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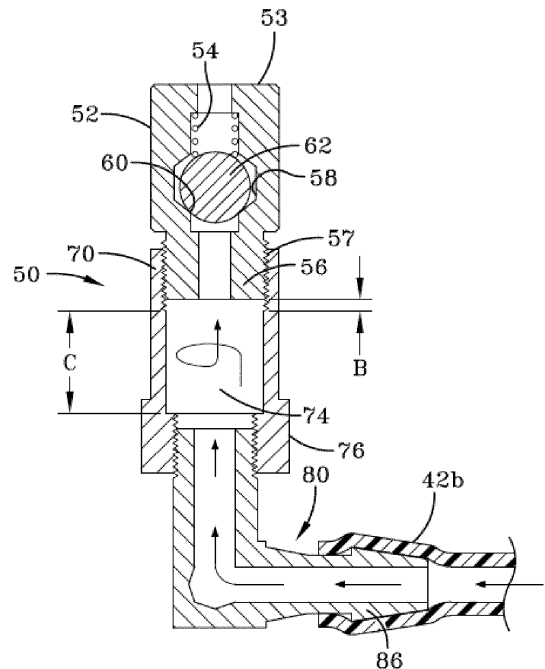
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(54) **Tire comprising a tire pressure regulator device**

(57) A tire comprising a tire cavity, first and second sidewalls extending respectively from first and second tire bead regions to a tire tread region, an air passageway comprising a flexible material operative to allow a portion of the air passageway near a tire footprint to substantially open and close the air passageway, and a regulator device (50) connected to an end (42b) of the air passageway is disclosed. In one option, the regulator device (50) is connected to a fitting (80) mounted to the tire sidewall having a first end for connecting to an end of the air passageway and a second end for connecting to a first end of a housing having an adjustable buffer volume (74) therein in fluid communication with a valve body (52). In a second option, the regulator device (50) comprises a regulator body mounted to the tire sidewall (30) having first end located within the tire cavity and a second end having an internal pump passageway for connecting to an end of the air passageway, a check valve (52) in fluid communication with the internal pump passageway and the air passageway, and a channel located between the second end and the check valve (52) in fluid communication with a buffer chamber (74).



**FIG-6**

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**Description**Field of the Invention

5 **[0001]** The invention relates generally to a tire comprising a tire pressure regulator device such as a self-inflating tire and, more specifically, to a pump mechanism for such tires.

Background of the Invention

10 **[0002]** Normal air diffusion reduces tire pressure over time. The natural state of tires is under inflated. Accordingly, drivers must repeatedly act to maintain tire pressures or they will see reduced fuel economy, tire life and reduced vehicle braking and handling performance. Tire Pressure Monitoring Systems have been proposed to warn drivers when tire pressure is significantly low. Such systems, however, remain dependant upon the driver taking remedial action when warned to re-inflate a tire to recommended pressure. It is a desirable, therefore, to incorporate a self-inflating feature  
15 within a tire that will self-inflate the tire in order to compensate for any reduction in tire pressure over time without the need for driver intervention. A self-inflating tire is described in EP-A-2 338 703 for instance.

Summary of the Invention

20 **[0003]** The invention relates to a tire in accordance with claim 1 and to a tire and rim assembly in accordance with claim 15.

**[0004]** Dependent claims refer to preferred embodiments of the invention.

**[0005]** In one aspect of the invention, the tire or the self-inflating tire and rim assembly may comprise a tire having a  
25 tire cavity, first and second sidewalls extending respectively from first and second tire bead regions to a tire tread region; an air tube connected to the tire and being composed of a flexible material operative to allow a portion of the air tube segment near a tire footprint to substantially open and close the air tube, a regulator device connected to an end of the air tube, the regulator device including an elbow fitting mounted in the tire sidewall, the elbow fitting having a first end for connecting to an end of the air tube and a second end for connecting to a first end of an adjustable housing, said adjustable housing having a buffer volume therein defined by a movable wall, said movable wall being connected to a  
30 valve body, wherein the valve body has an outer threaded surface that is received within the adjustable housing. The volume of the buffer chamber may be adjustable. The buffer chamber may have an adjustable outer wall. The buffer chamber may be formed in the void formed by a threaded fastener mounted in a chamber. The regulator device may be mounted in the tire cavity or may be mounted in the tread of the tire. The air tube may be sequentially flattened by the tire footprint to pump air along the air passageway in either a forward tire direction of rotation or a reverse tire direction of rotation. In one aspect, the pump inlet and the regulator device are mounted to the annular air tube may be substantially  
35 180 degrees apart. In an other aspect, the regulator device are mounted to the annular air tube substantially 360 degrees apart. The cross-sectional shape of the air tube may be elliptical.

**[0006]** In an other aspect of the invention, the tire or the self-inflating tire and rim assembly may have a tire cavity,  
40 first and second sidewalls extending respectively from first and second tire bead regions to a tire tread region, an air tube connected to the tire and being composed of a flexible material operative to allow a portion of the air tube segment near a tire footprint to substantially open and close the air tube, a regulator device connected to an end of the air tube, the regulator device including a regulator body mounted in the tire sidewall, the regulator body having first end located within the tire cavity, wherein the first end has an internal passageway that is in fluid communication with the tire cavity, said regulator device having a second end having an internal pump passageway for connecting to an end of the air tube;  
45 a check valve in fluid communication with the internal passageway and the pump passageway, wherein the regulator device further comprises a channel located between the second end and the check valve, wherein the channel is in fluid communication with a buffer chamber.

Definitions

50 **[0007]** "Axial" and "axially" means lines or directions that are parallel to the axis of rotation of the tire.  
**[0008]** "Buffer volume" may mean the pump minimum volume.  
**[0009]** "Chafer" is a narrow strip of material placed around the outside of a tire bead to protect the cord plies from wearing and cutting against the rim and distribute the flexing above the rim.  
55 **[0010]** "Circumferential" means lines or directions extending along the perimeter of the surface of the annular tread perpendicular to the axial direction.  
**[0011]** "Equatorial Centerplane (CP)" means the plane perpendicular to the tire's axis of rotation and passing through the center of the tread.

[0012] "Footprint" means the contact patch or area of contact of the tire tread with a flat surface at zero speed and under normal load and pressure.

[0013] "Pump maximum volume" may mean the volume of fluid located between the peristaltic pump tube inlet and the outlet valve.

5 [0014] "Radial" and "radially" means directions radially toward or away from the axis of rotation of the tire.

Brief Description of the Drawings

10 [0015] The invention will be described by way of example and with reference to the accompanying drawings in which:

FIG. 1 is an isometric view of the valve, tube and filter for a peristaltic pump assembly.

FIG. 2 is a side view of the assembly of Fig. 1 shown mounted in a tire.

FIG. 3 is an enlarged partial cross sectional view of the tire and rim assembly with the pump valve mechanism shown mounted in the tire.

15 FIG. 3A is an enlarged perspective view of the pump valve mechanism of Fig. 3.

FIG. 4 is a perspective view of a first embodiment of a regulator mechanism of the present invention.

FIG. 5 is a partial section view through the regulator mechanism of Fig. 4 in the direction 5-5.

FIGS. 6 and 7 are cross-sectional views of the regulator mechanism in operation, in the closed position and the open position, respectively.

20 FIG. 8 is a perspective view of a second embodiment of a regulator mechanism of the present invention shown in a first position.

FIG. 9 is perspective view of the regulator mechanism of FIG. 8 shown in a second position.

FIG. 10 is a perspective view of the adjustable cap of the regulator mechanism of FIG. 8.

FIG. 11 is a perspective view of a second embodiment of a pump system of the present invention.

25 FIGS. 12A and 12B illustrate front views of an interchangeable valve body.

FIGS. 13A, 13B and 13C represent an illustration of the pump maximum volume, the pump variable volume, and the buffer or pump minimum value.

Detailed Description of Example Embodiments of the Invention

30 [0016] Referring to FIGS. 1 through 3, a tire assembly 10 includes a tire 12, a peristaltic pump assembly, and a tire rim. The tire 12 mounts in a conventional fashion to a pair of rim mounting surfaces 18 located adjacent outer rim flanges. The outer rim flanges have an outer rim surface 22 that engages the bead area of the tire. The tire 12 is of conventional construction, having a pair of sidewalls 30 extending from opposite bead areas to a crown or tire tread region 38. The tire 12 and rim enclose a tire cavity 40.

35 [0017] As shown in FIGS. 1- 2, the peristaltic pump assembly includes a pump tube 42 that is mounted in a tire passageway, which is preferably located in the sidewall area of the tire, preferably near the bead region or the pump assembly comprises such tire passageway. The tire passageway is preferably molded into the sidewall of the tire during vulcanization and is preferably annular in shape. The pump tube 42 has a first end 42a joined together by an inlet device 46 and a second end 42b joined together with an outlet device 50. The pump tube 42 comprises a tube formed of a resilient, flexible material such as plastic, silicone, elastomer or rubber compounds, and is capable of withstanding repeated deformation cycles when the tube is deformed into a flattened condition subject to external force and, upon removal of such force, returns to an original condition generally circular in cross-section. The tube is of a diameter sufficient to operatively pass a volume of air sufficient for the purposes described herein and allowing a positioning of the tube in an operable location within the tire assembly as will be described. Preferably, the tube has a circular cross-sectional shape, although other shapes such as elliptical or lens shape may be utilized. Alternatively, the passageway molded or formed into the tire sidewall may serve as the pump tube 42, i.e. it is sufficient to provide an air passageway acting as the pump tube 42 without providing a separate tube element.

45 [0018] As shown in Fig. 2, the inlet device 46 and the outlet device 50 are spaced apart a desired distance typically in the range of approximately 90 degrees or more, typically about 180 degrees to 360 degrees. If 180 degrees is selected, two 180 degree pumps may be used. The inlet and outlet device may be located adjacent each other, thus forming a single 360 degree pump. Other variations may be utilized, such as 270 degrees, etc.

[0019] The inlet device 46 in its simplest form may be the inlet tube end exposed to the atmosphere. The inlet device may optionally comprise a check valve and/or an optional filter.

55 [0020] The outlet device 50 is a pressure and flow regulating device, and regulates the tire cavity pressure or maximum pressure. The outlet device 50 also functions to regulate the flow into and out of the tire cavity. The outlet device is described in more detail, below.

[0021] As will be appreciated from FIG. 2, the inlet device 46 and the outlet device 50 are in fluid communication with

the circular air tube 42. As the tire rotates in a direction of rotation 88, a footprint 100 is formed against the ground surface 98. A compressive force 104 is directed into the tire from the footprint 100 and acts to flatten a segment 110 of the pump 42. Flattening of the segment 110 of the pump 42 forces a portion of air located between the flattened segment 110 and the outlet device 50, in the direction shown by arrow 84 towards the outlet device 50. The portion of air will then regulated through the outlet device 50. If the pressure at the inlet of the outlet device is sufficiently high, the internal valve will open and fill the tire cavity, as described in more detail, below.

**[0022]** As the tire continues to rotate in direction 88, the previously flattened tube segments 110, 110', 110" will be sequentially refilled by atmospheric air flowing into the inlet device 46 along the pump tube 42. The inflow of air from the inlet device 46 continues until the outlet device 50 rotating counterclockwise as shown with the tire rotation 88, passes the tire footprint 100.

**[0023]** The location of the peristaltic pump assembly will be understood from FIGS. 2-4. In one embodiment, the peristaltic pump assembly is positioned in the tire sidewall, radially outward of the rim flange surface in the chafer. So positioned, the air tube 42 is radially inward from the tire footprint 100 and is thus positioned to be flattened by forces directed from the tire footprint as described above. The segment 110 that is opposite the footprint 100 will flatten from the compressive force 114 from the footprint 100 pressing the tube segment against the rim flange surface. Although the positioning of the tube 42 is specifically shown as between a chafer of the tire at the bead region and the rim surface, it is not limited to same, and may be located at any region of the tire such as anywhere in the sidewall or tread. The diametric sizing of the peristaltic pump air tube 42 is selected to span the circumference of the rim flange surface.

#### Pressure Regulating Outlet Device

**[0024]** The regulator device 50 is a pressure and flow regulating device, and regulates the tire cavity pressure or maximum pressure. The regulator device 50 also functions to regulate the flow into and out of the tire cavity 40. The regulator device 50 has a valve body 52 having a first end 53 that has a valve passageway 54 that extends from the first end to a second end 56. The first end of the valve body 52 is mounted through the tire sidewall as shown in Figures 3, 3A so that the valve passageway 54 is in fluid communication with the tire cavity 40. The valve passageway 54 has an expanded portion 58 and a narrow portion 60. A preferably large ball 62 is received in the expanded portion 58 and positioned for engagement with the narrow portion 60. A spring is positioned within the valve passageway for engagement with the ball 62. The spring biases the ball into engagement with the narrow portion 60, so that flow is blocked in the interior passageway 54.

**[0025]** The second end 56 of the valve body has an outer threaded portion 57 that is received within a first threaded end 70 of an adjustable housing 72. The adjustable housing has an internal cavity 74 that extends from the first threaded end 70 to the second threaded end 76. The internal cavity 74 has a fixed buffer volume portion and an adjustable buffer volume portion. The fixed volume portion is defined by the non-threaded inner wall of the internal cavity having a length C. The fixed volume is equal to the cross-sectional area of the internal cavity times the length C. The adjustable volume portion is defined by the amount of the threaded length that is exposed within the internal cavity and is indicated as distance B. The adjustable volume is determined from the distance B times the cavity cross-sectional area. The distance B may be zero if the valve body is fully received within the adjustable housing. The adjustable housing and respective internal buffer volumes may be modified by substituting the adjustable housing as shown in Fig. 12A in order to increase the fixed buffer volume or by substituting the adjustable housing as shown in Fig. 12B in order to decrease the fixed buffer volume.

**[0026]** The regulator device 50 further comprises an elbow fitting 80 having a first end 82 connected to the adjustable housing inlet end 76 and a second end connected to the pump tube outlet 42b. The second end of the elbow fitting 80 may comprise a flared fitting 86.

**[0027]** The maximum air pressure delivered by the peristaltic pump can be fixed by setting the volume of the pump tube and the buffer volume located between the end of the tube and the check valve and the adjustable buffer chamber. The pump tube volume is selected by design with the tube dimensions and the tube length. As shown in Figure 11, multiple pump tubes may be used, with the selection of the tube length and inner tube dimensions to tune the system. The buffer or dead volume can also be set by design. The air in the buffer volume chamber is not compressed, but functions to tune or adjust the maximum air pressure of the pump system. The buffer volume acts as a storage chamber for accumulating air mass for transfer to the tire cavity. Increasing the buffer volume will decrease the tire pressure, while decreasing the buffer volume will increase the tire cavity pressure. Thus, by adjusting the buffer volume, one can adjust the desired tire final pressure.

**[0028]** The operation of the system and the outlet device 50 can now be described. As shown in Fig. 2, the tire rotates in a direction of rotation 88, and a footprint 100 is formed against the ground surface 98. A compressive force 104 is directed into the tire from the footprint 100 and acts to flatten a segment 110 of the pump 42. Flattening of the segment 110 of the pump 42 forces a portion of air located between the flattened segment 110 and the regulator device 50, in the direction shown by arrow 84 towards the outlet device 50. The portion of air will then be regulated through the outlet

device 50. If the pressure at the inlet of the regulator device is sufficiently high, the fluid pressure will overcome the spring pressure (cracking pressure), thus opening the internal check valve. Thus fluid from the pump outlet 42b will flow into the elbow fitting 80 and into the adjustable housing 72.

**[0029]** If the pressure in the pump tube 42b is less than the tire pressure, the ball 62 will engage the narrow portion 60 and block flow from either direction. The check valve when closed, blocks flow from communicating from the pump 42b into the tire cavity 40, and also prevents back flow from the tire cavity into the pump 42. When the check valve is closed, the pump compresses the air in the pump tube 42. Air from the pump tube enters the elbow fitting 80 of the regulator device, and then enters the buffer volume chamber 74. The buffer volume chamber will fill while the check valve remains closed. When the pressure in the inlet 56 of the regulator device exceeds the cracking pressure, the check valve opens and will allow air from the pump to fill the tire cavity. The check valve will close when the inlet pressure  $P_T$  falls below the cracking pressure. The cycle of opening and closing the check valve will allow the tire cavity to be filled as the tire rotates a specified distance. A maximum tire cavity will be reached based upon the pump volume and the buffer volume. The buffer volume may be adjusted by turning the valve body 52 relative to the adjustable housing. Increasing the buffer volume results in a decrease of tire final pressure, while decreasing the buffer volume results in an increase of the tire final pressure. The advantage of having an adjustable buffer volume allows the maximum system pressure of the tire cavity to be tuned for a specific tire.

**[0030]** Figures 8-10 illustrate a second embodiment of a pressure regulator 200. The pressure regulator 200 comprises a valve body 202 having an internal passageway 204 that extends through the valve body 202. The internal passageway 204 includes a movable check valve assembly 206. The movable check valve assembly includes a ball 208, a spring 210 housed within a receptacle 212. The receptacle has a retainer 214 which retains the ball 208 within the check valve assembly. The outer edge of the receptacle may have external threads like a screw, so that the receptacle may be screwed into or out of the internal passageway 204. A variable buffer volume 220 is located adjacent the movable check valve assembly, so that when the movable check valve assembly is rotated clockwise, the variable buffer volume decreases. The outer receptacle of the check valve may have notations on it to indicate to a user to indicate the relationship of the number of turns to the volume adjustment. Alternatively, the movable check valve may slide within the passageway 204, with retaining means located within the passageway which allow the position of the movable check valve to be repeatedly adjusted and then fixed in position.

**[0031]** The valve body 202 of the pressure regulator 200 further comprises a second portion 222 which is at right angles to the first portion 224 of the valve body. The second portion has an interior fixed dead volume 230 which is in fluid communication with the variable volume 220. Located adjacent the interior fixed dead volume 230 is an outlet 240. The outlet 240 is connected to the pump tube outlet 42b. The second portion 222 is mounted in the tire, typically in the sidewall and connected to the pump tube outlet 42b. The first portion 224 of the valve body is mounted through the sidewall and into the tire cavity 40.

**[0032]** The operation of the system and the outlet device 200 can now be described. As shown in Fig. 2, the tire rotates in a direction of rotation 88, and a footprint 100 is formed against the ground surface 98. A compressive force 104 is directed into the tire from the footprint 100 and acts to flatten a segment 110 of the pump 42. Flattening of the segment 110 of the pump 42 forces a portion of air located between the flattened segment 110 and the regulator device 200, in the direction shown by arrow 84 towards the outlet device 200. The portion of air will then be regulated through the outlet device 200. If the pressure at the inlet of the regulator device is sufficiently high, the fluid pressure will overcome the spring pressure (cracking pressure), thus opening the internal check valve. Thus fluid from the pump outlet 42b will flow into the regulator and out into the tire cavity through a hole in the adjustable check valve assembly.

**[0033]** If the pressure in the pump tube 42b is less than the tire pressure, the ball 208 will engage the narrow portion 214 and block flow from either direction. The check valve when closed, blocks flow from communicating from the pump 42b into the tire cavity 40, and also prevents back flow from the tire cavity into the pump 42. When the check valve is closed, the pump compresses the air in the pump tube 42. Air from the pump tube enters the regulator device, and fills the buffer volume chambers 220, 230. When the pressure to the inlet of the regulator device exceeds the cracking pressure, the check valve opens and will allow air from the pump to fill the tire cavity. The check valve will close when the inlet pressure  $P_{T \text{ falls}}$  below the cracking pressure. The cycle of opening and closing the check valve will allow the tire cavity to be filled as the tire rotates a specified distance. A maximum tire cavity will be reached based upon the pump volume and the buffer volume. The buffer volume may be adjusted by turning the adjustable check valve relative to the housing. Increasing the buffer volume results in a decrease of tire final pressure, while decreasing the buffer volume results in an increase of the tire final pressure. The advantage of having an adjustable buffer volume allows the maximum system pressure of the tire cavity to be tuned for a specific tire.

**[0034]** The table below indicates exemplary tires, all having the same internal tire volume of 38 l and initial tire pressure of 1.8 bar. All of the exemplary pumps have a circumferential length of 180 degrees. Examples 1 and 2 have a pump size of 2x1 with a pump volume of 1036 mm<sup>3</sup>. For example 1 the buffer volume is selected to be 459 mm<sup>3</sup>, resulting in a desired final tire pressure of 2.2 bar. A distance of 241 km is needed to achieve the final tire pressure. If the buffer volume is decreased to 351 mm<sup>3</sup>, with all other variables being equal, the final tire pressure will be 2.9 bar (Ex. 2) as

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compared to 2.2 bar for Ex. 1. A longer distance of 490 km will be needed to achieve a higher final tire pressure of 2.9 bar.

**[0035]** Examples 3 and 4 illustrate a smaller tube size resulting in a smaller pump volume of 700 mm<sup>3</sup>. For a buffer volume of 310 mm<sup>3</sup> (Ex 3) results in a final tire pressure of 2.2 bar and a needed distance of 355 km to achieve the final tire pressure. Ex 4 illustrates all the properties of Ex. 3, except for a smaller buffer volume of 237 mm<sup>3</sup>, resulting in a higher final tire pressure of 2.9 bar achieved in 727 km.

**[0036]** Examples 5-8 have the same properties as examples 1-4, with example 5 corresponding with example 1, etc. the cracking pressure of the valve is higher for examples 5-8 as compared to 1-4. A slightly lower buffer volume is needed in examples 5-8 to achieve the same final tire pressure as examples 1-4. The higher cracking pressure also results in a significantly shorter distance to be traveled by the pump/tire in order to result in the final tire pressure. The volume ratios of the buffer volume to pump volume may be used to determine a new buffer volume should the pump volume or cavity volume change. The buffer volume may be adjusted by rotating the screw. The number of turns of the screw (e.g. 5 turns) would result in a distance of 4 mm with a screw pitch of 75 mm.

Cracking Pressure	Cavity			Tire Volume	Initial Tire pressure	A	B	C	D
	Angle	Size	Volume [mm <sup>3</sup> ]			Buffer Volume [mm <sup>3</sup> ]	Final Tire pressure	Needed Distance	Volumes Ratio
0.1 bar	180	2x1	1036	38L	1.8bar	459	2.2bar	241 km	0.443
	180	2x1	1036	38L	1.8bar	351	2.9bar	490km	0.339
	180	27x05	699.5	38L	1.8bar	310	2.2bar	355km	0.443
	180	27x05	699.5	38L	1.8bar	237	2.9bar	727km	0.339
0.3bar	180	2x1	1036	38L	1.8bar	422	2.2bar	137km	0.407
	180	2x1	1036	38L	1.8bar	329	2.9bar	324km	0.318
	180	27x05	699.5	38L	1.8bar	285	2.2bar	203km	0.407
	180	27x05	699.5	38L	1.8bar	222.5	2.9bar	485km	0.318

**[0037]** The maximum air pressure delivered by a peristaltic pump embedded in a tire can be fixed by setting the right volume of the pump tube and the buffer volume. The pump tube volume can be set by design with the dimensions of the tube sections and tube length. The buffer volume can also be set by design but can also be easily manually changed by the mean of a dedicated device or by interchanging appropriate parts before the valve. This can be implemented with either a set of tube with different lengths or a set of small tanks to be inserted before the valve.

### Claims

1. A tire comprising a tire cavity (40), first and second sidewalls (30) extending respectively from first and second tire bead regions to a tire tread region (38), an air passageway (42) comprising a flexible material operative to allow a portion of the air passageway (42) near a tire footprint (100) to substantially open and close the air passageway (42), and a regulator device (50, 200) connected to an end (42b) of the air passageway (42), wherein

(i) the regulator device (50, 200) is connected to or comprises a fitting (80) mounted to or in the tire sidewall (30), the fitting (80) having a first end for connecting to an end of the air passageway (42) and a second end for connecting to a first end of a housing (72), the housing (72) having an adjustable buffer volume (74) therein, the adjustable buffer volume (74) being in fluid communication with a valve body (52, 202); and/or

(ii) the regulator device (50, 200) comprises a regulator body mounted to or in the tire sidewall (30), the regulator body having first end located within the tire cavity (40), wherein the first end has an internal passageway that is in fluid communication with the tire cavity (40), the regulator device (50, 200) having a second end having an internal pump passageway for connecting to an end of the air passageway (42), a check valve (52, 202) in fluid communication with the internal pump passageway and the air passageway (42), and wherein the regulator device (50, 200) further comprises a channel located between the second end and the check valve (52, 202), wherein the channel is in fluid communication with a buffer chamber (74).

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2. The tire of claim 1 wherein the tire (12) comprises an air tube connected to the tire (12) and being composed of a flexible material operative to allow a portion of the air tube near the tire footprint (100) to substantially open and close the air tube, the air tube providing the air passageway.
- 5 3. The tire of claim 1 or 2 wherein the regulator device (50, 200) is connected to an end of the air tube or to an end of the air passageway.
4. The tire of at least one of the previous claims wherein the fitting (80) is an elbow fitting.
- 10 5. The tire of at least one of the previous claims wherein the housing (72) is an adjustable housing.
6. The tire of at least one of the previous claims wherein the housing (72) or the adjustable housing has the adjustable buffer volume (74) therein defined by a movable wall, the movable wall being connected to the valve body (52).
- 15 7. The tire of at least one of the previous claims wherein the valve body (52) has an outer surface, preferably a threaded outer surface, that is received within the housing (72).
8. The tire of at least one of the previous claims wherein the buffer chamber or the adjustable buffer volume has an adjustable outer wall.
- 20 9. The tire of at least one of the previous claims wherein the buffer chamber or the adjustable buffer volume is formed in a void formed by a preferably threaded fastener mounted in a chamber.
10. The tire of at least one of the previous claims wherein the regulator device (50, 200) is mounted in the tire cavity (40) or mounted to the tire cavity (40).
- 25 11. The tire of at least one of the previous claims wherein the regulator device (50, 200) is mounted in the tire cavity (40) or mounted to the tread (38) of the tire (12).
- 30 12. The tire of at least one of the previous claims wherein the air passageway is sequentially flattened by the tire footprint (100) to pump air along the air passageway in either a forward tire direction of rotation or a reverse tire direction of rotation.
- 35 13. The tire of at least one of the previous claims wherein a pump inlet and the regulator device (50, 200) are mounted to the air passageway substantially 180 degrees or substantially 360 degrees apart.
14. The tire of at least one of the previous claims wherein the cross-sectional shape of the air passageway (42) is elliptical and/or wherein the air passageway (42) is an annular air passageway.
- 40 15. A self-inflating tire assembly comprising a tire in accordance with at least one of the previous claims mounted to a rim.

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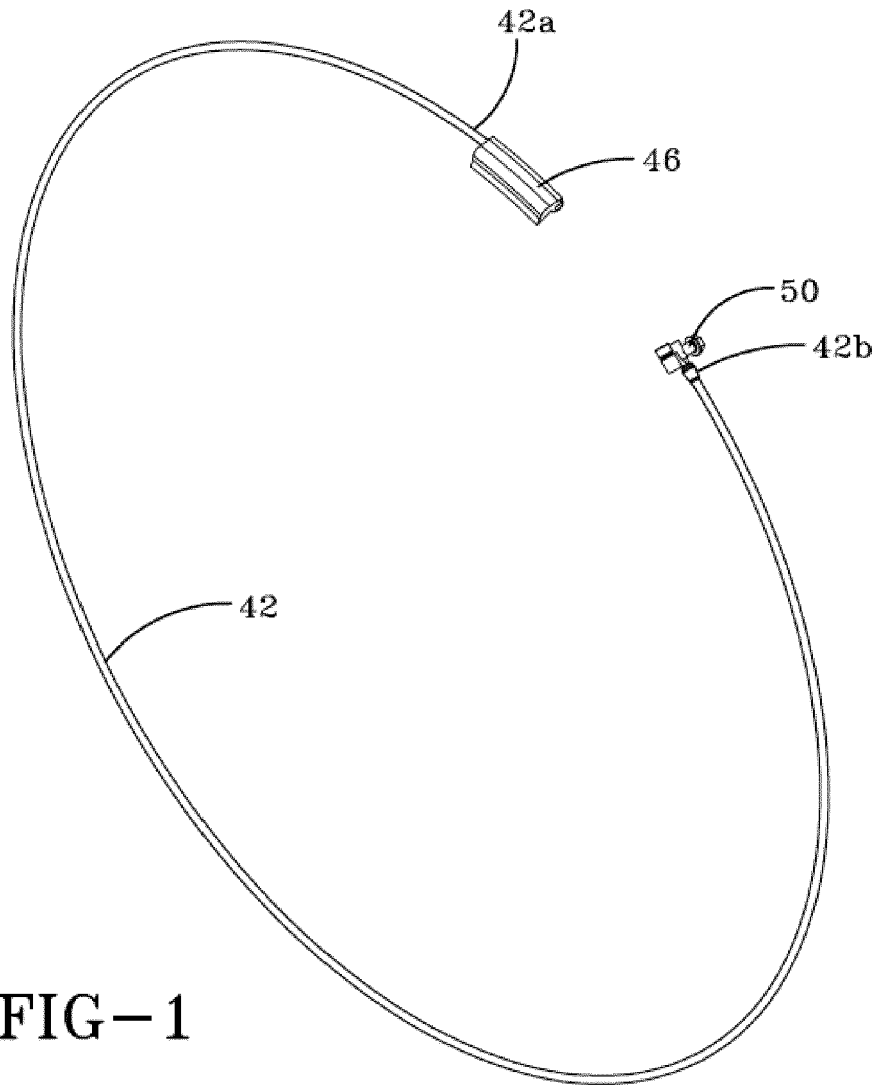


FIG-1



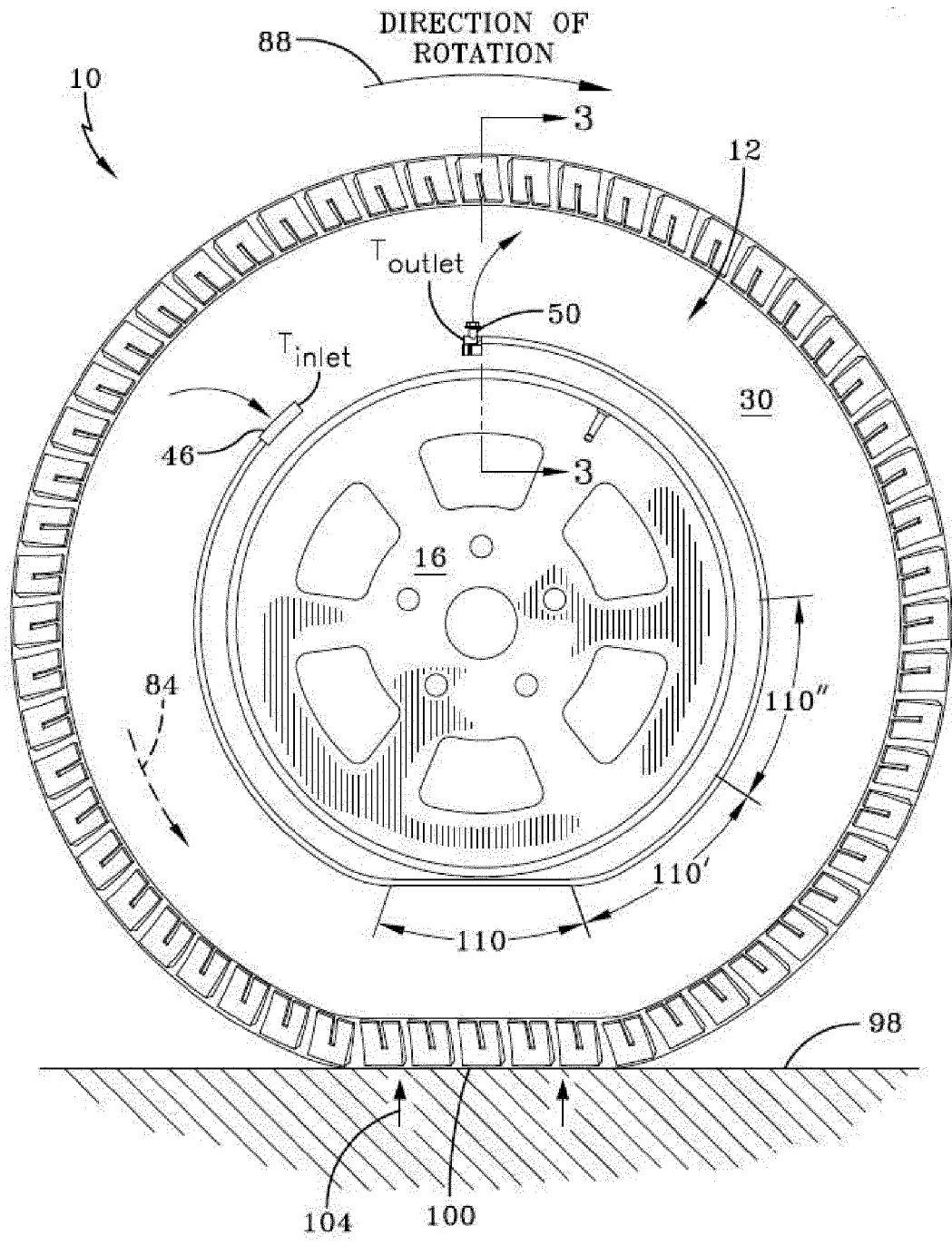
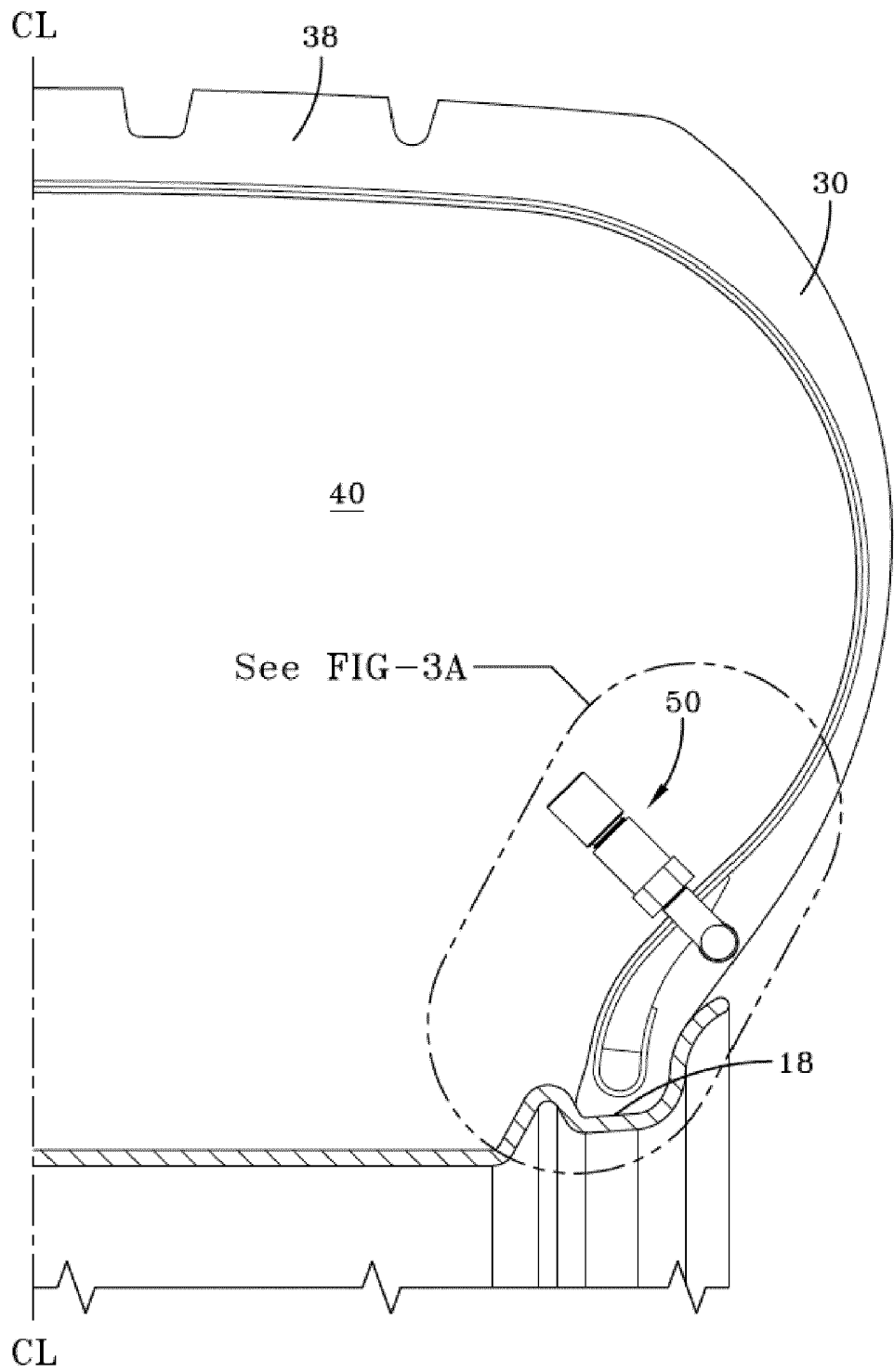


FIG-2



**FIG-3**

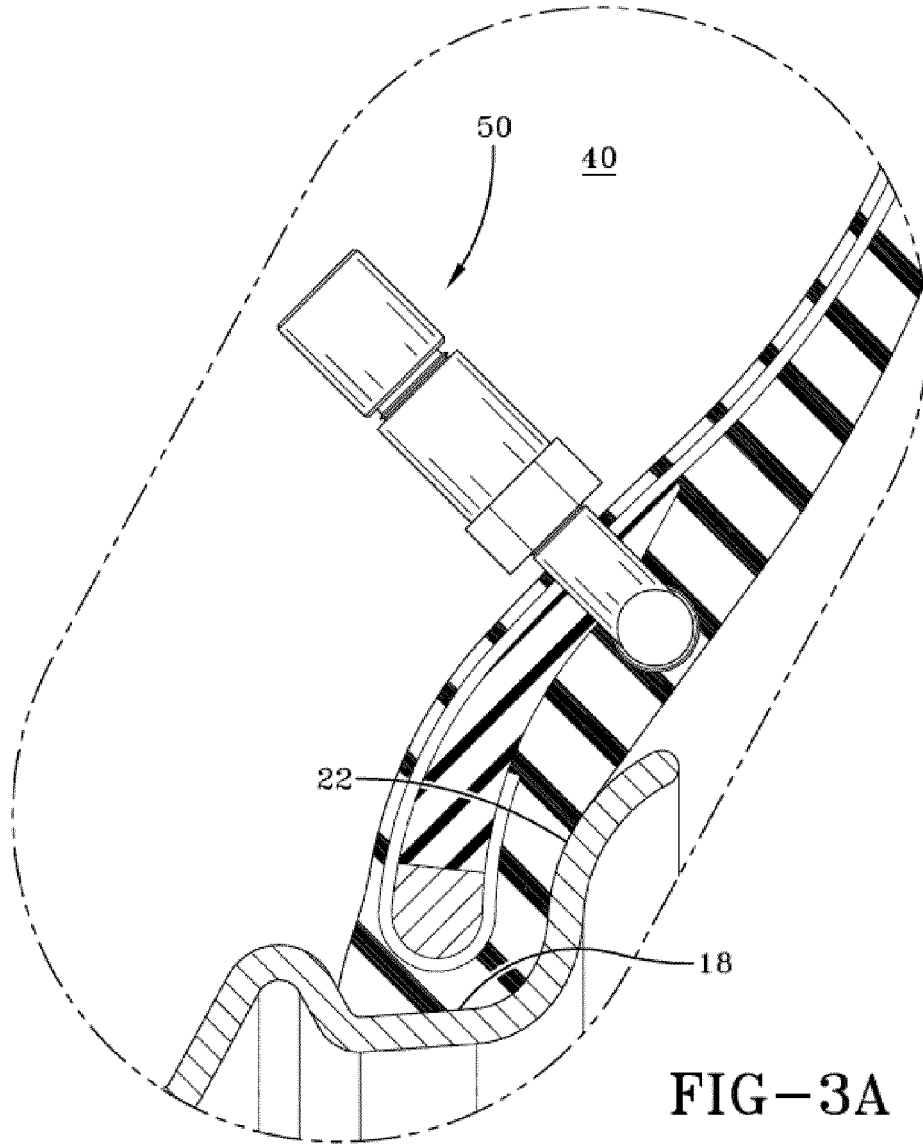
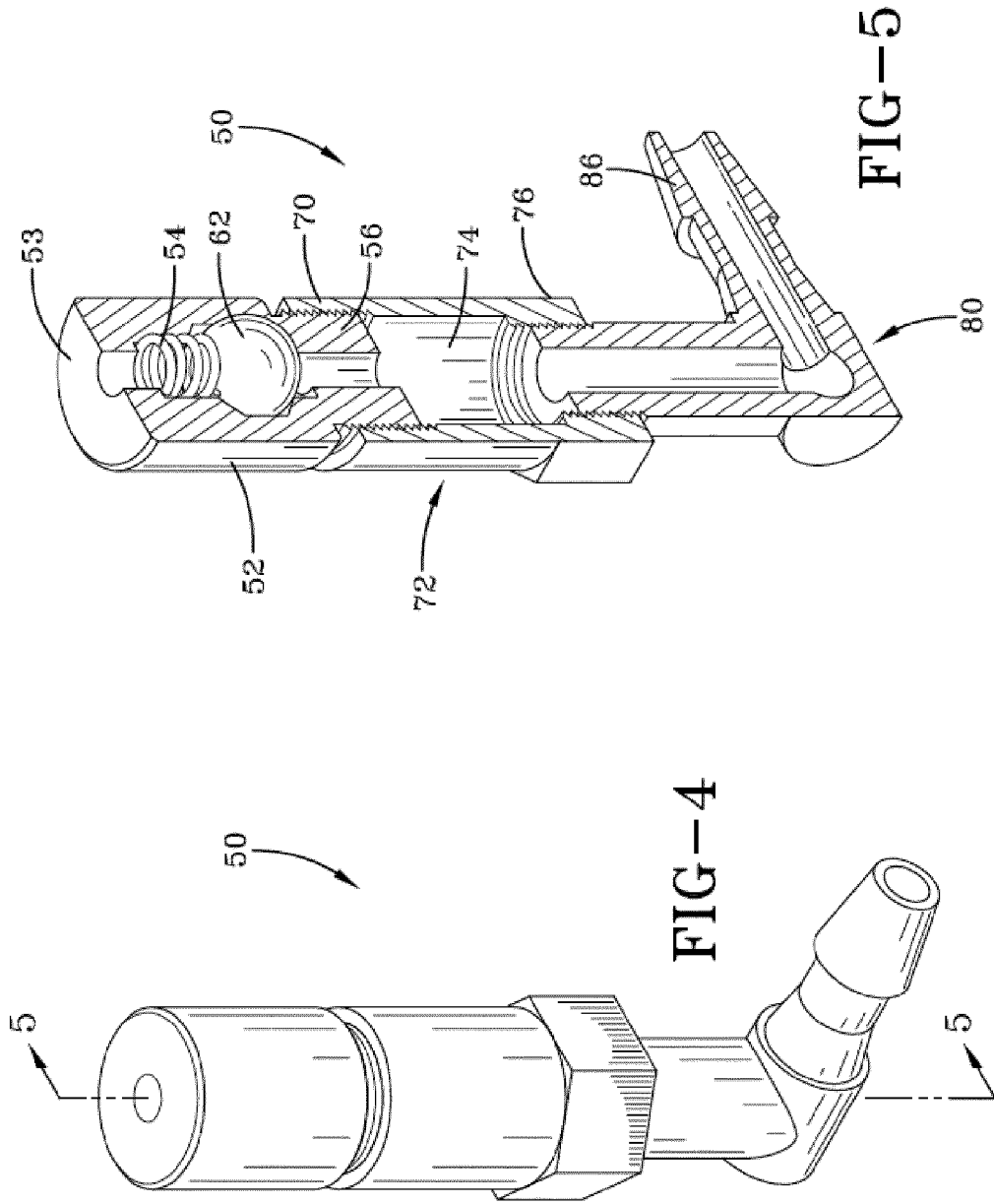


FIG-3A



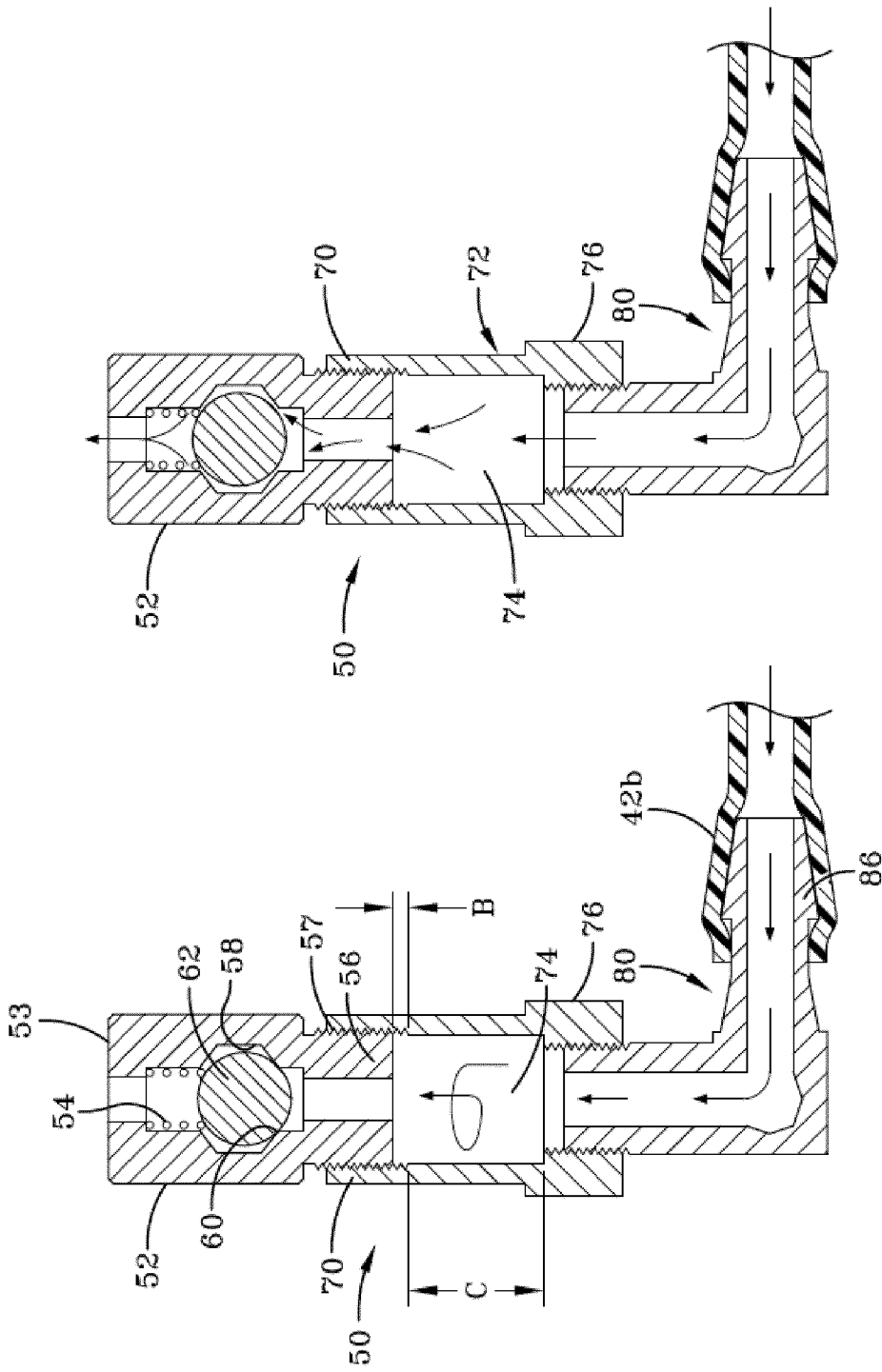
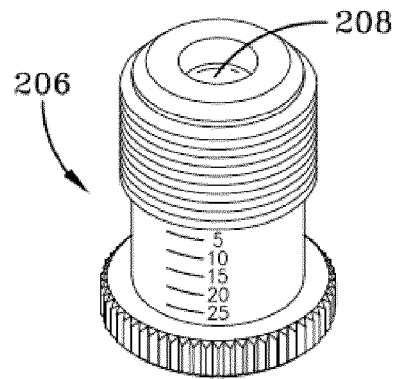
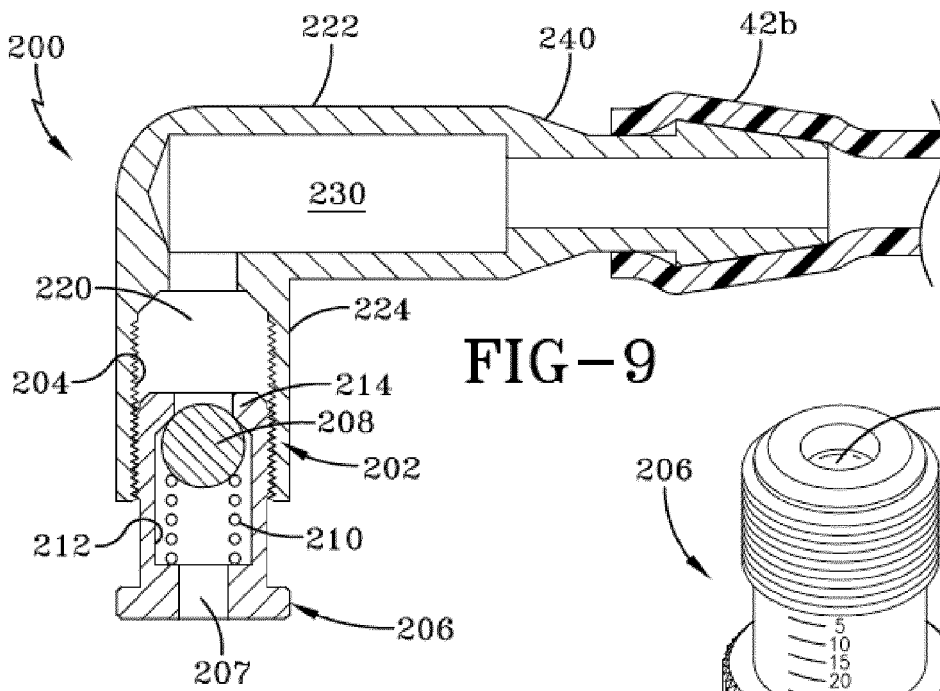
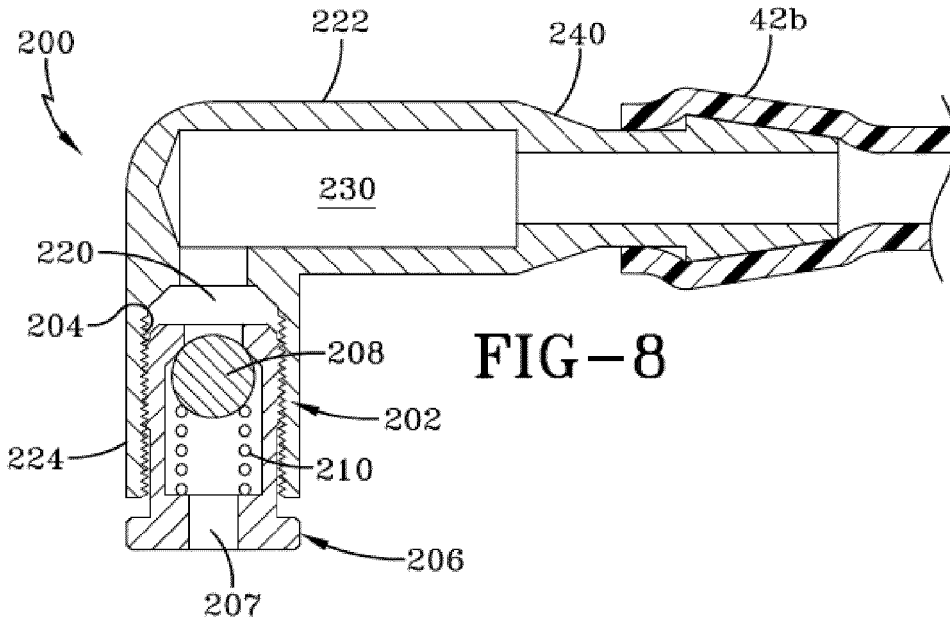


FIG-7

FIG-6



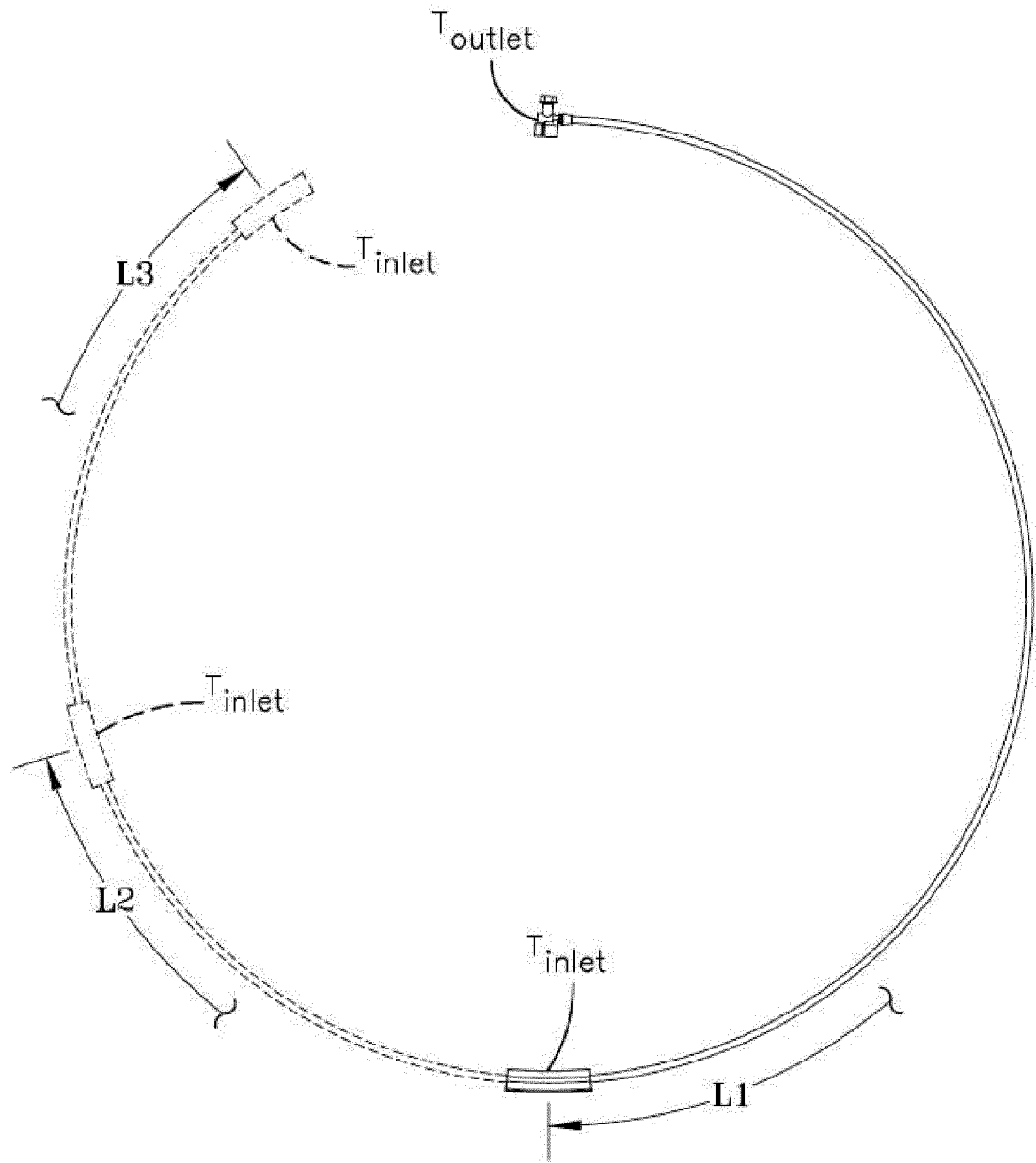


FIG-11

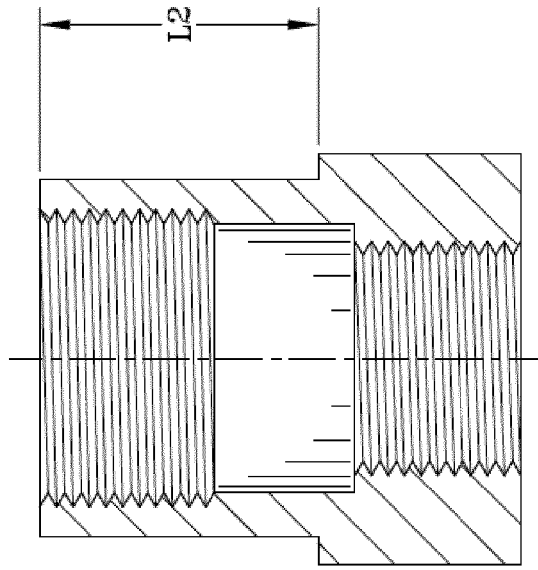


FIG-12B

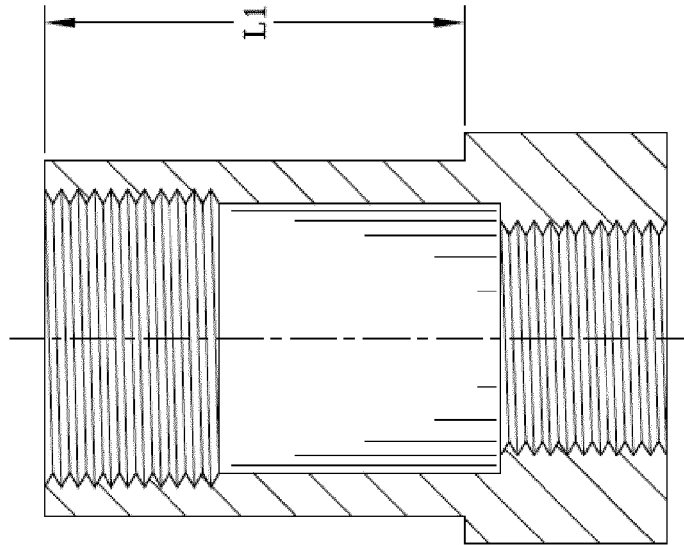
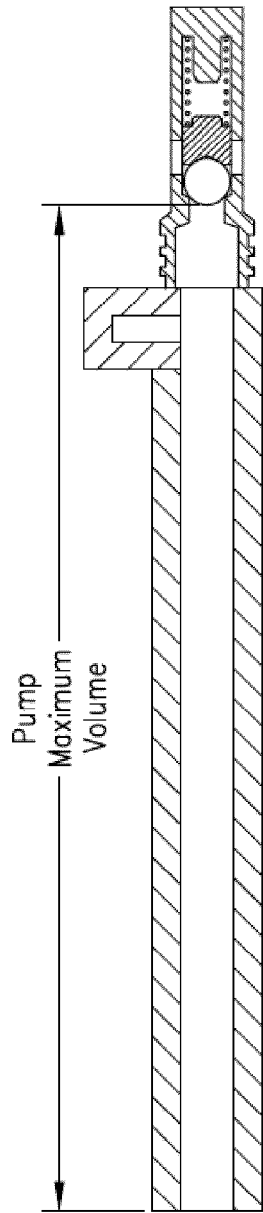
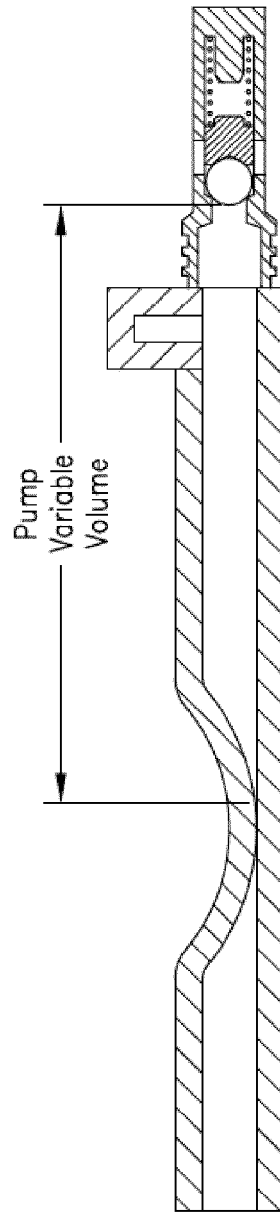


FIG-12A

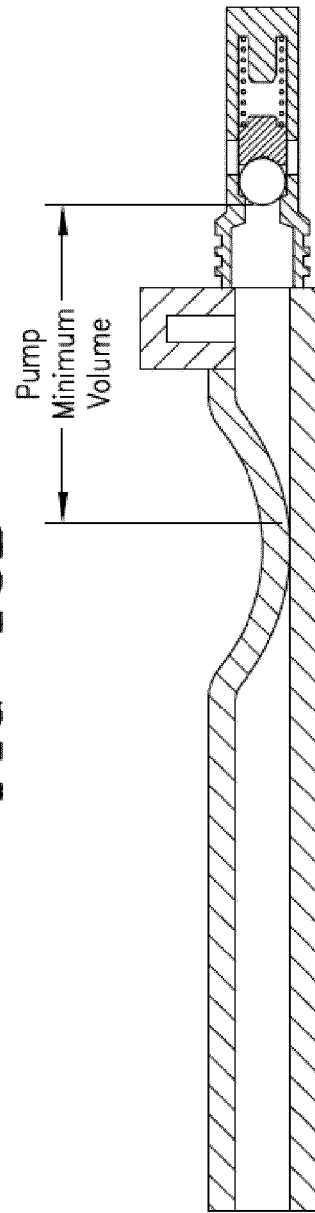




**FIG-13A**



**FIG-13B**



**FIG-13C**



EUROPEAN SEARCH REPORT

Application Number  
EP 12 19 1449

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