冲程引擎中的燃烧行程的一部分来燃烧。不幸地，该活塞环无法完全封闭该活塞汽缸。因此，意图润滑该汽缸的曲轴箱油反而会被吸进该燃烧室并且在燃烧过程中燃烧。另外，燃烧废气包括在汽缸中未燃烧的燃料和废气，它们同时通过该活塞环然后进到该曲轴箱中。进到该曲轴箱的废气通常称为"渗漏 (blow-by)"或"漏气 (blow-by gas)"。

[0004] 漏气主要是由污染物，像是烃 (未燃烧的燃料)、二氧化碳或水蒸气，所有这些都会对该引擎曲轴箱造成损害。该漏气在该曲轴箱中的量可能是烃在进气歧管内的浓度的数倍。单纯地排放出这些气体到大气中会增加空气中的污染。但是捕集 (trapping) 该曲轴箱中的漏气又会使这些污染物从空气中冷凝出来并且随着时间累积在其中。所冷凝出的污染物在该曲轴箱内部形成腐蚀性酸物质及污泥，会稀释掉润滑油。这会降低油润滑该汽缸与该曲轴的能力。未能适当润滑该曲轴箱组件 (例如，该曲轴和该连杆) 的劣化油可能是使引擎性能变差的一个因素。不足够的曲轴箱润滑会造成该活塞环不必要的磨损，同时降低该燃烧室与该曲轴箱之间的密封件的品质。随着引擎老化，该活塞环与该汽缸壁之间的间隙会增加，造成大量的漏气进入该曲轴箱中。太多的漏气进到该曲轴箱中会造成功率损耗，甚至会使引擎故障。而且，在该漏气中的冷凝水可能会造成引擎元件生锈。

[0005] 这些问题对于柴油引擎特别明显。柴油引擎燃烧柴油燃料，其比汽油更油腻且更重。当燃烧时，柴油燃料会产生致癌物质、颗粒状物质（烟灰）、以及 NOx（氮污染物）。这就是为什么大多数的柴油引擎与大钻机卡车从其排气管吐出黑烟的印象相关联。同样地，在柴油引擎之曲轴箱中产生的漏气比汽油产生的漏气更加油腻且更重。因此，研发出针对柴油引擎的曲轴箱通风系统，来补救存在于该曲轴箱中的漏气。通常，曲轴箱通风系统把漏气从曲轴箱强制通风 (PCV) 阀排出，并且引入到该进气歧管进行重新燃烧。在柴油引擎中，该柴油漏气比在汽油引擎中更重且更油腻。因此，该柴油漏气必须在它们能通过该进气歧管进行循环再利用之前先被过滤。

[0006] PCV 阀从该曲轴箱再循环（即排放）漏气回到该进气歧管，以在燃烧过程中重新供给空气 / 燃料，来进行再燃烧。这是特别理想的，因为有害的漏气不会轻易被排放到大气中。曲轴箱通风系统也应设计成限制（或理想地消除）该曲轴箱中的漏气，以使得该曲轴箱尽可能维持干净。早期的 PCV 阀包括简单的单向逆止阀 (one-way check valves)。这些 PCV 阀仅靠该曲轴箱与进气岐管之间的压力差来正常运作。当活塞于进气期间向下行进时，该进气歧管中的空气压力变得比周遭的大气环境更低。这个结果通常称为”引擎真空”。该真空把空气挤向该进气歧管。因此，空气能够从该曲轴箱中被抽出而通过 PCV 阀在其间所提供的导管，进到该进气歧管。该 PCV 阀基本上是打开单向通道，让漏气从该曲轴箱排回到该进气歧管。在压力差改变的情况下（即该进气歧管中的压力变得比该曲轴箱中的压力相对要高），PCV 阀关闭，并防止气体离开该进气歧管和进入该曲轴箱。因此，该 PCV 阀是为”正向 (positive)”曲轴箱通风系统，其中，气体仅被允许往一个方向流动 - 从该曲轴箱出而进入该进气歧管。该单向逆止阀基本上是一个全开或全关阀 (all-or-nothing valve)。即是说，当该进气歧管内的压力相对小于该曲轴箱内的压力时，该阀在此期间是完全打开。或者，当该曲轴箱内的压力相对小于该进气歧管内的压力时，该阀完全关闭。以单向逆止阀为基础的 PCV 阀无法在任何时候决定 (account for) 存在于曲轴箱内的漏气变化量。在该曲轴箱内的漏气变化量会在不同的驱动条件下以及因为引擎的制造商及型号而变化。

[0007] PCV 阀的设计已经过改良超越该基本的单向逆止阀，能够更佳调节从该曲轴箱排出到该进气歧管的漏气量。PC 阀的设计采用弹簧相对于通风口来定位内部节流器（像是锥形或盘形），通过该通风口让该漏气从该曲轴箱流到该进气歧管。该内部节流器是定位在靠近该通风口的地方，其距离是与引擎真空相对于弹簧张力的程度成正比。该弹簧的目的是为了对于在该曲轴箱与该进气歧管之间的真空压力变化做出反应。这个设计是想要改善这个全开或全关的单向逆止阀。例如，在闲置的时候，引擎真空压力高。该弹簧偏置 (spring-biased) 节流器是被设定成即使该引擎制造出相对少量的漏气，在大压力差下用来排放大量漏气。该弹簧定位该内部节流器，从而实质上允许空气从该曲轴箱流到该进气歧管。在加速时，由于引擎负荷增加，使得该引擎真空降低。因此，即使该引擎制造出更多的漏气，该弹簧能够将内部节流器向下推，减少空气从该曲轴箱流到该进气歧管。当车辆朝着恒定航速移动时，真空压力则会随着加速度减小（即引擎负荷减少）而增加。再者，该弹簧会把内部节流器拉回远离通风口到一个实质上允许空气从该曲轴箱流向该进气歧管的位置。在这种情况下，因为引擎在由于较高的引擎转速的航速下会产生更多的漏气，所以希望借着该压力差，增加空气从该曲轴箱流向该进气歧管。因此，仅依赖引擎真空与弹簧偏置节流器的这种 PCV 阀改善并不会让漏气从该曲轴箱排放到该进气歧管达到最优化，特别是

在车辆不断变化速度的情况下（例如，市内驾驶或走走停停的公路交通）。

[0008] 曲轴箱通风的一个关键点是，引擎真空是以引擎负荷作为函数来变化，而非引擎速度与漏气变化量，某程度上，是以引擎速度为函数，而非引擎负荷。例如，当引擎速度保持相对稳定时（例如在定速下空转或驱动），引擎真空较高。因此，当引擎正在空转（idling）时（或许是每分钟900转（rpm））所表现出的引擎真空的量，基本上等同于在公路上以定速巡航时（例如2500到2800rpm之间）所表现出的引擎真空的量。在2500rpm时的漏气生产速率远比在900rpm还要高。但是，因为以弹簧为基础的PCV阀在不同的引擎速度下在该进气歧管和该曲轴箱之间经历相似的压力差，所以以弹簧为基础的PCV阀无法决定在2500rpm与900rpm之间的漏气产量差距。该弹簧仅对空气压力的改变作出反应，这是以引擎负荷为函数而非引擎速度。举例来说，引擎负荷通常在加速或爬坡时增加。随着车辆加速时，漏气产量也跟着增加，但是由于引擎负荷增加，使得该引擎真空降低。因此，以弹簧为基础的PCV阀在加速时从该曲轴箱排出的漏气量可能会不足。因为该弹簧仅对引擎真空作出反应，所以此种以弹簧为基础的PCV阀系统无法排出以漏气生产为主的漏气。

[0009] Collins的美国专利第5228424号，其内容以引用的方式并入本文，是一个以二阶段弹簧为基础的PCV阀，用以调节从该曲轴箱排到该进气歧管之漏气的例子。具体来说，Collins揭露一种PCV阀具有两个圆盘于其中，用以调节在该曲轴箱和该进气歧管之间的空气流动。第一圆盘具有一组孔洞在其中，并且被设置在通风口与该第二圆盘之间。第二圆盘的尺寸设计成覆盖第一圆盘的孔洞。当极少或完全没有真空存在时，该第二圆盘会被保持紧靠该第一圆盘，从而导致两个圆盘皆保持紧靠着该通风口。而新的结果是会允许小气流过该PCV阀。增加的引擎真空会推动该圆盘紧靠弹簧而远离该通风口，从而允许更多漏气从该曲轴箱流入，通过该PCV阀而回到该进气歧管。引擎真空的微量存在会造成至少该第二圆盘从该第一圆盘移开，使得少量的漏气通过上述第一圆盘的孔洞，从该引擎曲轴箱排出。每当该节流阀的位置表示出该引擎是在低定速下运作（例如，空转时）时，该第一圆盘通常会实质覆盖该通风口。当车辆加速时，该第一圆盘可能会从该通风口移开，以增加该漏气排出该曲轴箱的速率。当该节流阀位置表示出该引擎是正在加速或是在更高定速下运作时，第一圆盘也可能从该通风口移开。该第一圆盘的位置主要是基于节流阀的位置，而该第二圆盘的位置主要是基于该进气歧管和该曲轴箱之间的真空压力。但是，漏气产量并非仅基于真空压力、节流阀位置、或它们的组合。反之，漏气产量是基于多个不同的因素，包括引擎负荷。因此，当该引擎负荷在类似的节流阀位置变化时，Collins的PCV阀也不适当地从该曲轴箱排放漏气到该进气歧管。

[0010] PCV阀的维护重要且相对简单。该润滑油必须定期更换，以移除随着时间存留于其中的有害污染物。在适当时间间隔下（通常每3000到6000英里）没有更换该润滑油可能导致PCV阀系统被污泥污染。堵塞的PCV阀系统最终将损害该引擎。假设润滑油有在适当时间间隔下进行更换，PCV阀系统应能保持清洁维持引擎寿命。

[0011] 现有技术的污染控制系统需要对含有漏气的曲轴箱或类似的引擎隔间开孔或钻洞，以便循环再利用该漏气。此种对曲轴箱的开孔或钻洞会有损害该引擎体或是伤害该引擎完整性的风险。另外，因为要把新的PCV阀安装到引擎隔间或是要靠近现有的PCV阀进行移除和更换都有其困难度，因此，不论是OEM或售后市场，在引擎上安装PCV阀的动作都可能是一个复杂或耗时的过程。

[0012] 因此,需要一种能够更简单、更方便以及花更少成本来安装的污染控制系统或相对应的 PCV 阀。本发明满足这些需求并且提供其它相关的优点。

发明内容

[0013] 本发明涉及一种 PCV 阀,适于从内燃机之曲轴箱排出漏气。本发明之 PCV 阀的入口是与引擎油盖上的端口流体连通,该引擎油盖被建构为将油填充管附接到该曲轴箱。本发明之 PCV 阀之出口被建构为与该内燃机之燃料 / 空气入口流体连通。本发明之 PCV 阀包括在该入口与该出口之间的二阶段逆止阀。该逆止阀的第一阶段是用于通过与控制器反应的电磁圈机构打开或关闭。该逆止阀的第二阶段是偏压在关闭位置,以便仅在内燃机内的真空压力大于预定阈值下打开。

[0014] 该 PCV 阀之入口可通过软管流畅地连接到该引擎油盖上之端口。或者是,该 PCV 阀之入口可与该引擎油盖上之端口共同延伸,使得该引擎油盖与该 PCV 阀一体形成,并且该 PCV 阀之入口即是该引擎油盖上之端口。过滤器滤网较佳地覆盖该引擎油盖中的端口。

[0015] 在污染控制系统,该 PCV 阀再次适于从该内燃机之曲轴箱排放漏气。该 PCV 阀之入口是与该内燃机之引擎油盖上的端口流体连通,使得该漏气通过该曲轴箱之油填充管被排放出。该 PCV 阀之出口是与该内燃机之燃料 / 空气入口流体连通。该 PCV 阀再次包括二阶段逆止阀,其中该第一阶段由该控制器指引,而该第二阶段与 OEM 设定相容,使得该逆止阀仅于当该控制器故障的情况下,在足够的真空压力下才打开。该控制器耦合到用以监测该内燃机之运作特性的感应器。该控制器用以选择性调节引擎真空压力,以可调整的方式增加或减少漏气从该内燃机排出的流体流速。

[0016] 该 PCV 阀之入口可与该引擎油盖上之端口共同延伸,使得该 PCV 阀是与该引擎油盖一体形成,而且该 PCV 阀之入口即是该引擎油盖上的端口。过滤器滤网可被包含在该引擎油盖中之端口上方。

[0017] 该 PCV 阀之出口可与 OEM 污染控制系统上之循环管线流体连通,其中该 OEM 污染控制系统是直接从该曲轴箱排出,而且该循环管线供给到该燃料 / 空气入口。该燃料 / 空气入口可为进气歧管、燃料管线、空气管线、或新鲜空气进气管。该燃料 / 空气入口可以是新鲜空气进气管,供空气过滤器供给到该内燃机之增压器。

[0018] 该系统也可包括与该 PCV 阀之出口流体连通的油分离器。该油分离器之油出口是与该内燃机之曲轴箱流体连通。该油分离器之气体出口是与该内燃机之燃料 / 空气入口流体连通。

[0019] 该内燃机可用汽油、甲醇、柴油、乙醇、压缩天然气、液化丙烷气、氢气,或醇系燃料运作。

[0020] 该控制器可在减少生产漏气期间,降低该引擎真空压力以降低通过该 PCV 阀之流体流速,并在提高生产漏气期间,增加该引擎真空压力以增加通过该 PCV 阀之流体流速。该控制器较好包括预编程软件程式,可闪存更新的软件程式,或是行为学习软件程式。该控制器也可包括无线发送器或无线接收器。该控制器还可包括耦合到引擎转速感应器的窗开关,其中该引擎真空压力是基于预定引擎转速或由该窗开关设定的多个引擎转速来调节。

[0021] 该控制器也可包括通电延迟定时器,以便阻止活化该内燃机之后的预定持续时间的漏气流动。该通电延迟定时器之预定持续时间可以是时间、引擎温度、或是引擎转速的函

数。该感应器可包括引擎温度感应器、火星塞感应器、加速计感应器、PCV 阀感应器定时或是排气感应器。另外，该运作特性包括引擎温度、引擎汽缸数量、即时加速度计算定时或是引擎转速。

[0022] 本发明之其他特征与优点将从下文更详细地叙述，并结合附图藉由示例方式说明本发明原理而变得显而易见。

附图说明

[0023] 该附图系图解说明本发明。在这样的附图中：

[0024] 图 1 示意性地示出用于柴油引擎的污染控制装置，具有可操作性地耦合到多个感应器的控制器以及 PCV 阀。

[0025] 图 2 示意性地示出内燃机内的 PCV 阀系统的一般性能。

[0026] 图 3 示意性地示出内燃机内的 PCV 阀系统之一替代实施例的一般性能。

[0027] 图 4 示意性地示出内燃机内的 PCV 阀系统之另一替代实施例的一般性能。

[0028] 图 5 是用于本发明系统之 PCV 阀结合油盖的透视图。

[0029] 图 6 是图 5 之 PCV 阀及油盖的分解透视图。

[0030] 图 7 是图 6 之 PCV 阀的部分分解透视图，示出空气节流器的组件。

[0031] 图 8 是图 6 之 PCV 阀的部分分解透视图，示出该空气节流器的局部真空。

[0032] 图 9 是沿图 5 之线 9-9 得到的 PCV 阀剖面图，显示没有空气流动。

[0033] 图 10 是沿图 5 之线 10-10 得到的 PCV 阀剖面图，显示受限的空气流动。

[0034] 图 11 是沿图 5 之线 11-11 得到的 PCV 阀之另一剖面图，显示完整的空气流动。

[0035] 图 12 是用于本发明系统的 PCV 阀结合油盖之一替代实施例的透视图。

[0036] 图 13 是本发明之油分离器的透视图。

[0037] 图 14 是图 13 之油分离器的分解图。

具体实施方式

[0038] 所示附图式为了方便说明，本发明之适用于内燃机的污染控制系统一般是由附图标记 10 来表示。在图 1 中，所示出的污染控制系统 10 一般具有控制器 12，最好是安装在汽车 16 的引擎盖 14 上。控制器 12 是电耦合到多个感应器中的任何一个，该感应器是用于监视与量测汽车 16 的即时运作状况与性能。控制器 12 通过 PCV 阀 18 的数位控制来调节内燃机内的引擎真空，再藉此调节漏气的流速。控制器 12 接收来自感应器的即时输入，感应器可包括引擎温度感应器 20、电池感应器 24、PCV 阀感应器 26、引擎转速感应器 28、加速计感应器 30 以及排气感应器 32。通过控制器 12 从感应器 20 到 32 得到的数据是用于调节 PCV 阀 18，在下文会有更详细的描述。

[0039] 控制器 12 也可控制车辆引擎中的其它装置。控制器 12 可以控制油流出油滤器或油分离器 19 的流速。控制器 12 也可调节引擎温度，以及充气调节室，其被设计为通过在重新引入燃料之前先充气和混合该燃料，来决定该燃料回到该燃料管线或回到该真空歧管。如果污染控制系统 10 故障，控制器 12 也可以调节净化系统，该净化系统触发该引擎回复到 OEM 系统，无论是 OEM 的 PCV 系统还是其它类型的漏气管理系统。控制器 12 也可以提供警报给该引擎的操作者。该警报能够令 LED 读出器闪烁，以便在故障的情况下报告该引擎实

际感测到的情况以及接收警报。类似像警示或照亮信号的警报能够传达该感测到的情况。控制器 12 可用闪存或其它类似元件来全面升级。这表示相同的控制器 12 和系统 10 几乎可以适用在具有所有不同种燃料的任何类型引擎。污染控制系统 10 适用于任何内燃机。例如，污染控制系统 10 可搭配汽油、甲醇、柴油、乙醇、压缩天然气 (CNG)、液化丙烷气 (LPG)、氢气、醇系燃料或实际上任何其它的可燃气体和 / 或蒸汽引擎来使用。这包括二冲程和四冲程 IC 引擎以及所有轻中型和重型的负载配置。

[0040] 图 2 到图 4 显示出污染控制系统 10 用于内燃机 36 的示意图。如图所示，PCV 阀 18(以及视需要的油分离器 19) 是设置在引擎 36 的曲轴箱 35 与进气歧管 38 之间。在运作时，进气歧管 38 经由管线 42 接收空气。空气过滤器 44 可设置在空气管线 42 与空气进气管线 46 之间，以过滤出新鲜空气进到污染控制系统 10。当活塞 50 从顶部死点 (top dead center) 下压到气缸 48 内时，进气歧管 38 中的空气被传送到活塞气缸 48。当活塞 50 下压，会在燃烧室 52 内制造出真空。因此，以曲轴 34 转速一半的速度运转的输入凸轮轴 54 被设计成用以打开输入阀 56，从而使进气歧管 38 遭受到该引擎真空。因此，空气从进气歧管 38 被吸入到燃烧室 52。

[0041] 一旦活塞 50 是位在活塞气缸 48 的底部，该真空效应终止且空气不再被从进气歧管 38 吸入到燃烧室 52。此时，活塞 50 开始从活塞气缸 48 向上移回，而燃烧室 52 内的空气被压缩。接着，燃料被从燃料管线 40 直接喷射到燃烧室 52 中。该喷射可進一步受到压缩空气管线中的压缩空气帮助。取决于燃料种类，燃烧可以是由火花、压缩、加热或其他已知方法产生。该燃料会在它被喷射到该燃烧室后点燃。

[0042] 在燃烧室 52 中被点燃的燃料 / 空气迅速扩散，导致气缸 48 内的活塞 50 下降。燃烧后，排气凸轮轴 60 打开排气阀 62，让燃烧室 52 的燃烧气体从排气管线 64 逸散出。通常，在燃烧循环中，排出气体的过量部分，“漏气”，会通过安装在活塞 50 之头部 68 的一对活塞环 66。

[0043] 这些漏气进到曲轴箱 35 成为高压高温气体。随着时间一久，像是碳氢化合物、一氧化碳、一氧化二氮和二氧化碳的有害排气，以及微粒，会在这些漏气中从气态中凝结或沉降出来，披覆在曲轴箱 35 内部，并且会与用以润滑曲轴箱 35 内部机构的油 70 混合。柴油污染控制系统 10 设计成将来自曲轴箱 35 的这些漏气的内容物循环回到该燃烧进气口，以供引擎 36 燃烧。这是通过利用曲轴箱 35 和进气歧管 38 之间的压力差来达到。

[0044] 图 2 显示一实施例，其中 PCV 阀 18 是通过引擎油盖 37 与曲轴箱 35 连通。引擎油盖 37 是安装在进到曲轴箱 35 中的油入口管 39 上。油入口管 39 较佳是让油加到引擎 36 的相同端口。在这个实施例中，PCV 阀 18 是与引擎油盖 37 一体形成，使得 PCV 阀 18 之入口端口 84 经过油盖 37 而开通到入口管 39。以这种方式，漏气从曲轴箱 35 被吸入，上到入口管 39，并通过油盖 37。过滤器滤网 85(图 5) 可被包含到油盖 37 的内部，以便当该漏气通过屏幕 85 时从中捕集和去除至少一部分的油。PCV 阀 18 的出口端 86 是与进气歧管 38 流体连通，以便把该漏气传回到燃烧室 52。该漏气可被直接供给到进气歧管 38、空气管线 42、新鲜空气管线 46 或燃料管线 40。在某些类型的引擎 36 中，特别是那些具有增压器 45 用以交替真空和正压力间的操作状态的引擎，该漏气最好是被供给到在增压器 45 之前的空气过滤器 44。PCV 阀 18 是与控制器 12 电连接，以便进行控制，如本文其他地方所述。

[0045] 图 3 显示一实施例，其中 PCV 阀 18 一样通过引擎油盖 37 与曲轴箱 35 相通。然而，

在这个实施例中，PCV 阀 18 通过软管 43 连接到引擎油盖 37。软管 43 通过油盖 37 将 PCV 阀 18 的入口端口 84 与匹配端口 87 连接。类似先前的实施例，漏气被从曲轴箱 35 吸入，上到入口管 39，通过油盖 37 和软管 43，进入到 PCV 阀 18。过滤器滤网 85 可被包含到油盖 37 内部。PCV 阀 18 之出口端 86 是与进气歧管 38 流体连通，以便让该漏气回到燃烧室 52。然而，PCV 阀 18 之出口 86 首先可通过油分离器 19，如下文所述。从油分离器 19 之出口端 174 来的漏气可直接供给到进气歧管 38、空气管线 42、新鲜空气管线 46 或是燃料管线 40。PCV 阀 18 是电连接到控制器 12，以便进行控制，如本文其他地方所述。

[0046] 图 4 显示另一实施例，其中 PCV 阀 18 一样通过引擎油盖 37 与曲轴箱 35 相通。在这个实施例中，PCV 阀 18 一样与引擎油盖 37 一体形成，但可配置如图 3 所示。如同其他实施例，该漏气被从曲轴箱 35 吸入，上到入口管 39，并通过油盖 37。过滤器滤网 85 一样可被包含到油盖 37 内部。在这个实施例中，PCV 阀 18 安装连到 OEM PCV 阀系统，该系统连接到曲轴箱 35 上的出口端口 72。排气管线 74 连接出口端口 72 到 OEM PCV 阀 21，而该 OEM PCV 阀 21 又通过返回管线 76 连接到进气歧管 38 或其他引擎入口。PCV 阀 18 之出口 86 是与 OEM PCV 系统之返回管线 76 流体连通，以便用相同方式让该漏气回到燃烧室 52。PCV 阀 18 电连接到控制器 12，以便进行控制，如本文其他地方所述。在这个实施例中，该漏气主要是经过本发明系统之 PCV 阀 18 来作为阻力最小的路径。OEM PCV 系统倾向具有比那些在本发明 PCV 阀系统 10 还要小的孔或端口。因为该漏气的流速是取决于压力差，即在活塞循环期间产生的真空，所以该漏气会跟随限制最小的路径。

[0047] 在运作上，该漏气通过 PCV 阀 18 离开相对高的压力曲轴箱 35，并且回到所述引擎 36 之燃烧室 52。燃料管线 40 可接收较纯的燃料蒸气，而较不纯的漏气可从曲轴箱 35 经由漏气管线 41 排出到进气岐管 38。这个过程藉由控制器 12 进行数位调节，如图 1 所示。送到燃料管线 40 的燃料蒸气在被重新引入引擎 36 之前可通过该燃料过滤器。

[0048] 图 5 中的 PCV 阀 18 通常经由一对电连接 78 而电耦合到控制器 12。控制器 12 经由该电连接 78 而至少部分调节流经 PCV 阀 18 的漏气量。在图 5 中，PCV 阀 18 包括橡胶壳体 80，该橡胶壳体 80 包围刚性外壳 82 的一部分。连接器电线 78 经由其中的孔洞（未示出）从外壳 82 延伸出。较佳地，外壳 82 是单一的且包括进气口 84 和排气口 86。通常来说，控制器 12 对于外壳 82 内的节流器进行操作，用于调节漏气进到进气口 84 与排出排气口 86 的速率。

[0049] 图 6 显示 PCV 阀 18 的分解透视图。橡胶壳体 80 覆盖端盖 88，其实质上密封于外壳 82，从而包围电磁圈机构 90 和空气流量节流器 92。电磁圈机构 90 包括设置在电磁圈 96 内的柱塞 94。连接器电线 78 操作电磁圈 96 并且经由端盖 88 中的孔洞 98 而延伸通过端盖 88。同样地，橡胶壳体 80 包括孔洞（未示出）以让连接器电线 78 电耦合到控制器 12。

[0050] 一般来说，存在于进气歧管 38 中的引擎真空导致漏气通过 PCV 阀 18 中的进气口 84 从曲轴箱 35 吸入，并且从 PCV 阀 18 中的排气口 86 排出。如图 6 所示的空气流量节流器 92 是一种机构，用于调节从曲轴箱 35 排放到进气歧管 38 的漏气量。调节漏气流速是特别有利，因为污染控制系统 10 能够在较高的漏气产量期间增加漏气从曲轴箱 35 排出的速率，并且在较低的漏气产量期间降低从曲轴箱 35 排出的速率。控制器 12 耦合到多个感应器 20 到 32，以监测汽车 16 的整体效率及运作，并且即时操作 PCV 阀 18，根据由感应器 20 到 32 得到的量测值来最大化漏气的循环再利用。

[0051] 漏气的运作特性及产量对每个引擎而言是独一无二的，且每辆车具有个别的引擎安装于其中。污染控制系统 10 能在工厂或后期制造中安装，以最大化汽车燃料效率，减少有害废气排放，循环再利用油和其他气体，并且除去该曲轴箱内的污染物。污染控制系统 10 的目的是策略性地根据漏气产量从曲轴箱 35 排放漏气，过滤漏气，然后循环再利用任何来自该漏气的油和燃料。因此，控制器 12 根据引擎速度和其他运作特征以及由感应器 20 到 32 得到的即时量测值，进行数位调节并控制 PCV 阀 18。污染控制系统 10 可集成到固定引擎，用于产生能源或用在工业用途。

[0052] 特别是，根据引擎速度以及车辆的其他运作特性来排放漏气，会减少碳氢化合物、一氧化碳、氮氧化物、二氧化碳、和颗粒排放物的总量。污染控制系统 10 藉由在燃烧循环中燃烧这些气体来循环再利用它们及微粒。所以，不再有大量的污染物从引擎经由废气排出。因此，污染控制系统 10 能够为每个引擎减少多达 40％到 50％的空气污染，增加每加仑多达 20％到 30％的输出，提升马力性能，降低引擎磨耗（由于低碳保留于其中）以及降低换油频率约 10 倍。考虑到美国每天消耗约 8.7 亿加仑石油，通过污染控制系统 10 对漏气进行循环再利用减少 15％的话，单在美国一天就能省下 1.3 亿加仑石油。若全世界每天消耗近 33 亿加仑的石油，就能每天省下约 5 亿加仑的石油。

[0053] 在一实施例中，漏气进入 PCV 阀 18 之进气口 84 的量通常如图 6 所示是由空气流量节流器 92 来调节。空气流量节流器 92 包括杆体 100，该杆体 100 具有后部 102、中部 104、以及前部 106。前部 106 的直径稍微小于后部 102 和中部 104。前弹簧 108 同心地设置在中部 104 和前部 106 上方，包括在杆体 100 之前表面 110 上方。前弹簧 108 最好是螺旋弹簧，螺旋弹簧之直径是从进气口 84 朝向前表面 110 减小。内缩套圈 112 将后部 102 与中部 104 隔开，并且提供作为让后卡环 114 能够附接到杆体 100 之处。前弹簧 108 的直径应接近或稍微小于后卡环 114 的直径。后卡环 114 接合到前弹簧 108 的一侧，而后弹簧 116 从电磁圈 96 附近的较宽直径渐缩到接近或稍微小于后卡环 114 之直径。后弹簧 116 最好是螺旋弹簧，并且楔入电磁圈 96 之前表面 118 和后卡环 114 之间。前部 106 也包括内缩套圈 120，其提供一附接点给前卡环 122。前卡环 122 之直径小于锥形前弹簧 108 之直径。前卡环 122 将前盘 124 固定地保持在在杆体 100 之前部 106 上。因此，前盘 124 被固定地楔入到前卡环 122 与前表面 110 之间。前盘 124 具有内直径，其组构成可滑动地接合杆体 100 之前部 106。前弹簧 108 的尺寸被制造成可接合后盘 126，如下文所述。

[0054] 圆盘 124 和圆盘 126 控制漏气进到进气口 84 和排出排气口 86 的量。图 7 和图 8 显示组装到电磁圈机构 90 并且外接到橡胶壳体 80 与外壳 82 的空气流量节流器 92。因此，柱塞 94 安装在电磁圈 96 之后部内，如其中所示。连接器电线 78 耦合到电磁圈 96，并藉由调节传到电磁圈 96 的电流来控制柱塞 94 在电磁圈 96 内的位置。增加或减少通过电磁圈 96 的电流会对应地加大或减小产生于其中的磁场。磁化柱塞 94 通过滑动进入电磁圈 96 或从电磁圈 96 内离开来响应磁场变化。增加通过连接器电线 78 传导到电磁圈 96 的电流会加大电磁圈 96 的磁场，并且导致磁化柱塞 94 在电磁圈 96 内进一步抑制。相反地，减少经由连接器电线 78 供给到电磁圈 96 的电流会缩小其中的电场，并导致磁化柱塞 94 从电磁圈 96 内部内滑出。如将在本文更详细地示出者，柱塞 94 在电磁圈 96 的定位至少部分决定了漏气可能在任何给定时间进到进气口 84 的量。这是通过柱塞 94 与杆体 100 的相互作用以及固定于其上的对应前盘 124 来完成的。

[0055] 图 7 具体显示出在闭合位置的空气流量节流器 92。杆体 100 之后部 102 具有外径，其尺寸约等于电磁圈 96 的内径。因此，杆体 100 可在电磁圈 96 内滑动。由于后部 106 与柱塞 94 的接合，杆体 100 在外壳 82 中的位置取决于柱塞 94 的位置，如图 9 到 11 中更具体地示出者。如图 7 所示，后弹簧 116 被压缩在电磁圈 96 之前表面 118 与后卡环 114 之间。这会将后盘 126 压缩靠抵前盘 124。同样地，前弹簧 108 被压缩在后卡环 114 和后盘 126 之间。这让后盘 126 得以与前盘 124 分开，如图 8 所示。

[0056] 如在图 9 到 11 中更好地示出（沿着图 5 的线 9-9，10-10，和 11-11），前盘 124 包括延伸部 130，其直径小于底部 132 的直径。后盘 126 的底部 132 之尺寸约为锥形前弹簧 108 之直径。以这种方式，前弹簧 108 固定在后盘 126 之延伸部 130 上方，以接合其中直径较大的底部 132 的平坦表面。后盘 126 的内径约为杆体 100 之中部 104 的外径尺寸，其直径小于中部 104 或后部 102 的任一个。在这方面，前盘 124 锁定位在前表面 110 和前卡环 122 之间的杆体 100 之前部 106 上。因此，前盘 124 之位置是取决于杆体 100 耦合到柱塞 94 时之位置。柱塞 94 滑动进入电磁圈 96 内或从电磁圈 96 内离开，取决于电流通过连接电线 78 传导的量，如上所述。

[0057] 图 8 显示 PCV 阀 18，其中在曲轴箱 35 和进气歧管 38 之间所增加的真空造成后盘 126 从进气口 84 缩回，从而让空气流过。在这种情况下，施加在圆盘 126 的引擎真空压力必须克服由前弹簧 108 施加的相反力。这里，小量的漏气可经由前盘 124 中的一对孔洞 134 而通过 PCV 阀 18。

[0058] 图 9 到 11 更具体地显示依据污染控制系统 10 之 PCV 阀 18 的功能。图 9 显示出在闭合位置的 PCV 阀 18。在此，没有漏气可进入进气口 84。如图所示，前盘 124 齐平靠抵定义在进气口 84 中的凸缘 136。后盘 126 之底部 132 的直径在前盘 124 中的孔洞 134 上方延伸且包围前盘 124 中的孔洞 134，以防止任何空气流过进气口 84。在这个位置，柱塞 94 是设置在电磁圈 96 内，从而压迫杆体 100 朝向进气口 84。后弹簧 116 从而压缩在电磁圈 96 之前表面 118 与后卡环 114 之间。同样地，前弹簧 108 压缩在后卡环 114 与后盘 126 之底部 132 之间。

[0059] 图 10 是一个实施例，显示出一种情况，其中由该进气歧管对该曲轴箱施加的真空压力要大于由前弹簧 108 置放后盘 126 齐平前盘 124 所施加的压力。在这个例子中，后盘 126 能够沿着杆体 100 外径滑动，从而打开前盘 124 中的孔洞 134。限量的漏气允许通过进气口 84 进到 PCV 阀 18，如由其中的方向箭头所指出者。当然，该漏气便会通过排气口 86 排出 PCV 阀 18，如由其中的方向箭头所指出者。在图 10 中所示出的位置，当前盘 124 维持靠抵凸缘 136 时，漏气的气流仍然受到限制。因此，只有有限的气流能通过孔洞 134。增加该引擎真空会因此增加施加在后盘 126 的空气压力。因此，前弹簧 108 进一步被压缩，使得后盘 126 持续从前盘 124 移开，从而创造出更大的气流路径，让额外的漏气窜出。再者，电磁圈 96 中的柱塞 94 可置放杆体 100 在 PCV 阀 18 内，以对弹簧 108、116 施加更大或更小的压力在，进而限制或允许气流通过进气口 84，如同由控制器 12 所决定者。

[0060] 图 11 显示另一种情况，其中藉由改变通过连接器电线 78 的电流而将柱塞 94 从电磁圈 96 内撤出，让额外的气流流过进气口 84。降低流过电磁圈 96 的电流会减小产生于其中的对应磁场，并且让磁化柱塞 94 缩回。因此，杆体 100 随着柱塞 94 从进气口 84 缩回。这让前盘 124 离开凸缘 136，从而让额外气流进到前盘 124 外径周围的进气口 84。当然，通过

进气口 84 的气流以及经由排气口 86 排出的漏气的增加会让漏气从曲轴箱 35 排到进气歧管 38 的量增加。在一个实施例中，柱塞 94 允许杆体 100 从外壳 82 内全部撤出，使得前盘 124 和后盘 126 不再限制通过进气口 84 以及经排气口 86 排出的气流。这对于在高引擎转速和高引擎负载下，会因为引擎增加漏气产量来说，是特别期待的。引擎负载是比转速更为可靠的漏气产量指标。另外，固定引擎（即，发电机）或那些非齿轮传动的引擎是在固定转速下运行。因此，系统 10 或 PCV 阀 18 最好是基于感测到的负载条件或在周期性的开关循环（即 2 分钟开 -2 分钟关）来控制，。当然，弹簧 108、116 可根据具有 PCV 阀 18 被并入污染控制系统 10 中的特定汽车来做不同应变。

[0061] 控制器 12 有效地通过增加或减少流经连接器电线 78 的电流来控制电磁圈 96 内的柱塞 94 之位置。控制器 12 本身可包括各种电子电路，包括开关、定时器、间隔定时器、中继定时器或其他已知的车辆控制模块。控制器 12 操作 PCV 阀 18 以响应一或多个这些控制模块的运作。例如，控制器 12 可包括 RWS 窗开关 (window switch) 模块，由 Beckly,W.VA. 的 Baker Electronix 公司提供。该 RWS 模块是一个电开关，用以激活超过预选的引擎转速，并且停用超过较高的预选引擎转速。该 RWS 模块被认为是"窗开关"，因为输出会在转速窗期间被激活。该 RWS 模块可以例如，结合引擎转速感应器 28 一起工作，以调节漏气从曲轴箱 35 排出的流速。

[0062] 较好地，当设定柱塞 94 在电磁圈 96 内的位置时，该 RWS 模块与由大多数转速计使用的标准线圈信号一起作用。汽车转速计是一种装置用来量测即时的引擎转速。在一实施例中，当漏气产量达到最小时，该 RWS 模块可在低引擎转速下激活电磁圈 96 内的柱塞 94。这里，柱塞 94 推动杆体 10 朝向进气口 84，使得前盘 124 抵靠在凸缘 136，通常如图 9 所示。在这方面，即使是在高引擎真空下，PCV 阀 18 从该曲轴箱经由前盘 124 中的孔洞 134 排出少量的漏气到该进气歧管。高引擎真空强迫漏气通过孔洞 134，从而强迫后盘 126 离开前盘 124，压缩前弹簧 108。在闲置时，该 RWS 模块激活电磁圈 96 以防止前盘 124 从凸缘 136 脱离，从而防止大量空气流经该引擎曲轴箱和该进气歧管之间。这在低引擎转速下是特别期待的，即使该引擎真空相对要高，漏气在该引擎内的产量会相对较低。明显地，控制器能同时与污染控制系统 10 的其他组件调节 PCV 阀 18，设定漏气从曲轴箱 35 排出的流速。

[0063] 在加速，提高引擎负载与较高引擎转速的期间，漏气产量会增加。因此，该 RWS 模块可关闭或降低流到电磁圈 96 的电流，使得柱塞 94 从电磁圈 96 内撤出，从而使前盘 124 从凸缘 136 脱离（图 11)，并允许较大量的漏气从曲轴箱 35 排到进气歧管 38。这些功能可发生在被预编程到该 RWS 模块中的选定之 RPM 或在选定之转速的给定范围内。当汽车编译 (eclipse) 另一预选 RWS（像是较高的转速）时，该 RWS 模块可重新激活，从而与电磁圈 96 内的柱塞 94 重新接合。在另一个实施例中，该 RWS 模块的变体可用于选择性地让柱塞 94 从电磁圈 96 内撤出。例如，传导到电磁圈 96 的电流起初可造成柱塞 94 在 900rpm 下让前盘 124 与进气口 84 的凸缘 136 接合。在 1700rpm 下，该 RWS 模块可激活第一阶段，其中传导到电磁圈 96 的电流降低二分之一。在这个例子中，柱塞 94 中途从电磁圈 96 内缩回，从而部分打开进气口 84 让漏气流通。当该引擎转速达到 2500 时，例如，该 RWS 模块可消除传到电磁圈 96 的电流，使得柱塞 94 从电磁圈 96 内完全缩回，以完全打开进气口 84。在这个位置上，特别最好是前盘 124 和后盘 126 以及在进气口 84 与排气口 86 之间有较长限制的气流。该阶段可通过引擎转速或由控制器 12 及基于感应器 20 到 32 的读数而决定的其他

参数和计算来调节。

[0064] 控制器 12 可被预编程、安装后进行编程或进行更新或闪存，以满足特定的汽车或车载诊断(OBD)的规格。在一个实施例中，控制器 12 配备有自我学习软件，使得该开关（在该 RWS 模块的情况下）适应于最佳时间来激活或停用电磁圈 96，或是柱塞 94 的位置移向电磁圈 96，以最佳化地增加燃料效率和减少空气污染。在一特别优选的实施例中，控制器 12 基于由感应器 20 到 32 得到的即时量测来优化漏气的排放。例如，控制器 12 可经由排气感应器 32 的反馈，决定汽车 16 排出增加的有害废气量。在这个例子中，控制器 12 可激活柱塞 94 从电磁圈 96 内撤回，以从该曲轴箱内排出额外的漏气，减少通过汽车 16 之排气口排出的污染量，如同由排气感应器 32 所量测到的。

[0065] 在另一实施例中，控制器 12 配备有 LED，用以闪烁来显示电源，以及显示控制器 12 等待接收引擎速度脉冲。该 LED 也可用于测量控制器 12 之功能是否正常。该 LED 闪烁直到该车辆达到指定的转速，此时控制器 12 经由连接器电线 78 改变传导到电磁圈 96 的电流。在一个特别优选的实施例中，控制器 12 维持传导到电磁圈 96 的电流量直到该引擎转速降到低于激活点 10％。这种机制称为磁滞。当引擎转速在一相对短的时间周期中跳动到高于或低于该设定点，磁滞被用在污染控制系统 10 以消除开 / 关脉冲，或称之为振颤(chattering)。磁滞也可以用于上述以电子为基础的阶段系统。

[0066] 控制器 12 也可以配备有通电延迟定时器(On Delay timer)，像是 KH1 模拟系列通电延迟定时器，由 Instrumentation&Control Systems, Inc. of Addison, III 制造。延迟定时器特别最好是用于初始启动的时候。低引擎转速会制造出少量漏气。因此，延迟定时器可集成到控制器 12 以延迟电磁圈 96 与相应柱塞 94 的激活。较好地，该延迟时间确保柱塞 94 维持完全嵌入到电磁圈 96 内，使得前盘 124 维持完全抵靠凸缘 136，从而限制漏气气流进入进气口 84 的量。延迟定时器可设定一段预定时间（例如 1 分钟）之后从进气口 84 激活释放圆盘 124 及 126 的任一个。或者，该延迟定时器可由控制器 12 设定为引擎温度的函数，由引擎温度感应器 20 量测，以及引擎转速的函数，由引擎转速感应器 28 或加速计感应器 30，电池感应器 24 或排气感应器 32 量测。该延迟可包括根据任何前述读数变化的范围。该可变定时器也可以与该 RWS 开关集成。

[0067] 控制器 12 最好是安装到汽车 16 之引擎盖 14 的内部，通常如图 1 所示。控制器 12 可被包装在一安装工具，以让使用者能如图所示安装控制器 12。用电上，控制器 12 是由任何合适的 12 伏特断路器供电。具有控制器 12 的工具可包括转接器，其中 12 伏特的断路器可从该电路板移除，并且换上单向连接到 PCV 阀 18 之连接器电线 78 的转接器（未示出），所以使用者安装污染控制系统 10 不能跨越控制器 12 和 PCV 阀 18 之间的该电线。控制器 12 也可以无线使用，经由远端遥控或手持单元来存取或下载由控制器 12 读取、储存或计算的即时计算与量测、储存数据或其它资料。

[0068] 在污染控制系统 10 的另一个态样中，控制器 12 基于引擎运作频率来调节 PCV 阀 18。例如，当该引擎通过一个共振频率时，控制器 12 可激活或停用柱塞 94。在一个较好的实施例中，控制器 12 阻挡所有从曲轴箱 35 到进气歧管 38 的气流，直到该引擎通过该共振频率后。控制器 12 也可以基于该引擎在各种运作条件下的感测频率而被编程以调节 PCV 阀 18，如上所述。

[0069] 此外，污染控制系统 10 是适用于各种引擎，包括汽油、甲醇、柴油、乙醇、压缩天然

气(CNG)、液体丙烷气(LPG)、氢和醇系引擎,或实际上任何其它的可燃气体和/或蒸汽引擎。污染控制系统10也可用于较大型的固定引擎,或用于船只或其它重型机械。另外,污染控制系统10可包括一或多个控制器12,以及一或多个结合多个感应器以量测该引擎或车辆性能的PCV阀18。污染控制系统10的使用是与汽车连接,如上文的详细描述,仅为一个较好的实施例。当然,污染控制系统10具有跨多种学科的应用,使用会产生废气之可燃性材料能被回收再利用。

[0070] 在污染控制系统10之另一个态样中,控制器12可调节控制PCV阀18。PCV阀18的主要功能是为了要控制曲轴箱35和进气歧管38之间的引擎真空量。柱塞94在电磁圈96内的定位很大程度决定了漏气从曲轴箱35行进到进气歧管38的流动速率。在一些系统中,根据初始的设备制造商(OEM),PCV阀18可调节气流以确保曲轴箱35和进气歧管38间的相对压力不会低于某一阈值。在控制器12故障的情况下,污染控制系统10自动回到OEM设定,其中PCV阀18作为二阶段逆止阀(two-stage check valve)。污染控制系统10的一个特别优选的态样是通过包含闪存更新控制器12达到与电流和未来OBD标准相容。此外,污染控制系统10的运作不影响目前OBD和OBD-II系统的运作条件。控制器12可根据标准OBD协定来存取或查询,且闪存更新可修改该BIOS,所以控制器12保持与未来OBD标准相容。较好地,控制器12操作PCV阀18来调节曲轴箱35和进气歧管38间的引擎真空,从而支配它们之间的空气流速,以优化排放系统10内的漏气。

[0071] 在污染控制系统10的另一态样中,控制器12可调节该运作组件的激活和/或停用,如上文中的详细描述,例如针对PCV阀18。这种调节的完成是通过,例如,前述的RWS开关、通电延迟定时器或其它电子电路和数位激活、停用或选择性地中间定位前述的控制组件。例如,控制器12可选择性地激活PCV阀18持续一至二分钟的时间,然后选择性地停用PCV阀18持续10分钟。这些激活/停用的次序可根据基于驾驶方式而预定或学会的次序来设定,例如,预编程的时序可通过控制器12的闪存更新来变化。

[0072] 图12显示PCV阀18与引擎油盖37一体形成的替代实施例。不同于图5所示的实施例,该实施例具有PCV阀18附接到引擎油盖37,藉由弯头或弯曲连接器。当引擎油盖37附接到引擎油入口39时,该弯头或弯曲连接器定向PCV阀18在一低轮廓(low profile)位置,即大致上水平的位置。该PCV阀18的低轮廓位置定向相同,以至于它大致沿着引擎36表面延伸。这在引擎室中是特别有用的,其中引擎油入口39是在引擎36顶端上,而引擎盖14在引擎36上方提供非常小的间隙。角度或弯曲最好是90度角,但可用其它角度表现,因为特别的引擎设计可能需要。PCV阀18如上述实施例以相同方式作用。

[0073] 从PCV阀延伸的电线78可包括防水连接器79a、79b来方便连接到控制器12。

[0074] 图13和图14显示油分离器19的配置。油分离器19具有罐体134,其具有顶部166和底部168。附接在罐体134上的是手把170,以及入口端172和出口端174。图14显示油分离器19从图13的方向翻转的分解图。可以看出手把170藉由螺丝钉176或其它附接方式附接在顶部166。顶部166的内部分成内室178与外室180。金属滤网182设置在内室178和外室180的开口周围。萤幕182最好是用螺丝钉184保持在适当位置。底部168的内部最好包括开放室(未示出),用于补集从该漏气冷凝出的油。底部168可包括钢丝绒186或其它类似的网格层材料。底部168的底侧包括排油口138。

[0075] 油分离器19还包括O型环或密封垫188设置在顶部166与底部168之间。O型

环 188 密封油分离器 19 以防止在压力下的运作中泄漏。顶部 166 和底部 168 最好是藉由耐用但可卸下的连接器固定在一起,像是螺纹连结器、凸块和槽道、或定位螺钉。在本领域之具有通常技术之人士应理解将顶部 166 和底部 168 固定在一起的各种方式。

[0076] 当完全组装时,油分离器 19 通过入口端 172 把漏气带进到内室 178。该漏气接着通过滤网 182 进到底部 168。当该漏气通过滤网 182 时,含在其中的一部分的油被被冷凝,且流到该内室的底部。该漏气接着越过并通过网格层 186,其中额外的油进一步从该漏气中冷凝出,留在该内室的底部。由该曲轴箱和该进气歧管之间的压力差造成的真空接着汲取该漏气朝上通过滤网 182,进到外室 180。第二通道经过滤网 182 进一步从该漏气冷凝出额外的油。滤网 182 和网格层 186 也有助于过滤微粒以及其它在漏气中的污染物。一旦被吸入出口室 180,该漏气通过出口端 174 被释放且被输送出,如在各种实施例中描述者。

[0077] 鉴于上述情况,本领域之技术人士应当理解,用于柴油引擎之本发明的污染控制系统包括结合柴油引擎使用的油过滤器和 PCV 阀。总之,在加速时以及在当拖拉重物时,该柴油引擎将制造出漏气,其包括燃料蒸汽、油、以及其它污染物。该漏气从该曲轴箱排到该油过滤器。这里,该漏气通过一系列的网状过滤器,其中油和其它污染物从该燃料蒸汽中滤出。该污染物被堵在网状过滤器中,而该油冷凝到该油过滤器底部。该冷凝油回到该曲轴箱,从该油过滤器底部出来。

[0078] 该纯化的燃料蒸汽从该油过滤器抽真空,通过该 PCV 阀回到该引擎进行重新燃烧。该 PCV 阀连接到控制器,其根据当前的引擎需求,允许各种燃料蒸汽量通过该阀。一旦该引擎蒸汽通过该 PCV 阀,会经由该燃料管线或通过该进气歧管,回到该引擎。

[0079] 虽然已经为了说明的目的详细描述几个实施例,但可在不脱离本发明之范围和精神下进行各种修改。因此,除了所附的权利要求以外,本发明不应被限制。

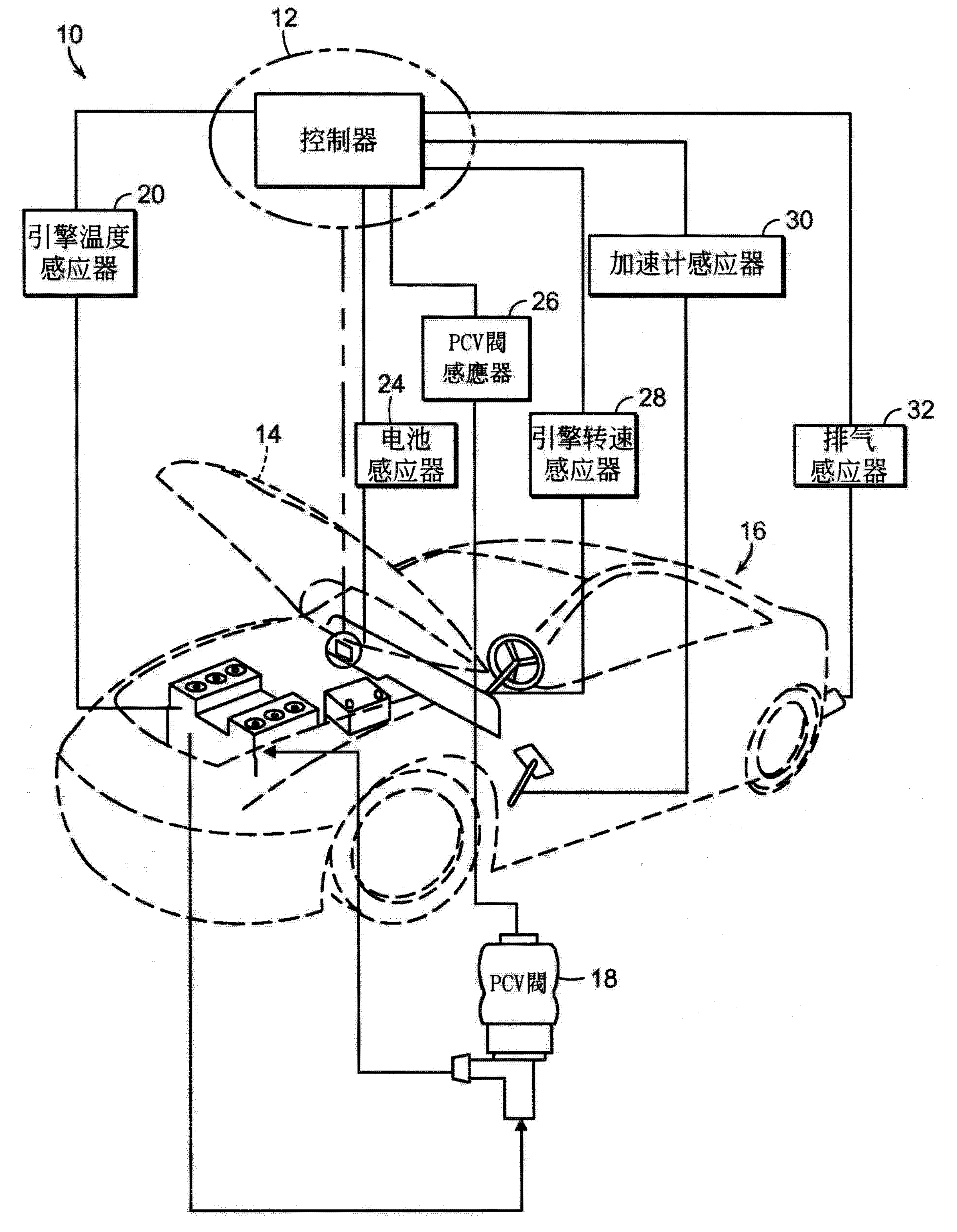
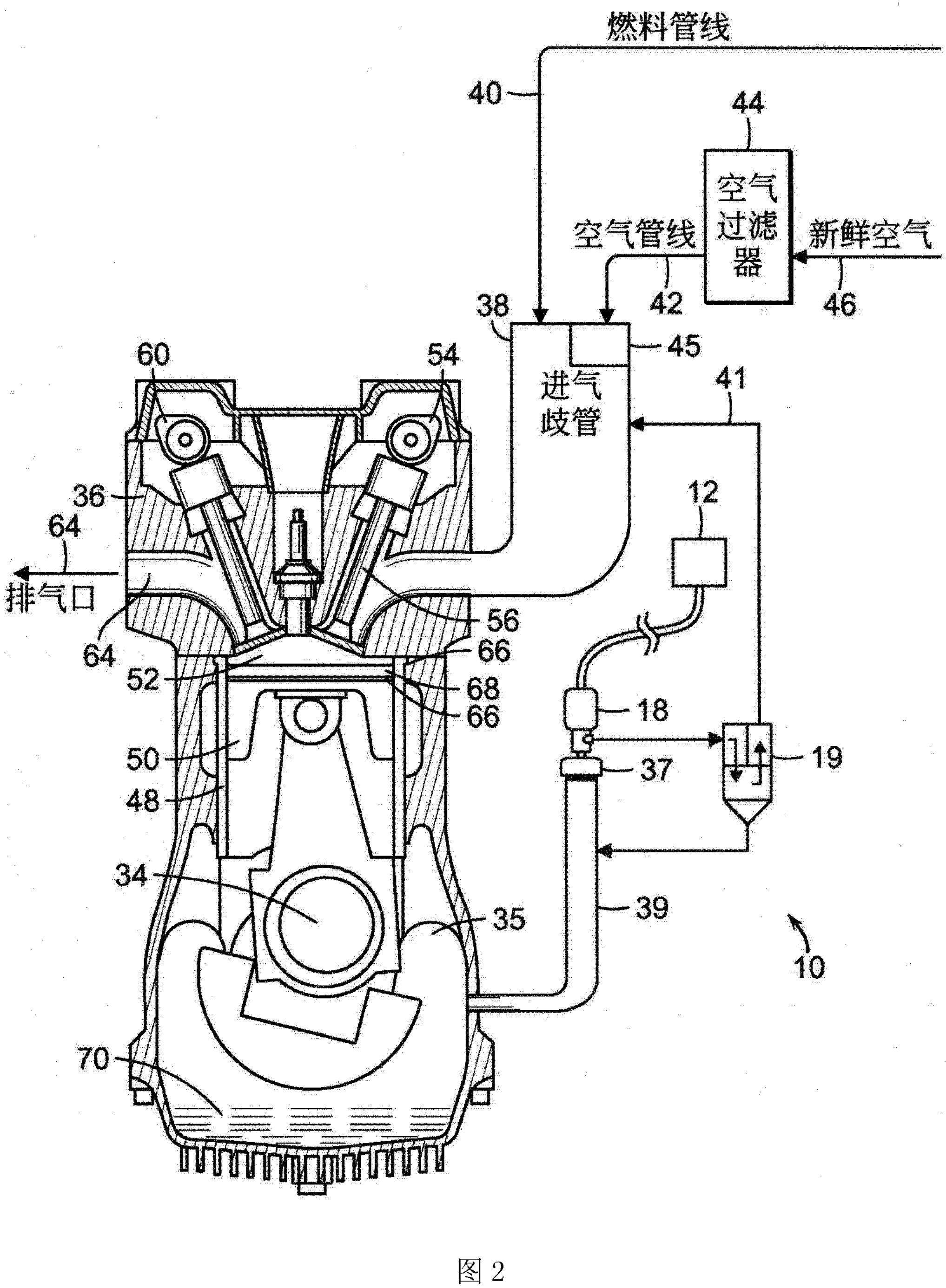

10
12
控制器
20
引擎温度感应器
30
加速计感应器
26
PCV阀感應器
24
电池感应器
28
引擎转速感应器
32
排气感应器
14
16
PCV阀
18

图 1


燃料管线
40
44
空气过滤器
空气管线
新鲜空气
42
46
38
45
60
54
进气歧管
41
36
64
12
排气口
64
56
66
52
68
66
18
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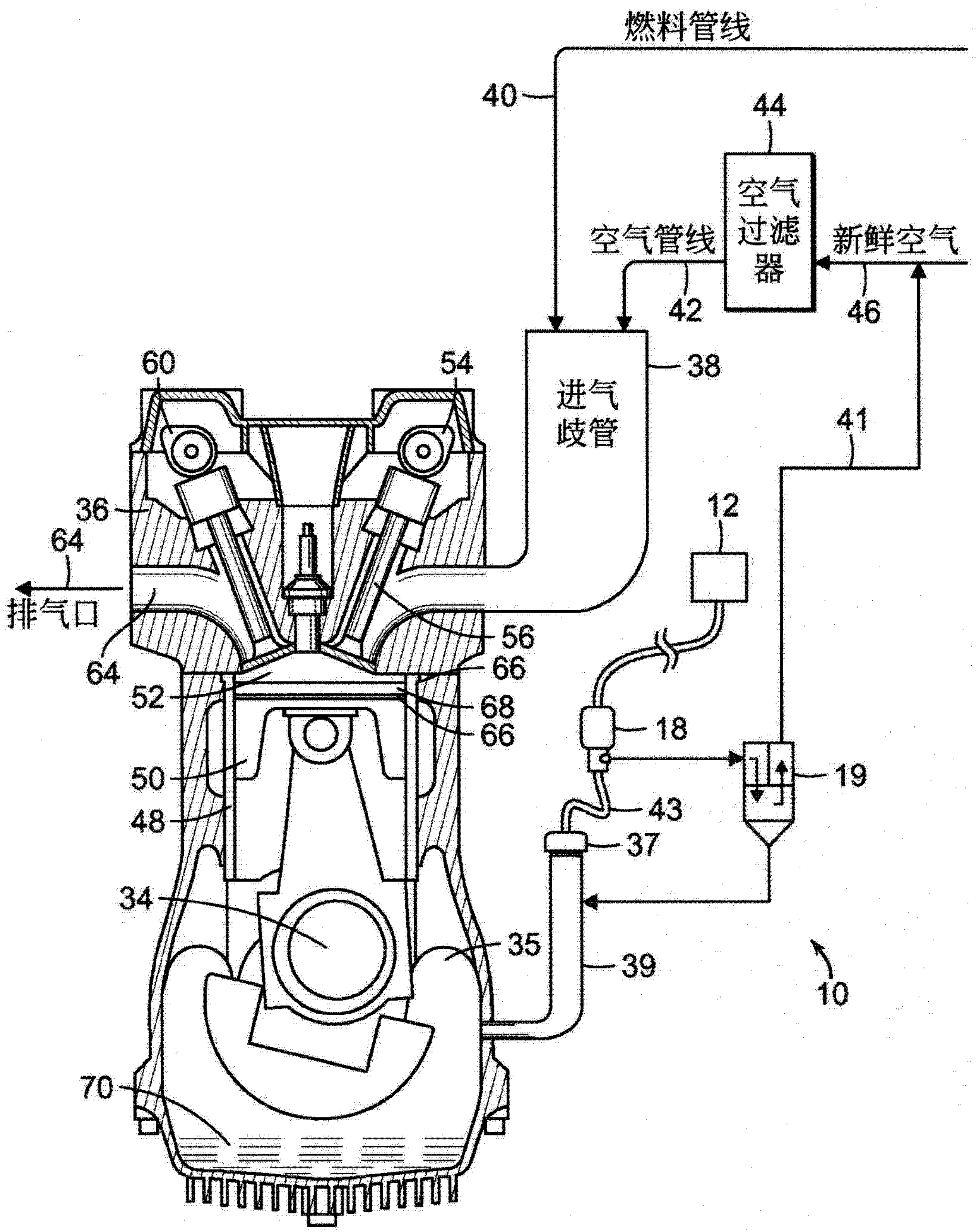
70

图 2


燃料管线
40
44
空气过滤器
空气管线
新鲜空气
42
46
38
进气歧管
60
54
41
36
64
12
排气口
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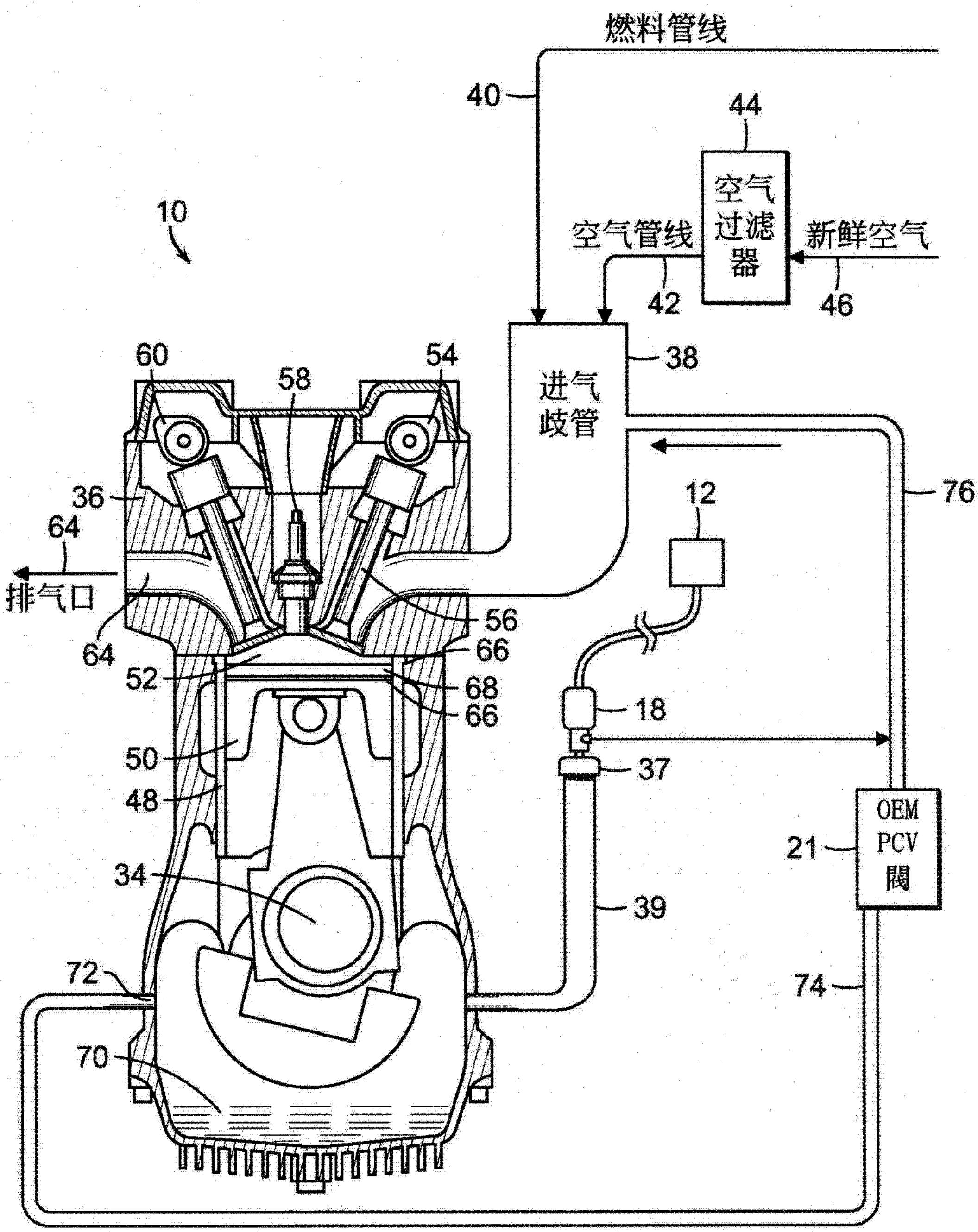
70

图 3


燃料管线
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44
空气
过滤
器
空气管线
新鲜空气
42
46
10
60
54
58
38
进气
歧管
36
64
排气口
64
12
76
56
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52
68
66
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37
50
48
21
OEM
PCV
阀
34
39
72
74
70

图 4

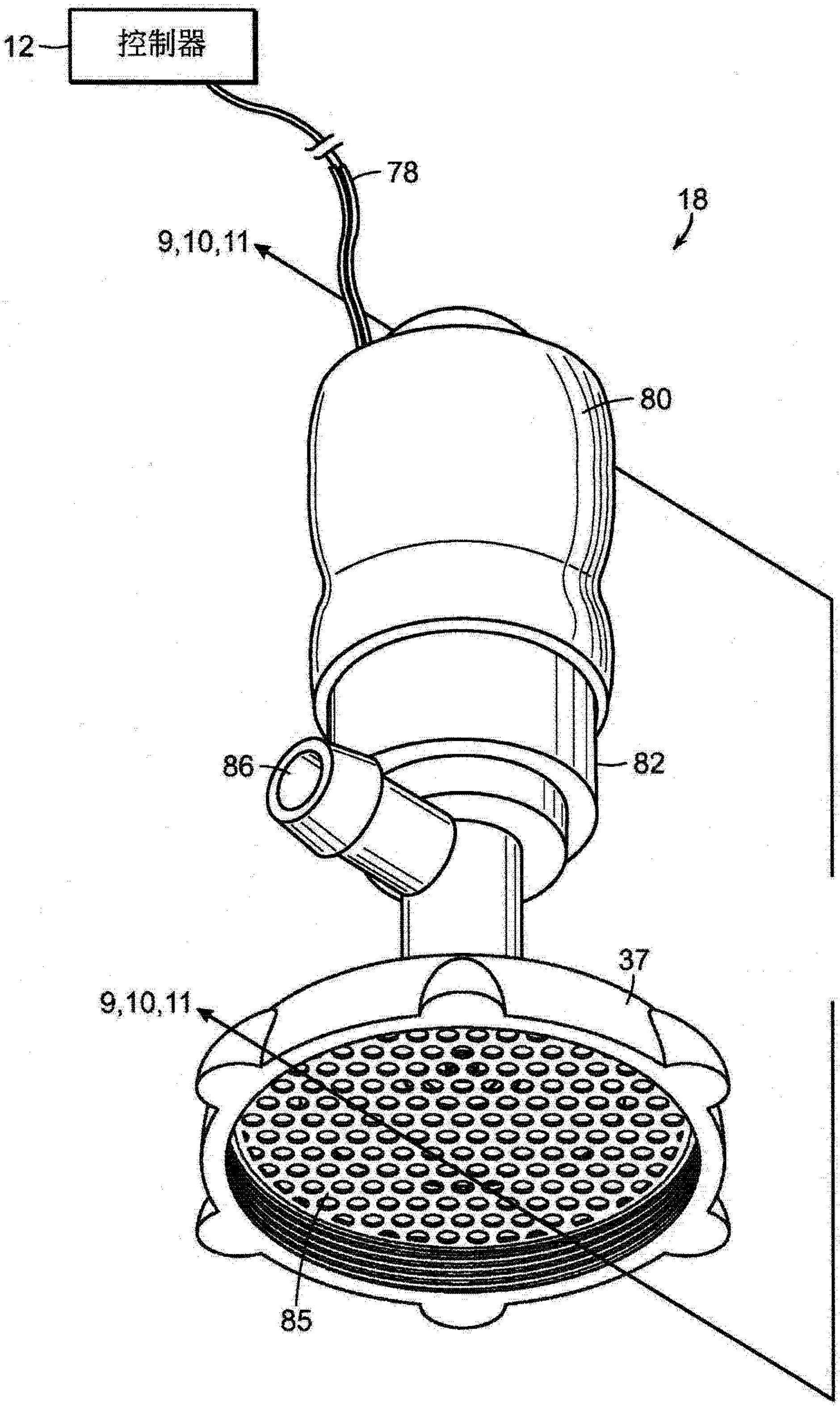

图 5

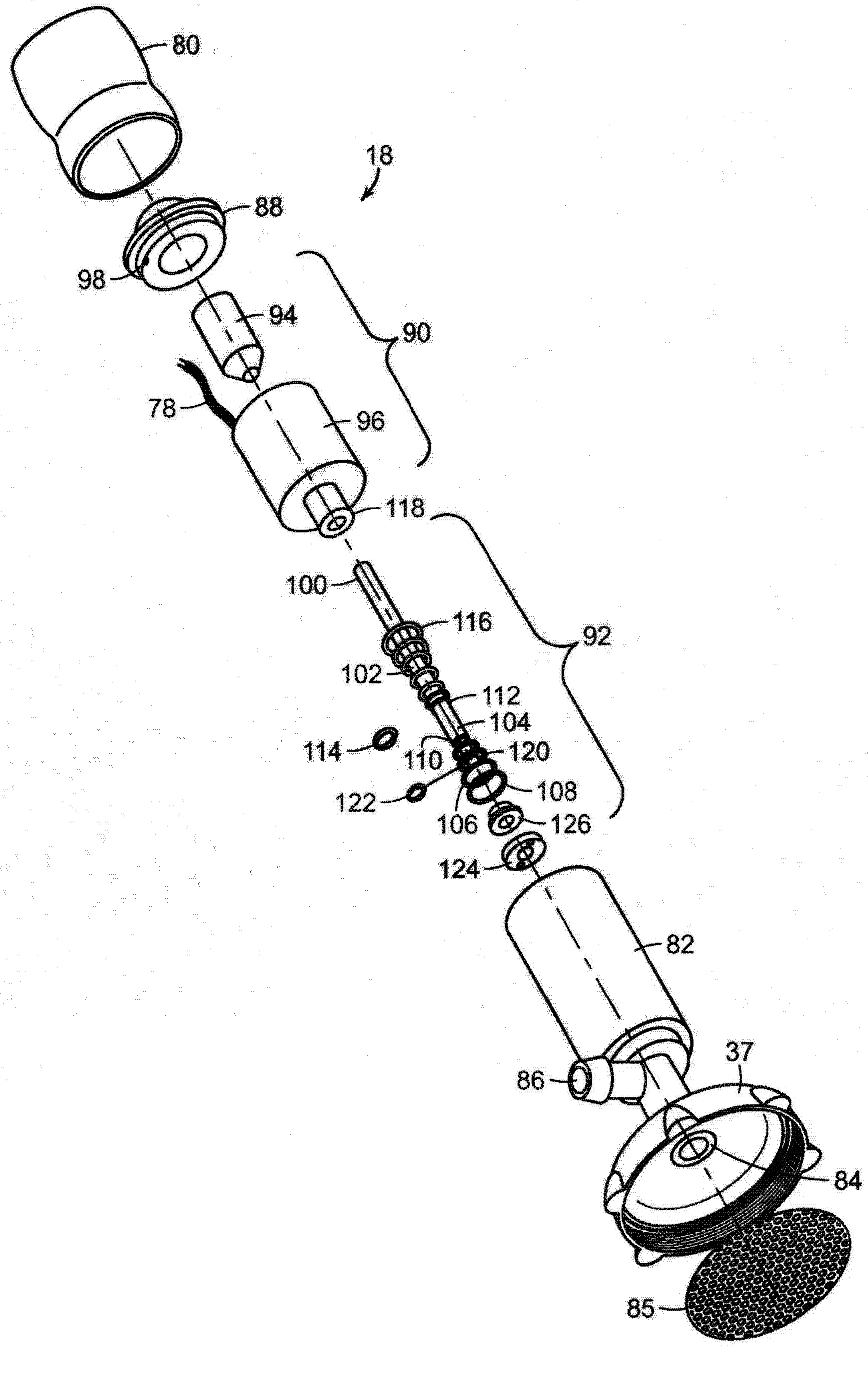
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图 6

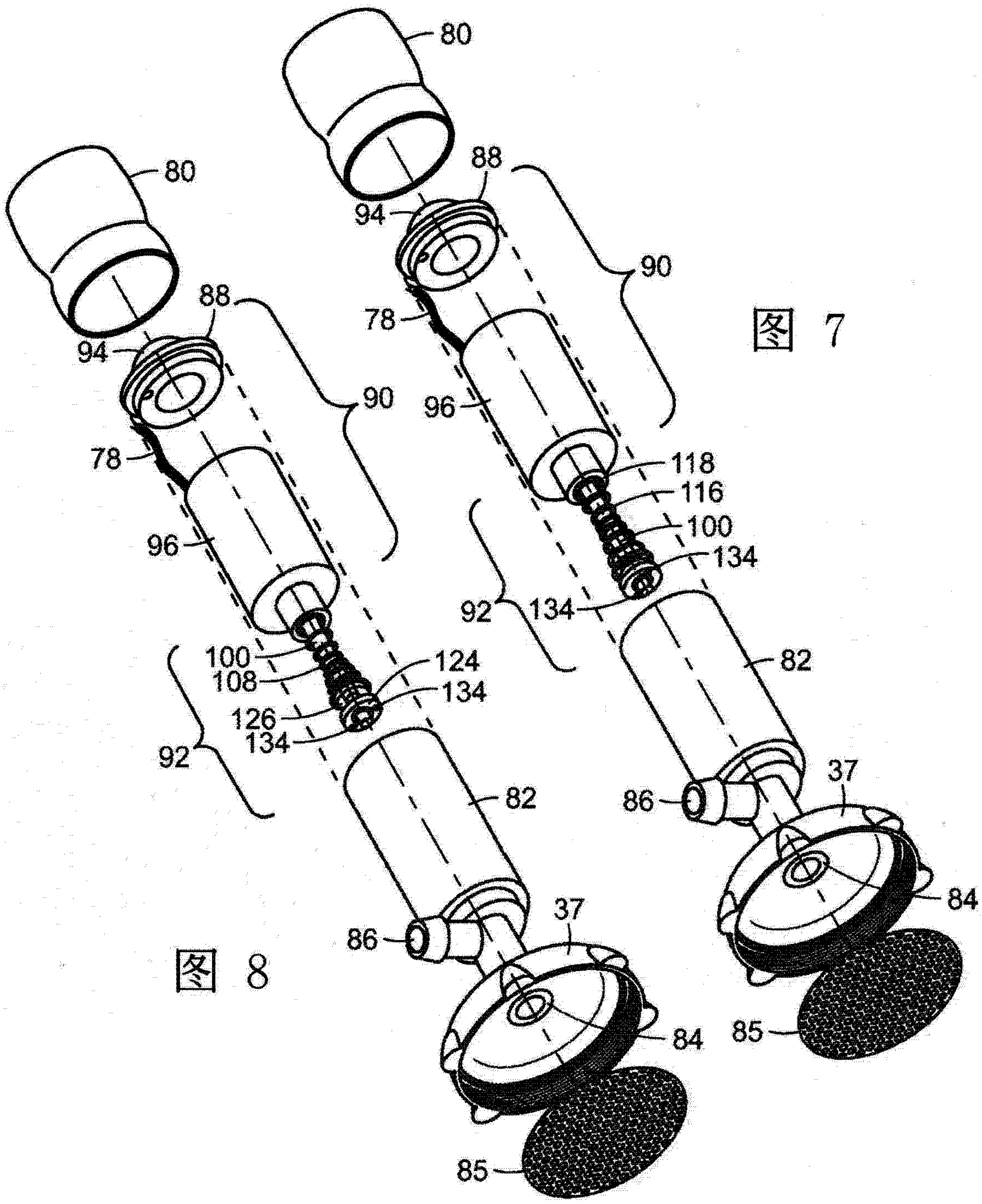
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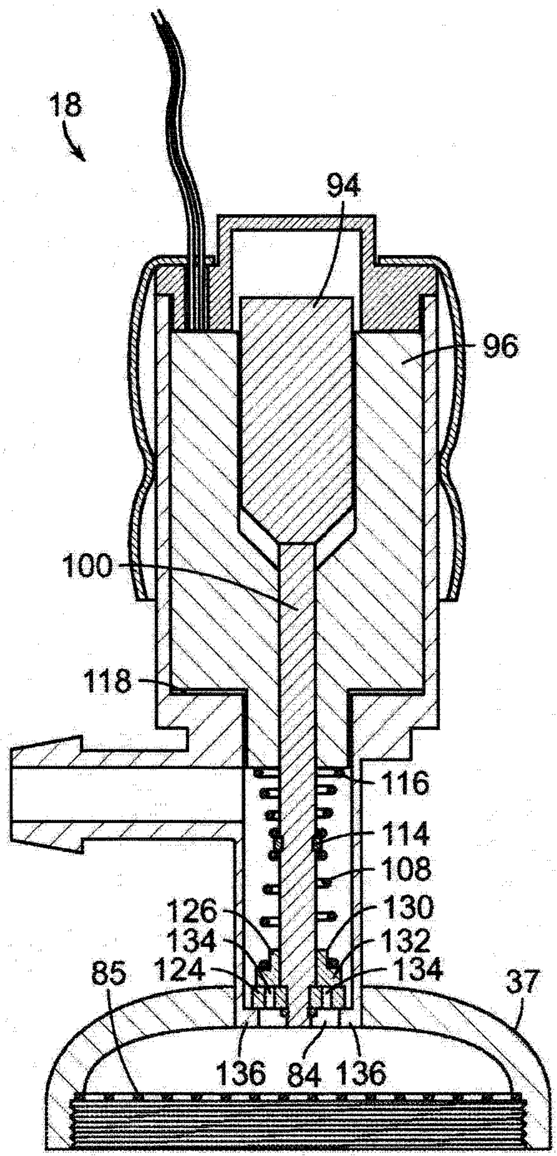
图 7

图 8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118
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114
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136

图 9

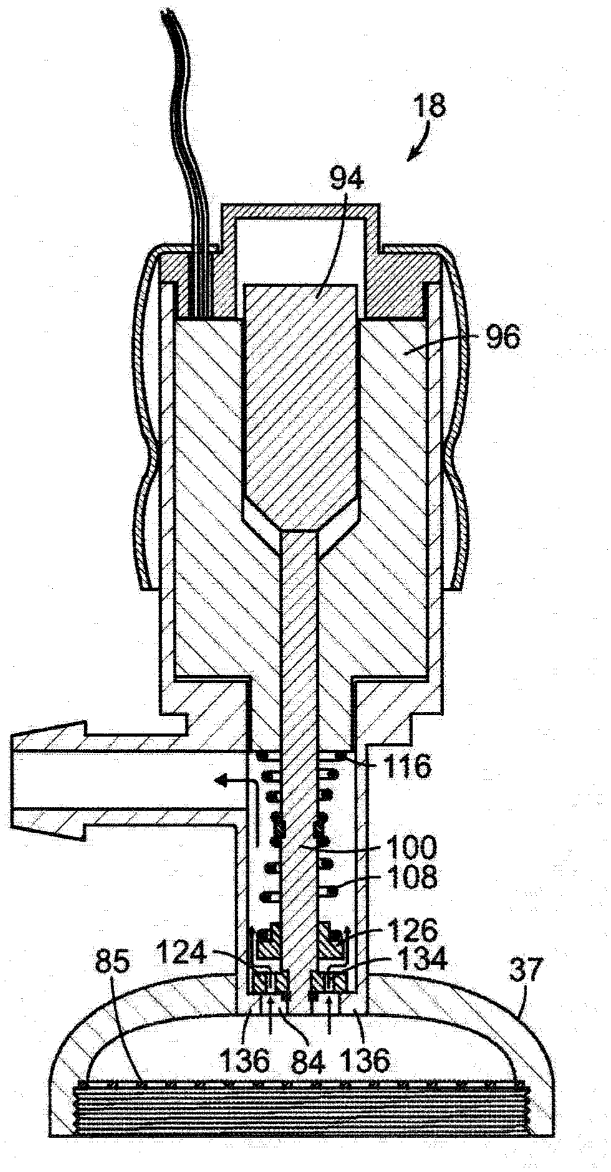

图 10

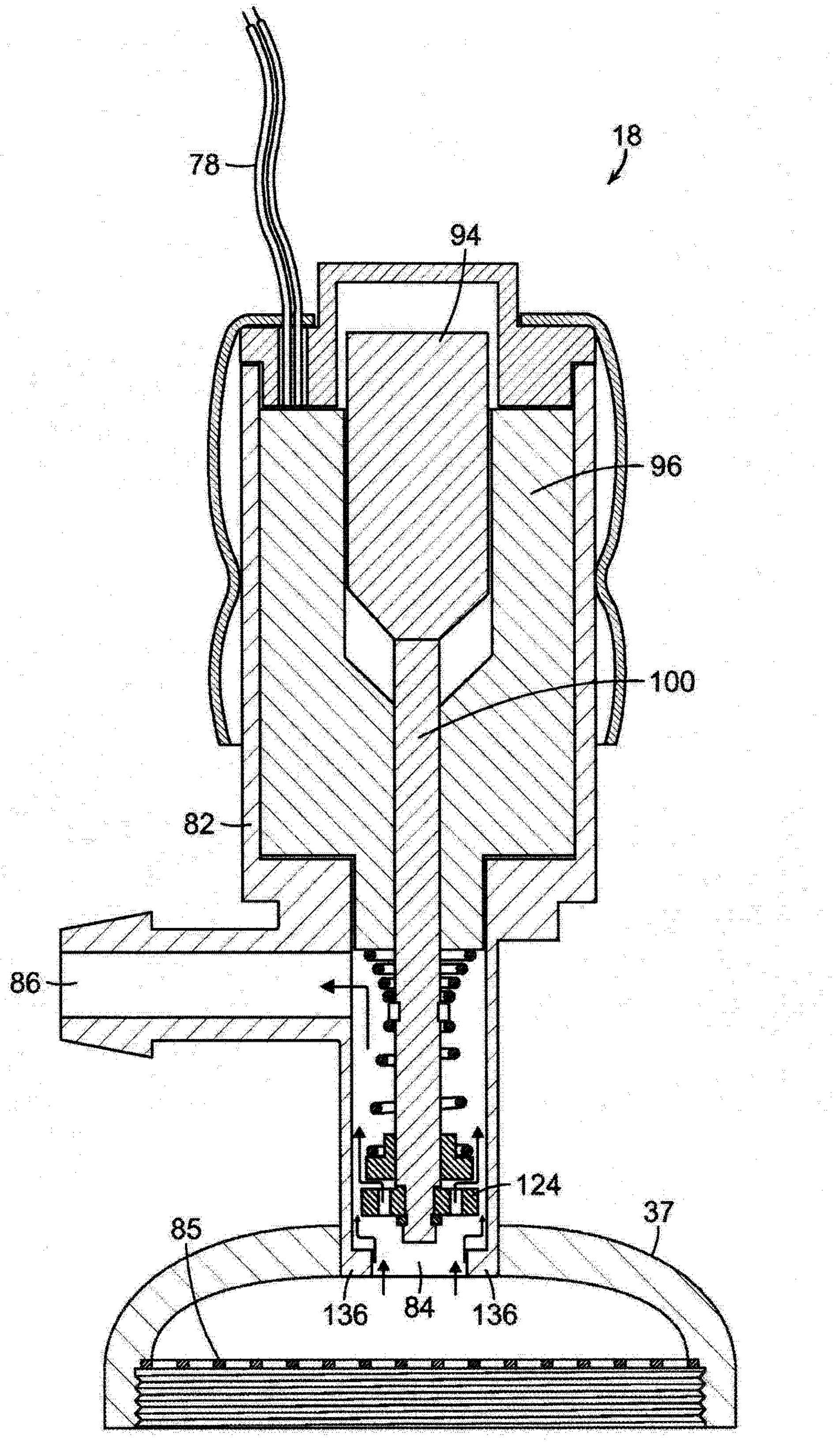

图 11

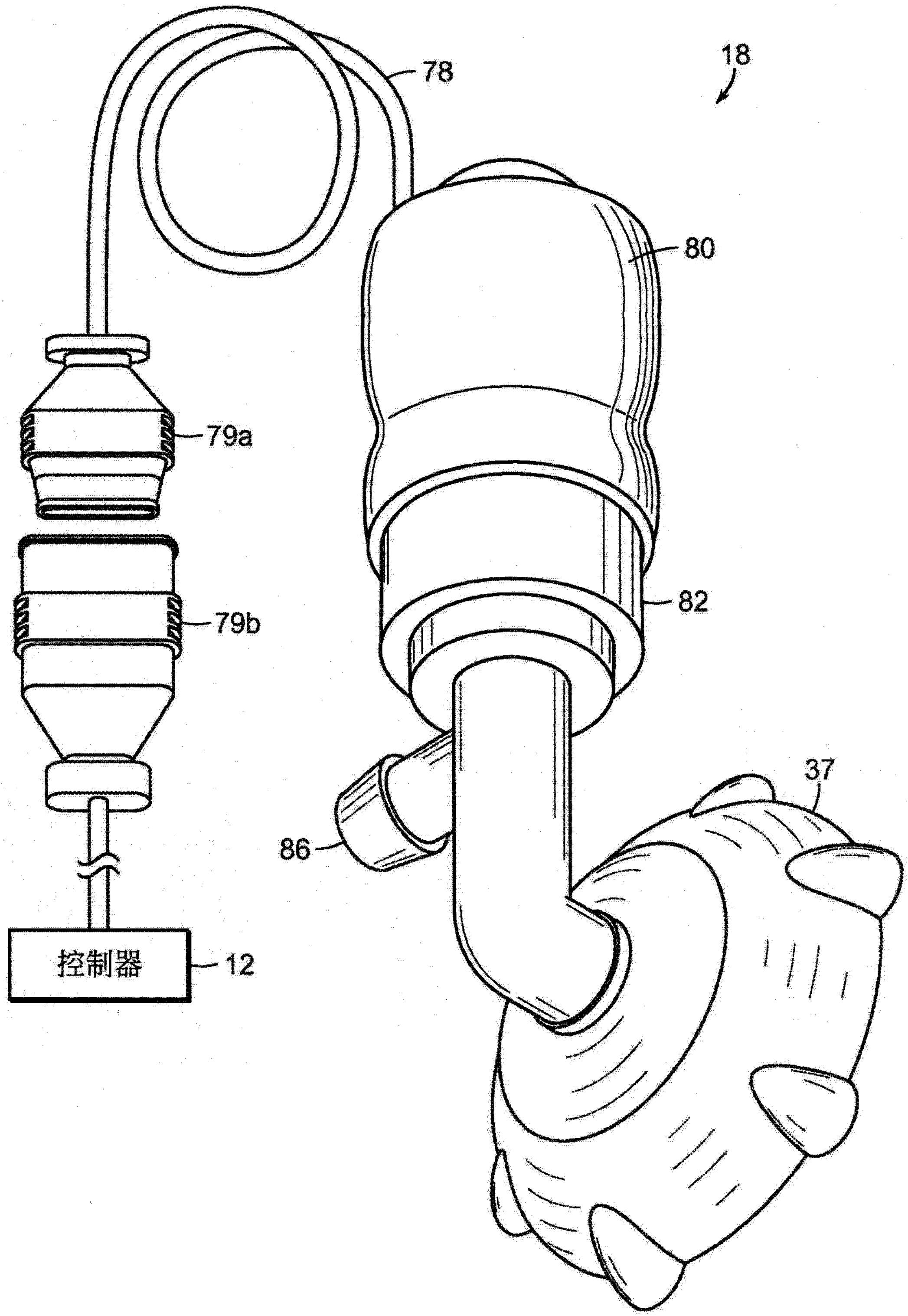

图 12

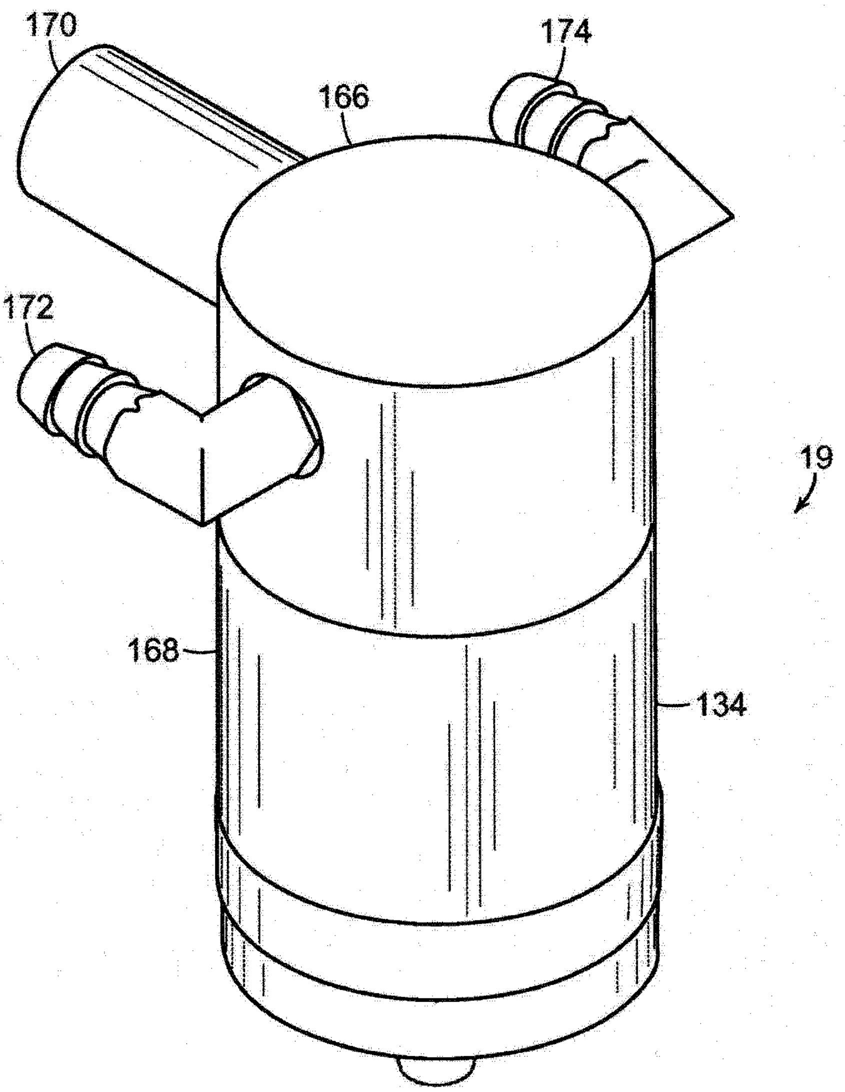

图 13

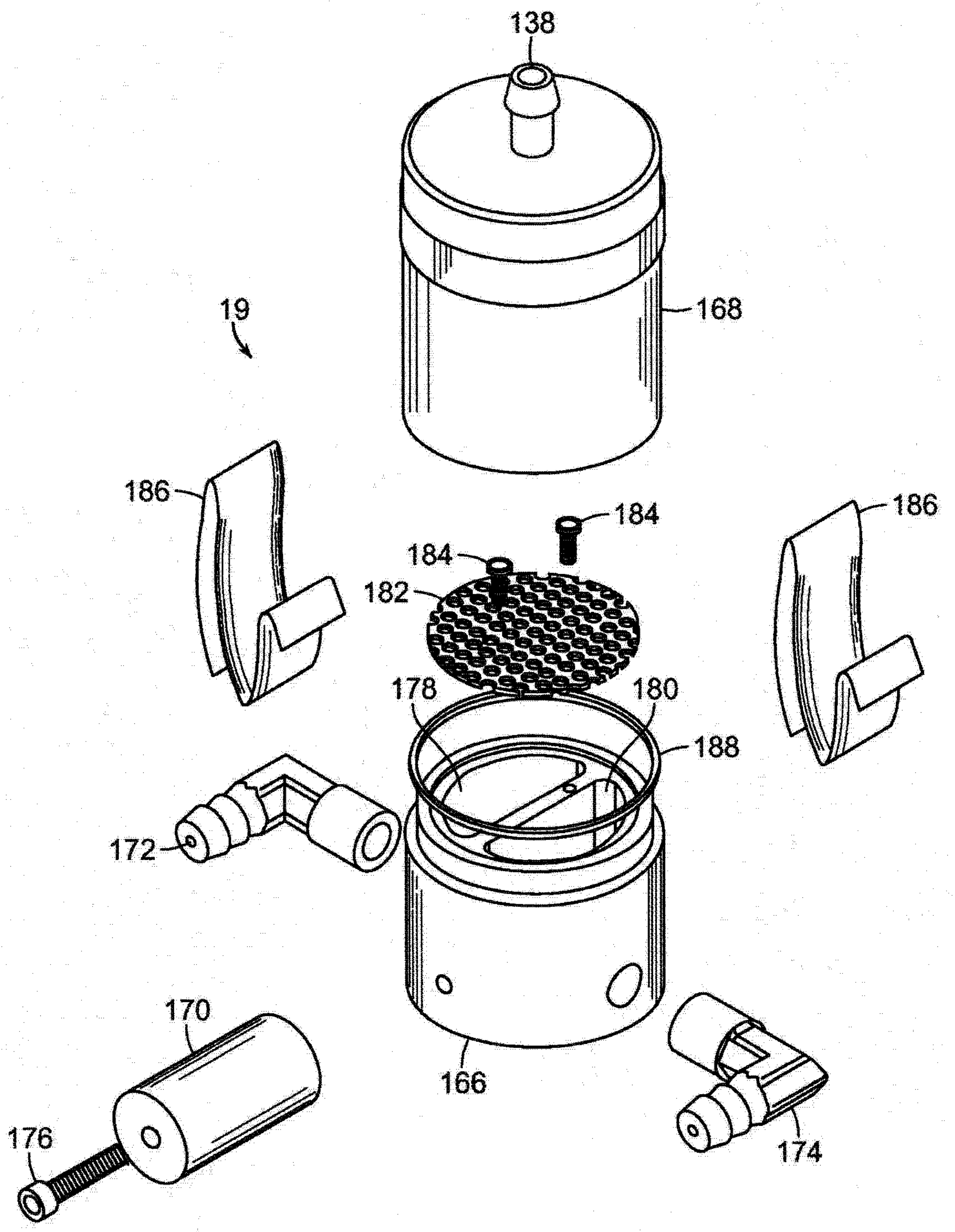

图 14