March 29, 1966 L. E. BERGGREN 3,242,876

PNEUMATIC PROPULSION TRANSPORATION SYSTEM

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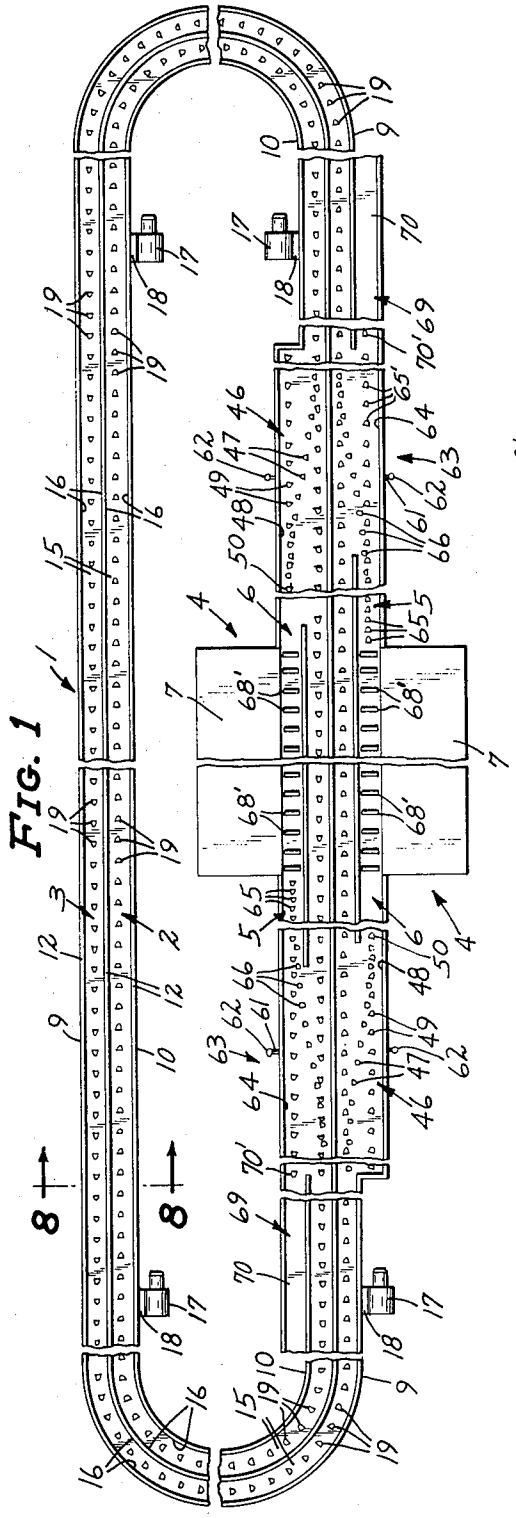

FIG. 1

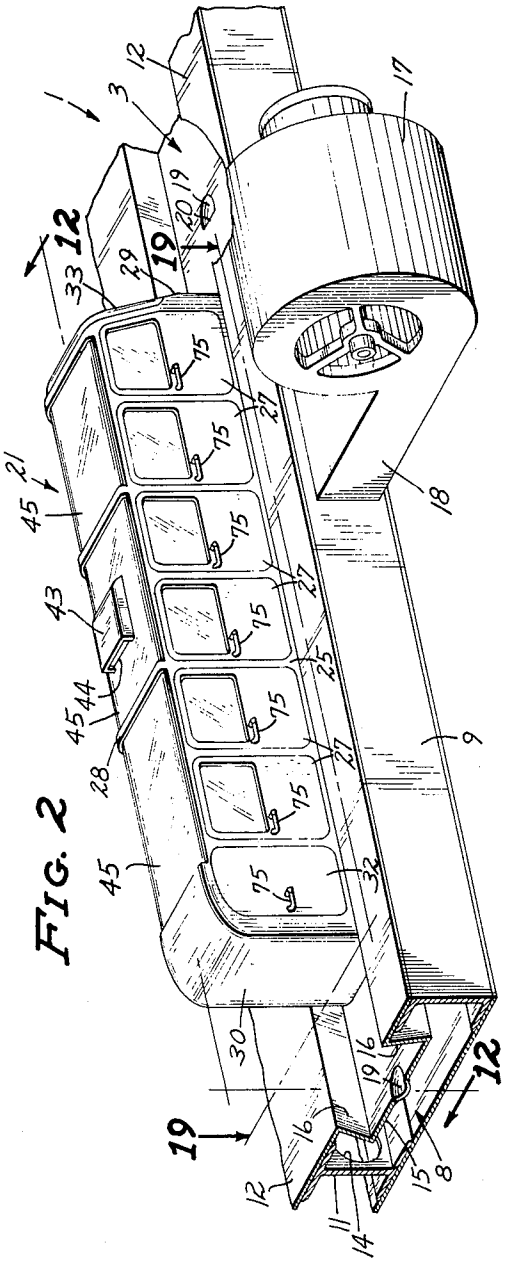

FIG. 2

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PNEUMATIC PROPULSION TRANSPORATION SYSTEM

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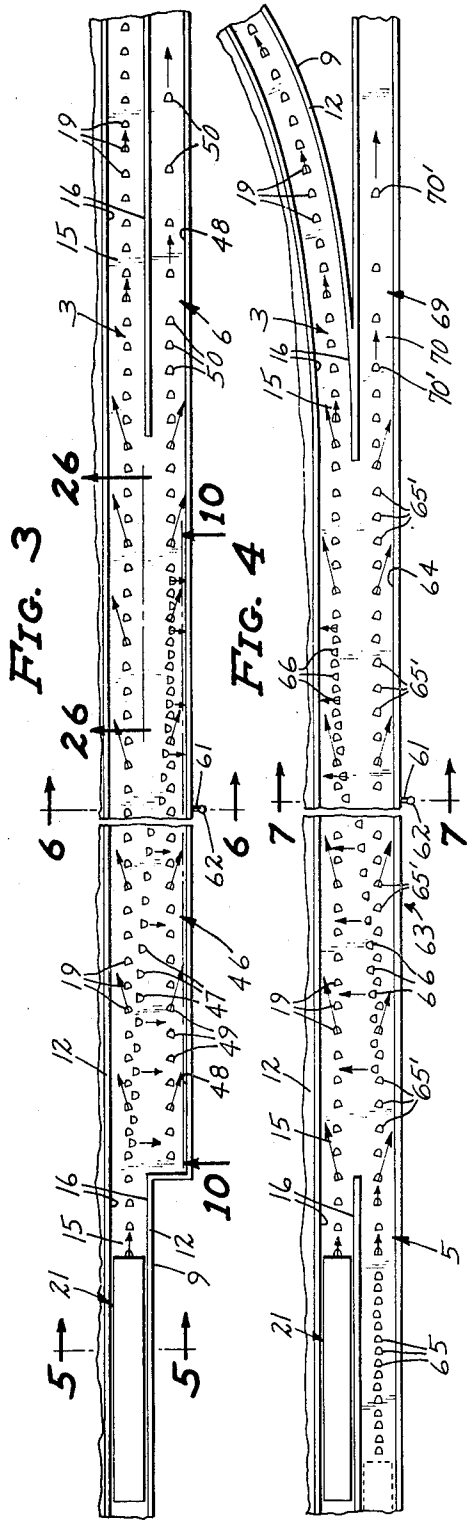

FIG. 3

FIG. 4

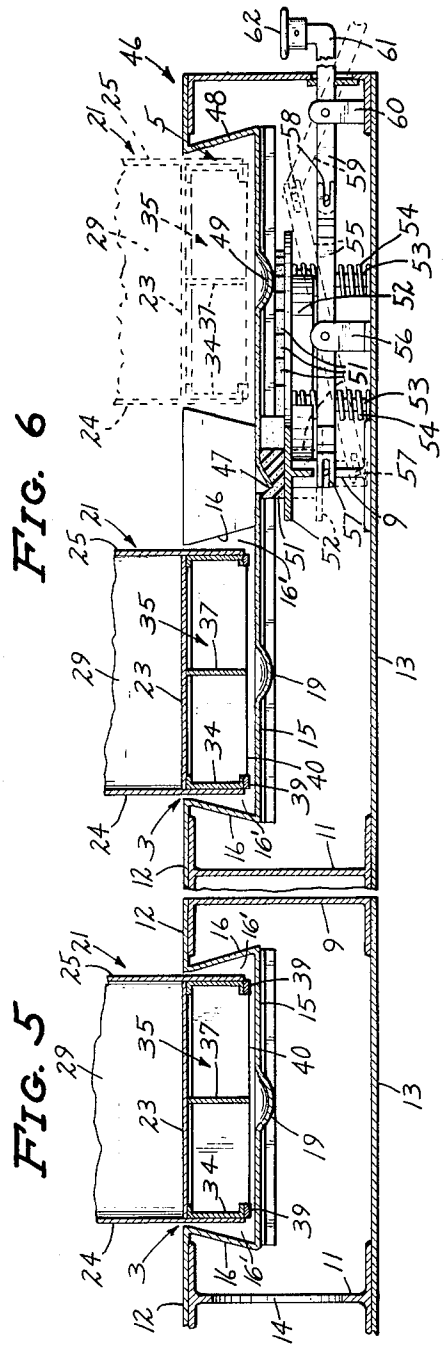

FIG. 6

FIG. 5

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FIG. 7

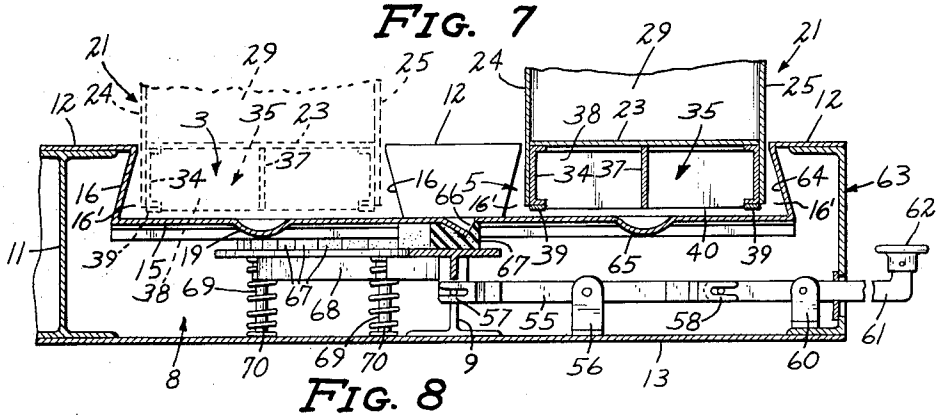


FIG. 8

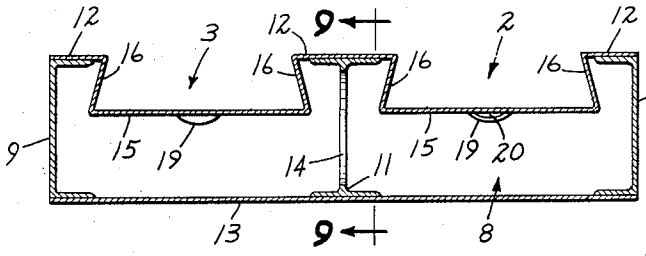


FIG. 31

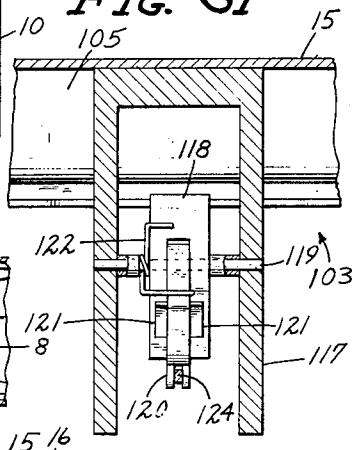


FIG. 9

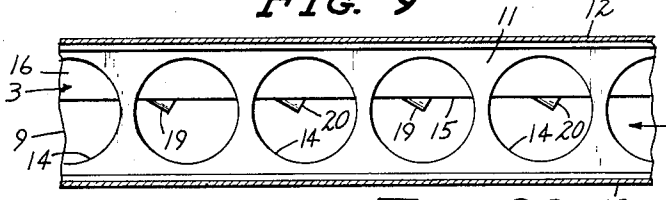


FIG. 29

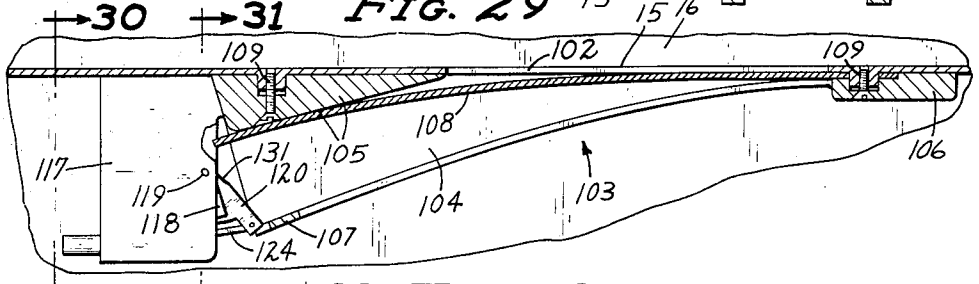
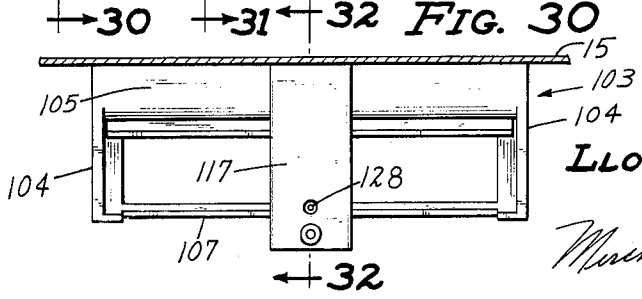


FIG. 30



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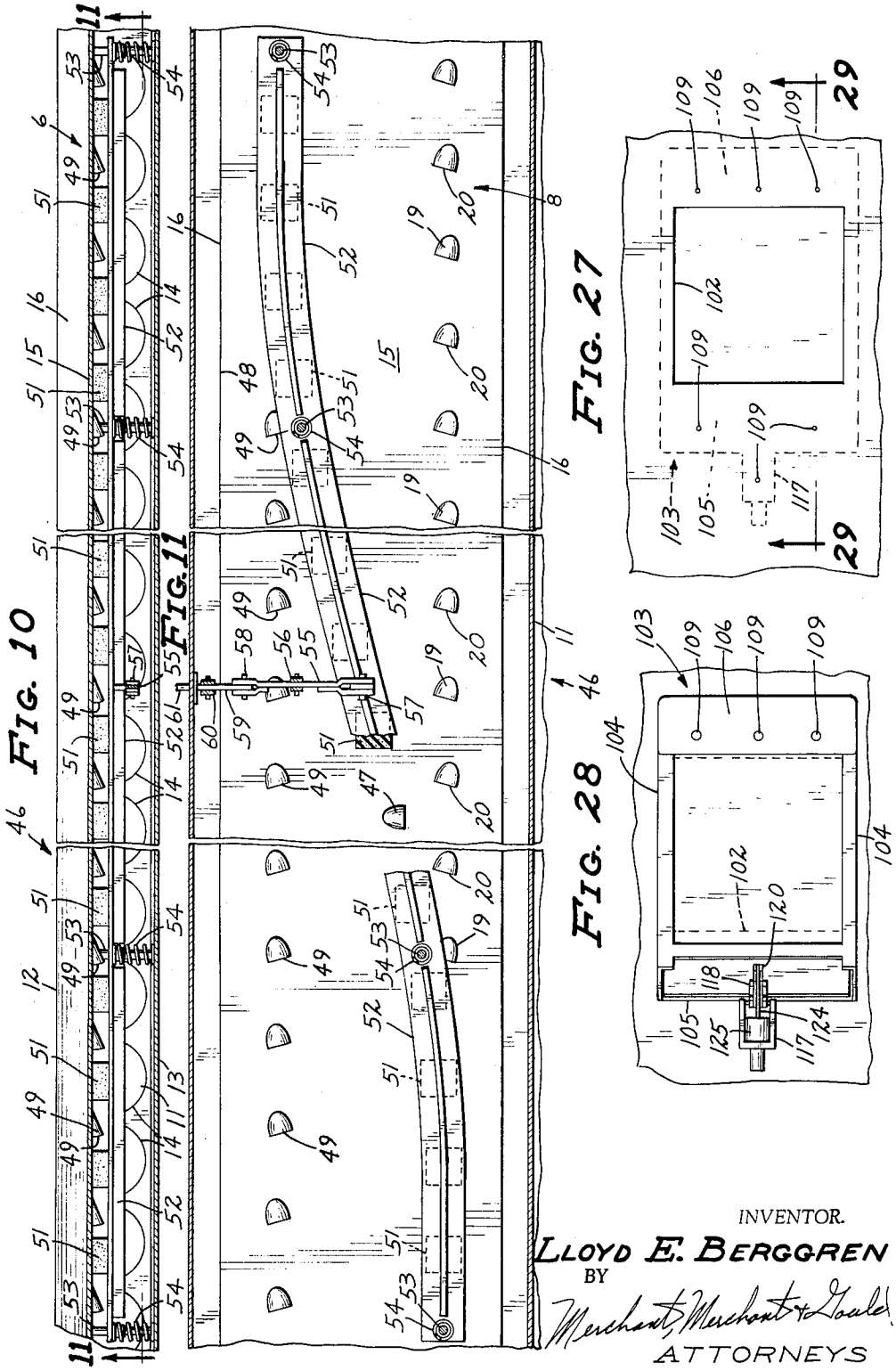

FIG. 10

FIG. 11

FIG. 27

FIG. 28

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FIG. 12

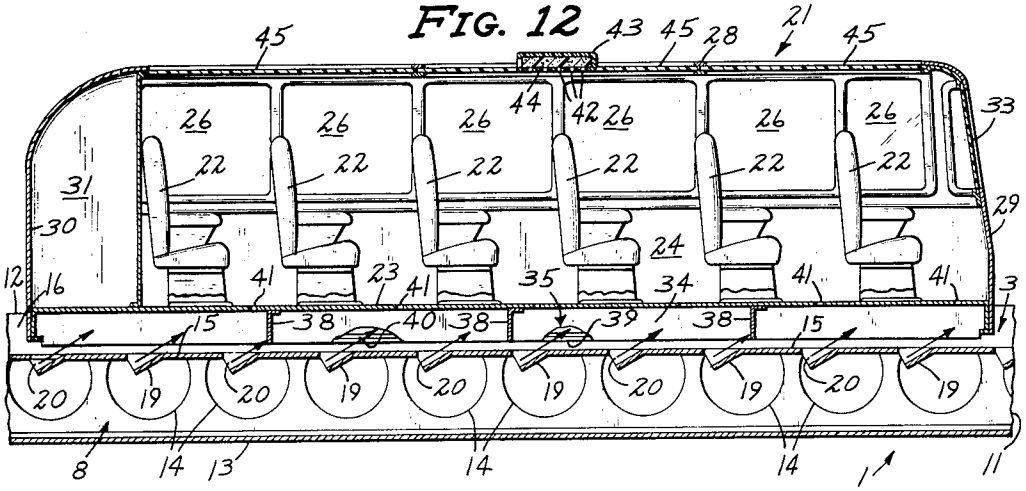


FIG. 13

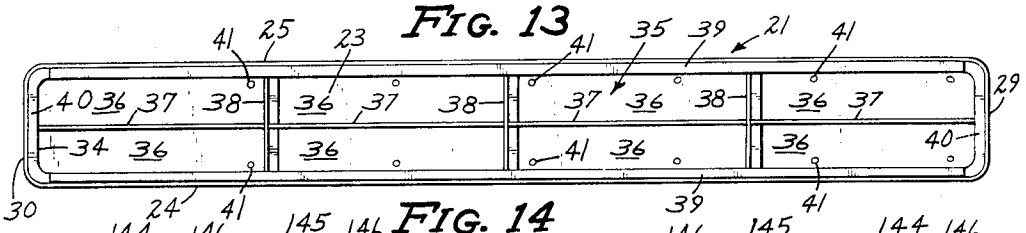


FIG. 14

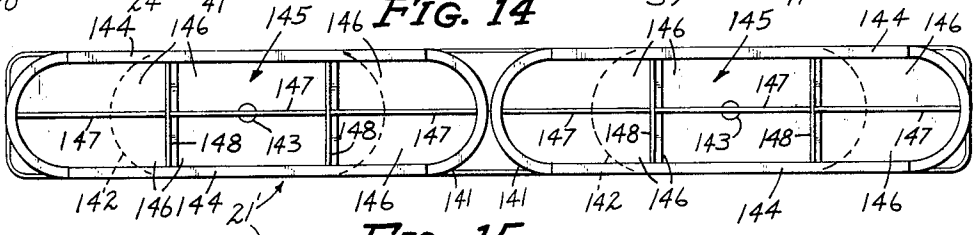


FIG. 15

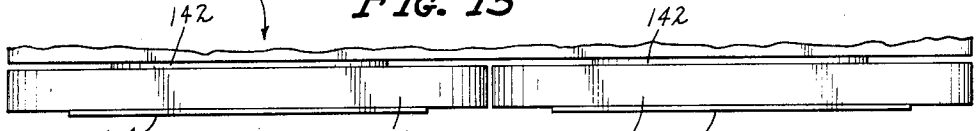


FIG. 16

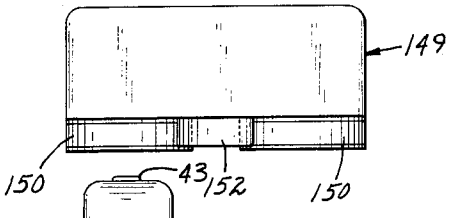


FIG. 17

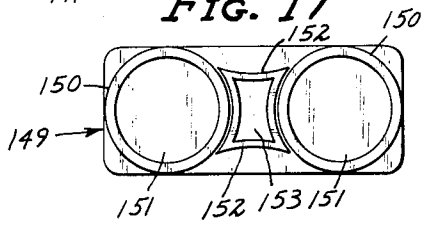
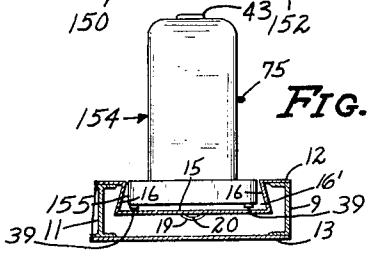


FIG. 18



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PNEUMATIC PROPULSION TRANSPORATION SYSTEM

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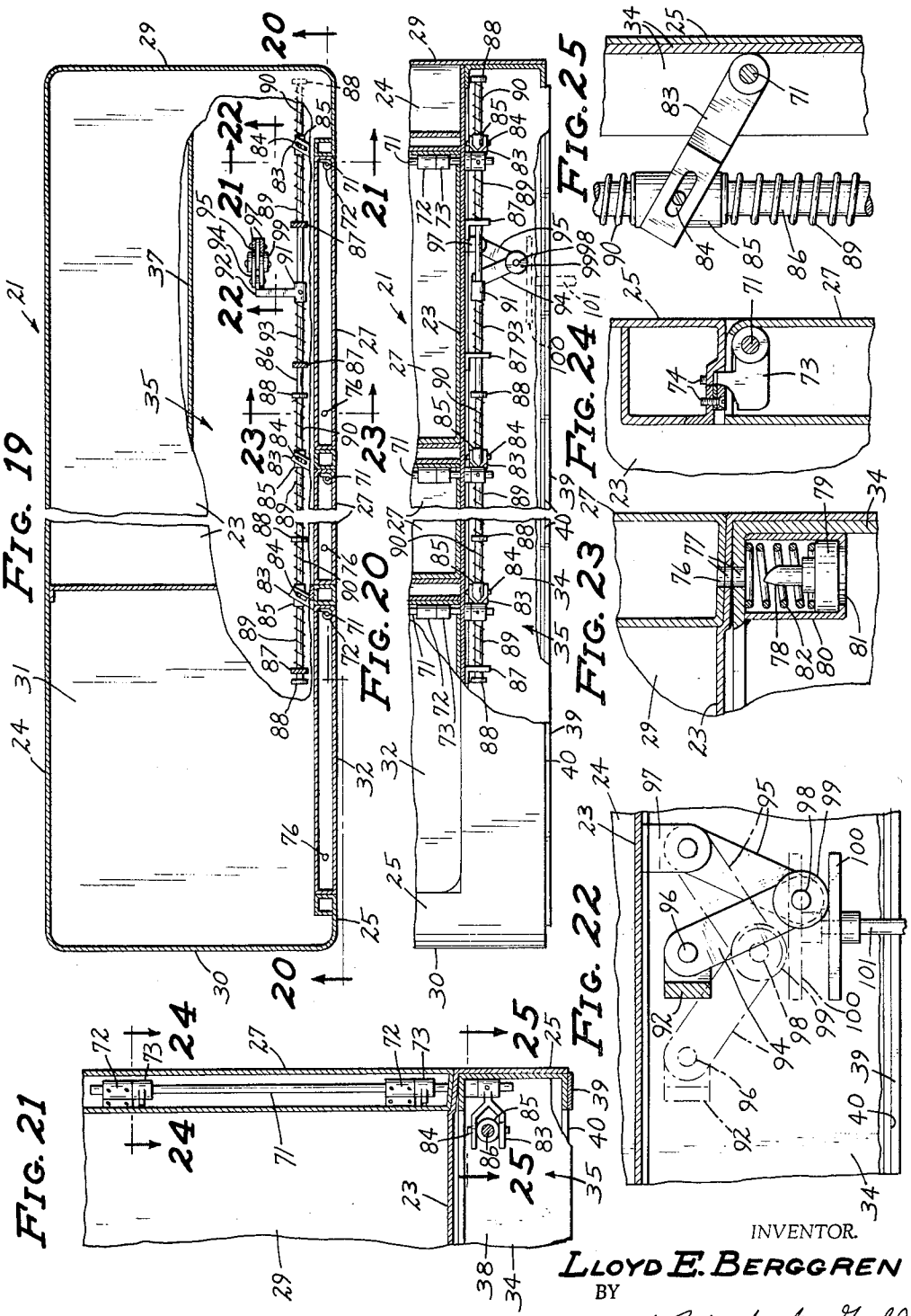

FIG. 19

FIG. 20

FIG. 21

FIG. 22

FIG. 23

FIG. 24

FIG. 25

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March 29, 1966 L. E. BERGGREN 3,242,876

PNEUMATIC PROPULSION TRANSPORATION SYSTEM

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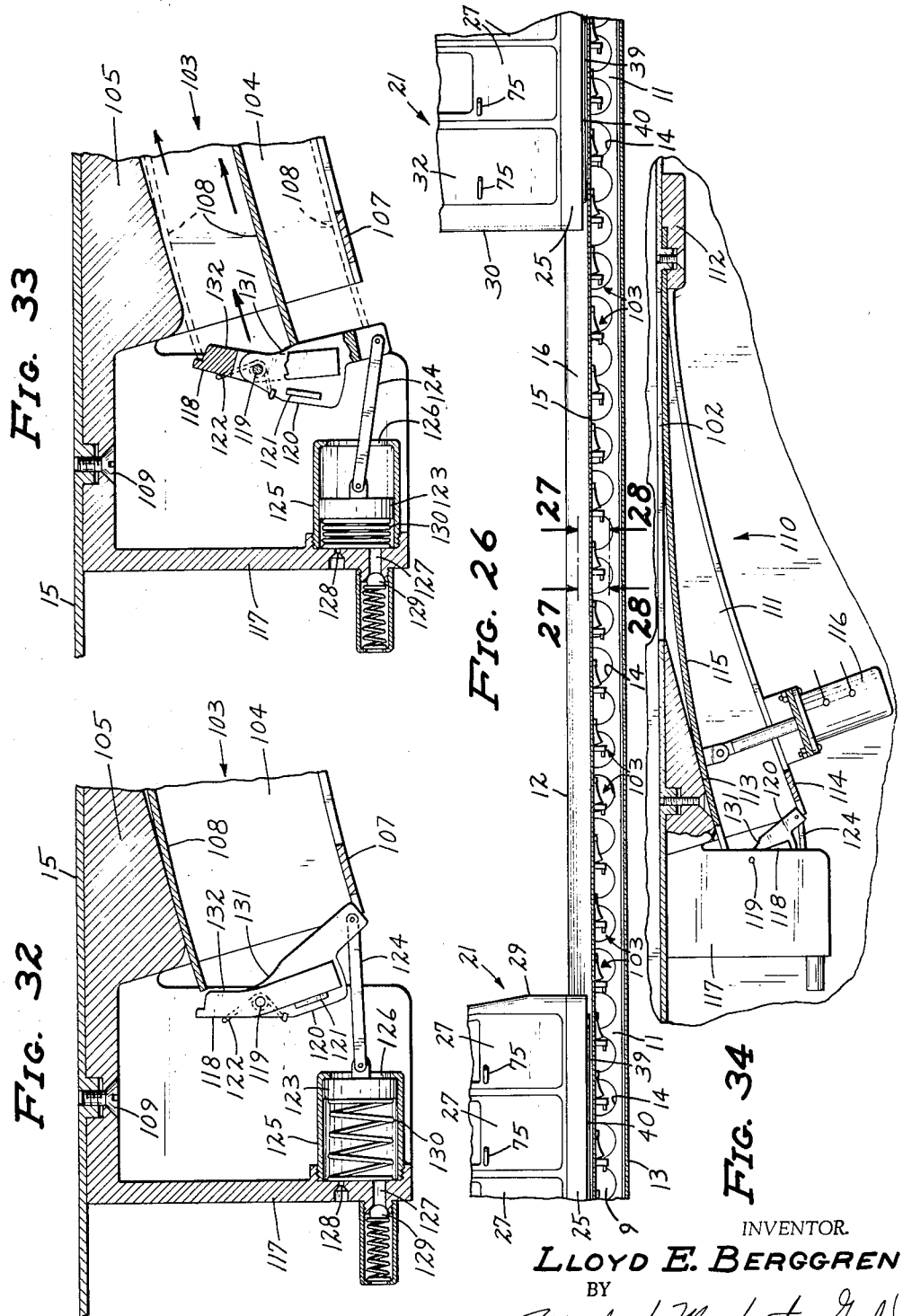

FIG. 33

FIG. 32

FIG. 26

FIG. 34

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FIG. 35

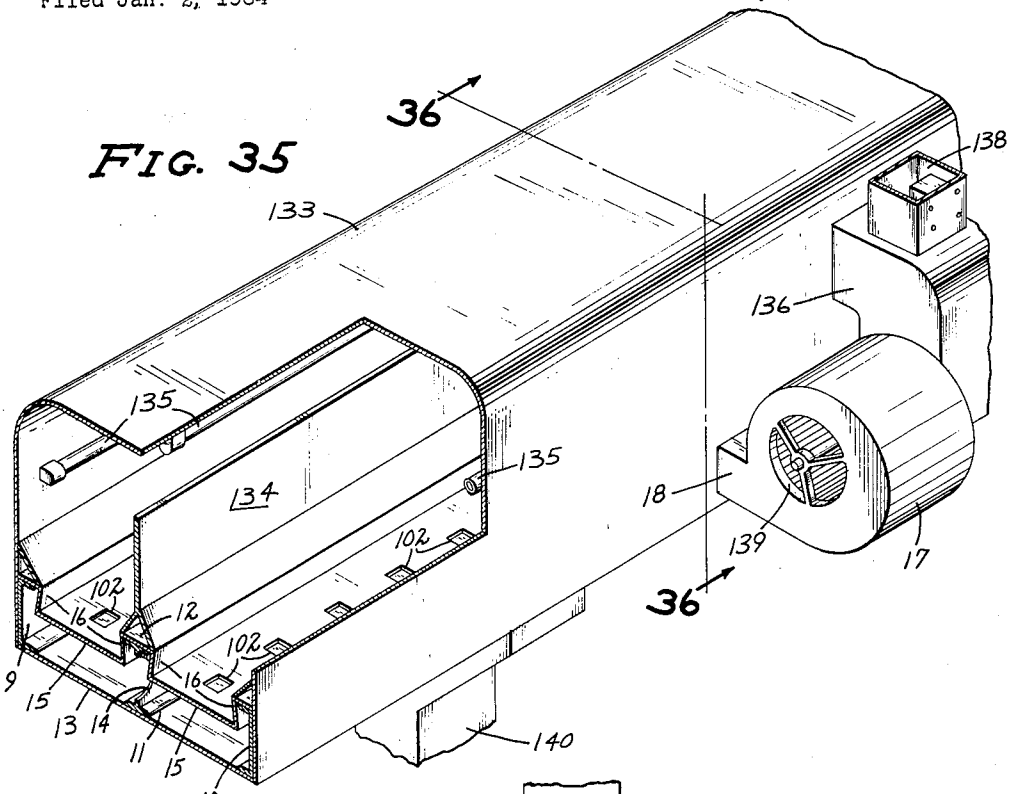
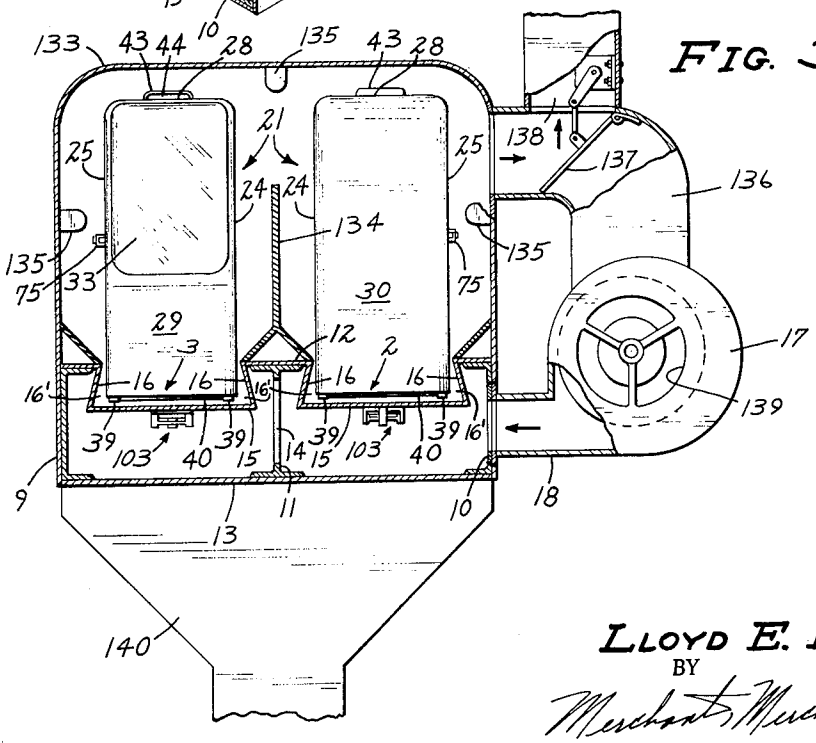


FIG. 36



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March 29, 1966 L. E. BERGGREN 3,242,876

PNEUMATIC PROPULSION TRANSPORATION SYSTEM

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FIG. 37

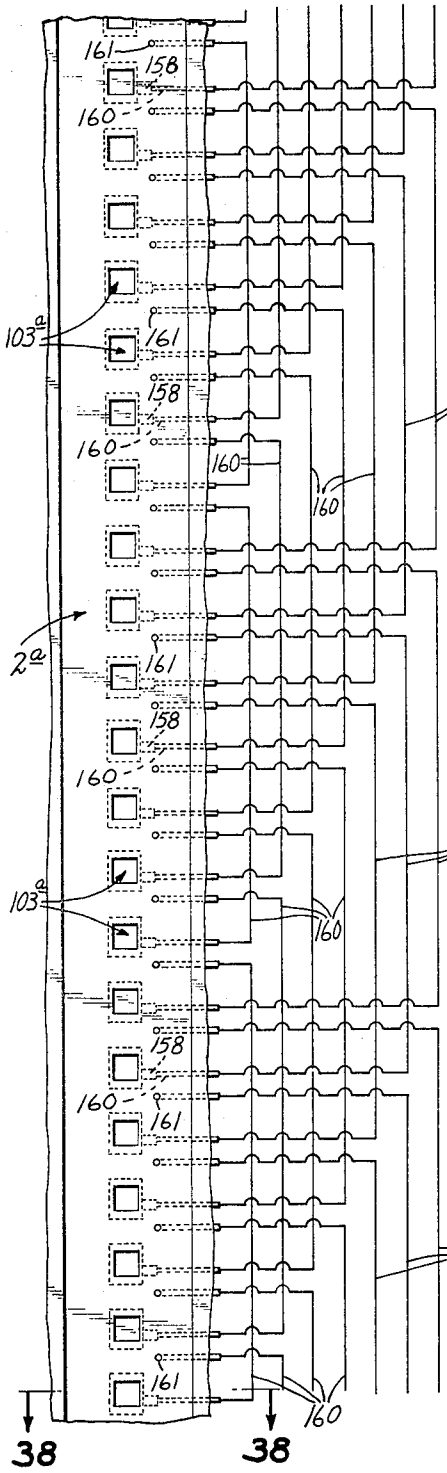


FIG. 38

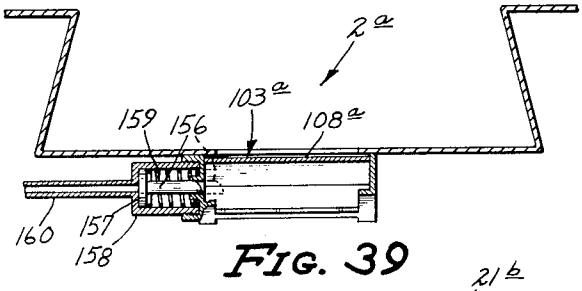


FIG. 39

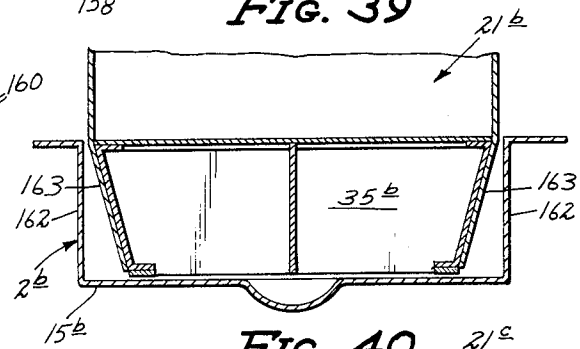


FIG. 40

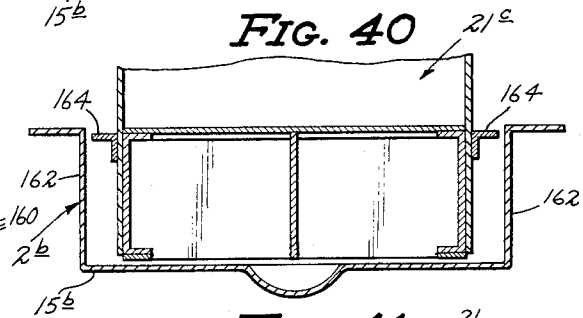
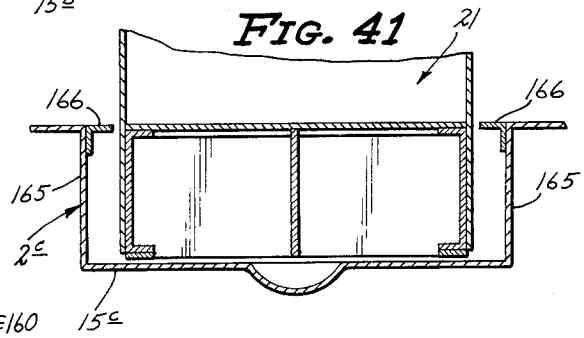


FIG. 41



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United States Patent Office 3,242,876 Patented Mar. 29, 1966

3,242,876

PNEUMATIC PROPULSION TRANSPORTATION SYSTEM

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Filed Jan. 2, 1964, Ser. No. 335,157
23 Claims. (Cl. 104—134)

My invention relates generally to rapid transit systems and more particularly to a pneumatic propulsion mass transportation.

More specifically, this invention utilizes the ground effect principle in supporting and propelling transport vehicles, and has for one of its primary objects the provision of a transportation system that is highly efficient in transporting loads or passengers to given destinations in a minimum of time and with a maximum of safety.

Another important object of my invention is the provision of novel means for levitating and propelling a transport vehicle.

Still another object of my invention is the provision of a transportation system in which a vehicle is disposed in a guideway, and of novel guideway construction which incorporates an air duct extending longitudinally of the guideway for passage of air utilized in levitating and propelling the vehicle.

Another object of my invention is the provision of a transportation system as set forth, in which air under pressure to levitate and propel the vehicle is supplied from stationary sources spaced from the guideway.

Another object of my invention is the provision of a transportation system which is adapted for use either on the ground surface, elevated above the ground, or disposed below ground level, as a subway, with equal facility.

Another object of my invention is the provision of a vehicle which requires no propulsion mechanism, fuel, or controls therein for effecting movement thereof.

Another object of my invention is the provision of means for supplying ventilation to said vehicle during movement thereof.

Another object of my invention is the provision of novel means for automatically controlling a supply of air under pressure to levitate and propel vehicles on the guideway, whereby to compensate for load variations in said vehicles.

Yet another object of my invention is the provision of means for automatically maintaining a predetermined spaced relationship between a plurality of independent vehicles longitudinally of the guideway.

Another object of my invention is the provision of a system having a loading and unloading station area laterally displaced from the main line of travel, and of novel means for moving a vehicle into said station area from said main line of travel and from the station area to said main line.

Another object of my invention is the provision of a pneumatic propulsion mass transportation system which can be built, operated and maintained at relatively low cost, and which is highly efficient in operation, rugged in construction and durable in use.

To the above ends, I provide a wall structure defining an elongated cross sectionally generally U-shaped guideway having opposed side walls and a bottom wall and a longitudinally extending air duct underlying said guideway, and one or more transport vehicles having bottom portions disposed in the guideway for movement of the vehicles longitudinally of the guideway. The bottom portion of each vehicle cooperates with the guideway bottom wall to define a plenum, the guideway bottom wall having longitudinally spaced conduit portions in the nature of jet openings therethrough for

movement of air under pressure from the duct to the guideway. Air under pressure is supplied to the duct from a suitable source, such as one or more blowers, and the jet openings are disposed to direct air from said duct in directions to levitate the vehicle or vehicles and propel the same in a given direction longitudinally of the guideway, the vehicle being devoid of individual propulsion motors and related mechanism. Means in the nature of valves are further provided for controlling movement of air through said openings, whereby to limit passage of air from the duct to the guideway to control speed of the vehicles and the minimum spacing between adjacent ones of said vehicles longitudinally of the guideway.

The above, and still further highly important objects and advantages of my invention will become apparent from the following detailed specification, appended claims and attached drawings.

Referring to the drawings, which illustrate the invention, and in which like reference characters indicate like parts throughout the several views;

FIG. 1 is a view in plan, partly diagrammatic, of a transportation system produced in accordance with my invention, some parts being broken away;

FIG. 2 is an enlarged fragmentary view in perspective of a transport vehicle disposed in a portion of the guideway of FIG. 1, some parts being broken away and some parts being shown in section;

FIG. 3 is an enlarged view corresponding to a portion of FIG. 1 showing a vehicle extraction or deceleration area of the guideway of my invention adjacent a station area thereof;

FIG. 4 is an enlarged view corresponding to a portion of FIG. 1 and showing a vehicle insertion or acceleration area adjacent the station area;

FIG. 5 is an enlarged fragmentary section taken substantially on the line 5—5 of FIG. 3;

FIG. 6 is an enlarged transverse section taken on the line 6—6 of FIG. 3, with some parts added and some parts being broken away;

FIG. 7 is an enlarged transverse section taken substantially on the line 7—7 of FIG. 4, with some parts added and some parts being broken away;

FIG. 8 is an enlarged transverse section taken substantially on the line 8—8 of FIG. 1;

FIG. 9 is a fragmentary longitudinal section taken on the line 9—9 of FIG. 8;

FIG. 10 is an enlarged fragmentary vertical section taken substantially on the line 10—10 of FIG. 3;

FIG. 11 is a view partly in horizontal section and partly in bottom plan, taken on the line 11—11 of FIG. 10;

FIG. 12 is an enlarged fragmentary vertical section taken on the line 12—12 of FIG. 2;

FIG. 13 is a view in bottom plan of the vehicle of FIGS. 2 and 12;

FIG. 14 is a view corresponding to FIG. 13, but showing a modified form of plenum defining wall portion of the vehicle;

FIG. 15 is a fragmentary view in side elevation of the bottom portion of a vehicle incorporating the structure of FIG. 14;

FIG. 16 is a view in side elevation of a further modified form of vehicle;

FIG. 17 is a view in bottom plan of the vehicle of FIG. 17;

FIG. 18 is a view corresponding generally to FIG. 5 but showing a further modified form of vehicle, on a reduced scale;

FIG. 19 is an enlarged fragmentary view, partly in plan and partly in horizontal section, taken substantially

on the line 19—19 of FIG. 2, some parts being broken away and some parts removed;

FIG. 20 is a fragmentary view, partly in elevation and partly in section, taken substantially on the line 20—20 of FIG. 19;

FIG. 21 is a vertical section taken substantially on the line 21—21 of FIG. 19, on an enlarged scale;

FIG. 22 is an enlarged fragmentary view partly in elevation and partly in vertical section, taken substantially on the line 22—22 of FIG. 19;

FIG. 23 is an enlarged fragmentary vertical section taken on the line 23—23 of FIG. 19;

FIG. 24 is an enlarged fragmentary horizontal section taken on the line 24—24 of FIG. 21;

FIG. 25 is an enlarged fragmentary view, partly in plan and partly in horizontal section, taken on the line 25—25 of FIG. 21;

FIG. 26 is an enlarged fragmentary longitudinal section taken on the line 26—26 of FIG. 3 with portions of a pair of spaced vehicles added, and showing valve equipped air openings for levitating and propelling the vehicles;

FIG. 27, sheet 4, is an enlarged fragmentary view in top plan, as seen from the line 27—27 of FIG. 26;

FIG. 28 is an enlarged fragmentary view in bottom plan, as seen from the line 28—28 of FIG. 26;

FIG. 29, sheet 3, is an enlarged fragmentary section taken on the line 29—29 of FIG. 27;

FIG. 30, sheet 3, is a view partly in elevation and partly in transverse section, taken on the line 30—30 of FIG. 29;

FIG. 31, sheet 3, is an enlarged transverse section taken on the line 31—31 of FIG. 29;

FIG. 32, sheet 7, is an enlarged fragmentary section taken on the line 32—32 of FIG. 30;

FIG. 33, sheet 7, is a view corresponding to FIG. 32 but showing a different position of some of the parts;

FIG. 34, sheet 7, is a view corresponding to FIG. 29, but showing a modified arrangement;

FIG. 35 is a fragmentary view in perspective of a portion of the transportation system of my invention, including an enclosure through which the vehicles of my invention travel;

FIG. 36 is an enlarged fragmentary transverse section taken substantially on the line 36—36 of FIG. 35;

FIG. 37 is a diagrammatic view of a guideway showing an interlock arrangement for the valves of FIGS. 27–32;

FIG. 38 is a fragmentary transverse section of the guideway, taken on the line 38—38 of FIG. 37; and

FIGS. 39, 40, and 41 are views corresponding generally to FIG. 5, but showing modified forms of vehicle and guideway structure.

Referring with greater detail to the drawings, and with special reference to FIGS. 1–13, thereof, a right-of-way 1 is shown as comprising a pair of elongated guideways 2 and 3 disposed in side-by-side relationship as shown in FIG. 1, a portion of each guideway 2 and 3 being laterally extended to provide a station area 4 and acceleration and deceleration areas 5 and 6 respectively, at opposite ends of their respective station areas 4, said station areas 4 including loading platforms 7, shown diagrammatically in FIG. 1. It will be appreciated that, while FIG. 1 shows a right-of-way in the form of a single double-tracked loop having a single station 4, it is intended that the system will involve as many guideways 2 and 3 as well as station areas 4 as required in a given transportation complex or system.

The guideways 3 and 4 are defined by wall structure which cooperates to define conduit means including a duct 8 underlying the guideways 3 and 4 and extending longitudinally substantially the entire length of the right-of-way 1. In the embodiment of the invention illustrated, the wall structure includes a pair of opposed side members 9 and 10, preferably in the form of structural steel channels, a central support member 11 extending longitudinally of the guideways 2 and 3, and upper and lower walls 12 and 13. The central support member 11 is preferably in the nature of structure I-beams having longitudinally spaced openings 14 for free passage of air therethrough. The upper and lower wall members 12 and 13, the channels 9 and 10 and I-beams 11 may be rigidly secured together by any suitable means, such as welding or the like. Specifically, the upper member 12 is formed to define the guideways 2 and 3, said guideways each having a generally horizontally disposed bottom wall 15 and laterally spaced side walls 16, the side walls 16 of each guideway being disposed in planes which converge upwardly, see particularly FIGS. 2 and 5–8. Air in the duct 8 is maintained under predetermined pressure by blowers or the like 17 having their outlet portions connected at spaced intervals along the right-of-way 1 by conduits or the like 18, the blowers 17 being driven by suitable and well-known means, not shown. Communication is had between the duct 8 and guideways 2 and 3 by conduit portions in the nature of downwardly deformed portions 19 which define jet openings 20 in the bottom walls 15 of the guideways 2 and 3, and which direct air under pressure from the duct 8 angularly upwardly and forwardly in the direction of desired travel of vehicles disposed in the guideways 2 and 3.

For the purpose of the present example, a preferred form of vehicle is shown in FIGS. 2, 5–7, 12, 19–26 and 36, and is indicated in its entirety by the reference numeral 21. It will be understood that as many vehicles 21 as required for adequate transportation will be provided in a given system, two thereof being shown fragmentarily in FIGS. 26 and 36. Preferably, the vehicles are generally rectangular, the vehicle shown being in the nature of a passenger conveyance having a plurality of passenger seats 22 therein, each seat preferably having capacity for one passenger. Such an arrangement permits the use of a vehicle which is quite narrow with a minimum of frontal area and providing a minimum wind resistance when the vehicle is in motion. The body of the vehicle 21 comprises a bottom wall 23, opposed sides 24 and 25, the former of which is equipped with windows 26 and the latter of which is provided with window-equipped doors 27, one adjacent each seat 22, a top wall 28, and front and rear walls 29 and 30 respectively. In the form of vehicle shown, access is had to a baggage compartment 31 rearwardly of the rearmost seat 22 by a door 32, and the front wall 29 is provided with a conventional windshield 33 of glass or other transparent material.

The front, rear and side walls of the vehicle 21 extend below the level of the bottom wall 23 thereof, and, together with the bottom wall or floor 23, are reinforced by a peripheral frame 34 preferably made from structural channel members or the like. The bottom wall 23 and frame 34 cooperate with the underlying portion of the bottom guideway wall 15 to define a plenum 35 that is divided into a plurality of compartments 36 by vertically disposed longitudinal and transverse partition elements 37 and 38 respectively, said partition elements being welded or otherwise rigidly secured to the bottom wall 23 and frame 34. Elongated skids or brake shoes 39 of suitable material are bonded or otherwise rigidly secured to the bottom surface 40 of opposite side portions of the frame 34 for engagement with the guideway bottom wall 15, as will hereinafter become apparent. The bottom wall 23 is provided with a plurality of air inlet openings 41, the top wall 28 having air outlet openings 42 therein which underlie a hood or the like 43 which, if desired, houses a porous filter element 44. It will be here noted that the top wall 28 may, if desired, comprise a plurality of panels 45 of rigid transparent or translucent material for transmission of light from the exterior of the vehicle 21 to the interior thereof, in cooperation with the windows in the front and side walls of the vehicle 21. It will be noted that a small amount of the air under pressure introduced to the plenum 35 from the duct 8 through the jet

openings 20, will be forced upwardly through the inlet openings 41 to the interior of the vehicle 21 to ventilate the same, the air circulating upwardly through the interior of the vehicle and escaping outwardly through the outlet openings 42.

Assuming that air in the duct 8 is substantially at atmospheric pressure, the vehicle 21 will be stationary, the skids or shoes 39 resting on the guideway bottom wall 15. Energization of the blowers or compressors 17 raises the pressure of air in the duct 8 and plenum 35 to levitate the vehicle 21. The deformed portions 19 of the guideway bottom wall 15, defining the jet openings 20, are so angularly displaced from the generally horizontal plane of the guideway bottom wall 15, that the jets of air moving through the jet openings 20 impart propelling force to the vehicle 21 in a forward direction longitudinally of the guideway in which the vehicle is disposed. By dividing the plenum 35 into a series of longitudinally spaced compartments, with the use of the transverse partition elements 38, longitudinal pitch stability of the vehicle is achieved. Should one end of the vehicle be more heavily loaded than the other end, a pressure build-up will occur at the loaded end due to the fact that escape of air from the plenum compartments 36 at the more heavily loaded end of the vehicle is not as rapid as that at the opposite end. This pressure build-up at the loaded end will tend to raise the loaded end of the vehicle, and a condition of fore and aft stability will be reached. It will be appreciated that a non-uniformly loaded vehicle will always tend to slope downwardly toward the loaded end thereof. However, by utilizing the transverse partitions 38, this slope is minimized. In like manner, the longitudinal partitions 37 aid materially in achieving roll stability in the vehicle. The guideways 2 and 3, being wider at their bottom portions than at the top portions thereof by virtue of the upwardly and inwardly sloping side walls 16, permit limited roll of the vehicle on its longitudinal axis. However, should the vehicle begin to roll on its longitudinal axis in one direction or the other laterally of the line of travel, the plenum compartments 36 at one side of the longitudinal partitions 37 raise relative to the plenum compartments 36 at the opposite side of the partitions 37, creating a pressure differential therebetween. This raising of the compartments 36 at said one side of the partitions 37 causes a rise in pressure in the space between the adjacent side wall 16 of the track and the raised side of the vehicle plenum portion; and this rise in pressure, together with said pressure differential between the plenum compartments at opposite sides of the longitudinal partitions 37 immediately rolls the vehicle back to a state of equilibrium. Yaw, or lateral sway, is held to a minimum and quickly eliminated by the pressure of air in the spaces 16' between the sides of the plenum and the adjacent side walls 16 of the guideway. Should yaw, or turning of the vehicle on a vertical axis, occur, a differential in pressure is created in the spaces 16' between the front and rear end portions of the vehicle. The tendency of the pressure to be equalized over the length of the vehicle causes the vehicle to immediately center itself in the guideway and to establish and hold a parallel relationship therewith. For the purpose of minimizing frictional contact between the sides of the vehicle and the upper side portions of the side walls 16 of the guideways, the guideways may be super elevated or banked as is common practice with highways and railroad beds. Further, if desired, the vehicle or vehicles 21 may be provided with skids or slippers, not shown, at the opposite sides thereof for engagement with the upper portions of the guideway side walls 16 to limit yaw or lateral movement of the vehicle in the guideway.

Assuming that air is delivered from the compressors 17 to the duct 8 at a constant volume and pressure, and that all of the vehicles 21 traveling in the guideways 2 and 3 are of substantially the same weight, the vehicles will travel in the guideways at substantially equal speeds. Hence, in order that any given vehicle might be brought to a stop at a given station area 4 without being struck by a succeeding vehicle, the deceleration areas 6 are laterally offset from their respective main line guideways 2 and 3 and include extraction area portions 46 which are extensions of the deceleration areas 6, see FIGS. 1, 3, 6, 10, and 11. At the deceleration area portions 46, the width of the guideways 2 and 3 is increased to slightly more than twice the normal width thereof, and the bottom guideway wall is formed to provide jet openings 47 which are disposed to direct jets of air transversely away from the main line of the guideways 2 and 3, as shown by arrows in FIGS. 3 and 6. As shown, the openings 47 are disposed in a row that extends at an oblique angle to the row of jet openings 20 toward the deceleration areas 6 and station area 4. It will be noted, with reference to FIGS. 1 and 3, that the outer side walls of the guide tracks 2 and 3 are removed at the extraction portions of their respective deceleration areas to permit lateral displacement of the vehicles 21. The deceleration areas 6 and their extraction portions 46 are provided with side walls 48 which limit lateral movements of the vehicles 21 in directions away from the main line of the guideways 2 and 3. It will be further noted, with particular reference to FIGS. 3 and 11 that the jet openings 20 at the extraction portions 46 are disposed to propel vehicles 21 angularly toward the inner side walls 16 of their respective guideways, to prevent the vehicles from accidentally moving laterally toward the deceleration areas when it is desired to by-pass the adjacent station area 4. At the extraction portions 46, the guideway bottom walls are provided with jet openings 49 that are disposed to propel vehicles 21 angularly toward engagement with the side walls 48, the deceleration areas having other jet openings 50 that direct air to the deceleration areas longitudinally toward their respective station areas 4. It will be noted that the jet openings 50 are spaced progressively further apart from the extraction areas 46 toward their respective station areas 4, whereby the flow of air to the plenums 35 is progressively reduced until levitation of the vehicles ceases, and engagement of the bottom guideway wall 15 in the deceleration area 6 by the brake shoes or skids 39 causes the vehicle 21 to stop at the station area 4.

If desired, some or all of the jets 50 may be disposed to levitate the vehicles only, without imparting forward movement thereto, so that the vehicles may coast on a cushion of air until reaching the station area. Further, if desired, provision may be made for excess thrust in the extraction jets through the jet openings 47 to move the vehicles 21 and hold the same positively against the curb or side walls 48.

The jet openings 47 are normally closed by suitable valve means which, in the embodiment shown, comprise valve blocks 51 mounted on an elongated beam 52 which underlies the bottom wall 15 of the extraction portion of the deceleration area 6. The beam 52 is mounted on a plurality of vertically disposed guide rods 53 and yieldingly urged in a direction to cause closing of the jet openings 47 by coil compression springs or the like 54, see particularly FIG. 10. Mechanism for moving the valve block elements 51 toward a valve open position against bias of the springs 54 involves a lever 55 that is pivotally mounted intermediate its ends to a supporting bracket 56 and which has a pin and slot connection 57 at one end with the beam 52, see particularly FIG. 6. The opposite end of the lever 55 has a pin and slot connection 58 with a second lever 59 pivotally connected at its intermediate portion to a supporting bracket or the like 60, the opposite end 61 of the lever 59 being adapted to be connected to suitable operating mechanism, not shown, for imparting valve opening movements

to the lever 59. In the embodiment shown in FIGS. 1, 3 and 6, the outer end portion 61 of the lever 59 is provided with a button, treadle or the like 62 for manual operation, if desired. While but a single set of valve block elements 51, mounting beam 52 therefor, and operating mechanism is shown in FIGS. 6, 10 and 11, it will be understood that the extraction portions of both deceleration areas are provided with such valve block elements and operating mechanism therefor. Thus, when it is desired to bring a given vehicle into a given station area, it is only necessary that the appropriate button 62 be depressed and held depressed until the vehicle has been shifted away from the main line, after which the button is immediately released to permit a following vehicle to continue along the main line of its respective guideway 2 or 3.

Each acceleration area 5 includes a vehicle insertion area portion 63 that is similar to but substantially a reversal of the extraction portions 46 of the deceleration areas 6. As shown in FIGS. 1 and 4, a portion of the outer guideway side wall 16 is removed and the bottom guide wall 15 is laterally extended to an outer side wall 64. Also, as with the extraction section, the jet openings 20 in the insertion portion of the acceleration area are disposed to direct air under pressure from the underlying duct 8 toward the inner side wall 16 of the main line of the guideways 2 and 3. The guideway bottom wall in the acceleration area is formed to provide jet openings 65 that are spaced relatively closely together whereby to accelerate movement of a vehicle leaving the adjacent station area 4 to the normal speed of vehicle travel before insertion is made thereof to the main line of travel. At the insertion portion 63, the guideway bottom wall 15 is provided with a plurality of jet openings 66 disposed in a row extending obliquely from the acceleration area adjacent the station area toward the main line of travel in the adjacent guideway 2 or 3, the jet openings 66 being disposed to direct flow of air transversely toward said main line of travel, as indicated by arrows in FIGS. 4 and 7. As shown in FIG. 7, flow of air through the insertion jet openings 66 is controlled by a plurality of valve elements 67, one for each of the jet openings 66. The valve elements 67 are carried by an elongated beam 68 mounted on vertically disposed rods 69 and yieldingly urged toward a closed position by springs 70. The beam 68 is moved toward a valve open position by mechanism identical to that associated with the valve carrying beam 52, the parts thereof being identified by reference characters identifying like parts in FIG. 6.

When a given vehicle 21 is caused to be propelled to a station area 4, it comes to rest at its respective loading platform 7 for unloading of passengers or freight, and for reloading for transit to the next destination. Means for moving the vehicle from the station area 4 to the pneumatically operated acceleration area 5 comprises a plurality of rollers or the like 68' shown diagrammatically in FIG. 1. Preferably, the rollers 68' are power driven by suitable means, not shown, and are held against rotation by conventional braking means such as brake shoes or the like, not shown, when a vehicle thereon is at rest in the station area. Then, when it is desired to move the vehicle from the station area to the pneumatic system, the rollers 68' are caused to rotate in the desired direction to move the vehicle on to the acceleration area. Obviously, a vehicle should not be moved from the station area 4 to the acceleration area 5 until an adequate space between vehicles on a given one of the guideways 2 and 3 exists. Should a vehicle at the station area 4 be inadvertently propelled from the station area on to the acceleration area 5 when insufficient spacing exists between a pair of vehicles approaching on the adjacent main line, the valve elements 67 will not be opened by the operator or operating mechanism, and the vehicle on the acceleration area 5 will be caused to travel along the side wall 64 and into a "fail safe" area 69, see FIGS. 1 and 4. The "fail safe" area 69 is similar to the guideways 2 and 3, the bottom wall 70 thereof being an extension of the wall 15 of the acceleration area 5, and having jet openings 70' that are progressively spaced further apart longitudinally outwardly from the insertion portion of the acceleration area, whereby to gradually decrease the volume of air under the vehicle thereon so that the skids 39 engage the bottom wall 70 and the vehicle slides gradually to a stop at a portion of the fail safe area having no jet openings. As shown in FIG. 4, jet openings 65' at the insertion portion of the acceleration area 5 are disposed to direct flow of air angularly toward the outer side wall 64 to prevent accidental insertion of the vehicle into the main line. Suitable means, not shown, will be utilized to return the vehicle to the adjacent station area 4 for reinsertion into the system. With this arrangement, collision with vehicles on the main line of the guideways 2 and 3 is avoided.

Means for locking each vehicle door 27 and 32, and for aiding in opening and closing of said doors, are shown in FIGS. 19–25, reference being had thereto. Each door 27 and 32 is rigidly mounted on a different one of a plurality of hinge pintles 71 by means of a pair of hinge elements 72 rigidly secured to the pintles 71 and to respective ones of the doors 27 and 32. As shown particularly in FIG. 21, the hinge elements 72 engage the upper ends of cooperating hinge elements 73 in which the pintles 71 are journalled, the hinge elements 73 being rigidly mounted to adjacent portions of the side wall 25 of the vehicle 21, by mounting screws or the like 74, see FIG. 24. The several doors 27 and 32 are provided with conventional latch means, not shown, for releasably holding the doors closed, the latch means including the usual inner and outer latch handles 75, the outer ones of which are shown in FIGS. 2 and 36.

Each door 27 and 32 is provided in its bottom portion with an aperture 76 that is aligned with a cooperating one of a plurality of apertures 77 in the bottom wall 23 and frame 34 of the vehicle, when the door is closed. A plurality of locking pins 78 are disposed one each in underlying axial alignment with a different one of the apertures 77, one of which is shown in FIG. 23. Each locking pin 78 extends axially upwardly from a cooperating piston 79 that is received in a cylindrical element 80 welded or otherwise rigidly secured to the interior surface of the frame 34, each of said cylindrical elements 80 being provided with openings 81 in the bottom walls thereof. Coil compression springs 82 are interposed between the pistons 79 and the upper ends of their respective cylindrical elements 80 to yieldingly urge their respective locking pins 78 away from their cooperating apertures 77 and 76, whereby to permit their respective doors 27 and 32 to be opened. When a vehicle 11 is disposed in overlying relationship to one or more of any of the jet openings, air under pressure within the plenum 35 imparts upward movement to each of the pistons 79, against yielding bias of the springs 82, to move the locking pins 78 into cooperating aligned apertures 77 and 76 to rigidly lock the doors 27 and 32 against opening movements while the vehicle is in transit. Obviously, when the pressure within the plenum 35 is sufficiently reduced, as when the vehicle is disposed in a station area, the springs 82 will cause the locking pins 78 to be retracted from the apertures 76 and 77, permitting opening of the doors 27 and 32.

Rigidly secured to the lower end of each pintle 71 for common pivotal movements therewith is one of a plurality of bifurcated crank arms 83 that have pin and slot connections 84 with individual sleeves or collars 85 axially slidably mounted on an elongated shaft 86, see particularly FIGS. 19—21 and 25. The shaft 86 extends longitudinally of the plenum 35 and is mounted for longitudinal sliding movements in brackets or the like 87 welded or otherwise rigidly secured to the bottom wall 23 of the vehicle 21. A plurality of abutment collars or the like 88 are rigidly secured to the shaft 86 in axially spaced rela-

tionship, and coil compression springs 89 and 90 are arranged in cooperating pairs on the shaft 86. The arrangement is such that each spring 89 is interposed between a different one of the sleeves 85 and an adjacent bracket 87, whereas each of the springs 90 is interposed between a different one of the sleeves 85 and one of the abutment collars 88, the springs 89 and 90 loosely encompassing the shaft 86. Preferably, the springs 90 are heavier than the springs 89 and exert greater force when compressed. Further, when the doors 27 and 32 are closed, and the shaft 86 moved to its limit of movement in a direction to the right with respect to FIGS. 19 and 20, the springs 89 are in a lightly compressed condition, whereas the springs 90 are in a substantially neutral state. Movement of the shaft 86 to the left with respect to FIGS. 19 and 20 causes the springs 90 to be compressed to urge the doors 27 and 32 in a door-opening direction. Hence, when a given door latch is released, its respective door 27 or 32 will automatically open to an extent wherein its respective springs 89 and 90 reach a state of equilibrium. Preferably, when this state of equilibrium is reached, the respective door 27 or 32 will be substantially fully open. It will be appreciated that, the sleeves or collars 85 being slidable on the shaft 86, the shaft 86 does not exert a positive opening force against the unlatched door, but only a yielding force thereagainst. Hence, should an obstruction, such as a person, be standing just outside the door during opening thereof, the likelihood of injury to the person or to the door is minimized. With one or more of the doors 27 and 32 open, movement of the shaft 86 to the right with respect to FIGS. 19 and 20 will release pressure of the collars 88 against their respective springs 90 and permit the springs 89 to bias the doors 27 in a door-closing direction. The yielding force exerted by the springs 89 is such that injury to a person or object in the path of closing movements of an open door 27 or 32 and struck thereby is also minimized.

Means for imparting longitudinal movements to the shaft 86 in opposite directions, is shown in FIGS. 19, 20 and 22, and comprises a shifter collar 91 fast on the shaft 86 and having a rigid arm 92 projecting laterally outwardly therefrom, a coil compression spring 93 interposed between the collar 91 and an adjacent one of the brackets 87 to yieldingly urge the shaft in one direction of its longitudinal movement, and other mechanism now to be described. The outer end of the arm 92 is pivotally connected to one end of one of a pair of toggle links 94 and 95, as indicated at 96, see particularly FIG. 22. One end of the other of the toggle links 94 and 95 is pivotally connected to a bracket 97 that is rigidly secured to the bottom vehicle wall 23, and the adjacent ends of the toggle links 94 and 95 are pivotally connected together by a pivot shaft or the like 98 in which is journalled a roller 99. The roller 99 is adapted to be engaged by a plate-like actuator 100 mounted on the upper end of a push rod 101 for vertical movements. Upward movement of the push rod 101 and actuator plate 100 imparts movement to the toggle links 94 and 95 in a direction to move the shaft 86 against bias of the spring 93 to cause the doors 27 and 32 to be yieldingly urged toward their open positions. The push rod 1 may be assumed to be vertically moved by any suitable operating means, not shown, and it will be appreciated that a separate push rod 101 and actuator plate therefor is provided adjacent each loading platform 7. Inasmuch as the operating mechanism for the push rod 101 does not, in and of itself, comprise the instant invention, showing and description thereof is omitted, in the interest of brevity.

It will be appreciated that a commercial embodiment of the system herein disclosed may involve many miles of guideway and air duct with a correspondingly vast number of jet openings between the duct and overlying guideways. The use of the jet openings as above described, obviously results in the movement of a great deal of air under pressure, a greater part of which is wasted. Hence, I provide each jet opening in the guideways 2 and 3, as well as in the portion of the acceleration and deceleration areas 5 and 6 and fail-safe areas 69 with automatic valve means, now to be described. Referring to FIGS. 26–33, 35 and 36, it will be seen that the bottom guideway walls 15 thereof are provided with jet openings 102 which comprise a portion of the conduit means for the guideways as do valves underlying each of the openings 102 said valves being indicated in their entireties by the reference numeral 103. The valves 103, being identical, but one thereof will be described in detail. The valve 103 comprises a frame-like valve body having opposed side walls 104, a valve seat 105 extending between the side walls 104 at one end portion thereof, a cross member 106 at the opposite end of the side walls 104, and a transverse stop bar 107 in laterally spaced relationship to the valve seat portion 105. A valve element 108, in the nature of a leaf spring, is anchored at one end in the cross member 106, the opposite end portion thereof being movable between the transverse stop member or bar 107 and the overlying valve seat portion 105. The valve 103 is rigidly secured to the bottom guideway wall 15 by screws or the like 109 screw threaded into the cross member 106 and valve seat portion 105, see particularly FIGS. 27 and 29. The valve element 108 is so formed and anchored as to be yieldingly urged toward engagement of its free end with the transverse stop bar 107, and is closed by the differential in air pressure between the duct 8 and the space above the guideway bottom walls 15. When a vehicle 21 passes over the valve 103, the air pressure within the plenum 35, being greater than atmospheric pressure, permits the valve element 108 to move toward its valve open position, as shown by the full lines and lower dotted lines in FIG. 33. The extent to which the valve element 108 moves toward the stop bar 107 is determined by the pressure differential between the duct 8 and overlying plenum 35. It will be noted that the valve engaging seat 105 and the valve element 108, in its open position, slope upwardly and forwardly in the direction of movement of the vehicle 21, whereby to direct air under pressure from the duct 8 to the plenum 35 in directions to levitate and propel the vehicle 21 forwardly in the guideways 2 and 3. As the vehicle moves forwardly away from overlying relationship to the valve 103, the higher pressure differential is immediately restored, moving the valve element 108 upwardly into engagement with its cooperating valve seat 105 to close the valve. Thus, as the vehicle 21 moves along its guideway 2 or 3, the valves 103 open in succession as the vehicle moves thereover and close in succession immediately as the vehicle leaves the space thereabove.

A modified form of the valve 103 is shown in FIG. 34, and is indicated in its entirety by the numeral 110. The valve 110 comprises a valve body having opposed side walls 111, one of which is shown, a cross member 112 at one end, a valve seat 113 at the opposite end, and a transverse stop bar 114 in underlying spaced relation to the valve seat 113. A leaf spring valve element 115, similar to the valve element 108, is yieldingly urged toward a closed position in engagement with the valve seat 113, and is moved to its open position against the stop bar 114 by a conventional solenoid 116. The solenoid 116 may be assumed to be connected in a suitable control circuit, not shown, the control circuit not forming a part of the instant invention. Preferably, a plurality of the valves 110 are used at the beginning of the acceleration areas 5 to initially pressurize the plenum 35 of each vehicle 21 as the vehicle is moved away from the station area. Further, and if desired, a plurality of valves 110 may be substituted for the valve block elements 51 and valve elements 67 and valve operating means therefor, to cause vehicles to be shifted from the

main guideways 2 and 3 to the deceleration areas and from the acceleration areas to the guideways 2 and 3.

In any rapid transit system involving the use of a plurality of vehicles or groups thereof on a single track or guideway, it is highly important that a minimum distance be maintained between said vehicles or groups thereof. This is particularly important in the system of the present invention in which the vehicles themselves are devoid of independent controls for the operation thereof. A minimum spacing between a pair of vehicles on the same guideway must be maintained for safety reasons as well as to give a leading vehicle sufficient time to be shifted from the main right-of-way to the deceleration area, and to re-close the valves governing the shifting of the lead vehicle before a following vehicle reaches the shifting jets—assuming of course, that it is desired that the following vehicle proceed on the right-of-way to a different station. A preferred means for maintaining a given longitudinally spaced relationship between a pair of adjacent vehicles moving along one of the guideways 2 or 3 is shown in FIGS. 27–34 and involves valve locking means associated with each of the valves 103 and, if desired, the valves 110. Each valve 103 is provided with a bracket 117 in which is pivotally mounted a valve engaging latch member 118, by means of a pivot pin or the like 119. A latch actuator 120 is pivotally mounted at one end to the pivot pin 119 and is provided with a latch-engaging bar 121 that is operative to move the latch member 118 in a valve releasing direction responsive to swinging movement of the latch actuator 120 in one direction about the axis of the pivot pin 119. A torsion spring 122 has opposite ends engaging the latch member 118 and actuator 120 and yieldingly urges the latch member 118 toward engagement with the valve 108 and with the latch engaging bar 121. The opposite or free end of the latch actuator 120 is connected to a piston 123 by means of a rigid link 124, the piston 123 being mounted in a cylinder 125 that is rigidly secured to the bracket 117. The link 124 extends into the cylinder 125 through an enlarged opening 126 in one end of the cylinder 125, the opposite end of the cylinder being substantially closed by the bracket 117 except for a relatively large opening 127 and a relatively small opening 128 through the cylinder end wall forming portion of the bracket 117. The relatively large opening 127 is normally closed by a spring pressed ball check valve 129, see FIGS. 32 and 33. The piston 123 is yieldingly urged in a direction to move the latch element 118 out of engagement with the valve element 108 by means of a coil compression spring 130.

With reference to FIG. 32, it will be seen that, when the piston 123 is moved by the spring 130 to the end of the cylinder 125 containing the large opening 126, the latch element 118 is disposed out of engagement with the adjacent end of the valve element 108. During downward opening movement of the latch element 108, the end thereof engages a cam surface or edge portion 131 of the latch actuator 120 and moves the same and the latch element 118 to their positions shown in FIG. 33. Air in the cylinder 125 between the piston 123 and the end wall defined by the bracket 117 is forced outwardly through the larger passage 127 and check valve 129 at a relatively rapid rate. During closing movement of the valve element 108, the free end thereof engages the front surface or edge 132 of the latch element 118 and cams the same rearwardly against bias of the torsion spring 122. When the latch element 108 reaches its closed position shown by the upper dotted lines in FIG. 33, the latch element 118 is yieldingly urged into latching engagement therewith by the torsion spring 122. During closing and latching of the valve element 108, the spring 130 moves the piston 123 toward its position of FIG. 32 the piston moving realtively slowly due to the relatively slow inflow of air to the cylinder 125 through the restricted opening 128. Thus, the valve 108 is locked in a closed position for the time interval required for movement of the piston 123 from its position of FIG. 33 to its position of FIG. 32, the cylinder 125 and piston 123 acting in the manner of a conventional dashpot.

Assuming that the rate of travel of the vehicle 21 in the guideways 2 and 3 is substantially 45 miles per hour or 62 feet per second, and that a minimum distance between said vehicle and a following vehicle is 26 feet, the relatively small opening 128 is so restricted that air will be admitted to the interior of the cylinder 125 at a rate which will require .4 of one second for the piston 123 to move from its position of FIG. 33 to its valve element releasing position of FIG. 32. Hence, should the distance between a pair of traveling vehicles 21 become less than the minimum of 26 feet, the valve element 108 will be held against opening when the following vehicle moves thereover, until the latch element 118 is moved out of engagement with the valve element 108. Thus, the supply of levitating and propelling air to the following vehicle is lessened, causing the following vehicle to decelerate until the minimum spacing therebetween and the preceding vehicle 21 is reached. It will be noted that, during movement of the latch actuator 120 from its position of FIG. 33 to its position of FIG. 32, the latch engaging bar 121 engages the latch element 118 to move the same out of engagement with the valve element 108. It will be further appreciated that, inasmuch as a plurality of valves 103 underlie a vehicle 21 at any given time, the vehicle may be decelerated by means of delayed opening of the valves 103 until the desired vehicle spacing is achieved, without appreciable loss in levitation of the vehicles.

FIGS. 35 and 36 show the right-of-way 1 as being enclosed by an elongated housing or the like 133 which overlies the guideways 2 and 3 to protect the guideways 2 and 3 from the elements, and the vehicles 21 from the effects of crosswinds and the like. Further, to eliminate turbulance within the housing 123, caused by the passing of one vehicle 21 by another thereof moving in the opposite direction on the adjacent guideway, I provide a generally vertically disposed partition 134 that extends longitudinally of the right of way. In order to provide illumination for the passengers in the vehicles 21, I provide conventional tubular lamps 135 that extend longitudinally of the right-of-way and which may be assumed to be disposed at desired space intervals longitudinally within the housing 133. With this arrangement, it is unnecessary to provide the housing 133 with windows or the like for illumination.

By providing the housing 133, the air used to levitate and propel the vehicles 21 along their respective guideways 2 and 3 may be returned to the blowers 17 by means of return ducts 136. If desired, the ducts 136 may be provided with valves 137 for controlling the percentage of air exhausted from within the housing 133 and returned to the fan 17. The valve or damper 137 may be moved to direct all of the air exhausted from within the housing 133 to the fan 17 or, selectively, to direct all or any portion of the exhausted air through an outlet 138 to atmosphere. For colder weather, suitable heating means, not shown, may be utilized in the blower system, to supply warm air to the enclosed right-of-way 1. When heated air is required, the damper or dampers 137 will preferably be moved to close the outlet 138 and permit re-circulation of the heated air through the entire system. It will be noted, with reference to FIGS. 35 and 36, that the blower 17 is provided with a second inlet opening 139 which may be partially or wholly closed by well-known means, not shown, preferably in cooperation with opening and closing movements of the valve or damper 137, to properly regulate the relative quantities of fresh and recirculated air through the system.

As shown in FIGS. 35 and 36, the entire structure may be elevated from ground level and supported by means of suitable pillars or like supporting structure 140 or, if desired, the system may be disposed at ground level, with the lower duct forming member 13 resting on the ground or on a suitable foundation. It will be further appreciated,

as above mentioned, that the entire right-of-way may be produced as an underground installation, as conditions require.

As shown in FIGS. 14–18, the plenum of a given vehicle **21** may be produced in various shapes. In the modified form shown in FIGS. 14 and 15, the vehicle is indicated generally at **21'**, said vehicle **21'** having a pair of longitudinally spaced frames **141** journalled in wearing plates or the like **142**, as indicated at **143** for pivotal movements on vertical axes. The frames **141** are provided with skid rails **144** and define plenums **145** that are divided into plenum compartments **146** by longitudinal and transverse partitions **147** and **148** respectively, similar to the partitions **37** and **38** respectively. The use of a pair of plenums of the type shown in FIGS. 14 and 15, pivotally secured to the vehicle **21'**, permits a guideway to be curved on a shorter radius than is possible with the use of a substantially longer plenum such as the plenum **35**. In other words, the arrangement illustrated in FIGS. 14 and 15 is analogous to the articulated wheel mounting arrangement of railroad vehicles and the like.

In the further modified arrangement illustrated more or less diagrammatically in FIGS. 16 and 17, a vehicle **149** is provided at its bottom with a pair of generally cylindrical frames **150** disposed in spaced relationship longitudinally of the vehicle **149** and defining a pair of plenums **151**. A pair of laterally spaced reversely curved frame walls **152** cooperates with the frames **150** to define a central plenum **153**. This arrangement is suitable for vehicles of relatively shorter length with respect to the width thereof than the vehicles **21** and **21'** and provides for an optimum plenum area consistent with the ability of the vehicles to negotiate guideway curves of relatively short radius.

In the modified form shown in FIG. 18, a vehicle **154**, shown in end elevation, is provided with a plenum defining frame **155** that is of greater width than the body of the vehicle **154** thereabove. Preferably, this type of vehicle is used for the purpose of conveying heavy freight, where a maximum plenum area is required.

An alternative arrangement for maintaining a predetermined minimum distance between vehicles on a given guideway is shown diagrammatically in FIG. 37 and involves a pneumatic interlock system. A guideway **2***a* is provided with a plurality of longitudinally spaced valves **103***a* each of which is provided, as shown in FIG. 38, with a latch **156** in the form of a plunger rod secured to a piston **157** that is mounted for reciprocatory movements in a cylinder **158** suitably mounted to the guideway **2***a*. A coil compression spring **159** yieldingly urges the piston **157** and latch bar or element **156** out of latching engagement with the adjacent valve element **103***a*. An air tube **160** extends from the outer end of the cylinder **158** longitudinally of the guideway **2***a* and in the direction of forward movement of a vehicle in the guideway, a predetermined distance, the opposite end of the air tube **160** communicating with the guideway **2***a* as indicated at **161**. As shown in FIG. 37, the air tubes **160** extend equal distances longitudinally of the guideway **2***a* and, as a vehicle passes over or by a tube end **161** or group thereof, the pressure of air in the plenum causes a corresponding valve element **108***a* rearwardly of the vehicle to be locked closed by pressure of air against its respective piston **157**. Then, as the vehicle moves beyond said given tube end **161**, air pressure within the air tube **160** is automatically released, and the spring **159** of the corresponding cylinder **158** causes retraction of the locking element **156** to permit the valve element **108***a* to open responsive to passage of a vehicle thereover.

In the modified forms shown in FIGS. 39 and 40, a guideway **2***b* is shown as comprising a bottom wall **15***b* and opposed vertical side walls **162**. In FIG. 39, a vehicle **21***b* is shown as being provided with a plenum **35***b* having downwardly converging side walls **163**. In FIG. 40, a vehicle **21***c* identical to the vehicle **21**, is provided with longitudinally extending flanges **164** that project laterally outwardly toward adjacent side walls **162**. In FIG. 41, a vehicle **21** is shown as being disposed in a guideway **2***c*, this guideway having a bottom wall **15***c* and laterally spaced vertical side walls **165**. A pair of longitudinally extending flanges **166** adjacent the upper edges of the side walls **165** project laterally inwardly toward the adjacent sides of the vehicle **21**. The arrangements shown in FIGS. 39–40 and 41 have substantially the same operating characteristics as that illustrated in FIGS. 2, 5–8 and others.

It will be appreciated that, while I have shown a vehicle as having a plurality of single seats in tandem, the present invention contemplates guideways which can accommodate cars having double seats, seats on opposite sides of a central aisle, or any desired seating arrangement.

While I have shown and described a preferred embodiment of my transportation system, and several modified forms of various components thereof, it will be understood that the same is capable of further modification, and that modification may be made without departure of the spirit and scope of the invention as defined in the claims.

What is claimed is:

1. A pneumatic propulsion transportation system comprising:

(a) means including a generally horizontal wall portion and generally opposed wall portions angularly displaced from said generally horizontal wall portion and defining an elongated upwardly opening guideway,

(b) a transport vehicle disposed in overlying relation to said generally horizontal wall portion for movement longitudinally of said guideway,

(c) said vehicle having a bottom portion in closely spaced relation to said generally opposed wall portions and cooperating with said generally horizontal wall portion to define a plenum,

(d) conduit means including a duct extending longitudinally of said guideway, one of said wall portions having a plurality of longitudinally spaced openings for communication between said duct and guideway, said conduit means being adapted to be connected to a source of air under pressure and operatively connected to said guideway defining means and disposed to direct air under pressure to said plenum in a direction to levitate said vehicle and propel said vehicle in one direction longitudinally of said guideway,

(e) a plurality of normally closed valves each individual to a different one of said longitudinally spaced openings and each arranged to open when disposed directly below said vehicle and to close responsive to movement of said vehicle away therefrom longitudinally of said guideway,

(f) and time delay devices operatively associated with each of said valves to hold said valves closed for a predetermined time interval after closing thereof.

2. A pneumatic propulsion transportation system comprising:

(a) wall structure defining, an elongated cross sectionally generally U-shaped guideway having opposed side walls disposed in planes which converge in an upward direction and a generally horizontal bottom wall, and a longitudinally extending air duct underlying said guideway,

(b) a transport vehicle having a bottom portion disposed in said guideway for movement of said vehicle longitudinally of said guideway,

(c) said vehicle bottom portion cooperating with wall portions of said guideway to define a plenum,

(d) and means for supplying air under pressure to said duct,

(e) said bottom wall of the guideway having longitudinally spaced openings therethrough for directing air from said duct to said plenum in a direction to levitate said vehicle and propel said vehicle in one direction longitudinally of said guideway.

3. A pneumatic propulsion transportation system comprising:

(a) means defining an upwardly opening guideway having a generally horizontal bottom wall and laterally spaced side wall portions projecting upwardly from said bottom wall,

(b) a transport vehicle disposed in overlying relation to said bottom wall for movement longitudinally of said guideway,

(c) said vehicle having a bottom portion cooperating with the underlying portion of said guideway to define a plenum,

(d) conduit means adapted to be connected to a source of air under pressure and operatively connected to said guideway defining means and disposed to direct air under pressure to said plenum in a direction to levitate said vehicle and propel said vehicle in one direction longitudinally of said guideway,

(e) said vehicle including wall structure defining a chamber and a doorway to said chamber,

(f) a door mounted in said doorway for opening and closing movements,

(g) means for opening and closing said door,

(h) and locking mechanism mounted on said vehicle and responsive to predetermine pressure differential between said plenum and said chamber to positively lock said door against opening movements, and responsive to a predetermined decrease in said pressure differential to release said door for opening thereof.

4. A pneumatic propulsion transportation system comprising:

(a) means defining an upwardly opening guideway having a generally horizontal bottom wall and laterally spaced side wall portions,

(b) a transport vehicle disposed in overlying relationship to said bottom wall for movement longitudinally of said guideway,

(c) said vehicle having a bottom portion cooperating with the underlying portion of said guideway to define a plenum,

(d) an air compressor having air inlet means and air outlet means,

(e) conduit means connected to said air outlet means and extending through said guideway defining means and disposed to direct the flow of air from said compressor to said plenum in a generally forward direction longitudinally of said guideway to levitate said vehicle and propel the vehicle in said forward direction,

(f) elongated wall structure extending longitudinally of said guideway for substantially the length thereof and cooperating therewith to provide a tube through which said vehicle travels,

(g) said conduit means further including a conduit section connecting said tube with said compressor air inlet means and arranged to deliver air from said tube above said guideway to said compressor.

5. A pneumatic propulsion transportation system comprising:

(a) means including a generally horizontal wall portion and laterally spaced wall portions projecting upwardly from said generally horizontal wall portion, defining an elongated guideway,

(b) a transport vehicle disposed in said guideway for free-floating movement longitudinally thereof,

(c) said vehicle having a bottom wall and a peripheral flange depending therefrom in closely spaced relation to said wall portions, said bottom wall and flange cooperating with said generally horizontal guideway wall portion to define a plenum,

(d) and conduit means adapted to be connected to a source of air under pressure and operatively connected to said guideway defining means and disposed to direct air under pressure to said plenum in a direction to levitate and propel said vehicle in one direction longitudinally of said guideway.

6. A pneumatic propulsion transportation system comprising:

(a) means defining an upwardly opening guideway having a generally horizontal wall and laterally spaced side wall portions projecting generally upwardly from said horizontal wall,

(b) a transport vehicle disposed in overlying spaced relation to said generally horizontal wall for free-floating movement longitudinally of said guideway,

(c) said vehicle having a bottom wall and side wall portions cooperating with said generally horizontal wall to define a plenum,

(d) and conduit means adapted to be connected to a source of air under pressure and operatively connected to said guideway defining means and disposed to direct air under pressure to said plenum in a direction to levitate said vehicle and propel said vehicle in one direction longitudinally of said guideway,

(e) said vehicle side wall portions and the adjacent side wall portions of said guideway cooperating to define air spaces normally of greater width adjacent said horizontal guideway wall than at the top of said guideway.

7. A pneumatic propulsion transportation system comprising:

(a) means defining an upwardly opening guideway having a generally horizontal wall and laterally spaced side wall portions projecting generally upwardly from said horizontal wall,

(b) a transport vehicle disposed in overlying spaced relation to said generally horizontal wall for free-floating movement longitudinally of said guideway,

(c) said vehicle having a bottom wall and side wall portions cooperating with said generally horizontal wall to define a plenum,

(d) and conduit means adapted to be connected to a source of air under pressure and operatively connected to said guideway defining means and disposed to direct air under pressure to said plenum in a direction to levitate said vehicle and propel said vehicle in one direction longitudinally of said guideway,

(e) said sidewall portions of one of said guideway and vehicle being disposed in planes which converge upwardly with planes in which the adjacent side wall portions of the other of said guideway and vehicle are disposed, whereby to define air spaces therebetween of greater width adjacent said horizontal guideway wall than at the top of said guideway.

8. The pneumatic propulsion transportation system of claim 7 in which said side wall portions of the vehicle are disposed in upwardly diverging planes, the side wall portions of said guideway being disposed in substantially vertical planes.

9. A pneumatic propulsion transportation system comprising:

(a) means defining an upwardly opening guideway having a generally horizontal wall and laterally spaced side wall portions projecting generally upwardly from said horizontal wall,

(b) a transport vehicle disposed in overlying spaced relation to said generally horizontal wall for free-floating movement longitudinally of said guideway,

(c) said vehicle having a bottom wall and generally vertical side wall portions cooperating with said generally horizontal wall to define a plenum,

(d) conduit means adapted to be connected to a source of air under pressure and operatively connected to

said guideway defining means and disposed to direct air under pressure to said plenum in a direction to levitate said vehicle and propel said vehicle in one direction longitudinally of said guideway,

(e) and a pair of opposed longitudinally extended flanges projecting laterally from the side wall portions of one of said guideway and vehicle toward the adjacent side wall portions of the other of said guideway and vehicle adjacent the top of said guideway and cooperating with said side wall portions to define air spaces normally of greater width adjacent said horizontal guideway wall than at the top of said guideway.

10. The structure defined in claim **2** in further combination with a plurality of valves each individual to a different one of said longitudinally spaced openings for controlling passage of air under pressure from said duct to said guideway.

11. The structure defined in claim **10** in which said valves include valve elements movable between valve open and valve closed positions and yieldingly biased toward one of said positions and operative responsive to predetermined pressure differential between said duct and guideway to move to the other of said positions against the yielding bias applied thereto.

12. The structure defined in claim **4** in further combination with a valve operatively associated with said conduit section for controlling flow of air therethrough to said compressor, said compressor air inlet means being operative to introduce air exterior of said tube to said compressor independently of said conduit section.

13. The structure defined in claim **3** in which said vehicle wall structure has an opening through said bottom portion providing communication between said plenum and said chamber, and a second opening from said chamber to the exterior of said vehicle remote from the plenum, whereby pressure differential between said plenum and said chamber and exterior of the vehicle provides a current of air through said openings and said chamber.

14. A pneumatic propulsion transportation system comprising:

(a) wall structure defining a pair of elongated cross-sectionally U-shaped guideways in spaced side by side relationship and each having opposed side walls and a bottom wall,

(b) said wall structure further defining an air duct underlying said guideways,

(c) transport vehicles associated with each of said guideways and each having a bottom portion disposed in a respective one of said guideways for movement of the vehicle longitudinally of said guideways,

(d) each said vehicle bottom portion cooperating with wall portions of its respective guideway to define a plenum,

(e) means for supplying air under pressure to said duct,

(f) one of the walls of each of said guideways having longitudinally spaced openings therethrough for directing air from said duct to said plenum to levitate said vehicle,

(g) the openings associated with one of said guideways being disposed to direct air therethrough to propel the vehicles associated therewith in one direction, said openings associated with the other of said guideways being disposed to direct air therethrough to propel vehicles associated therewith in the opposite direction.

15. The structure defined in claim **14** in further combination with support means extending longitudinally of said duct intermediate said guideways, said support means cooperating with portions of said duct defining wall structure to support said guideways, said support means defining openings for free passage of air between portions of said duct at opposite sides of said support means.

16. A pneumatic propulsion transportation system comprising:

(a) means, including a generally horizontal wall portion and laterally spaced side wall portions projecting upwardly from said generally horizontal wall portion, defining a guideway,

(b) a transport vehicle disposed in overlying relationship to said generally horizontal wall portion for movement longitudinally of said guideway,

(c) said vehicle having a bottom portion cooperating with the underlying portion of said guideway to define a plenum,

(d) means defining a second guideway laterally displaced from said first mentioned guideway and in operative connection therewith,

(e) conduit means adapted to be connected to a source of air under pressure and operatively connected to said guideway defining means and including conduit sections disposed to direct air under pressure to said guideways and into said plenum to levitate said vehicle and propel said vehicle in one direction longitudinally of said guideways,

(f) and means for shifting said vehicle from one of said guideways to the other of said guideways.

17. The structure defined in claim **16** in which said means for shifting said vehicle comprises:

(a) other conduit sections disposed to direct air under pressure to said guideways in a direction generally away from one of said guideways toward the other of said guideways,

(b) and valve means for controlling passage of air through said other conduit means.

18. The structure defined in claim **16** in which said conduit sections associated with said second guideway are disposed in spaced relationship longitudinally of said second guideway, the spacing between adjacent conduit sections in the second guideway being progressively greater in one direction longitudinally of said second guideway.

19. A pneumatic propulsion transportation system comprising:

(a) means defining an elongated guideway having a generally horizontal wall portion and laterally spaced side wall portions projecting upwardly from said generally horizontal wall portion,

(b) a transport vehicle disposed in overlying relationship to said generally horizontal wall portion for movement longitudinally of said guideway,

(c) said vehicle having a bottom portion cooperating with the underlying portion of said guideway to define a plenum,

(d) means defining a station area laterally displaced from said guideway and in operative communication therewith,

(e) conduit means adapted to be connected to a source of air under pressure and operatively connected to said guideway-defining means and said station area-defining means and including conduit sections disposed to direct air under pressure to said guideway and into said plenum to levitate said vehicle and propel said vehicle in one direction longitudinally of said guideway,

(f) said conduit means including other conduit sections adjacent said station area and disposed to propel said vehicle toward said station area,

(g) and valve means for controlling passage of air through said other conduit sections, whereby said vehicle is propelled selectively toward said station area or along said guideway in laterally spaced relation to said station area.

20. The structure defined in claim **19** in which said guideway further defines a vehicle deceleration area and an acceleration area each disposed at an opposite end of said station area, said other conduit sections being disposed in said deceleration area in a row extending at an oblique angle to the longitudinal dimension of

said guideway toward said station area, and in which said conduit means further includes acceleration conduit sections disposed in a row at said acceleration area extending from said station area toward said guideway at an oblique angle to the longitudinal dimension of said guideway, said acceleration conduit sections being disposed to direct air under pressure through said guideway defining means and into said plenum in a direction to propel said vehicle away from said station area toward said guideway angularly of said one direction longitudinally of the guideway.

21. A pneumatic propulsion transportation system comprising:

(a) wall structure defining an elongated cross-sectionally generally U-shaped guideway having opposed side walls and a bottom wall and a longitudinally extending air duct underlying said bottom wall,

(b) a transport vehicle having a bottom portion disposed on said guideway for movement of said vehicle longitudinally of said guideway,

(c) said vehicle bottom portion cooperating with said bottom guideway wall to define a plenum,

(d) means for supplying air under pressure to said duct,

(e) said guideway bottom wall having longitudinally spaced openings therethrough for directing air from said duct to said plenum in a direction to levitate said vehicle and propel said vehicle in a forward direction longitudinally of said guideway,

(f) a portion of said guideway being laterally extended to provide a station area at one side of the guideway and deceleration and acceleration areas each at an opposite end of said station area elongated in the direction of said guideway,

(g) and means for selectively moving said vehicle from said guideway to said deceleration area and toward said station area or permitting said vehicle to be moved along said guideway in laterally spaced relation to said station area.

22. The structure defined in claim 21 in which said guideway bottom wall is provided with a row of deceleration openings in spaced relation generally longitudinally of said deceleration area, said row extending angularly from said guideway toward said station area, said deceleration openings being disposed to direct air from said duct to said deceleration area in a direction generally laterally away from said guideway, said last mentioned means including valves for opening and closing said deceleration openings, and operating mechanism for said valves.

23. The structure defined in claim 21 in which said guideway bottom wall is provided with a row of acceleration openings in spaced relation generally longitudinally of said acceleration area, said row extending angularly from said station area toward said guideway, said acceleration openings being disposed to direct air from said duct to said acceleration area in a direction laterally toward said guideway, said last mentioned means including valves for opening and closing said acceleration openings, and operating mechanism for said valves.

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