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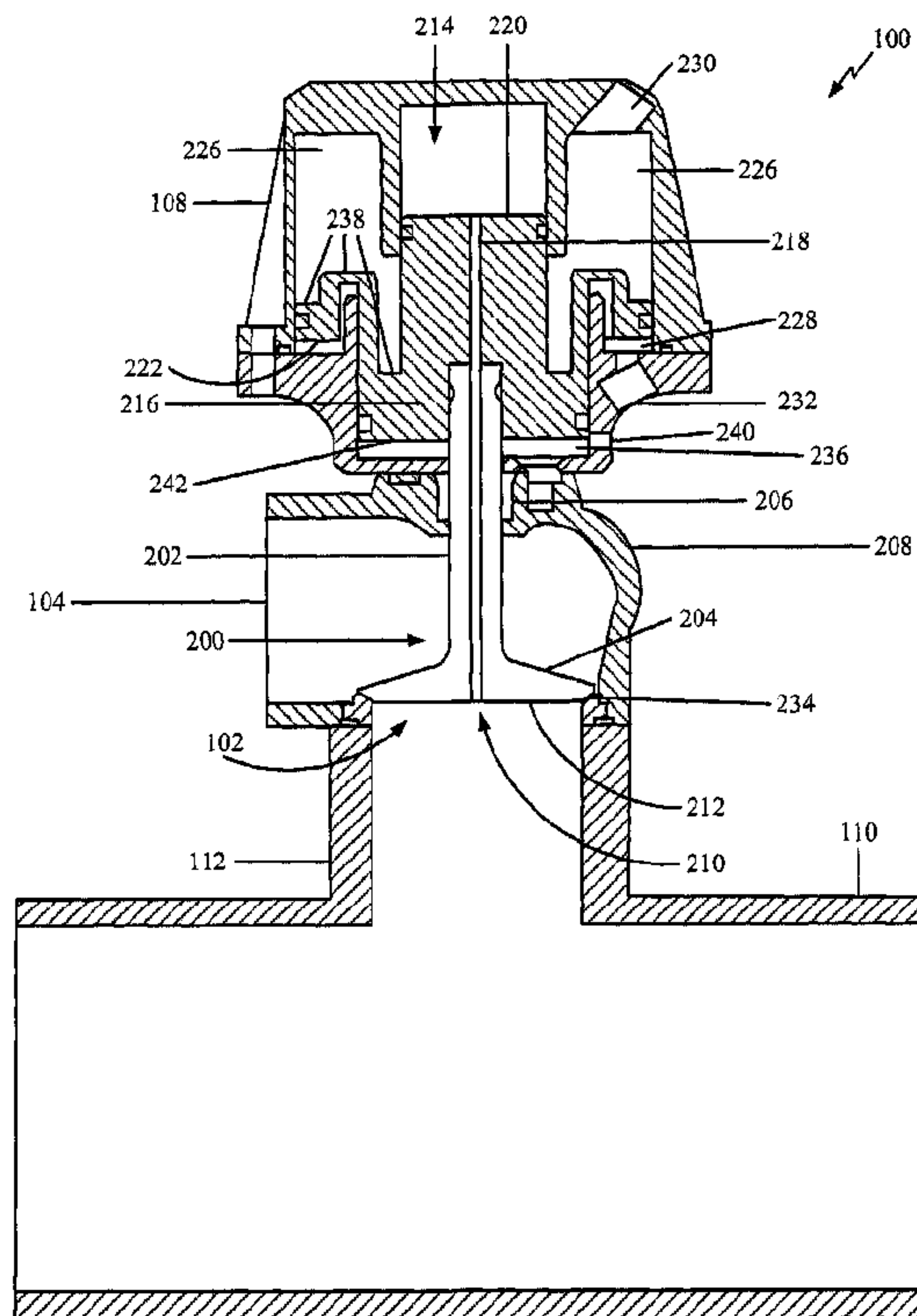
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(54) **Titre : SOUPAPE A INVERSION ET DISPOSITIF D'ACTIVATION**

(54) **Title: COUNTER-BIASED VALVE AND ACTUATOR ASSEMBLY**



(57) **Abrégé/Abstract:**

A valve actuator assembly, counter-biased by a working fluid (or gas) pressure, is disclosed. The valve actuator assembly comprises a valve and a pneumatic or hydraulic actuator. A port is defined axially through the valve and actuator that communicates a working fluid (or gas) pressure acting on the valve face to a counter-biasing chamber inside an actuator housing. This design eliminates, reduces, or overcomes a force acting on a face of the valve by communicating a common working pressure of the fluid (or gas) to a substrate on the actuator with a resultant force vector opposite the valve face.

ABSTRACT

A valve actuator assembly, counter-biased by a working fluid (or gas) pressure, is disclosed. The valve actuator assembly comprises a valve and a pneumatic or hydraulic actuator. A port is defined axially through the valve and actuator that communicates a working fluid (or gas) pressure acting on the valve face to a counter-biasing chamber inside an actuator housing. This design eliminates, reduces, or overcomes a force acting on a face of the valve by communicating a common working pressure of the fluid (or gas) to a substrate on the actuator with a resultant force vector opposite the valve face.

COUNTER-BIASED VALVE AND ACTUATOR ASSEMBLY

BACKGROUND

Field of Use

5 [0001] The embodiments described herein relate to the mechanical arts. More specifically, the present invention relates to valve actuator assemblies.

Description of the Related Art

10 [0002] It can be appreciated that valve actuator assemblies have been in use for years. These assemblies control the flow of liquids or gasses in a variety of industrial and mechanical settings. Typically, valve actuator assemblies comprises one of three main types of design: those comprising diaphragm actuators, actuator pistons, or electromechanical actuators. These assemblies are typically used in controlling one or more functions of internal combustion engines or in other industrial applications.

15 [0003] The main drawback with conventional valve actuator assemblies is that the valve typically needs to be biased closed with an extremely high spring pre-load in order to counter-act or negate the force created by the working pressure of fluid (or gas) against the face of the valve. Another problem with conventional valve actuator assemblies is that the high spring pre-load requirement reduces the responsiveness of the actuator to control the valve. Another problem with conventional valve actuator assemblies is that they are typically over-designed
20 to be far more robust than they would otherwise need to be in order to withstand the high spring pressures mentioned heretofore.

[0004] While the valve actuator assemblies just described may be suitable for the particular purpose to which they address, it would be desirable to reduce the high spring pressures in order to reduce the design requirements of the valve and actuator and improve responsiveness.

25 SUMMARY

[0005] In view of the foregoing disadvantages inherent in the known types of valve actuator assemblies now present in the prior art, the embodiments described herein provide for a new valve and counter-biased valve actuator assembly. The counter-biased valve and actuator assembly uses a fluid (or gas) working pressure to eliminate, reduce, or overcome a
30 force acting on the face of a valve by communicating a common working pressure of the fluid (or gas) to a substrate with a resultant force vector opposite of the valve face, wherein the

same can be utilized for improving the function of the common valve and actuator assembly design as it is known heretofore.

[0006] The general purpose of the embodiments described herein, which will be described subsequently in greater detail, is to provide a new valve and valve actuator assembly, counter-biased by a working fluid (or gas) pressure, that has many of the advantages of the valve actuator assemblies mentioned heretofore and many novel features that result in a new valve and valve actuator assembly, counter-biased by working fluid (or gas) pressure, which is not anticipated, rendered obvious, suggested, or even implied by any prior art valve actuator assemblies, either alone or in any combination thereof.

10 [0007] To attain this, the embodiments described herein generally comprise a valve and a pneumatic/hydraulic piston actuator assembly. The valve comprises a standard valve defined by a valve stem and a valve head, the valve head having a valve face. However, the valve differs from the prior art by having a port formed axially through the length of the valve, through the valve face and extending through the end of the valve stem. The port
15 communicates a fluid (or gas) working pressure acting on the valve face to a counter-biasing chamber.

[0008] One object of the embodiments described herein is to provide a valve and counter-biased valve actuator assembly, counter-biased by a working fluid (or gas) pressure, that will overcome the shortcomings of prior art devices.

20 [0009] Another object of the embodiments described herein is to provide a valve and valve actuator assembly, counter-biased by a working fluid (or gas) pressure, for improving the function of a common valve and actuator assembly design, as it is known heretofore.

[0010] Another object is to provide a valve and valve actuator assembly, counter-biased by working fluid (or gas) pressure, that eliminates, reduces, or overcomes a force acting on the
25 face of a valve by communicating a common working pressure of the fluid (or gas) to a substrate with a resultant force vector opposite the valve face.

[0011] Another object is to provide a valve and valve actuator assembly, counter-biased by a working fluid (or gas) pressure, that reduces the need for unnecessarily high spring or force pre-loads to bias the valve closed against the fluid (or gas) working pressure.

30 [0012] Another object is to provide a valve and valve actuator assembly, counter-biased by

a working fluid (or gas) pressure, that improves the actuation response time, measured by the ability of the valve to operate at higher frequencies, by reducing or eliminating the spring or force pre-load to bias the valve.

[0013] Other objects and advantages of the present invention will become obvious to the reader and it is intended that these objects and advantages are within the scope of the embodiments present herein.

[0014] To accomplish the above and related objectives, the embodiments described herein are illustrated in the accompanying drawings, attention being called to the fact, however, that the drawings are for illustrative purposes only, and that changes may be made in the specific construction illustrated without departing from the general concepts described herein.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] The features, advantages, and objects of the present invention will become more apparent from the detailed description as set forth below, when taken in conjunction with the drawings in which like referenced characters identify correspondingly throughout, and wherein:

[0016] FIG. 1 illustrates a valve actuator assembly in accordance with one embodiment, shown in a perspective view;

[0017] FIG. 2 illustrates the valve actuator assembly of FIG. 1 in a cutaway view;

[0018] FIG. 3 illustrates another embodiment of an actuator piston used within the valve actuator assembly of FIG. 1 or FIG. 2; and

[0019] FIG. 4 illustrates the valve actuator assembly of FIG. 1 or FIG. 2 used in a typical automotive application, in this example, a turbocharged automotive engine.

DETAILED DESCRIPTION

[0020] Valve actuator assemblies are typically used to control the position of a valve in applications to perform flow or pressure regulation through the valve actuator assembly. The embodiments described herein provide for an ability to alter the influence of working pressures acting on a face of a valve in such an assembly. The fluid or gaseous pressure acts on a surface area of the valve face and generally produces a resultant force in a vector normal and opposite to this surface. One of the primary objectives of the embodiments disclosed herein is to reduce, eliminate, or overcome the force of the working pressure on the valve

face.

[0021] Turning now to the drawings, FIG. 1 illustrates a valve actuator assembly in accordance with one embodiment, shown in a perspective view. Valve actuator assembly 100 comprises an inlet port 102, an outlet port 104, a valve housing 106, and an actuator housing 5 108. Other components of valve actuator assembly 100, not visible in FIG. 1, will be described later herein. Valve actuator assembly 100 attaches to conduit 110 via channel 112 via screws or other known fastening methods. It should be understood that inlet port 102 and outlet port 104 may be interchanged, i.e., fluid or gas may, alternatively, enter port 104 and exit via port 102. Outlet port 104 connects to a second conduit (not shown) which carries the 10 gas or liquid from outlet port 104. The flow of fluid or gas from conduit 110 to the second conduit is controlled by a valve contained within valve actuator assembly, which is described in more detail below.

[0022] The actuator housing 108 is defined in one embodiment to mate with an actuator piston (not shown), the resultant combination thus functioning as a single-tier actuator piston. 15 Their mating defines at least two volumetric chambers in the actuator housing 108, which will be described in greater detail later herein.

[0023] The actuator housing 108 is typically characterized as a two-component structure modeled about the geometry of the actuator piston. In one embodiment, the actuator housing assembly takes the form of two-chambers and has the ability to accommodate either the 20 actuator piston based on a two-substrate diaphragm or a singular component design. In another embodiment, the actuator housing is defined by the geometry of a multi-tiered actuator piston described in FIG. 3 later herein.

[0024] FIG. 2 illustrates the valve actuator assembly 100 of FIG. 1 in a cutaway view. Shown is valve actuator assembly 100 mounted to a conduit 110 via channel 112. Valve actuator assembly 100 is typically secured to channel 112 via retaining screws or some other type of 25 mechanical fastener. Valve actuator assembly 100 comprises a valve 200, which is commonly known as a "poppet" valve. Other types of valves could be used in alternative embodiments. Valve 200 is defined by a valve stem 202 and valve head 204, the valve head 204 having a valve face 212. Valve 200 is secured via a channel 206 formed between valve 30 housing 208 and actuator housing 108, with one end of valve 200 being retained within

actuator piston **216**, as shown. The actuator piston **216** generally retains the valve **200** so as to impart resultant fluid or gaseous pressures acting on substrate areas of the piston, as will be explained in more detail below.

5 [0025] Valve **200** further comprises a port **210** defined axially through the entire length of valve **200**, including stem **202** and valve face **212**. A second port **218** is defined through actuator piston **216** that is at least partially aligned with port **210** in valve **200**. The combined ports **210** and **218** form an opening or conduit that communicates working fluid (or gas) pressure from the conduit **110** acting on the valve face **212** to a counter-biasing chamber **214**. In another embodiment, the valve **200** and actuator piston **216** are formed as a single unit
10 having a single port formed through the entire structure, from valve face **212** through substrate area **220**.

[0026] The substrate area **220** of actuator piston **216** in the counter-biasing chamber **214** forms a surface that is subjected to a resultant vector force asymmetrically normal to the force imposed against valve face **212**. In other words, the fluid or gas pressure in conduit **110** is
15 imparted to counter-biasing chamber **214** via ports **210** and **218**, which acts on the substrate area **220** of actuator piston **216**, driving actuator piston **216** down, in this case, towards conduit **110**. The force on actuator piston **216** is proportional to the amount of surface area of substrate area **220**; the larger the surface area, the greater the force on actuator piston **216**.

[0027] The actuator piston **216** acts as both the main actuator and valve retainer. In one
20 embodiment, as shown in FIG. 2, the actuator piston in combination with housing **108** forms multiple pressure control chambers **214**, **226**, **228** and **236**. Each of these control chambers are associated with a substrate area, or surface, of a portion of actuator piston **216**. These are shown as substrate areas **220**, **238**, **222**, and **242**, respectively, shown in bold. It should be understood that these control chambers and substrate areas have a cross section that is
25 generally associated with the overall geometry of the actuator housing **108**, in this embodiment, circular when viewed from above. Each of the pressure control chambers is connected to a respective pressure control port, shown as pressure control ports **210/218**, **230**, **232**, and **240**, respectively.

[0028] The force exerted on actuator piston **216** is in proportion to the pressures seen inside
30 each of the control chambers and associated substrate areas of piston actuator **216** upon which

the pressure is exerted. The number of control chambers may vary depending upon the application. In addition, the number of chambers in use in any particular application may vary. For example, a valve actuator assembly could be designed and built comprising 3 control chambers, while in use, only applying a pressure control signal to two of the three control chambers. Any unused control chambers may be sealed by installing a cap onto a respective pressure control port or they may be left open to atmospheric pressure, depending upon the particular application.

[0029] The actuator piston **216** is generally defined by, but not limited to, three commonly known geometries. In one embodiment, as shown in FIG. 2, the actuator piston **216** comprises a simple valve retainer that is connected to a two-substrate flexible diaphragm. In another design, the actuator piston **216** comprises a single component that retains the valve and has two substrate areas in counter axial orientations. In yet another embodiment, the actuator piston **216** comprises a multi-tiered design as described by patent 6,863,260 wherein it acts as a retainer, but also defines four volumetric chambers and four actuation substrates.

This design is described in FIG. 3 and explained as follows.

[0030] FIG. 3 illustrates another embodiment of actuator piston **216**, shown here as actuator piston **316**. As shown, actuator piston **316** comprises an elliptical or polygonal-profiled object extruded in one axis of varying diameters. Actuator piston **316** comprises a shaft **318** and tiers **300 - 314**, each tier comprising a different geometric profile from other tiers, or levels, extruded on actuator piston **316**. Each tier may have different diameters, widths or dimensions to define a surface area available for a pressure control signal to act upon. Shaft **318** comprises a longitudinal extension, such as a rod, or cylinder, having one of any number of cross-sections, extending the length of actuator piston **316** around which the various tiers are imposed. Shaft **318** additionally comprises a first shaft end **326** and a second shaft end **328**. In some cases, a tier may have a diameter equal to the diameter of shaft **318**, for example, tiers **300, 310, 312, and 306**. A resultant force on actuator piston **316** is produced by the combination of pressure control signals acting upon the different surface areas defined by the tiers.

[0031] The geometric profiles representing the tiers do not necessarily have to be axially aligned. The most common implementation of actuator piston **316** will be one wherein

actuator piston **316** will travel in an axial direction that is perpendicular to the geometric profiles of the tiers. The piston/housing relationship typically assumes that actuator piston **316** will be the component that will travel and move in relation to the actuator housing **108**.

5 [0032] Each tier generally comprises a top surface, a bottom surface, and an outer wall, such as top surface **320**, and an outer wall **324** (a bottom surface not shown). A top surface of one tier may be a bottom surface of another tier. For example, top surface **320** of tier **302** is the same surface as a bottom surface of tier **310**; the bottom surface of tier **302** is the same surface as a top surface of tier **308**. As mentioned previously, the outer walls of some, or all, of the tiers are in contact with the various inner walls defining cavities of actuator housing
10 **108**. This contact forms chambers that change in volume as either actuator piston **316**, or actuator housing **108**, travels along an axis common to both components. The surfaces of the cavity inner walls may act as a sealing surface with either the material of the tiers or with a seal housed by, or integrated into, the tier outer walls. Alternatively, actuator housing **108** may comprise materials for providing a sealing surface with the tiers. Furthermore,
15 independent seals such as O-rings, for example, can also be integrated into the tiers and/or shaft **318**, to mate with the housing cavity inner surfaces to create a seal. Any number of existing seal technologies can be integrated into actuator piston **316**, including, but not limited to, o-rings, washers and metal seals. In the example of FIG. 3, such independent seals may be placed around tier **314**, tier **308**, or tier **303**.

20 [0033] Although shown in FIG. 3 as a piston of single-piece construction, actuator piston **316** can alternatively be constructed of distinct and separate objects that fit the aforementioned description and that are connected together to form resultant actuator piston **316**. Accordingly, actuator piston **316** may be manufactured of any currently available materials, such as plastic, metal, or any other rigid or semi-rigid material, depending on each particular
25 application.

[0034] Referring back to FIG. 2, pressure control signals may be communicated to control chambers **226**, **228**, and **236** via pressure control ports **230**, **232**, and **240**, respectively, to control operation of valve **202**. These pressures each may be applied as positive pressures or negative pressures and may originate from different sources. The pressure control signals
30 typically comprise gas, liquids, or a combination of the two. In addition, each pressure

control port could transmit a unique pressure type. For example, the pressure control signal communicated to pressure control port **230** could comprise a gas while the pressure control signal communicated to pressure control port **232** could comprise a liquid. The pressure control signals introduced to pressure control ports **230**, **232**, and **240** can either be the same or mutually exclusive, and may be introduced at varying points in time so as to control the position of valve **202** relative to sealing surface **234**, and thereby controlling the flow of material from discharge port **104**. In any given application, there can exist a multiplicity of chambers defined by annular walls, end walls, and tier surfaces used to create forces operating against actuator piston **216**. The quantity of such chambers, tier surface areas, or other chamber-defining characteristics need not be equal or similar.

[0035] Actuator piston **216** will move in one of two directions, either up or down with respect to actuator housing **108**. For example, if a pressurized fluid is communicated through pressure control port **232** into control chamber **228**, that fluid, barring any other forces acting on actuator piston **216**, will act to effectively move the actuator piston **216** in a direction that allows for the expansion of the pressurized fluid or gas into chamber **228**. The actuator piston **216** will move in a direction where the force will find a differential, i.e., in an upward movement in this example, or away from conduit **110** and, in turn, cause valve **200** to open with respect to sealing surface **234**.

[0036] The actuator piston **216** will be displaced in a direction proportional to the net combined force operating against each substrate surface and the valve face. Each of the forces against the substrate surfaces are, in turn, proportional to pressure signals applied via pressure control ports and into respective pressure control chambers, against respective substrate surface areas. For example, a positive pressure signal applied to control chamber **226** via pressure control port **230** would be offset an equal, positive pressure signal applied to control chamber **228** via pressure control port **232** if both substrate areas **238** and **222** are equal in surface area. In this case, piston actuator **216** and valve **200** would not move. In another example, if the same pressures were applied to control chambers **226** and **228**, but the surface area of substrate **238** was twice as great as the surface area of substrate **222**, then the piston actuator **216** would move toward the closed position shown in FIG.2. In yet another example, if a positive pressure is communicated to pressure control port **230** and a negative

pressure is communicated to pressure control port **232**, and the tier surfaces of each control chamber are equal, the actuator piston **216** will move in a downward direction at twice the force of each individual pressure control signal (assuming, of course, that the valve **202** has not yet contacted sealing surface **234**).

5 [0037] Assembly of valve actuator assembly **100** generally begins with the actuator housing **108** mating with the actuator piston **216**, which then mates with the valve **202** and finally valve housing **208**. There are several permutations of design and assembly available. Other embodiments may find that the design requirements necessitate a one-piece valve and actuator piston design. The interconnectivity of the components would be fundamentally unchanged
10 however.

[0038] There exists myriad methodologies to manufacture these components. Processes that can be used include, but are not limited to, investment casting, die casting, injection molding and wrought machining. Materials that can be used can include, but are not limited to, ferrous and non-ferrous metals, plastics and advanced resin-based composites.

15 [0039] FIG. 4 illustrates a valve actuator assembly **400** used in a typical automotive application, in this example, a turbocharged automotive engine **402**. Ambient air enters an inlet **404** of turbocharger **403** to be compressed and routed to a charge cooler **406** via ducting **408**. The compressed air then enters the engine **402** and the spent gases exit through ducting **410** and into an inlet of an exhaust turbine section **412** of turbocharger **403**. In order to
20 regulate the operating speed of the turbocharger, a regulating valve, commonly known as a wastegate, is generally required. These mechanical valve assemblies typically comprise a common "poppet" valve that regulates exhaust gas pressure and flow entering the turbocharger. The valve is typically biased in the closed position by a spring inside a valve housing assembly. In the example of FIG. 4, this regulating valve comprises valve actuator
25 assembly **400** as described previously hereto. The valve inside the valve actuator assembly **400** may be biased in a closed position by a spring and the valve and actuator inside the valve assembly **400** comprises ports **210** and **218** to respond to the pressure of the gas inside ducting **410** acting on the valve face. Attributes of the spring, such as the size, restoring force, and spring constant, is typically reduced from what would normally be required to bias the valve
30 in the closed position, due to the equalizing effect of ports **218** and **210**.

[0040] In the example of FIG. 4, valve actuator assembly 400 is controlled by an actuating pressure control signal 414 from the compressed ambient air from turbocharger 403 prior to entering cooler 406. It should be understood that this pressure control signal 414 could, alternatively, originate from the outlet of cooler 406 or be supplied from a source other than the components shown in FIG. 4. In the example of FIG. 4, the pressure control signal 414 is a positive pressure, connected to pressure control port 232, that operates to open the valve inside the actuator assembly 400. As the valve is opened, exhaust gases from ducting 410 are passed by the valve actuator assembly 400 and discharged through conduit 416, typically to ambient air or a noise-suppression system. As the valve inside valve actuator assembly 400 opens, pressure and flow of exhaust gasses is reduced inside ducting 410, thereby slowing the rotation of turbocharger 403. If the pressure inside ducting 408 becomes too small, pressure control signal 414 likewise is reduced, causing the valve inside valve actuator assembly 400 to close, thereby increasing the pressure inside ducting 410. As a result, turbocharger 403 increases it's rotation. In this manner, a feedback loop is established to regulate turbocharger 403.

[0041] It should be noted that in this example, there is only one pressure control signal applied to the valve actuator assembly, pressure control signal 414 connected to pressure control port 232. The second pressure control port remains unconnected. In this arrangement, the force of the exhaust inside ducting 410 and the pressure control signal 414 acts to push the valve open, while a biasing spring acts to close the valve. In other embodiments, the second pressure control port can be connected to a second pressure control signal to further control operation of the valve. In still other embodiments, valve actuator assembly 400 could comprise more than two pressure control ports, each pressure control port connected to a particular control chamber within the valve actuator assembly. Finally, in other embodiments, one or more unused ports may be capped so that any gases inside respective control chambers remains trapped inside those control chambers.

[0042] With respect to the above description, it is to be realized that the optimum dimensional relationships of the various components of the pipe couplers include variations in size, materials, shape, form, function and manner of operation, assembly and use, and are deemed readily apparent and obvious to one skilled in the art. All equivalent relationships to

those illustrated in the drawings and described in the specification are intended to be encompassed by the embodiments described herein. Therefore, the foregoing is considered as illustrative only of the principles and descriptions provide herein. Further, since numerous modifications and changes may be contemplated by those skilled in the art, it is not desired to
5 limit the embodiments described herein to the exact construction and operation shown and described, and accordingly, all suitable modifications and equivalents may be resorted to, falling within the scope of the present disclosure.

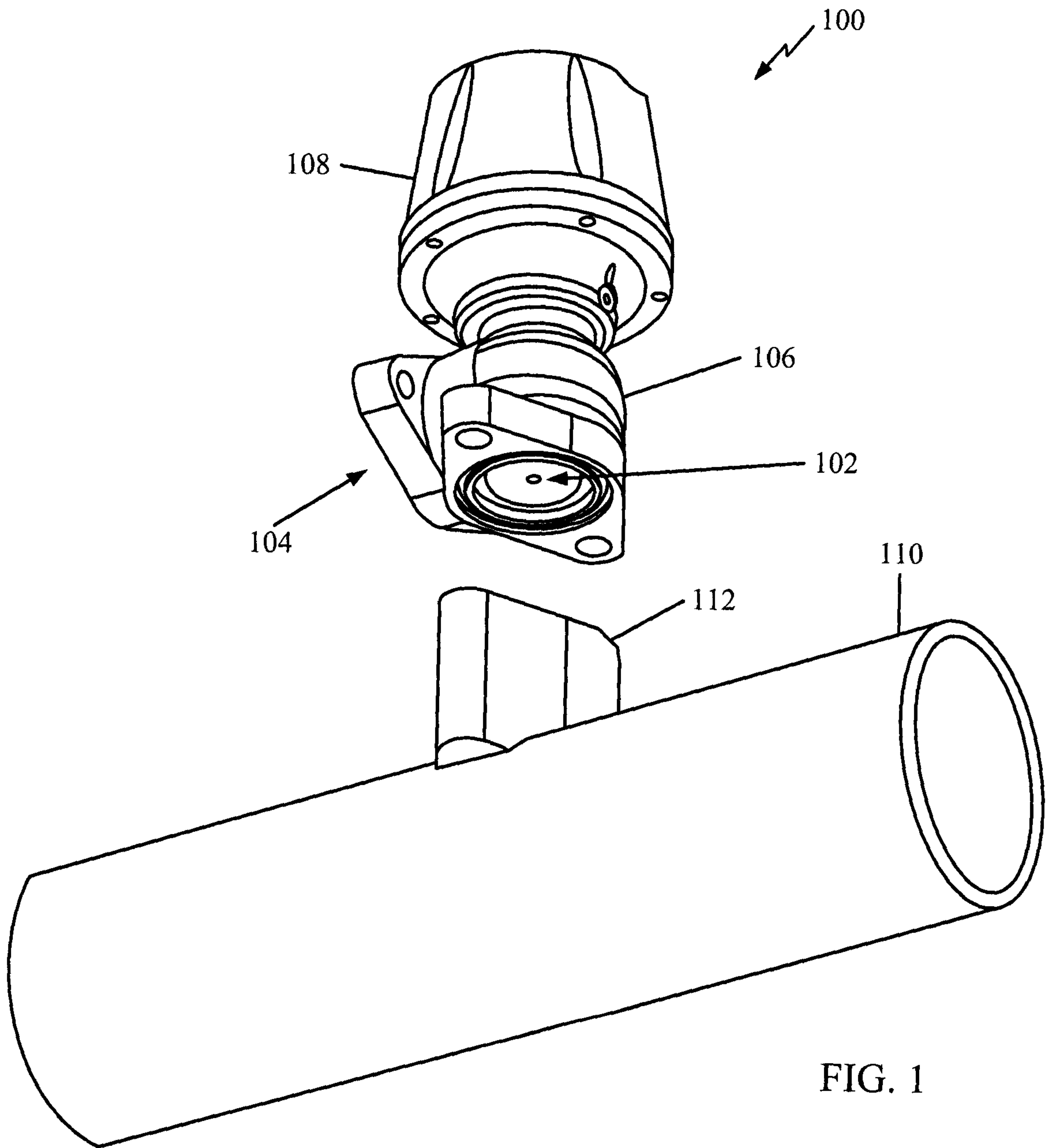
CLAIMS:

1. A valve actuator assembly, comprising:
an actuator housing;
an actuator piston disposed within the actuator housing, the actuator piston
5 comprising a first port formed through the actuator piston, wherein the actuator piston and
the actuator housing, together, define a counter-biasing chamber connected to the first port
and a plurality of control chambers; wherein a first control chamber and the counter-biasing
chamber are both positioned on the same side relative to the actuator piston;
a first pressure control port, connected to the first control chamber, for passing a
10 pressure control signal to the first control chamber and into contact with a surface of the
actuator piston; and
a valve comprising a second port formed axially through the valve, the second port
at least partially aligned with the first port;
wherein the valve has a valve face having a surface area that is greater than the
15 surface area of the portion of the actuator piston forming a portion of the counter-biasing
chamber.
2. The valve actuator assembly of claim 1, further comprising:
a valve housing connected to the actuator housing, comprising an intake port and a
20 discharge port.
3. The valve actuator assembly of claim 1, wherein the actuator piston and the valve
comprise a single entity and the first and second ports join to form a single port through the
single entity.
25
4. The valve actuator assembly of claim 1, wherein the valve comprises a poppet
valve.
5. The valve actuator assembly of claim 1, further comprising:

at least two lower control chamber formed by the actuator piston and the actuator housing, wherein each lower control chamber includes an individual pressure control port connected thereto.

- 5 6. The valve actuator assembly of claim 1, further comprising:
a second control chamber formed between the actuator piston and the actuator housing; and
means for passing a second pressure control signal to the second control chamber.
- 10 7. A method for controlling flow, comprising:
providing a valve assembly to control fluid or gaseous flow from a first conduit to a second conduit, the valve assembly comprising:
an actuator housing;
an actuator piston disposed within the actuator housing, the actuator piston
15 comprising a first port formed through the actuator piston, wherein the actuator piston and the actuator housing, together, define a counter-biasing chamber connected to the first port and a plurality of pressure chambers where at least one of the pressure chambers is an upper pressure chamber positioned above a surface of the actuator piston; and
20 a valve comprising a second port formed axially through the valve, the second port at least partially aligned with the first port;
wherein the upper pressure chamber is connectable to a source of variable positive pressures, negative pressures, or combinations thereof; and
operating the valve by applying a pressure control signal to a pressure control port on
25 the actuator assembly, the pressure control port connected to the control chamber.
8. The method of claim 7, comprising:
operating the valve by applying a second pressure control signal to a second pressure control port on the actuator assembly, the second pressure control port connected to the
30 second control chamber.

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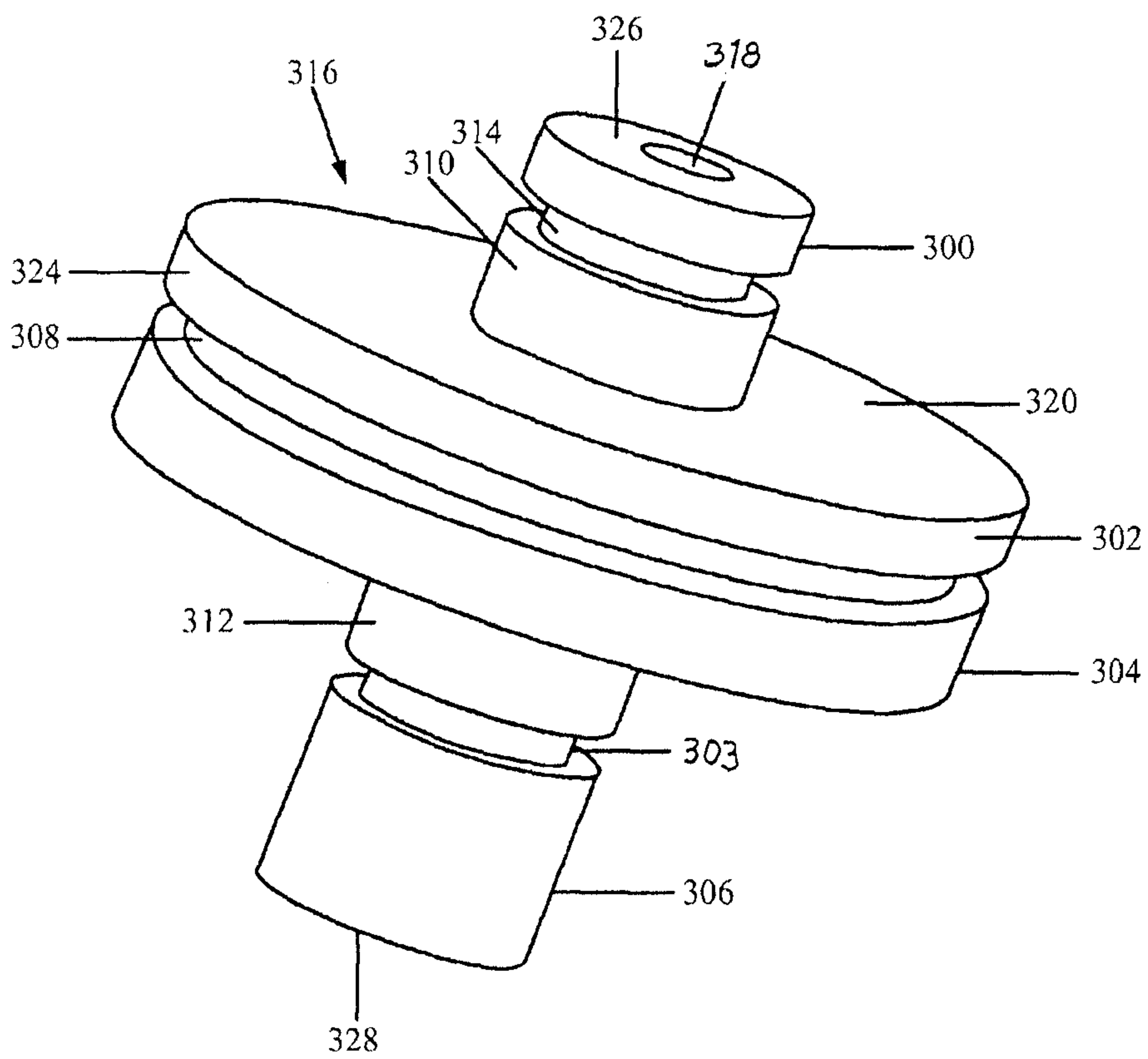


FIG. 3

