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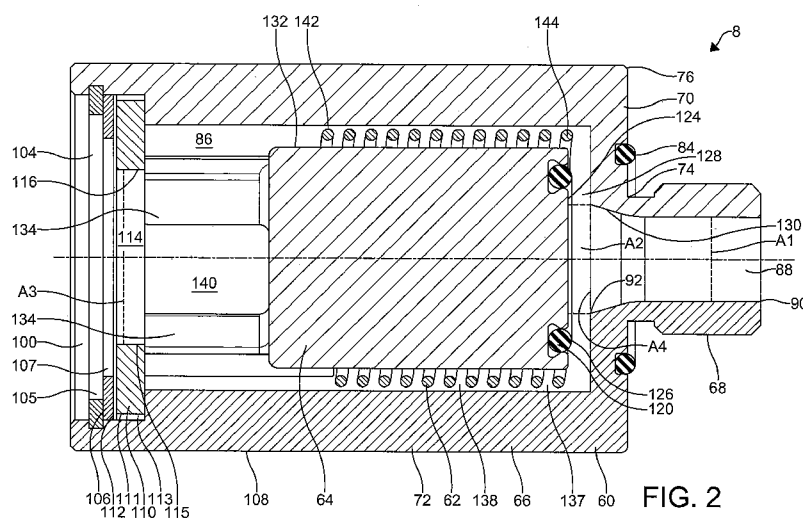


FIG. 2

(57) Abstract: A valve assembly for a tire pressure management system including a housing. The housing includes a base portion attached to a cap portion. The cap portion defines a first perforation. An annular member is attached to the housing. The annular member defines a second perforation. The second perforation is in fluid communication with the first perforation when the valve assembly is in an open position. A biasing member is disposed in the housing adjacent the first perforation. A shuttle assembly is in contact with the biasing member. The shuttle assembly includes a piston and a sealing member. The sealing member is attached to an outer surface of the piston. The sealing member is in sealing contact with a portion of the base portion when the valve assembly is in a closed position.

TITLE

VALVE ASSEMBLY FOR A TIRE PRESSURE MANAGEMENT SYSTEM

CROSS-REFERENCE TO RELATED APPLICATION

This application is claiming the benefit, under 35 U.S. C. 119(e), of the provisional U.S. patent application which was granted Serial No. 62/281,896 and filed on January 22, 2016, the entire disclosure of which is hereby incorporated by reference.

BACKGROUND OF THE INVENTION

The invention relates to a valve assembly for a tire pressure management system.

Conventional wheel valves are limited to a low operating pressure range. As a non-limiting example, the operating pressure range may be up to about 100 pounds per square inch (psi). When exposed to pressures greater than the aforementioned operating range, conventional wheel valves may leak or fail. Also, such wheel valves tend to be bulky, expensive, and complex to manufacture.

It would be advantageous to develop a valve assembly suitable for use as a wheel valve that is easier and inexpensive to manufacture. It would also be desirable if such a valve assembly was operable at higher pressures and quickly closed with a minimal drop in pressure during an inflation cycle or deflation cycle.

BRIEF SUMMARY OF THE INVENTION

Embodiments of a valve assembly for a tire pressure management system are provided.

In an embodiment, the valve assembly comprises a housing. The housing includes a base portion attached to a cap portion. The cap portion defines a first perforation. An annular member is attached to the housing. The annular member defines a second perforation. The second perforation is in fluid communication with the first perforation when the valve assembly is in an

open position. A biasing member is disposed in the housing adjacent the first perforation. A shuttle assembly is in contact with the biasing member. The shuttle assembly comprises a piston and a sealing member. The sealing member is attached to an outer surface of the piston. The sealing member in
5 sealing contact with a portion of the base portion when the valve assembly is in a closed position.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING

The above, as well as other advantages of the embodiments will
10 become readily apparent to those skilled in the art from the following detailed description when considered in the light of the accompanying drawings in which:

FIG. 1 depicts a schematic view of a tire pressure management system;

FIG. 2 depicts a sectional view of an embodiment of a valve assembly;

15 FIG. 3 depicts an exploded view of the valve assembly of FIG. 2;

FIG. 4 depicts a sectional view of another embodiment of the valve assembly;

FIG. 5 depicts an exploded view of the valve assembly of FIG. 4; and

20 FIG. 6 depicts a perspective view of certain areas within the embodiments of the valve assembly.

DETAILED DESCRIPTION OF THE INVENTION

It is to be understood that the invention may assume various alternative orientations and step sequences, except where expressly specified to the
25 contrary. It is also to be understood that the specific assemblies and methods illustrated in the attached drawings, and described in the following specification are simply exemplary embodiments of the inventive concepts. Hence, specific dimensions, directions or other physical characteristics relating to the
30 embodiments disclosed are not to be considered as limiting, unless expressly state otherwise. Also, although they may not be, like elements in various embodiments may be commonly referred to with like reference numerals within this section of the application.

Various embodiments of a valve assembly 8 are described herein. The embodiments of the valve assembly 8 described herein may have applications to commercial and off-highway vehicles. Also, it would be understood by one of ordinary skill in the art that these embodiments could have industrial,
5 locomotive, military and aerospace applications.

Referring now to FIG. 1, the valve assembly 8 is preferably utilized adjacent a wheel assembly 10. In certain embodiments, the valve assembly 8 may be attached to the wheel assembly 10. However, it should be appreciated that the valve assembly may be used with other types of assemblies. For
10 example, the valve assembly may be utilized in a pneumatic assembly.

Typically, a wheel assembly 10 comprises a tire and a wheel rim. The tire and the wheel rim may be conventional in the art. The tire is attached to the wheel rim and the valve assembly 8 may be attached to the wheel rim. Attaching the tire to the wheel rim forms the wheel. The wheel houses a
15 pressurized fluid such as, for example, air. The pressurized air housed in the wheel will be referred to herein as tire pressure.

On an end, the valve assembly 8 is in fluid communication with the wheel. On an opposite end, the valve assembly 8 is also in fluid communication with one or more portions of a tire pressure management
20 system. The tire pressure management system may be of the central tire inflation system (CTIS) variety. The tire pressure management system may have inflate only capability to allow one or more tire pressures to be increased. However, it is preferred that the tire inflation system has inflate and deflate capability to allow one or more tire pressures to be increased and/or
25 decreased. An embodiment of the tire pressure management system 12 having the valve assembly 8 is illustrated in FIG. 1.

With reference to FIG. 1, the tire inflation system 12 may comprise a control unit 14. The control unit 14 may comprise a pressure sensor 16 for measuring the pressure of air. Preferably, the control unit 14 also comprises a
30 plurality of valve assemblies 18, 20, 22, 24, 25 which are of the solenoid variety, and a first fluid conduit 26 for controlling the flow of and directing air

through the control unit 14. The control unit also comprises a variable are valve assembly 27.

The control unit 14 also comprises an electronic control portion 28. The electronic control portion 28 may receive input signals from the pressure sensor 16, a power supply 30, and one or more additional sensors such as, for example, a load sensor and a speed sensor. Additionally, the electronic control portion 28 may receive input signals from an operator control device 32. The electronic control portion 28 may include a microprocessor 34 operating under the control of a set of programming instructions, which may also be referred to as software. The electronic control portion 28 may include a memory in which programming instructions are stored. The memory can also store identification codes, tire pressure records and/or user inputs over a period of time.

The electronic control portion 28 outputs signals to the valve assemblies 18 – 24, 25, 27 to open or close the valve assemblies 18 – 24, 25, 27. The electronic control portion 28 may also output signals to a display device. The display device may be included as a part of the operator control device 32 or a freestanding device.

The control unit 14 selectively communicates with an air supply 36 via an air supply circuit 38. The pressure sensor 16 measures the pressure of the air supply 36 via the air supply circuit 38 and the first fluid conduit 26. The control unit 14 also preferably comprises a control valve assembly 24. The control valve assembly 24 may be provided with an orifice which is smaller than the orifice of the supply valve assembly 22 and is utilized to provide a bleed of air from the air supply 36 to a fluid control circuit 40. Preferably, the supply valve assembly 22 and control valve assembly 24 are of the solenoid variety as mentioned above.

When it is desired to decrease the tire pressure, the control unit 14 provides a signal to a deflate valve assembly 25 to open. The deflate valve assembly 24 separates a variable area valve assembly 27 from the first fluid conduit 26 until it is desired to decrease the tire pressure. The variable area valve assembly 27 acts as a throttle valve and controls the pressure in the fluid control circuit 40 to prevent the valve assembly 8 from closing when the tire

pressure is being decreased. Preferably, the deflate valve assembly 24 and the variable area valve assembly 27 are as described in WO 2014/124429, the entire disclosure of which is hereby incorporated by reference.

The air supply 36 is utilized to check the tire pressure and, if needed, increase and/or decrease the tire pressure. The air supply 36 is preferably provided by an air compressor 42 attached to the vehicle. Preferably, the air supply 36 also comprises a reservoir 44 such as, for example, a wet tank. The compressor 42 is in fluid communication with the reservoir 44 via a supply conduit 46. The air compressor 42 supplies pressurized air to the reservoir 44 for storage therein. Pressurized air from the air supply 36 is provided to the air supply circuit 38 via the reservoir 44. In certain embodiments, a drier 48 is provided for removing water from the air supply 36. A filter (not depicted) may also be interposed in the air supply circuit 38 or the supply conduit 46.

The control unit 14 selectively provides or receives pressurized air from the fluid control circuit 40. The fluid control circuit 40 is utilized to provide fluid communication between the control unit 14 and one or more wheels 10, 10A. Preferably, fluid communication between the control unit 14 and the one or more wheels 10, 10A circuit 40 is permitted or prohibited by opening or closing a channel valve assembly 18.

The fluid control circuit 40 comprises the valve assembly 8. The fluid control circuit 40 will be described below with reference to one valve assembly 8. However, it should be appreciated that the fluid control circuit 40 may comprise a plurality of valve assemblies 8, 8A. For example, a first valve assembly 8 associated with a wheel 10 on a drive axle of the vehicle could be provided and a second valve assembly 8A associated with another wheel 10A on the drive axle could be provided. Preferably, the first valve assembly 8 and the second valve assembly 8A are similarly configured. The fluid control circuit 40 may also comprise one or more fluid conduits 54, 56 and one or more rotary assemblies 58, 58A.

Preferably, the tire pressure is equal to a target tire pressure. The target tire pressure can be selected to be a desired pressure. After the target tire pressure is selected, it is programmed into the control unit 14. If it is

determined that the tire pressure is not equal to the target tire pressure, the tire pressure can be adjusted. For example, in certain embodiments, if it is determined that the tire pressure is less than the target tire pressure, the tire pressure can be increased. In other embodiments, if it is determined that the tire pressure is greater than the target tire pressure, the tire pressure can be decreased.

The valve assembly 8 is utilized to measure and/or adjust the tire pressure. The valve assembly 8 allows pressurized air to be directed from the wheel 10 to the remaining portions of the tire pressure management system 12 and vice versa to measure and/or adjust the tire pressure. During a tire pressure measurement or adjust, the valve assembly 8 is in an open position or placed in the open position. In FIGs. 2 and 4, the valve assembly 8 is shown in an open position. When the tire pressure is not being measured or adjusted, the valve assembly 8 is in a closed position or placed in the closed position.

Referring now to FIGs. 2-5, the valve assembly 8 comprises a housing 60. The housing 60 is preferably metallic. However, it should be understood that the housing may be formed utilizing other materials. In an embodiment (not depicted), the housing is formed by joining a plurality of components. However, as illustrated, it is preferred that the housing 60 is a single member that is formed in a unitary manner. The valve assembly 8 also comprises a biasing member 62 and a shuttle assembly 64.

In an embodiment, the housing 60 comprises a base portion 66 and a cap portion 68. As illustrated in FIGs. 2 and 4, the biasing member 62 and shuttle assembly 64 are disposed in the base portion 66. The base portion 66 comprises an upper wall portion 70 and an outer wall portion 72. Preferably, the base portion 66 is unitarily formed by casting a metal. However, it should be understood that the base portion 66 may be formed using other materials and processes. It should also be understood that the base portion 66 may be formed by joining the upper wall portion and the outer wall portion.

The upper wall portion 70 is of an annular shape. At an end 74, the upper wall portion 70 is attached to the cap portion 68. At an opposite end 76, the upper wall portion 70 is attached to the outer wall portion 72. The upper

5 wall portion 70 has an inner surface 78 and an outer surface 80. A groove 82 may be formed in the outer surface 80. The groove 82 may be of the dovetail variety. A sealing member 84 is disposed in the groove 82. The sealing member 84 provides a seal between the outer surface 80 of the valve assembly 8 and a portion of a component that the valve assembly 8 is coupled to. The inner surface 78 of the upper wall portion 70 partially defines a base cavity 86. For certain embodiments of the valve assembly 8, it is preferred that the inner surface 78 is flat, i.e. without any perceptible ridges or grooves, so that it provides a even sealing surface when it is desired for the valve assembly 8 to be in the closed position.

10 The cap portion 68 is in a perpendicular relationship with the upper wall portion 70. The cap portion 68 is attached to the upper wall portion 70 at the first end thereof 74 and extends away therefrom. Preferably, the cap portion 68 is of a generally cylindrical shape and is unitarily formed by casting a metal. However, it should be understood that the cap portion 68 may be formed in different shapes and/or by using other materials and processes. It should also be understood that the cap portion 68 may be formed by joining a plurality of components.

15 A first perforation 88 is formed through the cap portion 68 and the upper wall portion 70. On an end 90, the first perforation 88 is in fluid communication with a portion of the fluid control circuit 40. On an opposite end 92, the first perforation is in fluid communication with the base cavity 86.

20 The first perforation 88 and the base cavity 86 are aligned. The first perforation 88 is shaped to militate against pressure losses that occur as pressurized air flows through an orifice constriction and to set a relative flow rate for the air as it is directed through the valve assembly 8. The first perforation 88 is preferably of a cylindrical shape and a substantially constant diameter in the cap portion 68. In the upper wall portion 70, the first perforation 88 gradually increases in diameter to and toward the end 92 thereof and the base cavity 86. Alternatively, the first perforation may be of other shapes that militate against pressure losses that occur as a fluid flows through an orifice constriction.

The upper wall portion 70 is in a perpendicular relationship with the outer wall portion 72. The outer wall portion 72 is of a generally cylindrical shape. The outer wall portion 72 is attached to the upper wall portion 70 at the second end thereof 76 and extends away therefrom. An inner surface 94 of the outer wall portion 72 and the inner surface 78 of upper wall portion 70 at least partially define the base cavity 86.

The inner surface 94 of the outer wall portion 72 has a first diameter portion 96 and a second diameter portion 98. The first diameter portion 96 partially defines the base cavity 86 and the second diameter portion 98 partially defines a stem cavity 100. The second diameter portion 98 has a diameter which is greater than a diameter of the first diameter portion 96. An interface 103 between the first diameter portion 96 and the second diameter portion 98 is sharply defined. A groove 102 is formed in the second diameter portion 98. A retaining ring 104 is disposed in the groove 102. The retaining ring 104 has a central opening 105.

A spring 106 is disposed in the stem cavity adjacent the groove 102 and abuts the retaining ring 104 on a side thereof. On an opposite side, the spring 106 abuts a filter 112. The spring 106 has a central aperture 107. The central opening 105 of the retaining ring 104 is of a diameter which is greater than a diameter of the central aperture 107. Preferably, the spring 106 is of the wave variety. In these embodiments, the wave spring may be metallic and formed from a spring steel.

The outer wall portion 72 has an outer surface 108. The outer surface may be knurled. In other embodiments, the outer surface of the outer wall portion may include a thread portion formed thereon. When provided, the thread portion engages a thread formed in a component the valve assembly is coupled to. In still other embodiments, two or more flat surfaces may be provided on the outer surface of the outer wall portion to aid in assembling the valve assembly 8. In these embodiments, it is preferred that at least two of the two or more flat surfaces are provided in a parallel relationship with each other.

An annular member 110 is attached to the inner surface 94 of the outer wall portion 72. More particularly, the annular member 110 is attached to the

second diameter portion 98 of the inner surface 94. Thus, in an embodiment, the annular member 110 is disposed in the stem cavity 100. However, it should be appreciated that, in other embodiments (not depicted), the annular member may be disposed in the base cavity. The annular member 110 has an outer
5 diameter 111 which is less than the diameter of the second diameter portion 98 of the inner surface 94. A space 113 may be provided between the outer diameter 111 of the annular member 110 and the second diameter portion 98. However, the outer diameter 111 of the annular member 110 is greater than the diameter of the first diameter portion 96 of the inner surface 94.

10 As illustrated, it is preferred that the annular member 110 and the housing 60 are formed as separate members and are not formed in a unitary manner. Forming the annular member 110 and the housing 60 as separate members reduces the complexity required to manufacture the valve assembly 8. However, it is preferred that the annular member 110 is formed in a unitary
15 manner. In other embodiments (not depicted), the annular member may be formed in another manner. Preferably, the annular member 110 is formed from a rigid, durable material. In one such embodiment, the annular member 110 is metallic. Preferably, the annular member 110 is a washer.

The annular member 110 is provided in a perpendicular relationship with
20 outer wall portion 72 and separates the filter 112 from the interface 103 between the first diameter portion 96 and the second diameter portion 98. The annular member 110 defines a second perforation 114. More particularly, an inner diameter 115 of the annular member 110 defines the second perforation 114. The diameter of the central aperture 107 of the spring 106 is greater than
25 the inner diameter 115 of the annular member 110. The second perforation 114 is in fluid communication with the first perforation 88 via the base cavity 86. Also, the second perforation 114 allows the base cavity 86 to communicate with the stem cavity 100.

30 The second perforation 114 is aligned with the base cavity 86 and the first perforation 88. The second perforation 114 is shaped to militate against pressure losses that occur as pressurized air flows through an orifice constriction and to set a relative flow rate of the air that enters the base cavity

86 or the stem cavity 100. In an embodiment (not depicted), the second perforation has a diameter which is of a length that varies radially. In this embodiment, the diameter of the second perforation varies from a first end to a second end thereof. Also, in this embodiment, it is preferred that the diameter
5 of the second perforation gradually decreases in length from the first end adjacent the base cavity to a reduced diameter in a center portion and then gradually increases in length along a remaining portion to the second end adjacent the stem cavity. In other embodiments (not depicted), the varying diameter of the second perforation may be defined by a pair of circular fillets or
10 by other conic sections. Alternatively, as is illustrated in FIGs. 2-5, the second perforation 114 may be of a diameter 116 that is substantially constant.

The shuttle assembly 64 comprises a piston 118 and a sealing member 120, 120A. The piston 118 and the sealing member 120, 120A are attached to each other. More particularly, the sealing member 120, 120A is attached to an
15 outer surface 124, 124A of the piston 118. In an embodiment like the one illustrated in FIGs. 2-3, the sealing member 120 is disposed in a groove 122 formed in the outer surface 124 of the piston 118. In this embodiment, the thickness of the sealing member 120 is such that the sealing member 120 extends beyond the outer surface 124 of the piston 118 and toward the first
20 perforation 88.

Preferably, the groove 122 is of the dovetail variety. As illustrated best in FIG. 3, in an embodiment, a portion 125 of the groove 122 gradually widens from an opening 127 of the groove 122. The gradually widening portion 125 of the groove 122 widens in a direction away from the outer surface 124 of the
25 piston 118. The opening 127 may include a portion 129 which is narrower than the gradually widening portion 125, i.e. the narrow portion of the opening is of a width that is less than a width of the gradually widening portion. The narrow portion 129 of the groove 122 is defined by one or more shoulders 131, 133. In an embodiment, an inner shoulder 131 and an outer shoulder 133 define the
30 narrow portion 129 of the groove 122. Preferably, the narrow portion 129 of the groove 122 is of a width that is less than a width of the sealing member 120.

It is preferred that the sealing member 120 is formed from a resilient material. In an embodiment, the sealing member 120 comprises an elastomeric material. In this embodiment, the sealing member 120 may comprise rubber or another elastomeric material. Forming the sealing member 120 with an elastomeric material allows the sealing member 120 to be compressed as it passes through the narrow portion of the groove 122 if the sealing member 120 is pressed into the groove 122 during the manufacture of the valve assembly 8. Also, forming the sealing member 120 with an elastomeric material allows certain portions of the sealing member 120 to expand and return to their original shape and width after being disposed in the groove 122. The composition of the sealing member 120, the width of the narrow portion of the groove 122, and the width of the sealing member 120 after it is disposed in the groove, allows the sealing member 120 to be attached and remain attached to the piston 118.

In certain embodiments, the groove 122 is of an annular shape. In these embodiments, the sealing member 120 is of an annular shape. In other embodiments, the sealing member 120 may be of another shape. In embodiments where the groove 122 is of an annular shape, it is preferred that the sealing member 120 is an O-ring.

In another embodiment, like the one illustrated in FIGs. 4-5, the sealing member 120A is attached directly to the outer surface 124A of the piston 118. More particularly, in this embodiment, the sealing member 120A is attached directly to the outermost surface 124A of the piston 118, which is the surface of the piston 118 that is nearest the first perforation 88. Also, in this embodiment, the sealing member 120A is of a conical shape. Preferably, the sealing member 120A is of a frusto-conical shape. However, when the sealing member 120A is directly attached to the outer surface 124A of the piston 118, the sealing member 120A may be of another shape. In these embodiments, it is preferred that the sealing member 120A is formed from a resilient material. In one such embodiment, the sealing member 120A comprises an elastomeric material such as, for example, rubber or another elastomeric material.

The sealing member 120, 120A comprises a sealing surface 126, 126A. The sealing surface 126, 126A is disposed adjacent the first perforation 88. In the embodiment shown in FIG. 2, the sealing member 120 is circumferentially disposed around the end 92 of the first perforation 88 and is in sealing contact with the inner surface 78 of the upper wall portion 70 when the valve assembly 8 is in the closed position (not depicted). In this embodiment and when the valve assembly 8 is in the open position, a space 128 separates the sealing member 120 from the inner surface 78 of the upper wall portion 70 as is shown in FIG. 2. In the embodiment shown in FIG. 4, the sealing member 120A is disposed in the first perforation 88 and is in sealing contact with a ramped transition surface 130 of the upper wall portion 70 when the valve assembly 8 is in the closed position (not depicted). The ramped transition surface 130 partially defines the first perforation 88 and is of a diameter that gradually increases in a direction to and toward the base cavity 86. In this embodiment and when the valve assembly 8 is in the open position, a space 128A separates the sealing member 120A from the inner surface 78 of the upper wall portion 70 and the ramped transition surface 130 of the upper wall portion 78 that defines the first perforation 88 as is shown in FIG. 2.

To place the valve assembly 8 into an open position, the shuttle assembly 64 is urged toward the annular member 110 by the biasing member 62. The bias provided to the shuttle assembly 64 is applied to the piston 118. The piston 118 comprises a main portion 132 and a plurality of shuttle supports 134. In an embodiment, the piston 118 is unitarily formed by injection molding a thermoplastic, preferably polyoxymethylene, such as that sold by E.I. duPont de Nemours and Company under the trademark Delrin®. However, it should be appreciated that the piston 118 may be formed using other materials and processes. For example, the shuttle may be formed by machining a metal. It should also be appreciated that the shuttle may be formed by joining a plurality of components.

The main portion 132 is a cylindrical-shaped body. However, it should be appreciated that other shapes may be used. The main portion 132 comprises a side surface 136. A definition of the side surface may be defined

by the process used to form the piston 118. The side surface 136 is shaped to increase a drag force applied to the shuttle assembly 64 by a fluid flowing adjacent thereto. The side surface 136 has a diameter smaller than the diameter of the first diameter portion 96 adjacent thereto. A space 137
5 between the side surface 136 and the outer wall portion 72 forms a portion of a fluid passage 138 which exists when the valve assembly 8 is in the open position.

The shuttle supports 134 are equally spaced apart and attached to the main portion 132. The shuttle supports 132 are shaped to increase a drag
10 force to the shuttle assembly 64 by a fluid flowing adjacent thereto. When the valve assembly 8 is in the open position, the annular member 110 acts as a positive stop for the shuttle assembly 64 and each of the shuttle supports 134 abuts the annular member 110 when the valve assembly 8 is in the open position. Also, when the valve assembly 8 is in the open position, each space
15 140 between successive shuttle supports 134 forms a portion of the fluid passage 138.

The biasing member 62 is preferably a compression spring such as, for example, a coil spring formed from a spring steel. However, it should be appreciated that the biasing member 62 may be of another kind, type, make
20 and/or formed from another material. As shown in FIGs. 2 and 4, the biasing member 62 is disposed in the base cavity 86 adjacent the first perforation 88. The biasing member 62 is pretensioned. The biasing member 62 contacts the shuttle assembly 64 and applies a bias thereto. To open the valve assembly 8, the biasing member 62 biases the shuttle assembly 64 toward the annular
25 member 110. Preferably, the biasing member 86 applies the bias to the shuttle assembly 64 via contact with the plurality of shuttle supports 134. In an embodiment, a first member end 142 of the biasing member 62 abuts each of the shuttle supports 134 and a second member end 144 abuts the upper wall portion 70.

30 In certain embodiments, the valve assembly 8 also comprises the filter 112. The filter 112 is utilized to prevent dirt and/or debris in the wheel 10 from entering the valve assembly 8. The filter 112 may be conventional in the art.

Preferably, the filter 112 is disposed in the stem cavity 100 and is attached to the annular member 110. The retaining ring 104 is disposed in the groove 102 to secure the spring 106, annular member 110, and filter 112 to the housing 60. The spring 106 is provided between the retaining ring 104 and the filter 112 and provides a bias to the filter 112 which maintains the filter 112 in an abutting relationship with the annular member 110. The bias provided by the spring 106 also maintains the annular member 110 in an abutting relationship with the interface 103 between the first diameter portion 96 and the second diameter portion 98.

As aforementioned, the valve assembly 8 may be in the closed position or the open position. In the open position, the fluid passage 138 is provided through the valve assembly 8. The fluid passage 138 comprises the first perforation 88, second perforation 114, space 128, 128A between the sealing member and the upper wall portion, space 137 between the shuttle assembly and the outer wall portion, and one or more of the spaces 140 between the shuttle supports 134.

When a pressure differential between the pressure within the fluid control circuit 40 and the tire pressure is above an opening threshold, the valve assembly 8 is in or placed in the open position. Referring now to FIGs. 2, 4, and 6, a relationship between an area A4 (hereinafter referred to as the fourth area) of the shuttle assembly 64 when the valve assembly 8 is in the closed position, the spring rate of the biasing member 62, and the pressure differential between the pressure within the fluid control circuit 40 and the tire pressure determines the opening threshold and facilitates placing the valve assembly 8 in the open position. Preferably, the opening threshold is about 5 psi or more. More preferably, the opening threshold is about 5 to about 8 psi. The valve assembly 8 may be configured to have a specific opening threshold. The valve assembly 8 remains in the open position so long as the pressure differential between the pressure within the fluid control circuit 40 and the tire pressure is above the opening threshold. In the open position, the sealing member 120, 120A does not contact the upper wall portion 70, allowing a flow of the pressurized air from the second perforation 114 to the first perforation 88

through the fluid passage 138 or allowing a flow of the pressurized fluid from the first perforation 88 to the second perforation 114 through the fluid passage 138.

When a pressure differential between the tire pressure and the pressure within the fluid control circuit 40 is above a closing threshold, the valve assembly 8 is in or placed in the closed position. Preferably, the closing threshold is about 5 to about 8 psi. The valve assembly 8 may be configured to be at a specific closing threshold. In the closed position, the sealing member 120, 120A sealingly contacts with the upper wall portion 70, preventing a flow of the pressurized air from the first perforation 88 to the second perforation 114 or vice versa. The valve assembly 8 remains in the closed position until the tire pressure management system 12 determines that the tire pressure needs to be adjusted.

Also, a relationship between an area A1 (hereinafter referred to as the first area) of the first perforation 88, an area A2 (hereinafter referred to as the second area) between the shuttle assembly 64 and the upper wall portion 70 when the valve assembly 8 is in the open position which corresponds to an area of a side of a right cylinder and an area A3 (hereinafter referred to as the third area) of the second perforation 114 determines the closing threshold and facilitates placing the valve assembly 8 in the closed position. The first area A1 must be greater than the second area A2, and the third area A3 must be greater than the second area A2 to obtain the closing threshold that is desirable for use with the tire pressure management system 12. Preferably, the third area A3 is about 1.1 times greater than the second area A2 and the first area A1 is about 3.8 times greater than the second area A2. Such a selection of the areas A1, A2, and A3 results in the closing threshold of about 5 to about 8 psi. As above-discussed, when the valve assembly 8 is in the open position, one or more spaces 140 between the shuttle supports 134 forms a portion of the fluid passage 138. A total cross sectional area of the spaces 140 between supports 134 is about equal to the first area A1. Also, as illustrated in FIG. 6, the fourth area A4 is larger than the first area A1. However, it should be appreciated that the areas A1, A2, A3, A4 could be of other sizes, proportions, and in different

locations in order to provide alternative opening thresholds, closing thresholds, pressure targets and valve functions.

Advantageously, the valve assembly 8 hereinabove described can manufactured easily and inexpensively. Also, the valve assembly 8 can
5 operate in an efficient manner at a wider range of pressures than the known designs. Further, the valve assembly 8 does not suffer from diminished performance under certain ambient temperature conditions which is observed in the known designs. For example, placing the valve assembly 8 in the open or closed position is not affected by low temperature conditions. Additionally,
10 when increasing or decreasing the tire pressure is complete, the valve assembly 8 can be placed in the closed position quickly to provide the desired tire pressure.

In accordance with the provisions of the patent statutes, the present invention has been described in what is considered to represent its preferred
15 embodiments. However, it should be noted that the invention can be practiced otherwise than as specifically illustrated and described without departing from its spirit or scope.

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CLAIMS

1. A valve assembly for a tire pressure management system,
5 comprising:

a housing that includes a base portion attached to a cap portion, the cap portion defining a first perforation;

an annular member attached to the housing, the annular member defining a second perforation which is in fluid communication with the first
10 perforation when the valve assembly is in an open position;

a biasing member disposed in the housing adjacent the first perforation,
and

a shuttle assembly in contact with the biasing member, the shuttle assembly comprises a piston and a sealing member attached to an outer
15 surface of the piston, the sealing member in sealing contact with a portion of the base portion when the valve assembly is in a closed position.

2. The valve assembly of claim 1, wherein the sealing member is disposed in a groove formed in the outer surface of the piston.
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3. The valve assembly of claim 1, wherein the sealing member is attached directly to the outer surface of the piston.

4. The valve assembly of claim 1, wherein, when the valve assembly is in the closed position, the sealing member is circumferentially disposed
25 around an end of the first perforation.

5. The valve assembly of claim 1, wherein, when the valve assembly is in the closed position, the sealing member is disposed in the first perforation
30 and is in sealing contact with a surface that defines the first perforation.

6. The valve assembly of claim 1, wherein the annular member and the housing are formed as separate members.

7. The valve assembly of claim 1, wherein the second perforation is of a diameter that is substantially constant.

8. The valve assembly of claim 1, wherein the housing comprises an outer wall portion, the outer wall portion having an inner surface and the inner surface having a first diameter portion and a second diameter portion, wherein the annular member abuts an interface between the first diameter portion and the second diameter portion.

9. The valve assembly of claim 1, wherein the sealing member comprises an elastomeric material.

10. The valve assembly of claim 1, wherein the biasing member applies a bias to the shuttle assembly which urges the shuttle assembly toward the annular member and the valve assembly to the open position.

11. The valve assembly of claim 1, wherein one or more portions of the shuttle assembly abut the annular member when the valve assembly is in the open position.

12. The valve assembly of claim 2, wherein the sealing member is of a thickness and the thickness of the sealing member is such that the sealing member extends beyond the outer surface of the piston and toward the first perforation.

13. The valve assembly of claim 2, wherein the groove is of an annular shape.

14. The valve assembly of claim 2, wherein the groove has an opening and a portion of the groove gradually widens from the opening in a direction away from the outer surface of the piston, the opening including a portion which is of a width that is less than a width of the portion of the groove that gradually widens.

15. The valve assembly of claim 3, wherein the sealing member is of a conical shape.

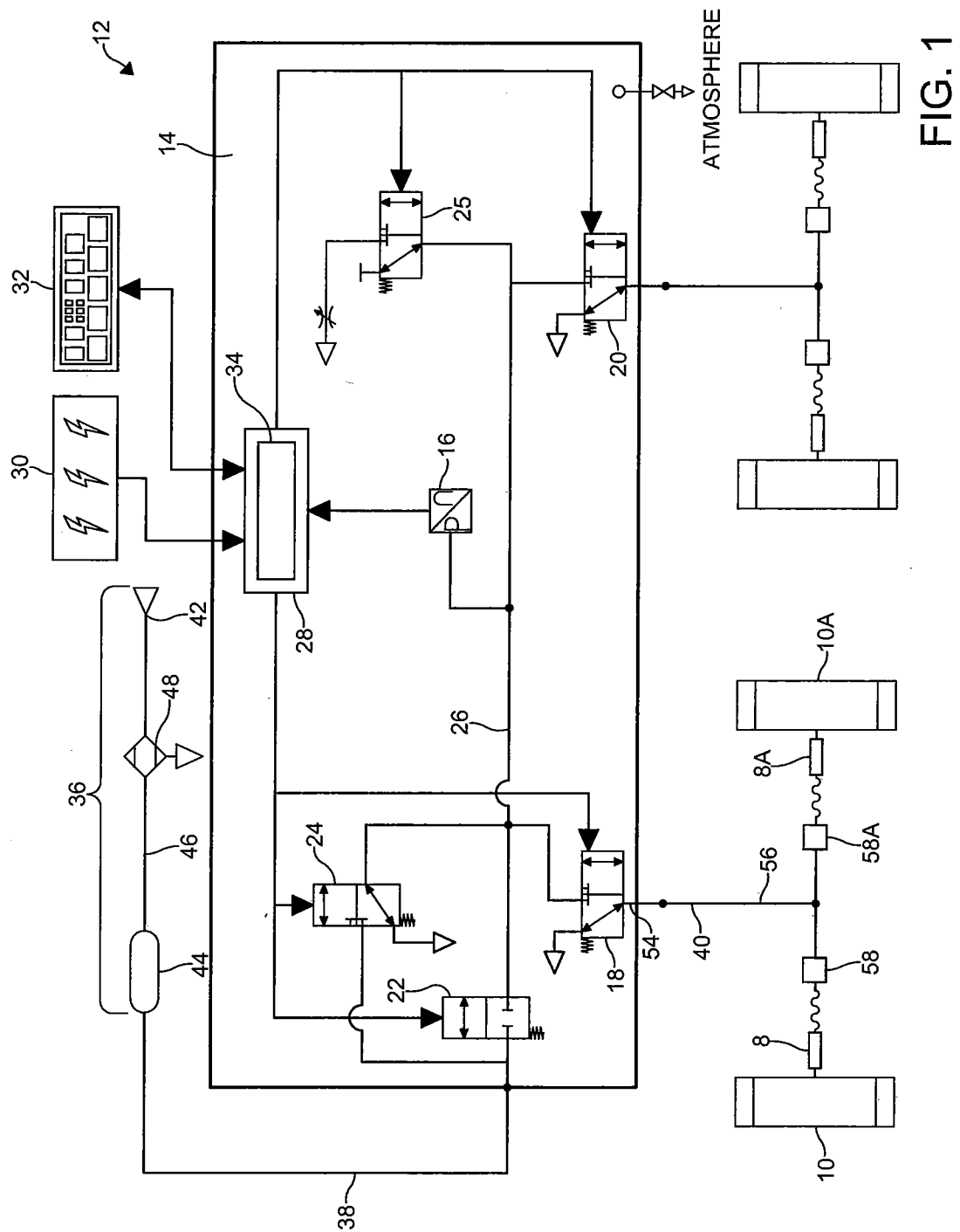
16. The valve assembly of claim 8, further comprising a filter abutting the annular member, the annular member separating the filter from the interface.

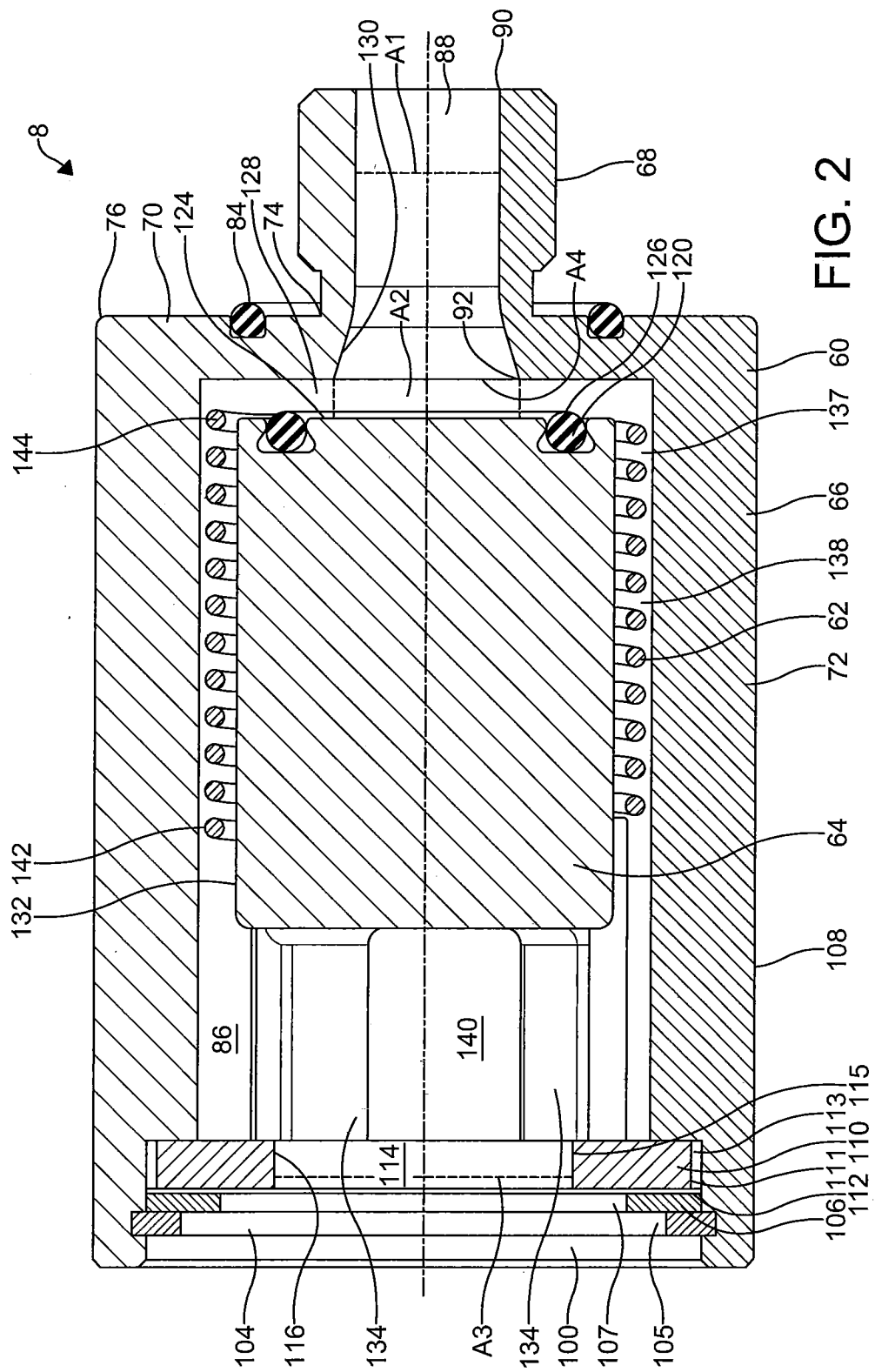
17. The valve assembly of claim 13, wherein the sealing member is of an annular shape.

18. The valve assembly of claim 15, wherein the sealing member is of a frusto-conical shape.

19. The valve assembly of claim 16, further comprising a spring disposed between the filter and a retaining ring, the spring providing a bias to the filter which maintains the filter in an abutting relationship with the annular member.

20. The valve assembly of claim 17, wherein the sealing member is an O-ring.





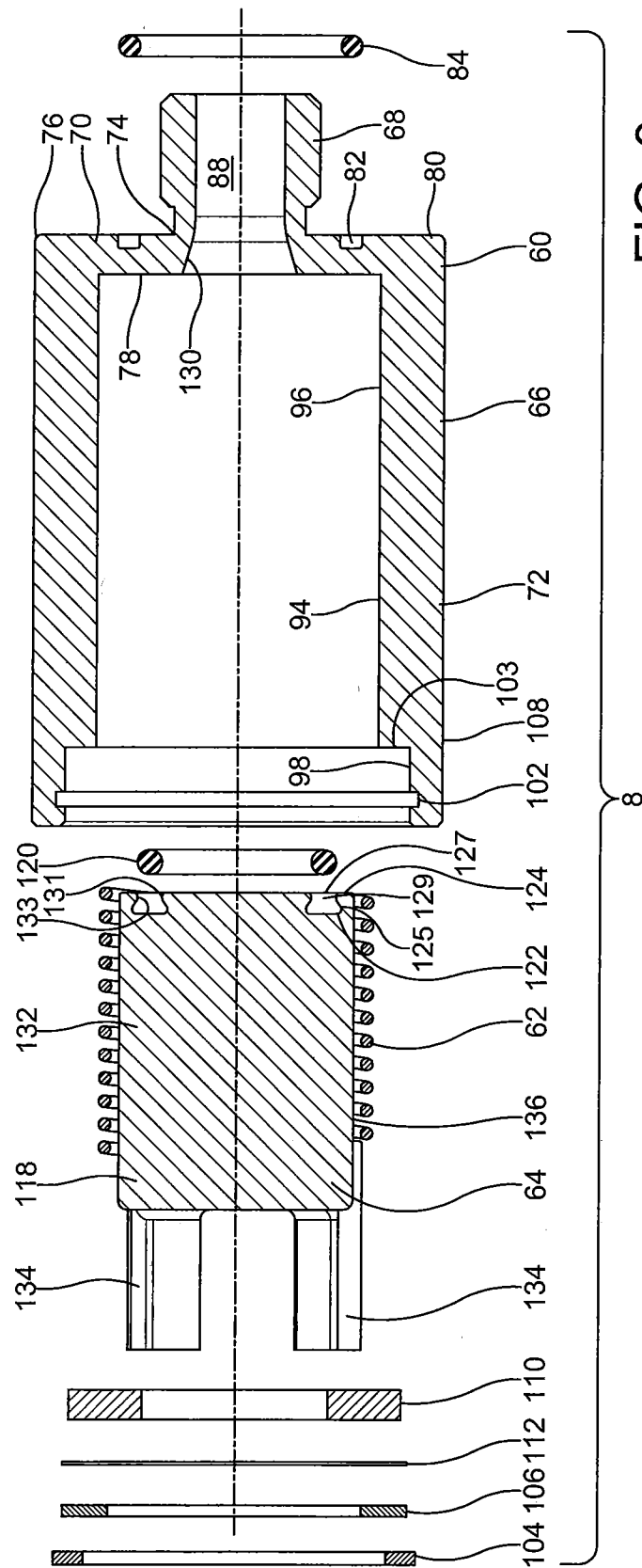


FIG. 3

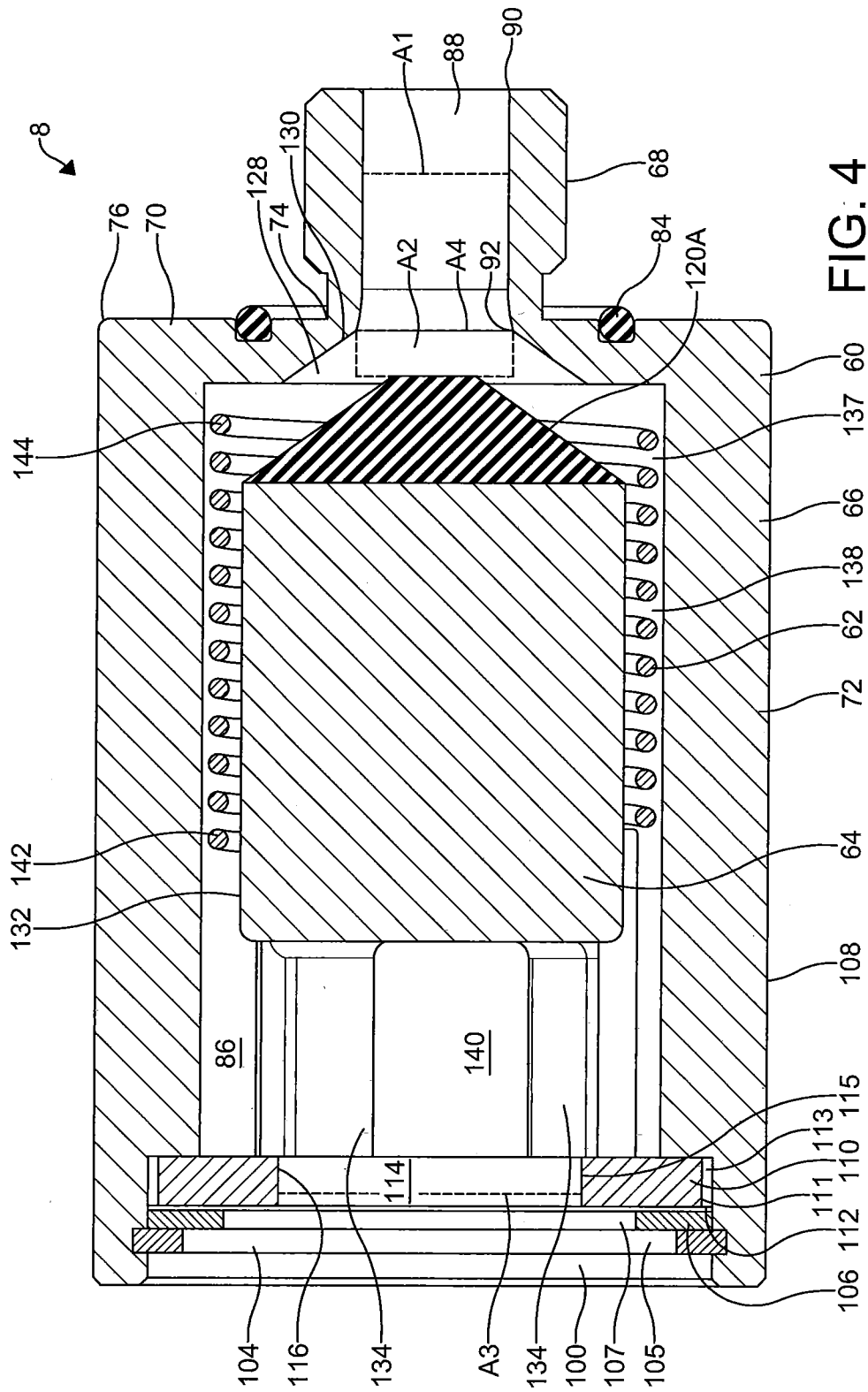


FIG. 4

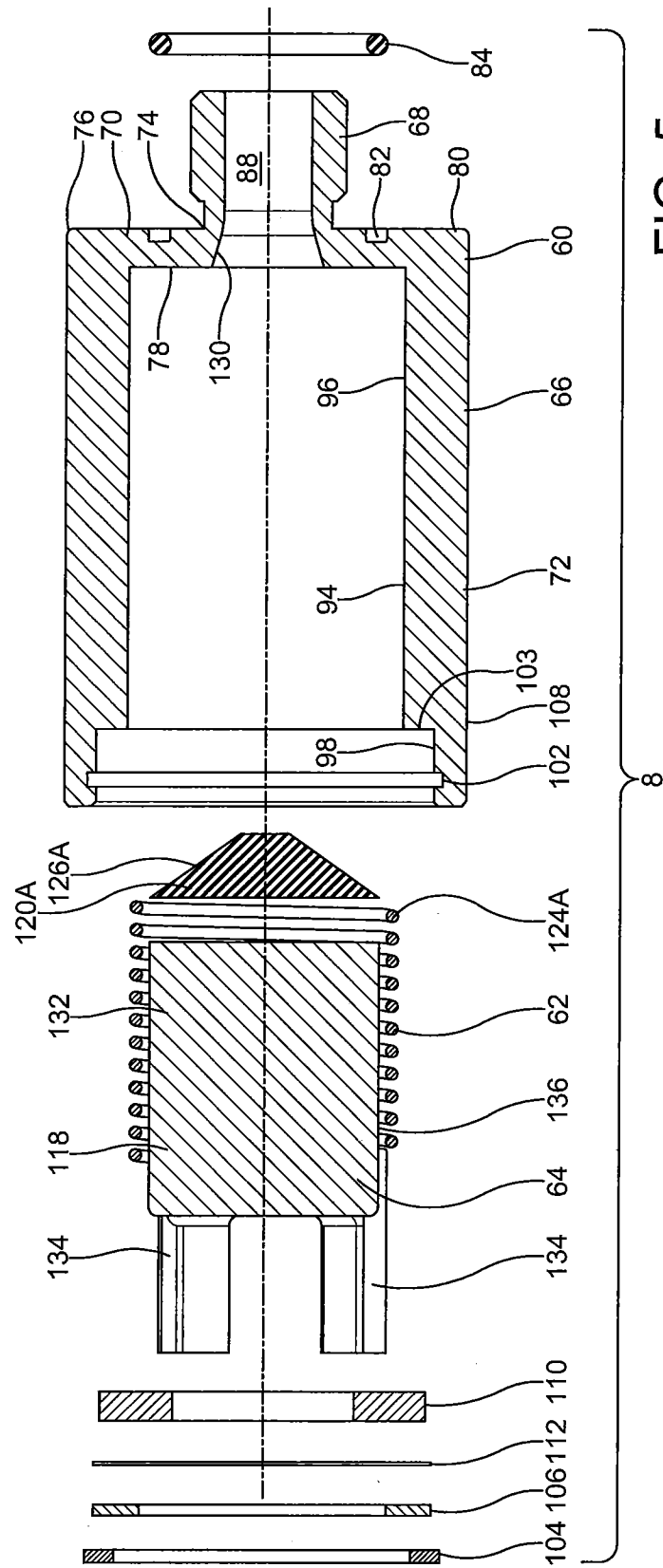


FIG. 5

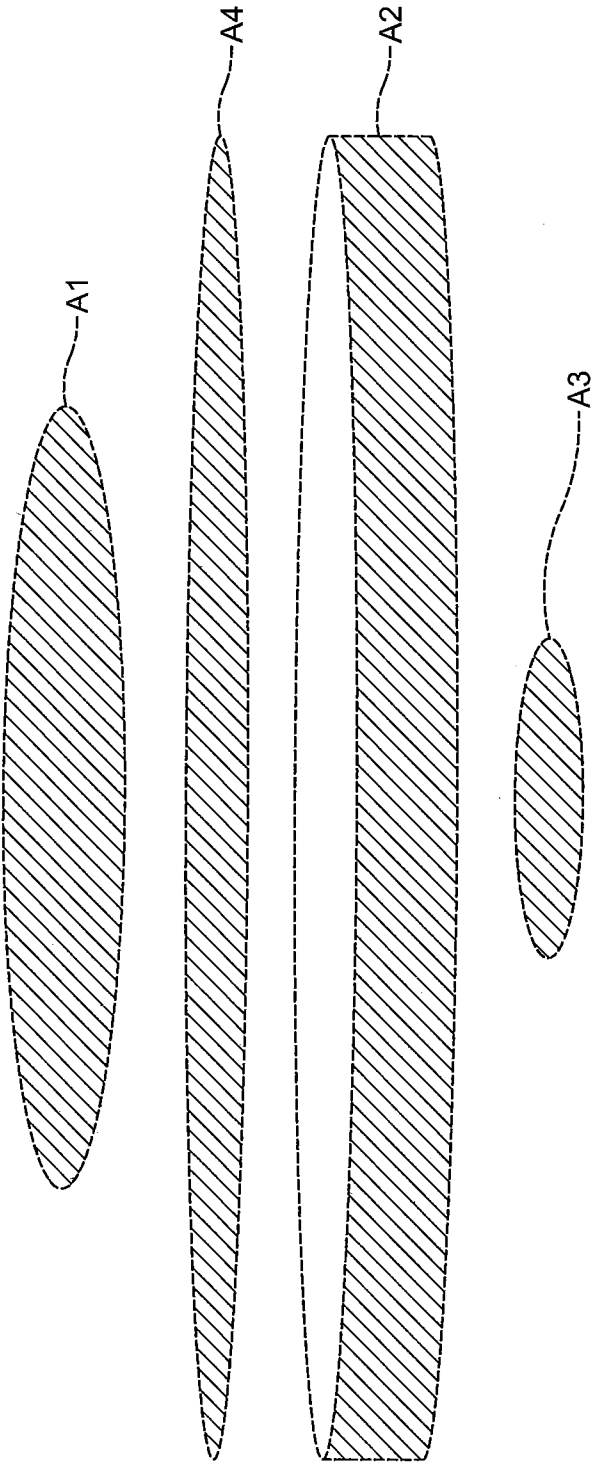


FIG. 6

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2017/014278

A. CLASSIFICATION OF SUBJECT MATTER
INV. B60C23/00 F16K15/20 F16K17/164 F16K17/196
ADD.

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)
B60C F16K

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

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

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2015/165846 A1 (SIDDER JASON M [US] ET AL) 18 June 2015 (2015-06-18) figures 4, 5, 5A -----	1,3-7, 9-12,16, 19
X	DE 10 2008 062073 A1 (KNORR BREMSE SYSTEME [DE]) 17 June 2010 (2010-06-17) figure 6B -----	1-6, 13-15, 17,20
X	GB 2 243 431 A (BROWNELL LIMITED [GB]) 30 October 1991 (1991-10-30) figure 2 -----	1,8,18
X	WO 2015/103018 A1 (DANA HEAVY VEHICLE SYS GROUP [US]) 9 July 2015 (2015-07-09) figure 5 ----- -/-	1



Further documents are listed in the continuation of Box C.



See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search

28 March 2017

Date of mailing of the international search report

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INTERNATIONAL SEARCH REPORT

International application No

PCT/US2017/014278

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 10 2008 062076 A1 (KNORR BREMSE SYSTEME [DE]) 17 June 2010 (2010-06-17) figures 9A-9C -----	1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2017/014278

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2015165846 A1	18-06-2015	CA 2879072 A1	20-02-2014
		EP 2872344 A1	20-05-2015
		US 2015165846 A1	18-06-2015
		WO 2014028142 A1	20-02-2014
DE 102008062073 A1	17-06-2010	NONE	
GB 2243431 A	30-10-1991	NONE	
WO 2015103018 A1	09-07-2015	EP 3089882 A1	09-11-2016
		US 2016288589 A1	06-10-2016
		WO 2015103018 A1	09-07-2015
DE 102008062076 A1	17-06-2010	NONE	