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(72) Inventor: **Cummins, Richard D.**  
**Orchard Park, NY 14127-4836 (US)**

(74) Representative:  
**Reichert, Werner F. Dr. Dipl.-Phys.**  
**Franz-Groedel-Strasse 1**  
**61231 Bad Nauheim (DE)**

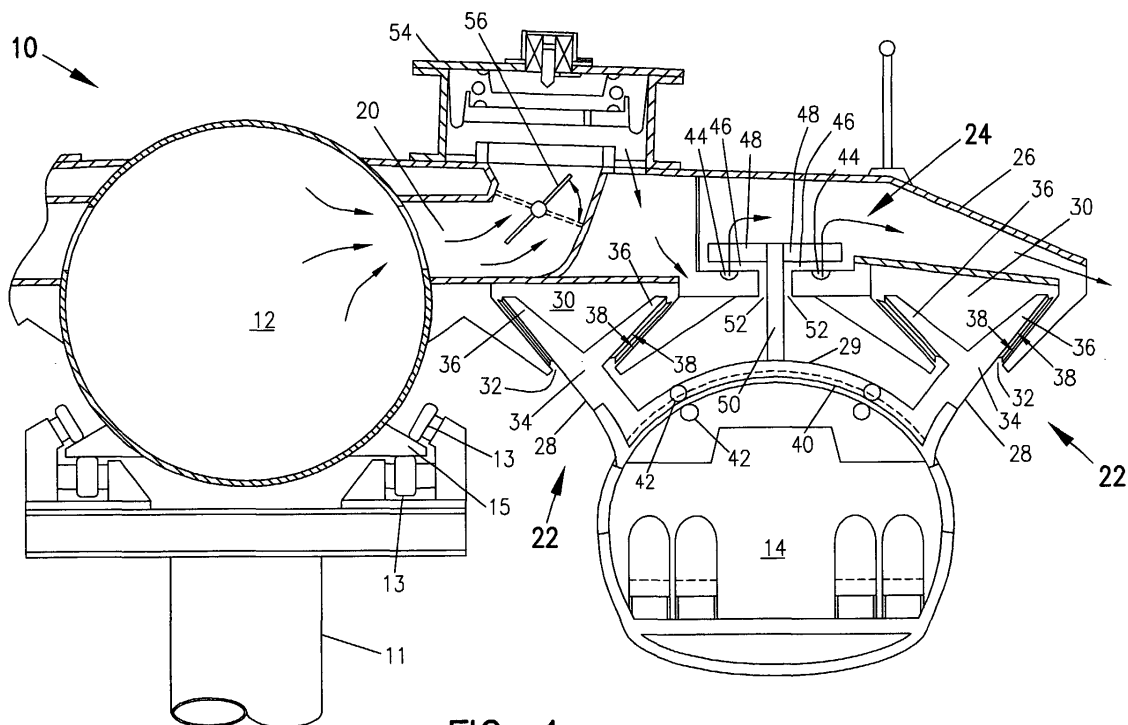
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(71) Applicant: **Cummins, Richard D.**  
**Orchard Park, NY 14127-4836 (US)**

(54) **All-weather guided vehicle system with pneumatic propulsion**

(57) An all-weather guided vehicle system comprises a tubular guideway (12) storing pressurized air and cantilevered beams extending bi-laterally from the guideway to support a continuous deck (26). Vehicles (14) are suspended under the deck (26) by way of carriages to which the vehicles are connected by arcuate

roller tracks (40). The beams support continuous angular channels slotted to receive suspension members (30) extending from the carriage for air or magnetic levitation. Impulse vanes (48) are provided on a vertical rod (56) extending through a slotted opening in a propulsion channel for cooperation with air jet nozzles (46) located within the channel to propel and brake the carriage (29).



**FIG. 1**

## Description

**[0001]** The present invention relates generally to guided vehicle systems, and more particularly to an all-weather guided vehicle system for high-speed travel between metropolitan hubs.

**[0002]** High speed "trains" or guided vehicle systems for passenger travel must operate without delays due to precipitation, snow, ice, and accompanying poor visibility, since such delays affect connecting ground and air transportation. Moreover, eliminating weather delays is an important safety consideration because the location and speed of every vehicle in the system is controlled both centrally and on-board each vehicle. Accordingly, protection of suspension and propulsion mechanisms of the guided vehicle system from the elements is of primary importance.

**[0003]** The present invention is, therefore, intended to provide an all-weather guided vehicle system. Protection from the elements is accomplished by enclosing the suspension and/or propulsion means of the vehicle system guideway in separate housings having a narrow continuous slot through an underside of the housing through which vertical rods or thin panels attach the suspension and/or propulsion means to the vehicle carriage. The narrow slots are preferably closed at unused portions of the guideway by automatically operated strip flaps to keep out wind driven snow and the like.

**[0004]** The nature and mode of operation of the present invention will now be more fully described in the following detailed description of the preferred embodiments taken with the accompanying drawing figure, in which:

Fig. 1 is a lateral cross-sectional view of an all-weather guideway and vehicle formed in accordance with a first embodiment of the present invention;

Fig. 2 is a lateral cross-sectional view of an all-weather guideway and vehicle formed in accordance with a second embodiment of the present invention;

Fig. 3A is a detailed sectional view of a tire track assembly shown in Fig. 2;

Fig. 3B is a detailed sectional view of an alternative tire track assembly of the present invention;

Fig. 3C is a detailed sectional view of an alternative tire track assembly of the present invention;

Fig. 4 is a side schematic view of the tire track assembly shown in Fig. 3A;

Fig. 5 is a lateral cross-sectional view of an all-weather guideway and vehicle formed in accordance with a third embodiment of the present invention;

Fig. 6 is a lateral cross-sectional view of an all-weather guideway and vehicle formed in accordance with a fourth embodiment of the present invention;

Fig. 7 is a sectioned perspective view of an all-weather guideway and vehicle formed in accordance with a fifth embodiment of the present invention.

Fig. 8A is a lateral cross-sectional view of an all-weather guideway and vehicle formed in accordance with a sixth embodiment of the present invention, with the vehicle being shown is an upright orientation; and

Fig. 8B is a lateral cross-sectional view of the all-weather guideway and vehicle shown in Fig. 8A, with the vehicle being shown is a tilted orientation.

**[0005]** Referring now to Fig. 1, a guided vehicle system according to a first embodiment of the present invention is shown and identified generally by the reference numeral 10. Vehicle system 10 includes an elongated tubular guideway 12 for storing and delivering pressurized air to suspension and/or propulsion means of the vehicle system. The guideway is supported above the ground by a series of support columns 11 spaced along the guideway and having support rollers 13 for engaging horizontally extending side tracks 15 on guideway 12 for allowing axially directed thermal expansion of the guideway. A plurality of vehicles 14 are designed for travel along both lateral sides of guideway 12, only one side being shown and described since the opposite side is a mirror image thereof.

**[0006]** A plurality of cantilevered beams 20 extend laterally from guideway 12 and serve to support vehicles 14, shown in the embodiment of Fig. 1 as being suspended from beams 20 by suspension means 22 and propelled along guideway 12 by propulsion means 24. Beams 20 preferably support a continuous deck 26 for shielding vehicle 14, suspension means 22, and propulsion means 24 from rain, ice and snow. As will be understood, beams 20 follow the thermal expansion of guideway 12 to which they are connected.

**[0007]** Suspension means 22 in the first embodiment comprises a pair of Y-shaped suspension members 28 extending upwardly from a carriage 29 for receipt within angular suspension channels 30 supported by beams 20, each angular suspension channel having a slot opening 32 extending the length thereof to accommodate a stem portion 34 of a Y-shaped suspension member 28. The legs 36 of each Y-shaped member oppose corresponding inner surfaces 38 of associated angular channel 30, and are separated slightly therefrom by a cushion of pressurized air or magnetic bearings to substantially eliminate surface-to-surface friction. Where a cushion of pressurized air is used, guideway 12 serves as an air reservoir for supplying lifting air. Carriage 29 with Y-shaped suspension members 28 is connected to vehicle 14 by an arcuate flanged track 40 extending along the carriage between suspension members 28 and arranged for engagement by a plurality of upper and lower roller wheels 42 spring-mounted on vehicle 14 in an arcuate configuration corresponding to that of track

40. In the alternative, roller wheels 42 could be mounted on carriage 29, and track 40 could be provided on vehicle 14. As will be appreciated, vehicle 14 rolls without swinging to achieve desired rotation about the center of curvature of track 40, which is located within vehicle 14 rather than over or under the vehicle. Also, the problem of crosswind torque about an external pivot point is eliminated. The overall height and crosswind profile of vehicle 14 is reduced because of the shared curvatures of the vehicle and carriage 29 without the need for "tilting space".

**[0008]** Propulsion means 24 preferably comprises a plurality of directionally biased nozzles 44 set within a substantially enclosed propulsion channel 46 supported by beams 20 underneath deck 26. A series of directionally biased vanes 48 are connected to carriage 29 by vertical rods 50 which fit through a slot opening 52 in the underside of propulsion channel 46. Air jets issuing from nozzles 44 impinge upon vanes 48 to propel carriage 29 and connected vehicle 14 along guideway 12, and also to brake the carriage and vehicle. Nozzles 44 are in communication with the interior of guideway 12 by way of a pilot-operated thruster valve 54 for supplying propulsion air to the nozzles, and an emergency/maintenance shut-off valve 56 is also provided.

**[0009]** A guided vehicle system according to a second embodiment of the present invention is shown in Fig. 2 and designated generally by reference numeral 60. The second embodiment 60 is similar to the first embodiment 10, except that it includes a plurality of topside fair-weather vehicles 62 mounted for travel above deck 26. A dedicated air propulsion and braking system 64 supplied with air stored within guideway 12 is provided for fair-weather vehicles 62, which may be air-levitated or magnetically levitated.

**[0010]** Another difference appearing in the second embodiment of Fig. 2 is the use of a high-speed "tire track" rails 70 and wheels 72A, 72B for suspension and alignment of carriage 29. Each tire track 70 resembles an automobile or truck tire in construction, except that it is not a closed loop. An enlarged view of tire track 70 and wheels 72A, 72B is presented in Fig. 3A, and a side elevational view of this structure is presented in Fig. 4. As may be seen in Fig. 4, tire track 70 includes a plurality of strip springs 74 mounted within the tread and side wall of the tire track 70 along a top region 73 and a side region 75 thereof, where the tire track is contacted by passing wheels 72A and 72B, respectively. Strip springs 74 spread out the load of the wheel greatly beyond the area of the depression of the wheel 72A or 72B into the surface of tire track 70. Since the load is extended over a much longer area or length of tire track 70, friction, total deflection, and deflection rates are reduced. The "squeeze" zones at the front and rear of the wheel depression are all but eliminated. If the strip springs are stiff enough to spread the wheel load out between the wheels, the number of flexures would be one per vehicle passage as opposed to one per wheel passage. The

vertical deflection accelerations may also be reduced by having the wheel heights increase gradually to the front and rear. These features may also permit use of lower tire pressure for tire track 70, and more numerous and smaller wheels 72, without undue increase in friction. Referring again to Fig. 3A, tire track 70 also includes a support frame 71 including an arcuate counterbrace element 71A that rises along the side of the tire track 70 opposite side region 75 to counteract the horizontal forces of the wheels 72B and to help support the tire track.

**[0011]** Figs. 3B and 3C show alternative tire track arrangements according to the present invention. In Fig. 3B, the counterbrace element 71A' is simply a vertical wall. As can be seen in Fig. 3B, wheels 72A, 72B can be connected to carriage 29 by dampers 31 for dissipating vibration energy for a smoother ride. The tire track variant of Fig. 3C is mounted for lateral and vertical adjustment relative to deck 26 by adjustable fasteners 65 extending through slots 67 formed in bifurcated frame 71' (lateral adjustment) and by shims 77 (vertical adjustment). A serrated crimping channel 69 and clamps 63 function to close and seal the tire track to maintain internal pressure.

**[0012]** Fig. 5 illustrates a third embodiment 80 designed to mitigate side sway of vehicle 14 from cross winds. The monorail guideway has a suspension/propulsion channel 81 having a slot opening 83 through an underside thereof. Suspension/propulsion channel 81 houses an upper tire track 70 as described in connection with Fig. 3, as well as a series of directionally uniform nozzles 44. A suspension/propulsion member 82 extends from the top of carriage 29 through slot opening 83, and includes wheels 72A, 72B for engaging tire track 70 and directionally biased vanes 48 for gathering the impulse from jets issuing from nozzles 44. An auxiliary stabilizing rail 76 is arranged to extend from support columns 11 to engage rollers 75 on the underside of carriage 29. As will be understood, stabilizing rail 76 helps to prevent side sway of vehicle 14. Of course, as an alternative, carriage 29 could be provided with a central fin along its underside for engagement by stationary rollers. In this embodiment, the vehicle carriage 29 includes a number of identical internal rings 78 spaced along the longitudinal axis of the vehicle which are integrated into the shell of a passenger compartment 79 so as to offer a smooth and continuous outer surface to the air flow. Roller wheels 42 permit the passenger compartment to rotate within the carriage rings 78, while the carriage 29 is restrained from lateral movement or rotation by upper tire track 70 and auxiliary guiding roller track 76. Both upper tire track 70 and stabilizing rail 76 are preferably narrow and are arranged along the centerline of vehicle 29 in order to minimize the "throw" of the switch and to give clearance for the vehicle to pass between upper and lower disconnected branches of guideway 12.

**[0013]** A vehicle system 90 according to a fourth embodiment of the present invention is shown in Fig. 6. In this embodiment, Y-shaped suspension/propulsion

members 28 are provided along the centerline 92 of carriage 29 and extend upwardly from carriage 29 for receipt within angular suspension/propulsion channels 93, and damper guides 95 mounted on support columns 11 receive a laterally extending member 94 of carriage 29 to prevent side sway.

**[0014]** A vehicle system 100 according to a fifth embodiment of the present invention is shown in Fig. 7. Vehicle system 100 is an aboveground system wherein the carriages 29 and vehicles 14 are suspended directly below an associated tubular guideway 12. The system shown includes parallel guideways 12 connected by a central support and supply structure 17. Each guideway 12 has a pair of parallel tire track rails 70 suspended therefrom for engagement by wheels of a carriage 29. The tubular guideways 12 and structure 17 help shield the carriages 29 and tire tracks 70 from freezing rain and snow.

**[0015]** Figs. 8A and 8B show a vehicle system 110 according to a sixth embodiment of the present invention. Vehicle system 110 represents a currently preferred arrangement for a topside fair-weather vehicle mounted directly above tubular guideway 12, whereby additional loading on a cantilevered deck extending from the guideway to protect a suspended vehicle is avoided. Vehicle system 110 comprises vehicle 14 supported on carriage 29 for pivotal tilting motion useful in guideway turns. An arcuate flanged track 40 extends along an upper portion of carriage 29 for engagement by a plurality of upper and lower roller wheels 42 spring-mounted on vehicle 14 in an arcuate configuration corresponding to that of track 40.

**[0016]** The guided vehicle systems of the fifth and sixth embodiments provide for suspension of the carriage directly below tubular guideway 12 and support of the carriage directly above the tubular guideway. Consequently, in these configurations, the efficiency of pressurized air transfer between tubular guideway 12 and propulsion means 24 is improved.

## Claims

1. A guided vehicle system (10, 60, 80, 90) comprising:

at least one tubular guideway (12) supported above the ground, said guideway (12) containing pressurized air;

a deck (26) extending laterally from said guideway (12) along the length of said guideway (12); a first carriage (29) suspended under said deck (26), said first carriage (29) including a plurality of directionally biased impulse vanes (48);

a first plurality of nozzles (44) for issuing air jets primarily along a common guideway direction, said first plurality of nozzles (44) communicating with said guideway (12) to receive said

pressurized air and being arranged to cooperate with said impulse vanes (48) of said first carriage (29) to propel said first carriage (29); a first passenger vehicle (14) carried by said first carriage (29).

2. The guided vehicle system as defined in claim 1, wherein the deck (26) is supported above the ground, defines a pair of continuous parallel suspension channels (30) and a at least one propulsion channel (46) centrally located with respect to said pair of suspension channels (30), said propulsion channel (46) having a slot opening (52) through an underside thereof, and wherein reduced friction support means are provided within each of said pair of suspension channels (30).

3. The guided vehicle system as defined in claim 1 and 2, wherein the carriage (29) including a pair of suspension members (28) received one within each of said pair of suspension channels (26) for operative connection with said deck (26) to suspend said carriage (29) for travel along the length of said pair of suspension channels, and said impulse vanes (48) being connected to said carriage by vertical members extending through said slot opening (52) in said propulsion channel (46).

4. The guided vehicle system as defined in one of the claims 1 to 3, further comprising a plurality of arcuate roller tracks (40) for suspending said vehicle (14) from said carriage (29) to allow said vehicle (14) to rotate about an axis of rotation that is internal to said vehicle (14).

5. The guided vehicle system as defined in claim 2, wherein each of said pair of suspension channels (30) has opposite inner surfaces (38) inclined to converge toward a slot opening (32) through a bottom of said suspension channel (30), each of said pair of suspension members (28) is a Y-shaped member, and said support means lifts said Y-shaped suspension member (28) away from surface-to-surface engagement with said inner surfaces of said suspension channel (30) and said support means provides levitating cushions of pressurized air between said Y-shaped member and said inner surfaces (38) of said suspension channel (30).

6. The guided vehicle system as defined in claim 2, wherein each of said pair of suspension channels (30) has a track rail (70) for engagement by at least one wheel (72A, 72B) provided on said suspension member (28), and wherein said track rail (70) includes an elastically deformable material and a plurality of strip springs (74) extending along said track rail (70) for engagement by said at least one wheel (72A, 72B), said plurality of strip springs (74) acting

to spread out the load from said at least one wheel (72A, 72B) over said elastically deformable material and wherein each of said track rails (70) includes a support frame and an arcuate portion of said elastically deformable material connected to said support frame to define an internal volume. 5

7. The guided vehicle system according to claim 6, wherein said arcuate portion of said track rail (70) includes a top region along which said strip springs (74) extend for engagement by a wheel rotating about a generally horizontal axis and a side region along which said strip springs extend for engagement by a wheel rotating about a generally vertical axis and said support frame includes a counter-brace opposite said side region. 10 15

8. The guided vehicle system as defined in claim 2, wherein a stabilizing rail (76) beneath said carriage extending parallel to said suspension (30) and propulsion channel (46), and at least one stabilizing roller (75) for engaging said stabilizing rail (76) to mitigate rotational away of said carriage (29). 20

9. The guided vehicle system as defined in claim 8, wherein said stabilizing rail (76) is stationary and said at least one stabilizing roller (75) is a pair of opposing rollers fixed to an underside of said carriage (29) for engaging opposite sides of said stabilizing rail (76). 25 30

10. The guided vehicle system as defined in claim 1, further comprising:

- a second carriage supported above said deck (26), said second carriage including a plurality of directionally biased impulse vanes; 35
- a second plurality of nozzles for issuing air jets primarily along a common guideway direction, said second plurality of nozzles communicating with said guideway to receive said pressurized air and being arranged to cooperate with said impulse vanes of said second carriage to propel said second carriage; and 40
- a second passenger vehicle (62) carried by said second carriage. 45

11. A guided vehicle system comprising:

- a tubular guideway (12) supported above the ground, said guideway containing pressurized air; 50
- a pair of track rails 70 supported by said tubular guideway (12) and parallel thereto;
- a carriage (29) having multiple wheels engaging said pair of track rails (70) for guided travel along said pair of track rails (70), said carriage (29) further having a transversely extending ar-

cuate roller track (40) and a plurality of directionally biased impulse vanes; a plurality of nozzles for issuing air jets primarily along a common guideway direction, said plurality of nozzles communicating with said tubular guideway (12) to receive said pressurized air and being arranged to cooperate with said impulse vanes of said carriage (29) to propel said carriage (29); and a vehicle (14) connected to said carriage (29) for travel with said carriage (29), said vehicle having a plurality of rollers (42) in an arcuate configuration corresponding to said roller track (40) of said carriage (29).

12. The guided vehicle system according to claim 11, wherein each of said pair of track rails (70) comprises an elastically deformable material and a plurality of strip springs (74) extending along said track rail (70) for engagement by said plurality of wheels, said plurality of strip springs (70) acting to spread out the load from said at least one wheel over said elastically deformable material and wherein each of said track rails (70) includes a support frame and an arcuate portion of said elastically deformable material connected to said support frame to define an internal volume..

13. The guided vehicle system according to claim 6 and 12, wherein said internal volume is filled with pressurized fluid.

14. The guided vehicle system according to claim 12, wherein said arcuate portion of each said track rail includes a top region along which said strip springs extend for engagement by wheels of said carriage rotating about a generally horizontal axis and a side region along which said strip springs extend for engagement by wheels of said carriage rotating about a generally vertical axis.

15. The guided vehicle system according to claim 14, wherein said support frame includes a counter-brace opposite said side region.

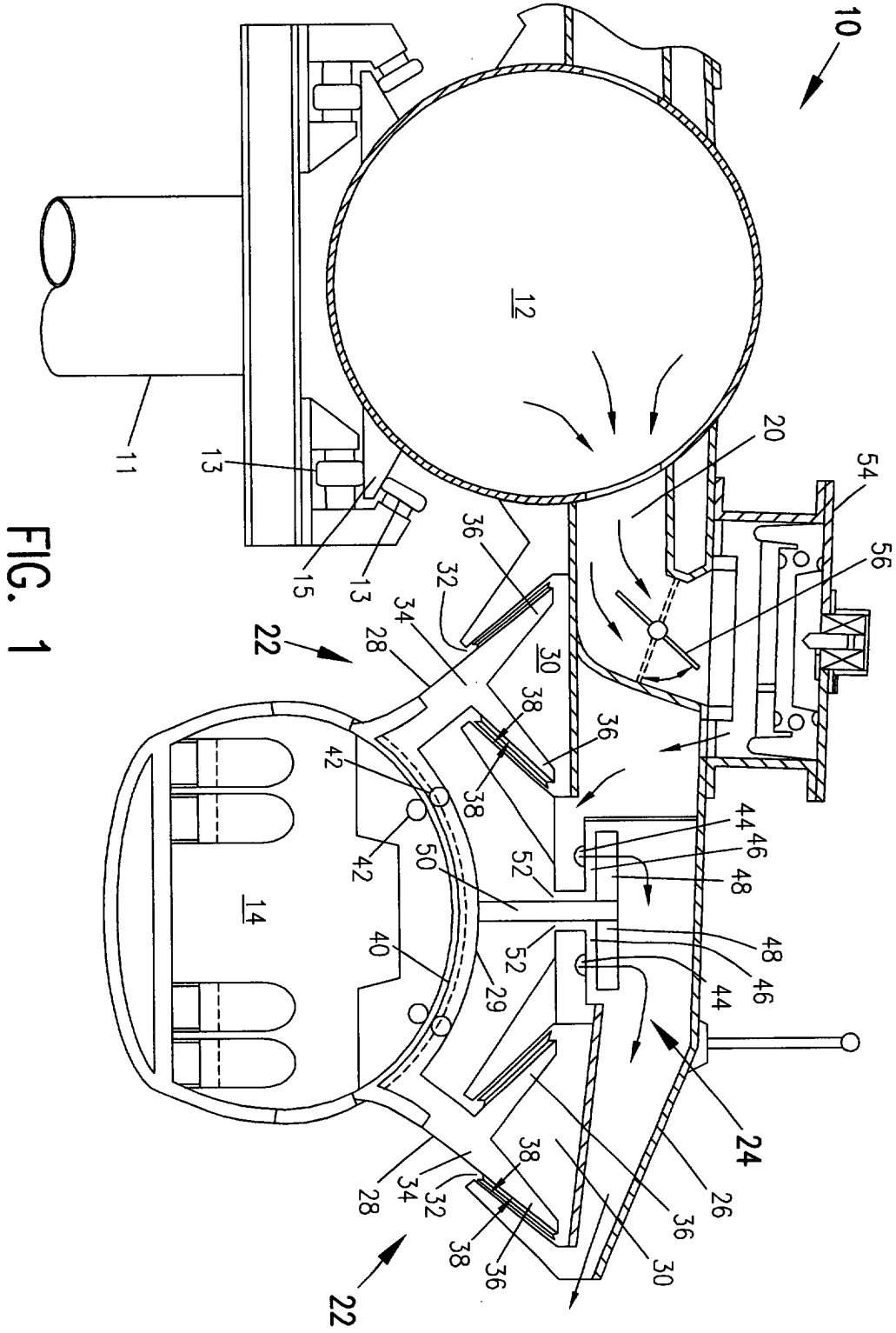


FIG. 1

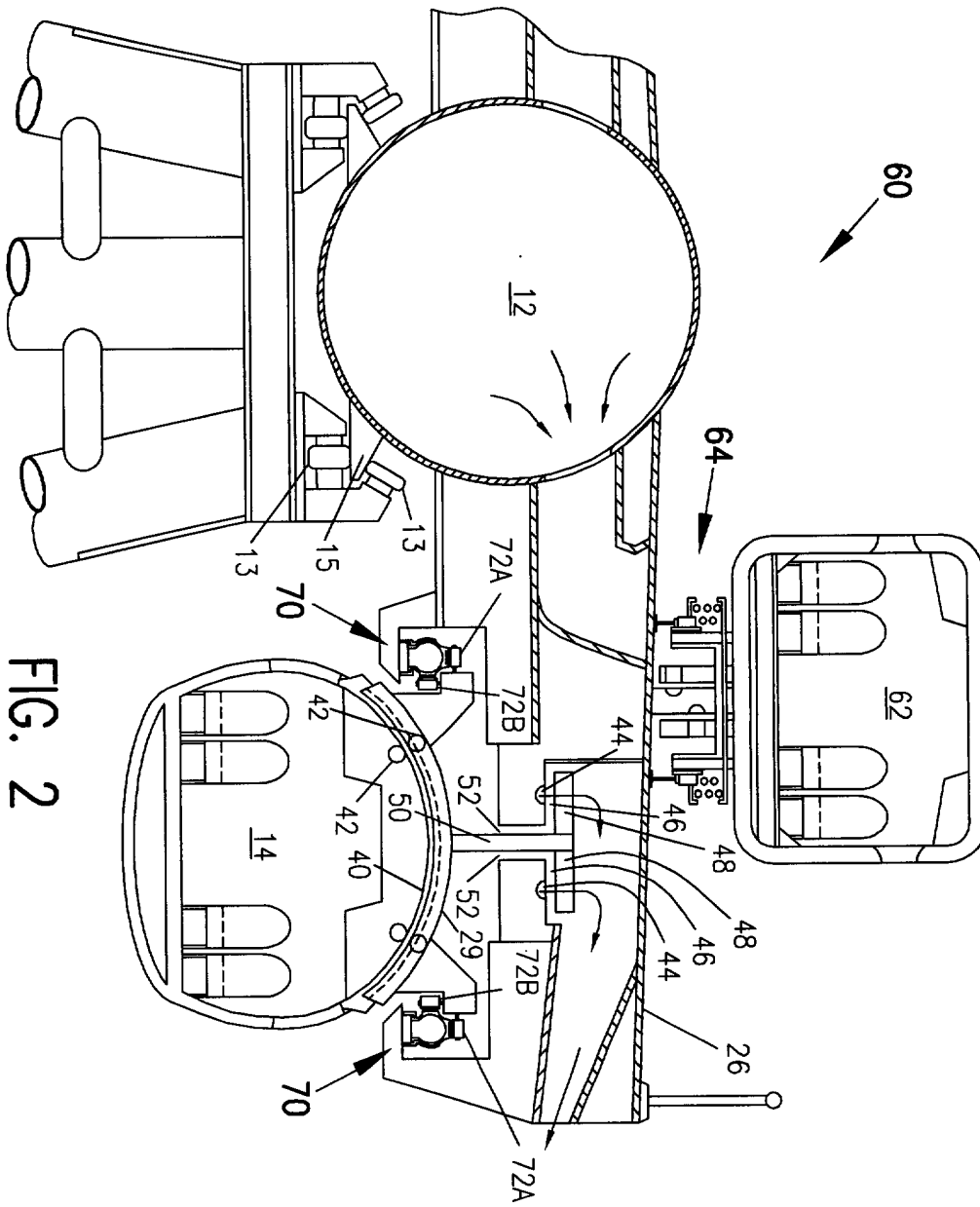


FIG. 2

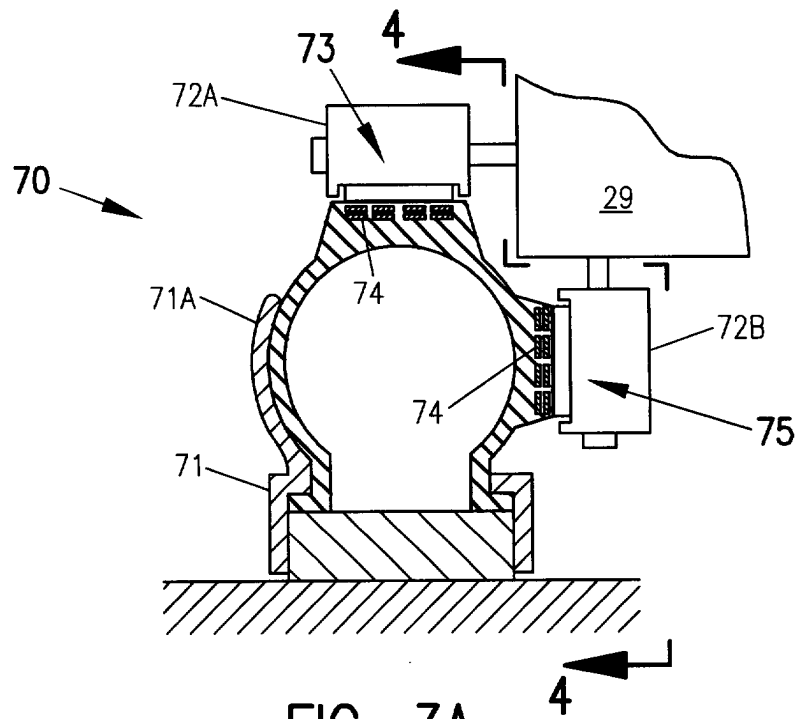


FIG. 3A

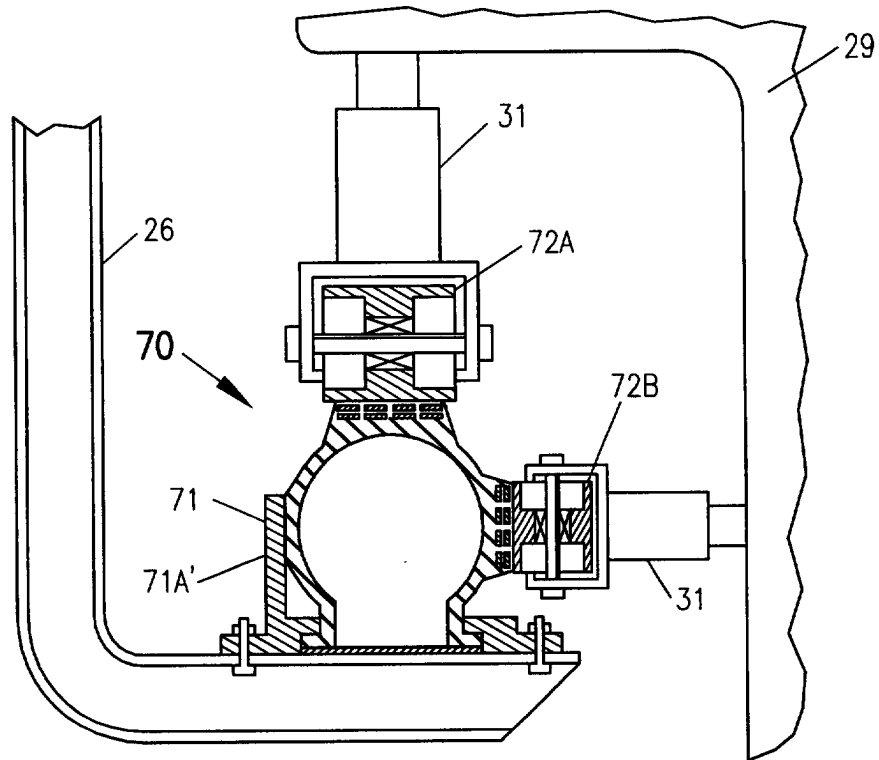


FIG. 3B

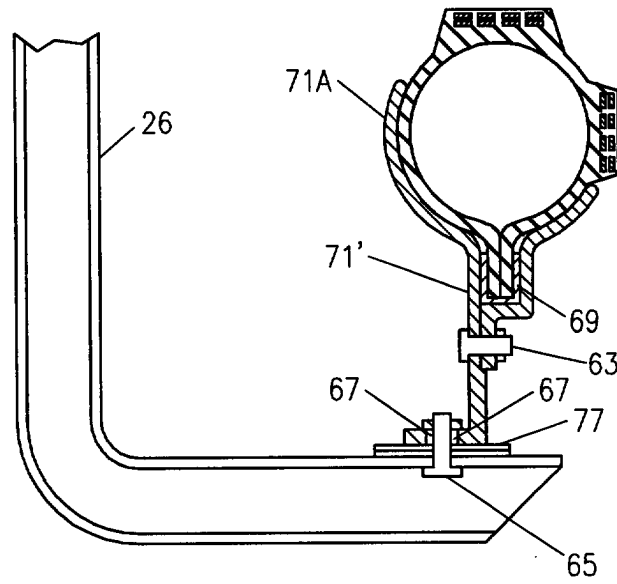


FIG. 3C

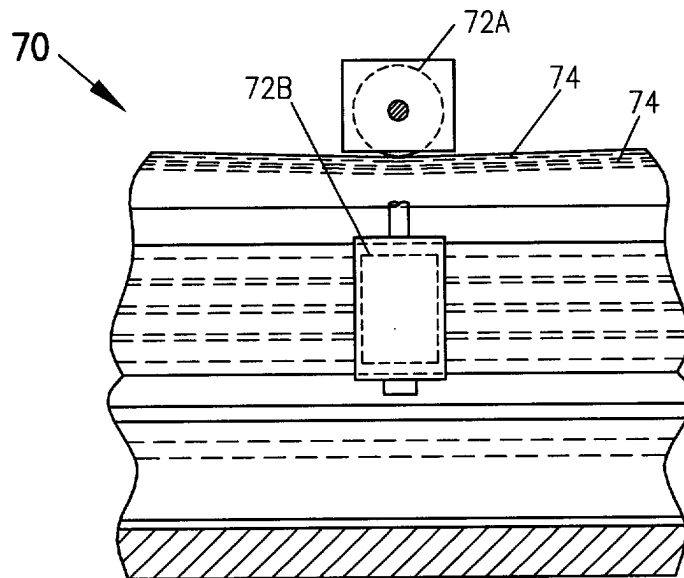
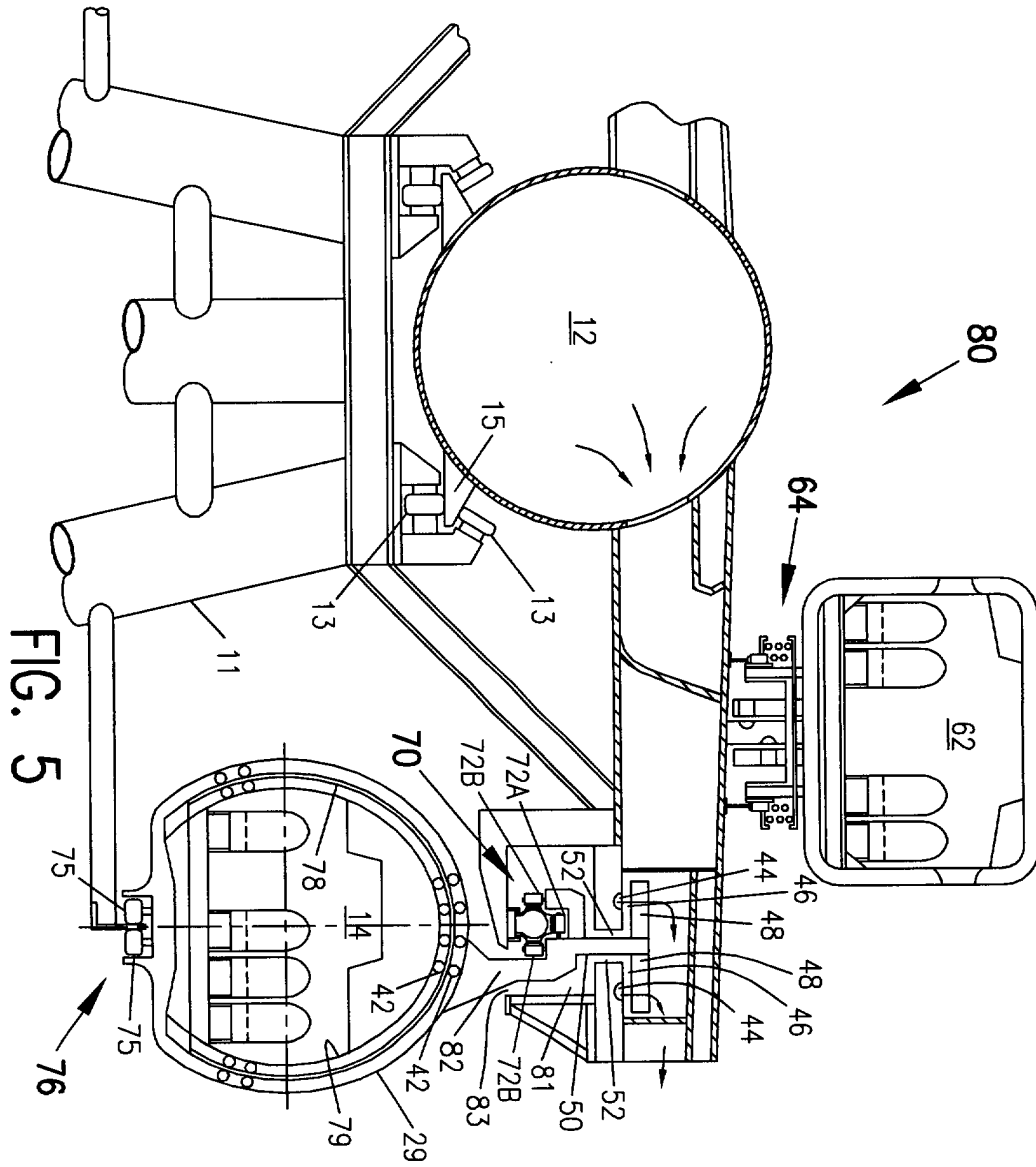


FIG. 4



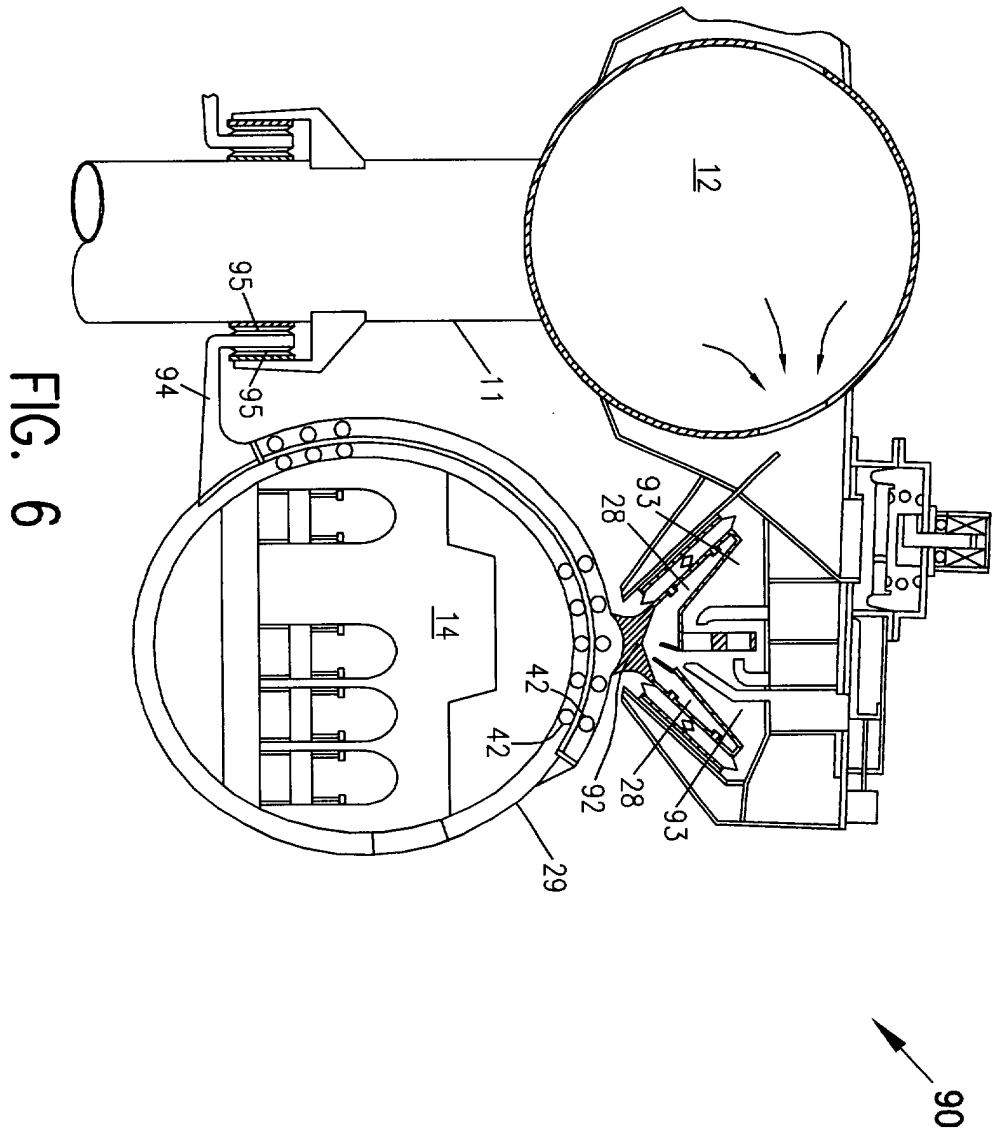


FIG. 6

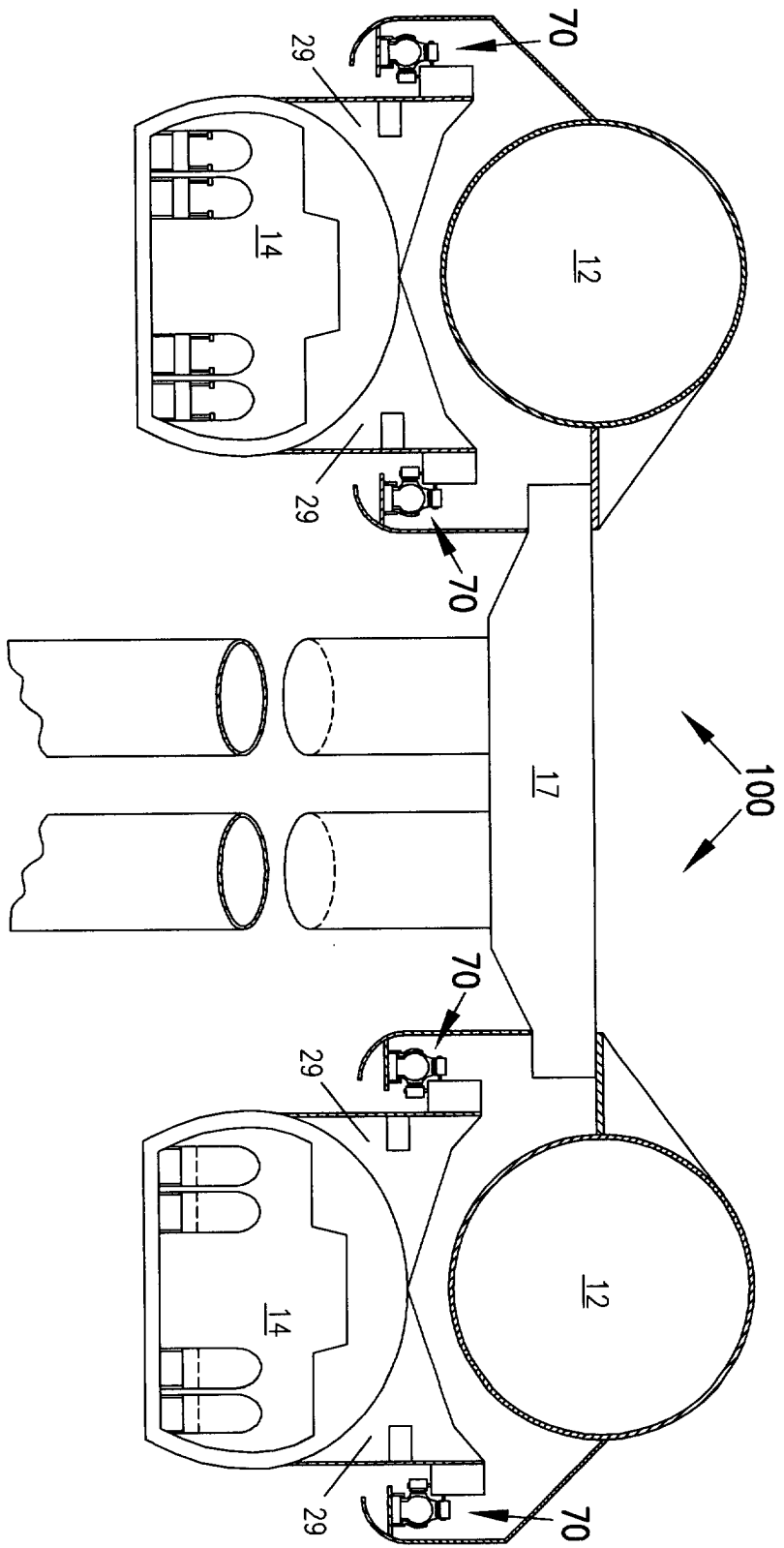


FIG. 7

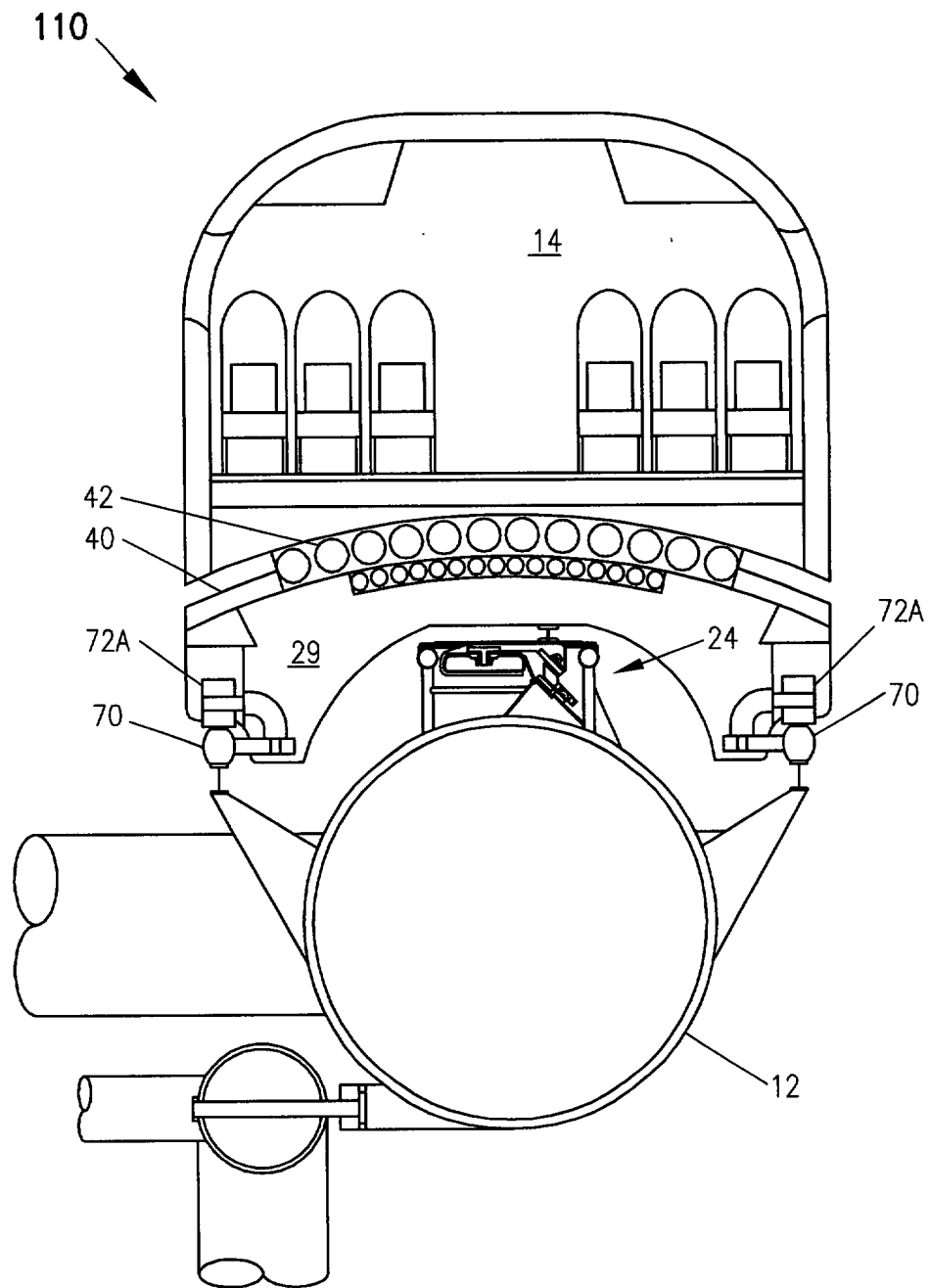


FIG. 8A

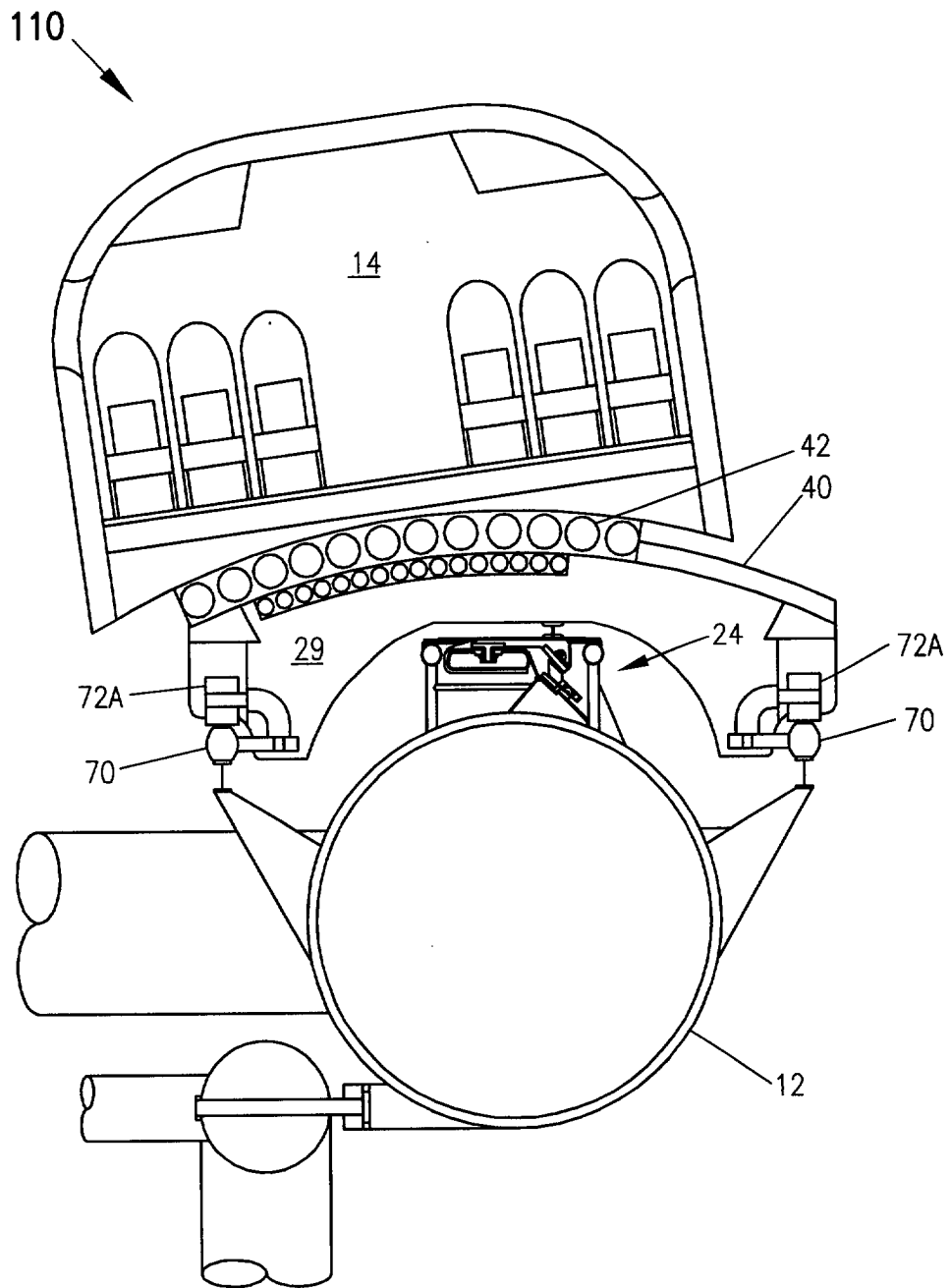


FIG. 8B



European Patent  
Office

EUROPEAN SEARCH REPORT

Application Number  
EP 02 02 2437

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
A	US 5 909 710 A (CUMMINS RICHARD D) 8 June 1999 (1999-06-08) * column 2, line 44 - column 3, line 53; figures *	1,11	B61B13/12 B61B3/02 B60V3/04
A	FR 2 077 441 A (BARTHALON MAURICE) 29 October 1971 (1971-10-29) * figures 1,3,5,6 *	1,11	
A	US 3 225 228 A (ROSHALA JOHN L) 21 December 1965 (1965-12-21) * column 2, line 36-53; figure 2 *	2,3,5	
A	DE 21 18 530 A (UNGER, MANFRED) 26 October 1972 (1972-10-26) * the whole document *	1,11	
A	US 3 238 894 A (MAKSIM JR JOHN) 8 March 1966 (1966-03-08)		
A	FR 2 123 719 A (AEROTRAIN) 15 September 1972 (1972-09-15)		
The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (Int.Cl.7)
			B61B B60V
Place of search		Date of completion of the search	Examiner
MUNICH		25 February 2003	Ferranti, M
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**ANNEX TO THE EUROPEAN SEARCH REPORT  
ON EUROPEAN PATENT APPLICATION NO.**

EP 02 02 2437

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on  
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25-02-2003

Patent document cited in search report		Publication date		Patent family member(s)	Publication date
US 5909710	A	08-06-1999	AU	8694498 A	08-03-1999
			WO	9908918 A1	25-02-1999
-----					
FR 2077441	A	29-10-1971	FR	2077441 A6	29-10-1971
-----					
US 3225228	A	21-12-1965	NONE		
-----					
DE 2118530	A	26-10-1972	DE	2118530 A1	26-10-1972
-----					
US 3238894	A	08-03-1966	NONE		
-----					
FR 2123719	A	15-09-1972	FR	2123719 A5	15-09-1972
-----					