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(54) CATS-CONSTRAINED AIRPLANE TRANSPORTATION SYSTEM

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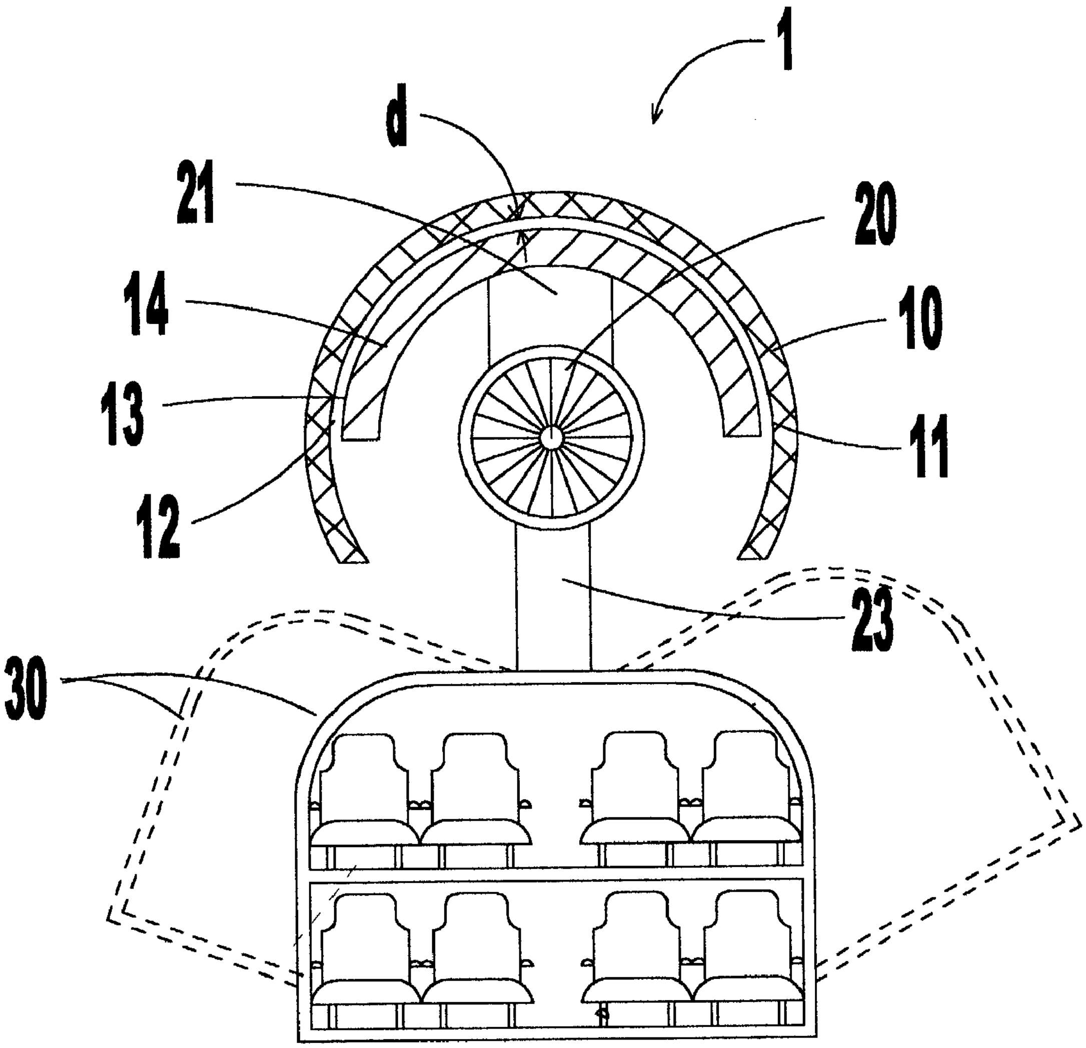
(57) ABSTRACT

An elevated high speed ground transportation system adaptable to existing right-of-ways for passenger travel between metropolitan centers utilizing a pair of tubular monorails with aerodynamic and hydrostatic fluid bearings providing low friction and propelled by thrust provided by a self-contained linear gas turbine resulting in a cost effective, safe, all-weather, low maintenance transportation system.



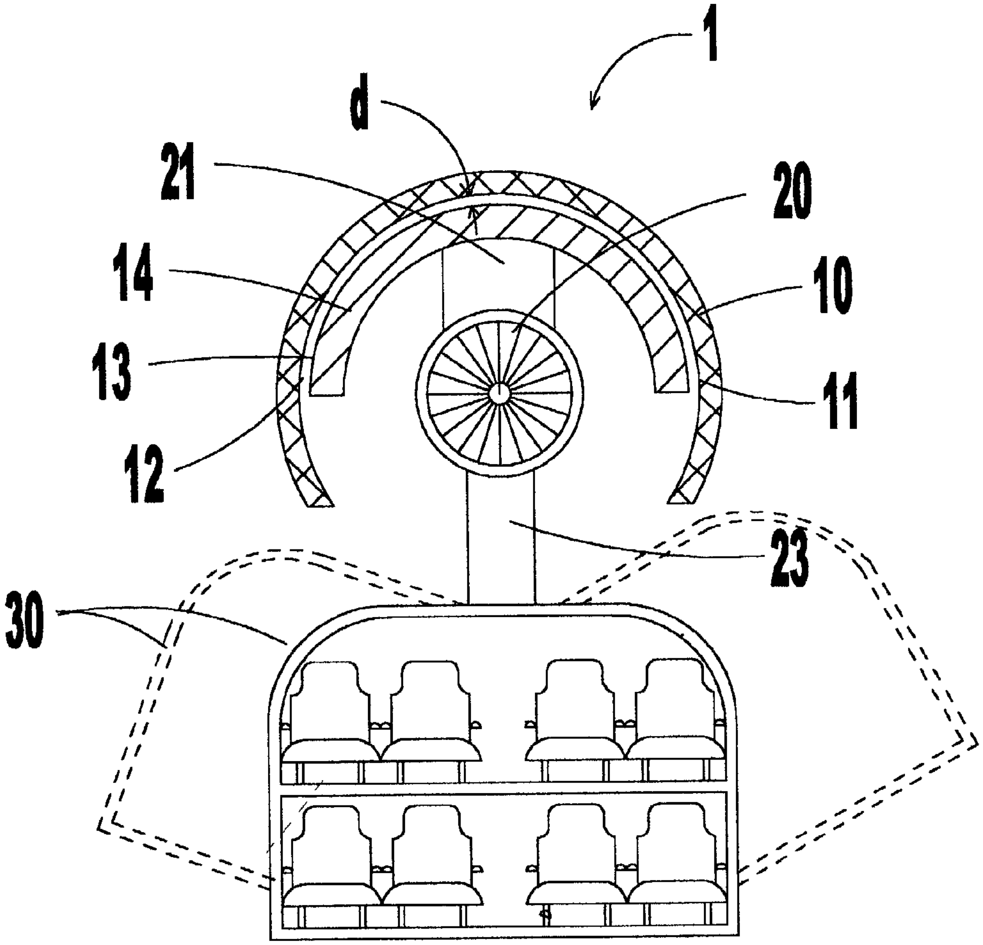


FIG. 1

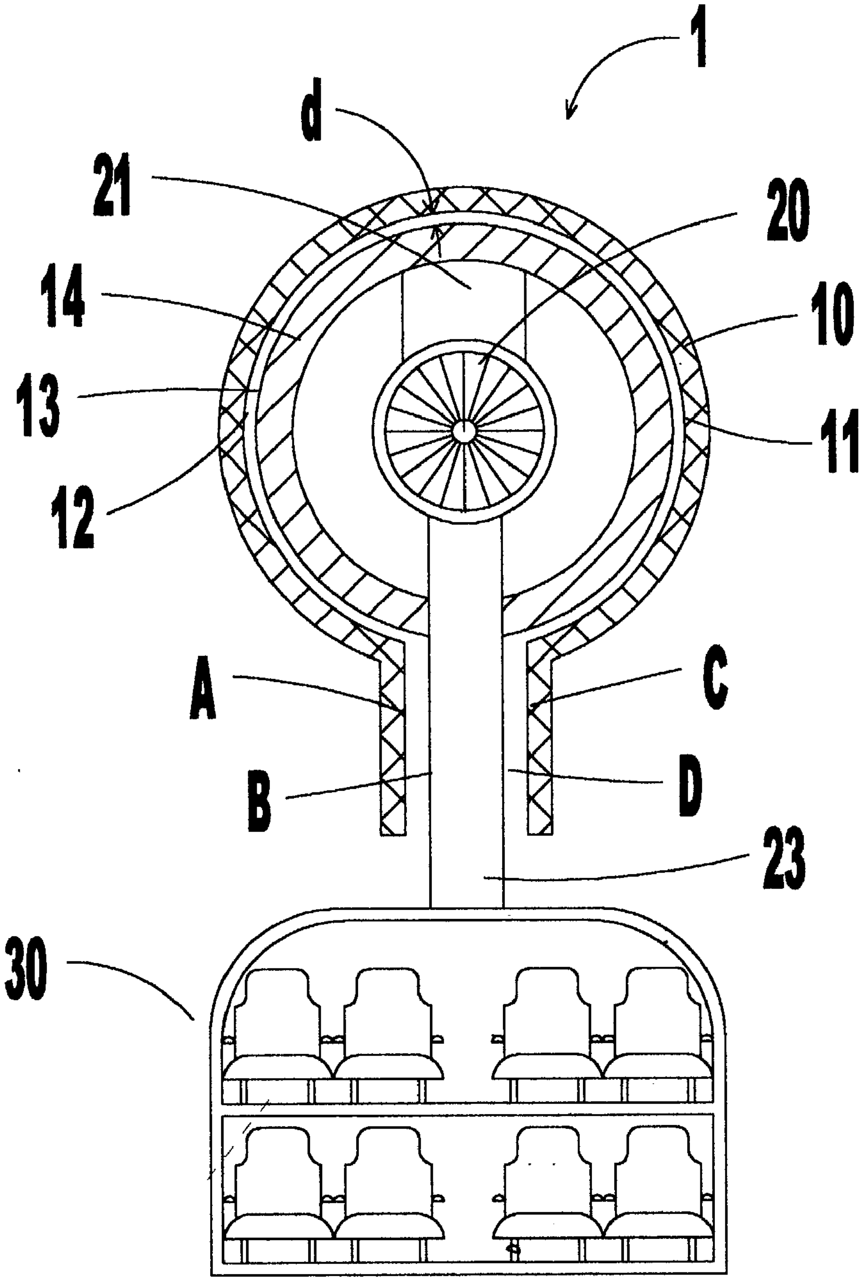


FIG. 2

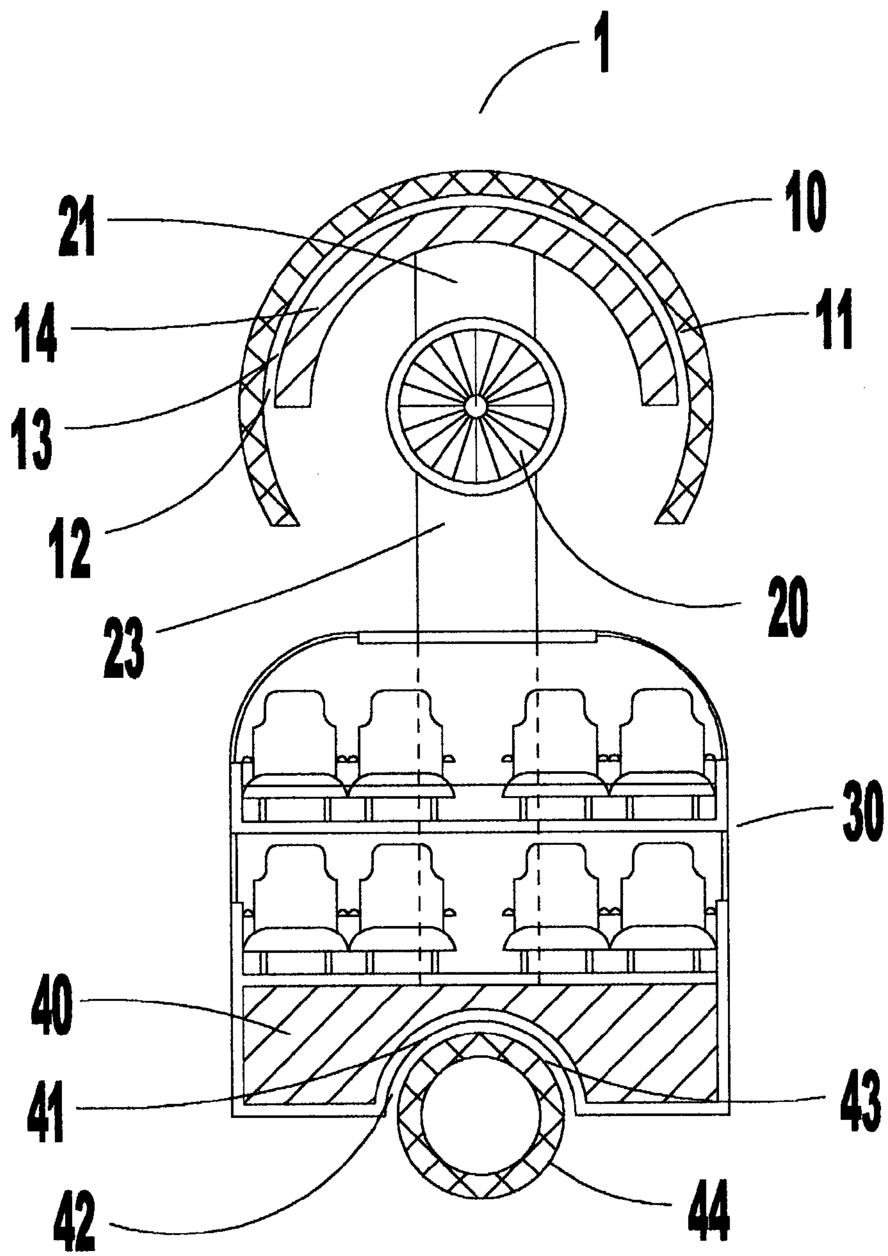


FIG. 3

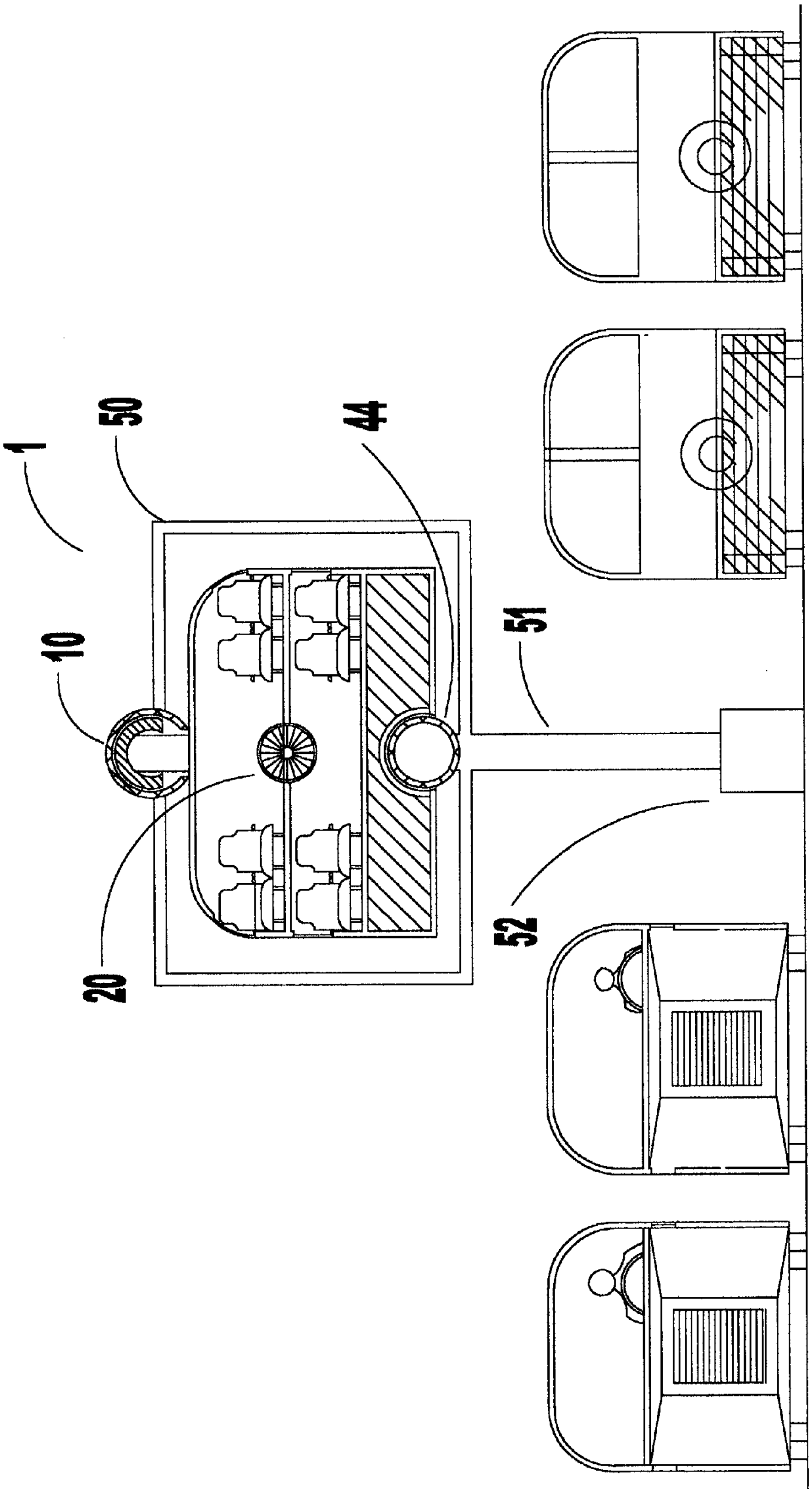


FIG. 4

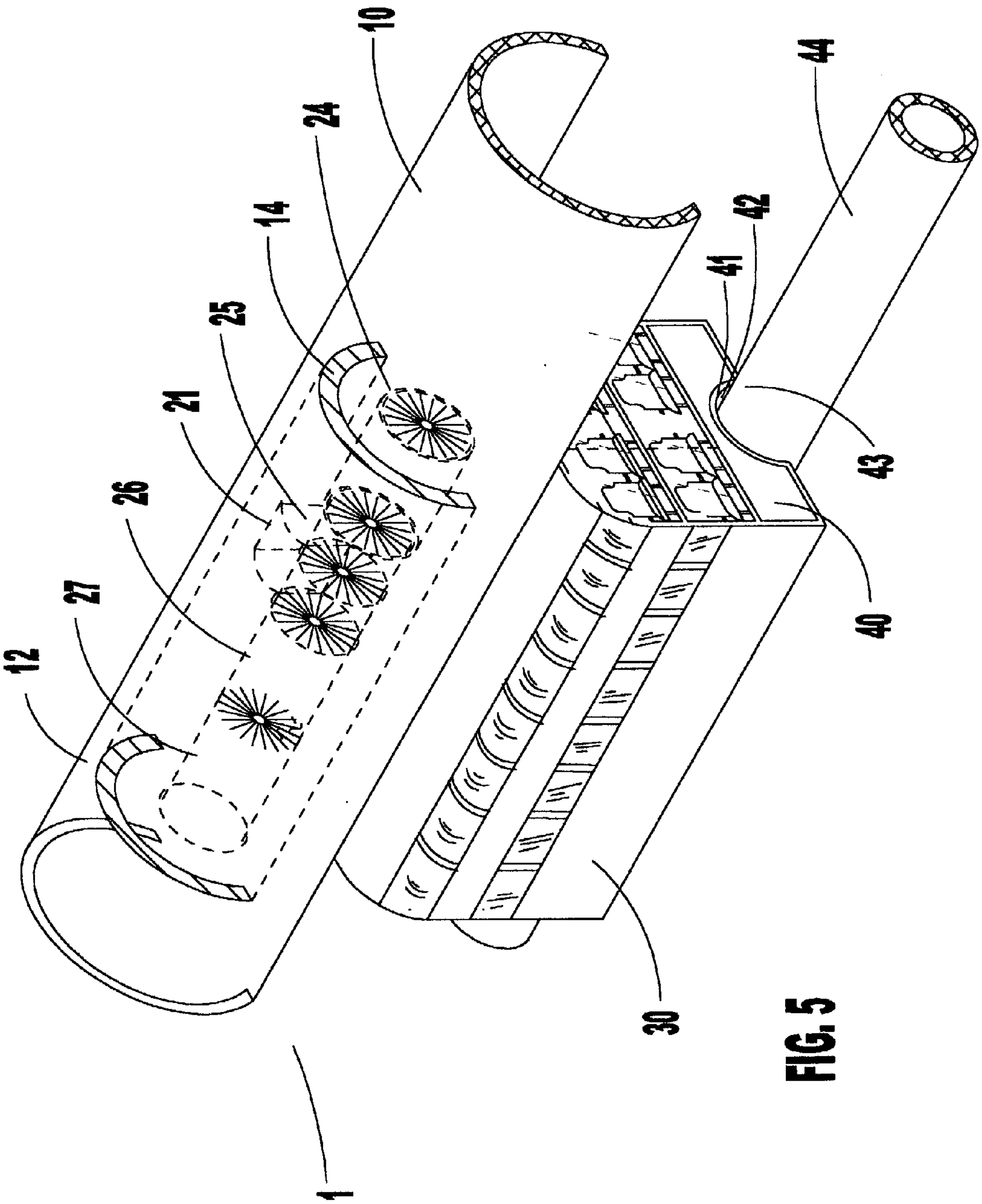


FIG. 5

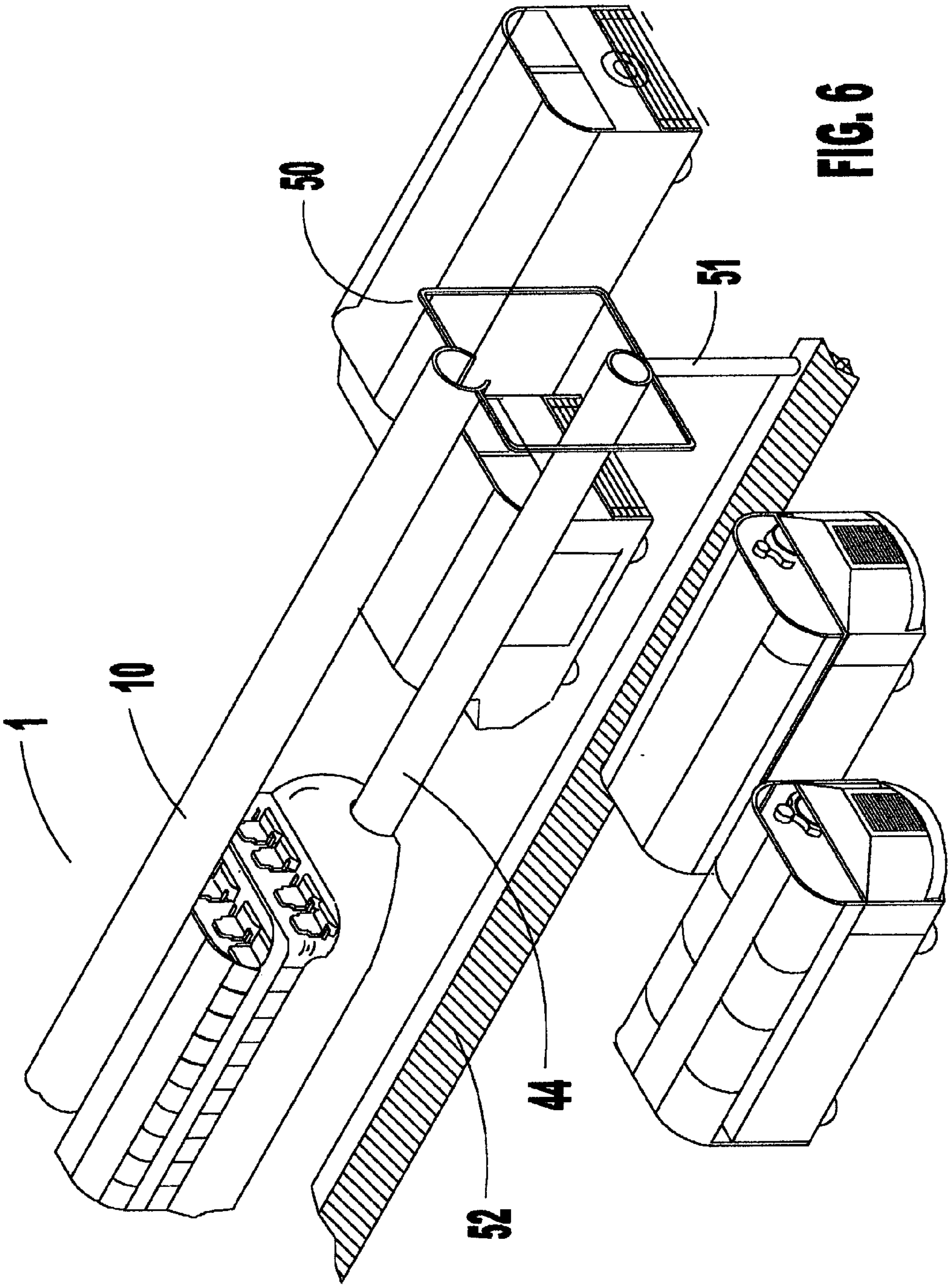


FIG. 6

	Automobile	Jet Plane	Train	Boat	Monorail Below (Levitation)	Monorail Above (Levitation)	Maglev	Tube Transport	CATS
Speed	4	9	2	2	5	5	8	8	8
All-Weather	7	6	8	6	2	6	6	8	9
Safety	5	4	6	6	4	5	5	4	8
Installation Cost	6	3	5	5	5	6	3	2	9
Effective Range	5	8	6	6	5	5	6	6	6
Transit Time	5	3	5	4	5	5	6	6	8
Terrorist Attack	8	4	5	4	4	6	6	6	7
Maintenance Cost	4	3	5	5	4	6	3	2	9
Freight Capacity	5	4	9	9	5	4	3	4	5
Psgr. Enjoyment	6	6	5	6	5	6	6	2	8
Total Score	55	50	56	53	44	54	45	48	77

FIG. 7

CATS-CONSTRAINED AIRPLANE TRANSPORTATION SYSTEM

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] Not Applicable

STATEMENT REGARDING FERERALLY SPONSORED RESEARCH OR DEVELOPMENT

[0002] Not Applicable

REFERENCE TO A MICROFICHE APPENDIX

[0003] Not Applicable

BACKGROUND OF THE INVENTION

[0004] 1. Field of the Invention

[0005] The present invention relates to a high speed ground transportation system of the overhead monorail type, generally classified under 104/23, 104/34, 104/89, 104/155 of the U.S. Patent Classification system.

[0006] 2. Description of Related Art

[0007] Many transportation systems have been devised to replace or augment the current highway system. The ideal high speed ground transportation (HSGT) system must meet the following criteria to be supremely successful: (a) it must allow high speed operation, (b) it must allow all-weather operation, (c) passenger safety must be assured in the event of a power failure, (d) construction, installation, and maintenance costs should be low, (e) it cannot be an attractive target for terrorists. (f) the transit systems effective range must be intermediate between automobile and long distance airline travel, and (g) it must be a pleasure to use or it will be a failure. These criteria allow pruning away those suggested HSGT systems not meeting these requirements until only those having the best features are left. Prior attempts have been either outrageously expensive or have contained a fatal design flaw that rendered them impractical. All have failed to property address the requirements for the ideal HSGT system.

[0008] It is instructive to categorize the patent literature on this subject then cull away those categories that lack a major HSGT requirement. A common pitfall is that some HSGT systems require that expensive travel ways must be built or each individual must own a special type vehicle. Communities will not provide funding for expensive construction costs and especially for right-of-way cost which is the most costly aspect of a new HSGT system. An ideal solution would be a HSGT transit system utilizing existing right-of-way to avoid this high cost since it would then already have been expensed.

[0009] Generally the proposed HSGT systems can be segregated as follows:

[0010] 2.1 Vehicle Above, Tracked Monorail Below

[0011] Monorail systems assure a uniform roadbed surface. Tracked vehicle systems eliminate road hazards and terrain dangers by reduction of directional choice. It is considerably easier driving an automobile on a paved road than through a forest. Tracked vehicle systems compensate for terrain elevation by control of roadbed placement using bridges and tunnels. A vehicle confronting a mountain has a much more difficult transportation task than one that can travel right through the mountain in a tunnel.

[0012] There are two main types of tracked monorails; vehicles provided with wheels contacting the monorail roadbed or vehicles somehow lifted off the monorail surface riding in air so that cumbersome, slow speed wheels are eliminated.

[0013] 2.1.1 Wheeled Monorail Vehicles

[0014] Hijlkema (U.S. Pat. No. 6,431,077) describes a monorail transit system with flat plates sliding on continuously introduced liquid instead of wheels. U.S. Pat. No. 6,401,625 shows an ordinary automobile with extended wheels traveling in parallel monorail tracks. U.S. Pat. No. 6,389,983 describes a vehicle with fins on a monorail track propelled by compressed air impinging on the fins for propulsion. Owen (U.S. Pat. No. 6,321,657) describes a monorail with a vibration isolated steel rail for a quieter ride. A linear drive motor with electrical power transmitted to the vehicle is described by Swensson in U.S. Pat. Nos. 6,182,576 and 5,845,581. A similar linear motor system picks up electric power from the steel rail in Nozaki, et. al., U.S. Pat. No. 5,492,066. LaSorte describes a vehicle with a lowered center of gravity to allow higher speed using conventional steel wheels on steel tracks in U.S. Pat. No. 4,899,665. Another electrified monorail is used in U.S. Pat. No. 5,590,604 using sliding electrical contacts. The tires of a land/water automobile ride on top of a monorail on land and on the underside in water in U.S. Pat. No. 5,775,226. In Westling's U.S. Pat. No. 4,036,147 a helicopter is tethered to a track picking up electrical power by use of a wheeled trolley. Electric motors are used to drive wheels on a steel track in Hawes U.S. Pat. No. 3,412,689. Streamlining a conventional vehicle on a monorail is used by Hinsken in U.S. Pat. No. 2,788,749.

[0015] 2.1.2 Levitated Monorail Vehicles.

[0016] To accomplish eliminating wheels schemes have been developed to allow the vehicle to ride on a cushion of air. This method uses an air bearing between the vehicle floor and the monorail surface. This type vehicle, sometimes called a hydrostatic bearing vehicle, is similar in principle to the hockey pucks used in game rooms. The air bearing efficiently allows high speed operation with the added advantage that track wear and tear is eliminated. A modified vehicle of this type uses the WIG (i.e., Wing-In-Ground) effect by use of a bottom-placed wing designed to increase the pressure of the cushion of air underneath the vehicle.

[0017] Hydrostatic air cushion monorail vehicles are known and are described, for example by Cavanah (U.S. Pat. No. 6,216,599) where onboard equipment such as the exhaust from a propeller, a turbojet or a turbofan provides compressed air for an air cushion monorail vehicle. Cummins (U.S. Pat. No. 5,909,710) describes a monorail vehicle of this type wherein the compressed air is supplied from pipes in the monorail and with valves activated when the vehicle passes providing air to support the vehicle on an air cushion. More recent air cushion vehicles of this type have a wing-shaped scoop wherein the vehicles forward motion changes dynamic pressure to static pressure for increased lift. A linear motor drive with the vehicle supported using air cushions is described in U.S. Pat. No. 5,542,356 by Richert.

A propeller provides both air cushion lift and forward propulsion in Jones, et. al air cushion vehicle in U.S. Pat. No. 4,643,268. An overhead trackway consisting of two tubes on the interior of each is a jet engine while "the trackway is lubricated from a longitudinally extending lubeline with synchronically operated nozzles spaced therealong" is described by Hughes in U.S. Pat. No. 3,938,445. A vehicle with flexible air cushions is described by Bertin in U.S. Pat. No. 3,744,429. VanVeidhuizen describes pressurized air supplied to a monorail underneath a vehicle wherein the vehicle opens a sealed slot in the pipe when it passes allowing vehicle levitation in U.S. Pat. No. 3,722,424 vehicle An air cuchion vehicle operating in a tracked grove on the ground is described by Bertelson in U.S. Pat. No. 3,712,406. Spring mounted bearing plates to compensate for roadway surface are described by Crios-Marle in U.S. Pat. No. 3,698,506. Valves opening at passage of a vehicle open up in Bloomfield U.S. Pat. No. 3,685,788 allowing pressurized air in a monorail to emit and support the vehicle. A concave-shaped channel is used by Girard in U.S. Pat. No. 3,675,582 in combination with wings underneath to provide lift for a ground track vehicle. Bertin discloses an air cushion vehicle with numerous nozzles in U.S. Pat. No. 3,648,620. Nardozzi describes a vehicle lifted by a continuous supply of water for forward push. Gas jets are used instead of a physical curtain around a gas cushion for a levitated vehicle described by Hart in U.S. Pat. No. 3,625,157. Pressurized air comes out of holes to levitate a vehicle when it is over head as allowed by valves opening in U.S. Pat. No. 3,621,787 by Giraud. Gas jets at the periphery control cushion pressure in gas cushions for a tracked vehicle in Hart U.S. Pat. No. 3,602,147. Numerous rollers acting on two steel rails with small hydrostatic bearings aside the rails provide rotational stability for a tracked vehicle in Schudder U.S. Pat. No. 3,587,471. Pressurized air in a monorail escapes when a vehicle is overhead using a vertical belt acting as a valve in U.S. Pat. No. 3,586,382. The jet engine power plant for propulsion is underground in a pipe so as to reduce noise in the air levitated vehicle described by Rosciszewski in U.S. Pat. No. 3,543,685. Pressurized liquid is periodically squirted up under a vehicle when a vehicle passes by, using valving means in U.S. Pat. No. 3,540,378 by Giraud. A ground track of circular arc is used by Mesnager in U.S. Pat. No. 3,500,763 so that centrifugal forces are axial to the center of gravity. Conventional rails supplemented by two small hydrostatic bearings each side are used by Hall in U.S. Pat. No. 3,308,767. Air from blowers spaced along a monorail provide air cushions for a monorail vehicle in U.S. Pat. No. 3,242,876 by Berggren. A V-shaped track made of sheet metal is used by Amann in U.S. Pat. No. 3,096,728 for a gas cushion vehicle. An inverted pyramid-shaped roadbed track, faced with stainless steel plates. is used by Crowley in U.S. Pat. No. 3,090,327 for an air cushion vehicle wherein air issues from a slot in the center of the vehicle as by a propeller.

[0018] 2.1.3 Maglev Vehicles

[0019] More recently another scheme to achieve elimination of wheels is by use of magnetic levitation. In this category vehicle, a maglev is propelled by electric linear motors while magnetic levitation provides guidance and suspension. Ordinary magnetic repulsion forces are not strong enough or workable for these systems and they require superconductive magnets, including liquid helium cooling to make them useable. Very large investments in guide way construction and associated electric power systems are required. Power lines alongside the track and feeder lines from centralized power plants, with a. c. frequency converters and speed control stations are also required at intervals along the track. The active part of the linear electric motor installed in the track is a major portion of the total guide way cost. Maglev vehicles are extremely power inefficient. First, because generation of electricity is extremely wasteful of fossil fuel, converting only about 9% of the energy in fossil fuel to electricity but also because the cryogenic liquid helium or nitrogen required not only expends a huge amount of energy to make available but continual replenishment is necessary by loss to ambient heat. According to Arrigo Mongini, acting associate administrator in the Federal Transportation Administration, maglev track is expected to cost $25 million to $50 million per mile, with high electric power costs additional. These high costs largely eliminate maglev as a viable energy efficient method to introduce HSGT.

[0020] A Maglev vehicle is described by Lamb (U.S. Pat. No. 6,510,799) in which a tracked monorail has periodically spaced magnets which oppose magnets in the vehicle. Harding (U.S. Pat. No. 6,178,892) describes a pressurized monorail with valving and vanes allowing an air cushion to support the traveling vehicle magnetically coupled to the monorail track. U.S. Pat. No. 6,152,045 proposes using monorails with magnetic levitation to carry water in dry areas. Kauffman (U.S. Pat. No. 5,363,857) describes a transportation system in which an automobile is driven into a carrier which is in turn supported in a guideway by repulsive magnets. Holine et. a., describes (U.S. Pat. No. 5,647,280) a rotable monorail rail which aligns as required for a magnetically levitated vehicle.

[0021] The above type monorail vehicles suffer from the main defect of all tracked monorails, what happens when it rains, snows, or ice forms affecting the roadbed? Obviously, ground-based monorails systems are not practical for all-weather transportation.

[0022] 2.1.4 Evacuated Tube Transport Vehicles

[0023] A proposed variation on the tracked monorail vehicle is the underground pneumatic tube system. This system, called the Evacuated Tube Transport (EET) system is based on department store pneumatic tube systems which had been used to transmit currency and papers from one floor to another; now mostly used by banks at outdoor windows. This proposed transportation system involves drilling tunnels deep underground connecting one city to another then shooting a capsule filled with passengers by the use of vacuum one side and compressed air the other. The main advantage of EET systems would be elimination of aerodynamic drag but tube transport systems are entirely impractical from many standpoints. EET cannot even be considered where there is the remote possibility of an earthquake because geologic shifts would be catastrophic. And an EET transportation system would be extremely susceptible to underground flooding where even tiny amounts of water would cause a huge shock to the speeding capsule. Earthquakes, mud slides, flash floods, or tidal waves could damage the tube on land or underwater killing the occupants and releasing tremendous destructive energy.

[0024] Transportation tubes deep under the earth, to achieve the great speed of "flywheel energy storage", would be highly stressed and require exotic materials to build while construction costs would be even more severely increased over difficult topography. At the great depths required the temperature and heat flux would be so great that the entire diameter of the EET tube would be taken up by the cooling water required and escaping steam would be a hazard. At high velocities any malfunction of seals or compromise of the integrity of the tube would be disastrous. Failure of one of the capsules would cause the failure of many while failure of the braking system could result in the passenger capsule shooting up penetrating through the terminal causing tremendous damage.

[0025] Once the trip has started there is no stopping or turning back. Encapsulated in an underground pipe deep under the earth prolonged extreme accelerations would cause acute passenger discomfort with the possibility of any one passenger experiencing extreme claustrophobia thus requiring all passengers to take sedative drugs as a precaution.

[0026] Oster (U.S. Pat. No. 5,950,543 describes an evacuated ETT system using capsules of passengers shot deep underground crossing continents all over the world. Jackson (U.S. Pat. No. 5,460,098) describes an underground tube transport system whereby a propeller provides an air cushion encircling the vehicle and for propelling the vehicle forward. Crafton (U.S. Pat. No. 5,029,531) describes an underground tunnel system with helical walls so that wheels can provide traction and keep the vehicle upright. A packing means at the ends of a capsule plus wheels driven alone a rail are used in the underground pneumatic transit system proposed by Ardeleauv in U.S. Pat. No. 4,166,419. U.S. Pat. No. 4,148,260 by Minovitch describes an underground tunnel vacuum system in which the capsule accelerates when dropped and decelerates when it again comes to the surface. Diggs (U.S. Pat. No. 4,023,500) describes an underground tube transport system criss-crossing the U.S. by which a capsule of passengers rides on a film of air as a free piston using packing sealing means at the front of the capsule so that compressed air at the back provides an air cushion while the passenger capsule is kept upright using magnetic means. Air pressure is increased behind a capsule vehicle while air pressure is reduced in front, using pumping stations spaced along the tubeway, in Valverde's U.S. Pat. No. 3,999,487. An evacuated tube transport system with "permanent magnetic rails of high coercivity" is described by Minovitch in U.S. Pat. No. 3,954,064. Similarly, a tube transport system using a leading seal at the lower half of a capsule and a trailing seal at the upper half of an underground pneumatic capsule plus longitudinal seals in slots along the tube is described by Vasilleevich in U.S. Pat. No. 3,952,667.

[0027] 2.2 Vehicle Below, Tracked Guideway Above.

[0028] The two main advantages of tracked monorails above the vehicle are that proper design by this scheme can solve the problems of right-a-way cost and all-weather operation. It is the cost of the right-of-way that is the main cost for any new guide way transportation system, especially near urban areas. If the monorail can be above existing traffic then right-a-way expense has already been absorbed. Also, if the overhead monorail can effectively act as a roof, protecting the roadway and vehicle from rain, snow, sleet, and ice this can solve the all-weather capability problem.

[0029] One problem with overhead monorail structures is the structures can be heavy and excessively large. Also, they may be difficult to manufacture at a central location for easy transport to location and the time and expense of fabricating overhead structures can be a primary contributor to excessive overhead monorail costs. Ideally, the overhead structure should be simple to fabricate and easily transportable. The guide rails should not be prone to accumulate snow, and ice, which would adversely affect all-weather operation. Overhead monorail systems can be divided into two types, wheeled monorails and levitated vehicle types. Some of the different systems are as follows:

[0030] 2.2.1 Wheeled Overhead Guideways

[0031] Slow speed automatic people conveying systems are in common use, for example, at amusement parks like Disney World. They are reliable and exhibit high continuous usage. Several patents recognize the advantage of an overhead guideway with suspended payload units. Hutchinson (U.S. Pat. No. 6,202,566), Rypinski (U.S. Pat. No. 3,861,315), Leibowitz (U.S. Pat. No. 4,841,871) describes automobiles conveyed in boxes connected to an overhead track using conventional wheels. Hutchinson (U.S. Pat. No. 6,202,566) describes an overhead monorail track in which wheels on the track provide motive power for a payload carrying trucks and automobiles below. Similarly Zimmerman (U.S. Pat. No. 3,118,392) proposes a system in which payloads are suspended from motor modules utilizing wheels in an overhead inverted U shaped monorail track. Rypinski (U.S. Pat. No. 3,861,315) also discloses a suspended vehicle transported with the aid of an overhead motor module riding in an inverted U shaped overhead track. Steel flanged wheels on a steel overhead track are proposed by Trenary in U.S. Pat. No. 5,381,737. Romine (U.S. Pat. No. 5,289,778) proposed a similar system for carrying automobiles in U.S. Pat. No. 5,289,778. Peterson (U.S. Pat. No. 5,074,220) proposes an overhead monorail system in which payload cabins hang from a motorized carriage that rides inside an enclosed tube-like travelway. The carriage uses in-line wheels riding in a concave lower surface along with a guide wheel traveling in an upper concave surface. The payload is supported from the carriage by a flange that extends through a slot in the guideway. A turn mechanism is utilized to guide rollers contacting cam surfaces on the sides of the guideway for turns.

[0032] Svensson (U.S. Pat. No. 6,450,103) uses a flat overhead surface with a web in the middle acting as electrical conductor for contact shoes which slide over the surface conducting electrical power to conventional wheels. He suggests using magnetic levitation as an option. The system disclosed by O'Neil et al. (U.S. Pat. No. 5,433,155) describes a method for control and locating of trains of vehicles. The system relies on electrical energy and computer control to suspend the vehicle. A conductor is used between the vehicle and the tube, but a computer failure could result in sudden suspension failure. No provision exists for active alignment of the tube. Behar in U.S. Pat. No. 5,957,056 describes an overhead monorail system in which passengers always remain in horizontal upright position no matter what the terrain. Hallett et al. (U.S. Pat. No. 5,060,575) shows a turn controller for a suspended track mounted vehicle. The system uses wide wheels that drive over the slot through which the payload hangs. Guide rollers on the vehicle make contact with a guide vane on the track structure. Gerhard (U.S. Pat. No. 4,214,535) proposes the use of elastic wheels for an overhead monorail conveyor system while Hallett (U.S. Pat. No. 5,060,575) proposes wide wheels in an overhead trackway. Trenary describes an overhead track system with flanged wheels inside a U-shaped track in U.S. Pat. No. 5,381,737.

[0033] None of the above systems are capable of HSGT operation because all rely on wheels. In addition, wheels and rounded traction surfaces result in high levels of friction, wear and noise especially at higher speed. Many of the systems use cams or other mechanical contact between the vehicle and guideway for positioning and steering (especially in Y-junctions and the like.).

[0034] 2.2.2 Levitated Vehicles in Overhead Guideways

[0035] Barber (U.S. Pat. No. 4,085,681) describes an air cushion vehicle with compressed air supplied from a linear gas turbine such that the compressed air impinges on slots projecting from the roadbed to provide forward motion. In U.S. Pat. No. 4,010,693 by Bliss, seals allow vacuum to provide vehicle lifting while air pressure provides an upward force in an overhead piston-type monorail track. Bertin (U.S. Pat. No. 3,580,181) uses a propeller to provide positive pressure in one chamber and negative pressure in another for a piston-type overhead monorail track for supporting a vehicle below. Another vehicle of somewhat similar design is described by Barthalon (U.S. Pat. No. 3,534,689) whereby the vehicle carries a vacuum pump and "sealing method" to provide negative pressure to lift the vehicle guided by an overhead track. Another reduced pressure method is described by Faure in U.S. Pat. No. 3,515,073 whereby a propeller provides reduced pressure in a chamber comprising the overhead monorail surface and the top of the vehicle while increased pressure lifts the vehicle below. Another U.S. Pat. No. 3,511,185 by Barthalon describes an overhead monorail with the undersurface of the monorail combined with the upper surface of the vehicle comprises a chamber which is evacuated by a vacuum pump in the vehicle. A wedge-shaped film of air is entrapped under the wing at the leading edge to provide an air cushion bearing in Maksim U.S. Pat. No. 3,238,894. Air compressed from a jet engine provides both an air cushion and also propulsion in Akmentin (U.S. Pat. No. 3,444,823) while aerodynamic lift occurs at high speed. McDonald (U.S. Pat. No. 3,233,556) forms ice on an overhead track to allow an overhead mechanism to slide until aerodynamic lifting occurs at high speed. Wheels hold a vehicle against a monorail track until wings provide aerodynamic lift at sufficient speed in Schaar (U.S. Pat. No. 2,976,820). Wheels on tracks above and below the vehicle guide it until a propeller allows speed sufficient to allow wings to provide aerodynamic lift in Bennie (U.S. Pat. No. 1,459,495).

[0036] Although air bearing system have considerable potential to achieve high speed by elimination of wheels for transportation of passengers and cargo, further development work has indicated that there is room for improvement. A review of the patents shows that an air bearing between the guide rails and the levitated vehicle involves considerable complexity both in the structures of the vehicle and rails and also in the pneumatic system required to supply air for the air bearing. Some air bearing guide rails seem complicated and thus expensive to construct. Sometimes the guide rail structure has two vertical plates, a top plate, the two round rails, plus ribs that connect the rails with the rest of the structure. This complicated construction involves considerable expense. In addition the guidance system of the vehicle is likewise rather complicated. Two concentric tubes are sometimes required to surround the round guide rails and provide the air bearing whereas a manifold and hose system is required to direct the air to the air bearing. The overall result is that the system is characterized by considerable complexity which increases the cost, the maintenance requirements, and the potential for operational and safety problems.

[0037] 2.3 Guided Aircraft Monorails.

[0038] The major advantage of the airplane is the low friction high speed travel possible with the added physical manifestation of aerodynamic lift. A considerable advantage to HSGT would accrue if the high speed advantage of aircraft could be kept while the free-flight hazards of the airplane could be eliminated. This is the goal of guided aircraft monorails. However, most schemes for guiding an aircraft-type vehicle along a monorail seem inelegant. Most methods simply use sensors to control proximity of the aircraft to a pathway monorail track but this does not allow a fast enough wing response control in the case of bumpy weather. Consequently the vehicle would be constantly banging against the monorail.

[0039] Examples of this type constrained airplane vehicle are U.S. Pat. No. 4,402,272 to Lehl et al. who describe a low wing monoplane with conventional fan jets for forward propulsion and proximity sensors to space the aircraft from a monorail. Compressed air from the monorail is introduced by valving along an elevated rail to form tubular air bearings. The aircraft has wheels which roll on the overhead rail structure when the vehicle is operating at low speeds such as when approaching or departing terminal areas but flies at high speed alongside the rail using a system of sensors to control and adjust the flight path in close proximity to the monorail. Thus this rail/aircraft system is supposed to accommodate slow speeds in terminal areas and high speeds between terminals. What happens when the free-flight aircraft is buffeted by high winds or air pockets knocking it out of position is not described. It would be a very bumpy, hazardous ride. Lehl describes a similar "flying aircraft" using conventional wheels on an overhead monorail at low speed and proximity sensors to control free flight at high speeds in U.S. Pat. No. 5,535,963. Leibowitz (U.S. Pat. No. 4,841,871) discloses a raised channeled monorail system with electrical cables from which the vehicles is suspended using conventional wheels at low speed and aerodynamic lifting at high speed while Halus (U.S. Pat. No. 5,653,174) also discloses an aircraft powered by electricity and guided by a linear electromagnetic motor using electrical power from a cable.

[0040] Chiquet (U.S. Pat. No. 4,022,403) describes an aircraft with foldable wings allowing it after landing to be of the same width as a conventional railway car so it can travel by wheels into the city on channels welded onto railroad tracks. Simuni (U.S. Pat. No. 5,222,689) describes a conventional aircraft with overhead propeller providing an air cushion at the front of the airplane and magnetic levitation to provide lift at the back of the airplane. Iida et al, (U.S. Pat. No. 5,215,015) describes a maglev type vehicle that is levitated until speed is sufficient for aerodynamic lift. Similarly, attractive magnets on a T-shaped monorail are used in Lay's scheme (U.S. Pat. No. 4,941,406) to lift the vehicle until aerodynamic lift speed is attained. A vehicle with both overhead track and undertrack uses sensors to control proximity to the tracks at aerodynamic lift speed in Bell (U.S. Pat. No. 4,703,697). Aerodynamic lift and motive power are supplied by a jet engine. Proximity to the rails is sensor controlled with "blasts of jetted air" plus airfoils positioning of the vehicle within the rails at high speed. U.S. Pat. No. 6,220,543 describes balloon-dirigibles tethered to a helicopter to prevent bomb threats.

[0041] 2.4 Linear Gas Turbines for HSGT

[0042] The cost of the vehicle itself, even when incorporating sophisticated technologies such as maglev, is a relatively small portion of the total transport system cost. Efficient on-board propulsion systems would make the vehicles less dependent on ground-based infra-structure and more autonomous in propulsion, levitation and guidance. The economic payoff of a self-contained propulsion system increases with increasing transit distances and railroad systems corroborate that argument: short-range transit systems typically utilize external electric power, whereas long-range transportation systems utilize autonomous propulsion in the form of Diesel locomotives. Because some means of providing compressed air is essential to vehicles using an air bearing it is instructive to review linear gas turbines for this capability.

[0043] The linear turbine drive consists of an onboard gas generator, typically an aeronautical fan/jet engine unit, a compressor, the turbine unit, and a thrust unit which provides gas jet reaction for propulsion of the vehicle. These turbomachinery components are normally oriented in-line with the track. The individual components, a row of nozzle blades and a row of turbine blades, are indigenous to the gas turbine while ducting allows bypassing some compressed gas for gas cushion levitation. The balance of the high pressure exhaust gas is strewn from the nozzle to produce the thrust propulsion force.

[0044] There are a number of patents which disclose railway vehicles utilizing the reaction of gas streams generated by gas turbine engines against fixed fins in the track for the purpose of propulsion. They fall into two categories: (I) those where the propulsive gas stream is generated on-board; and, (II) those where the propulsive gas stream is supplied from an external source, e.g. by pipeline and compressors installed along the track. A gas deflector rail, the linear equivalent of a stator blade stage in a rotary turbine, is attached to the track as disclosed by Gerhardt in U.S. Pat. No. 5,669,308 whereby the gas deflector rail is a fence-like structure extending along the track in which the pickets consist of flow turning blades. They serve to deflect into a forward direction the gas stream which was exhausted by the nozzles into a nearly backward direction. The gas stream is directed into the vehicle-mounted turbine blades to produce additional forward thrust which is of a similar magnitude as the thrust produced by the nozzles. The propulsion system may also include turbine components having an opposite orientation for the purpose of producing reverse thrust for braking and vehicle motion reversal. Control gates are used to selectively operate the propulsion system in the forward or reverse thrust mode. The exhaust from the linear turbine system can also be used in a gas cushion providing levitation for the vehicle. U.S. Pat. No. 3,547,042 to O'Connor, U.S. Pat. No. 2,869,479 to Hutchinson, and U.S. Pat. No. 4,841,871 describe similar linear gas turbine powered transportation systems. Bertin (U.S. Pat. No. 3,648,620) describes a gas cushioned vehicle riding on a monorail whereby the gas cushion is formed by a linear gas turbine. A conventional gas turbine provides propulsion. Wheels are used to propel the vehicle suspended from an overhead monorail and driven by a conventional propeller.

[0045] Patents in the second category include U.S. Pat. No. 4,085,681 to Barber; U.S. Pat. No. 3,242,876 to Berggren; U.S. Pat. No. 3,718,096 to Bloomfield et al.; U.S. Pat. No. 2,228,885 (German file number) to Gantzer; U.S. Pat. No. 3,540,378 to Giraud; U.S. Pat. No. 3,815,866 to Wirth. These patents (with the exception of Bloomfield) combine fluid reaction type propulsion with gas-cushion levitation. Mouritzen's paper entitled "Impulsive-Jet Transportation Systems" published in Mechanical Engineering, Vol. 94, No. Feb. 2, 1972, pages 12-17, also deals with an external high-pressure-air power system. The Category II systems require a complicated valving system in the pipe network which must be actuated to supply the high pressure air only at the instant the train is passing a particular valve. To minimize gas flow losses these valves must be rather closely spaced. An essential distinguishing feature of the inventions of Category II, however, is that the external power supply does not provide the desired autonomy in propulsion and the associated low cost of construction which is achieved with the category one self-contained power source vehicles.

[0046] Jet engine thrust from the gas turbine can be deflected as described by Horinouchi in U.S. Pat. No. 4,587,804 for V/STOL aircraft and by use of a variable axisymmetric nozzle in Urruela (U.S. Pat. No. 6.067,793) to control both speed and gas output direction for HSGT requirements. Wirth (U.S. Pat. No. 3,815,866) describes a valve mechanism for controlling thrust for a gas turbine levitation vehicle.

BRIEF SUMMARY OF THE INVENTION

[0047] The invention relates to a passenger, or cargo, high speed ground transportation (HSGT) system and more particularly to an all-weather overhead guideway channel using an aerodynamic air bearing from which the payload is suspended to achieve low friction for HSGT operation. A modified version provides a second lower hydrostatic air bearing for added vehicle lift plus rotational stability whereby movement about the upper air bearing axis, such as by crosswinds, are countered. High speed vehicle propulsion is provided by conventional gas jet reaction force from a self-contained linear gas turbine which provides both compressed air for the air bearings and propulsive thrust. The linear turbine drive used in the present invention as a propulsion system provides desired autonomy of operation. Vehicle breaking is conventional and provided by reverse thrust of the gas turbine engine.

[0048] The aerodynamic air bearing disclosed allows high speed while the specific overhead monorail design protects the air bearing from adverse weather conditions. In the event of power failure the vehicle comes to a safe stop. Passenger safety is assured by vehicle catch supports in the remote event of air supply failure whereby the vehicle slides on the monorail and comes to a friction halt. A major advantage of the inventive system disclosed is that it can be installed over existing highways or train track. Thus installation cost is low because right-of-way cost has already been expensed but also because the monorails are made of low construction-cost pipe. Because the vehicles are relatively small-sized terrorists do not see them as attractive targets. Maintenance cost is almost non-existent because the vehicle never touches the track. In effect the vehicle "flies" with all the advantages of high vehicle speed in air but with none of the hazards of free flight. Unlike a conventional airplane, the CATS (Constrained Airplane Transportation System) vehicle cannot crash.

[0049] Studies have determined that a cruising speed of about 300 mph is practical for various stage lengths, with reasonable acceleration and deceleration. At such speed, wheels become impractical.

[0050] Accordingly, the principal object of the present invention is to provide a rapid transit system that includes an overhead aerodynamic air bearing combining both low friction for high speed operation and vehicle lifting as a consequence of reduced static pressure produced by the moving air in the air bearing.

[0051] It is an object of the present invention to provide a rapid transit system to include an overhead aerodynamic air bearing with added vehicle rotational stability provided by deflection stabilizers acting to bring about rotational stability and thereby elimination of vehicle rotation about the aerodynamic air bearing center axis.

[0052] It is a further object of the present invention to provide a rapid transit system that includes an overhead air bearing with added vehicle lifting means provided by a second hydrostatic air bearing of concave-down outer surface matching the convex-up outer surface of a monorail thus allowing additional air bearing support of the vehicle while countering vehicle rotation about the axis of the aerodynamic air bearing.

[0053] It is a further object of the invention to provide a rapid transit system that includes the gas propulsion supply means centered between the upper and lower air bearings so as to minimize torque about an axis transverse to the longitudinal direction of the monorail.

[0054] Another object of the present invention is to provide a rapid transit system that includes air bearing means allowing high speed operation.

[0055] A further object of the present invention to provide a rapid transit system constructed over existing traffic so that right-of-way costs have already been expensed.

[0056] Another object of the present invention is to provide a rapid transit system including air bearings of configuration shielding and protecting them from adverse weather conditions.

[0057] Another further object of the present invention to provide a rapid transit system that includes inherent safe vehicle stopping in the event of power failure.

[0058] Another further object of the present invention to provide a rapid transit system of moderate passenger number whereby terrorists do not see them as attractive targets.

[0059] A further object of the present invention to provide a rapid transit system that is of low installation cost because the monorails are constructed of pipe.

[0060] It is a further object to provide a rapid transit system that is of low maintenance cost because the vehicle never contacts the monorail surface.

[0061] It is a final object of the present invention to provide a rapid transit system that has an effective range between automobile and jet plane travel distances.

BRIEF DESCRIPTION OF THE DRAWINGS

[0062] **FIG. 1** is a partial sectional view of the overhead aerodynamic air bearing of the present invention including passenger cabin suspended therefrom showing possible rotation of the passenger cabin due to crosswinds about the axis of the overhead air bearing.

[0063] **FIG. 2** is a partial sectional view of the overhead aerodynamic air bearing of **FIG. 1** including passenger cabin suspended thereon, combined with deflection stabilizers consisting of sidewalls providing aerodynamic rotational stabilization.

[0064] **FIG. 3** is a partial sectional view of the overhead air bearing of **FIG. 1** including passenger cabin suspended therefrom with added vehicle lifting means provided by a second hydrostatic air bearing positioned below of concave air bearing surface matched to the external surface of a monorail pipe and by combination providing rotational stability

[0065] **FIG. 4** is a partial sectional view of the present monorail train invention over existing highway traffic showing the gas turbine power source centered between the upper and lower air bearings so as to minimize thrust torque about an axis transverse to the longitudinal direction of the monorail.

[0066] **FIG. 5** is a perspective view of a monorail train according to the present invention showing in cutaway view a linear gas turbine with ducting providing pressurized air to the upper air bearing chamber.

[0067] **FIG. 6** is a perspective view of the present transit invention showing elevated structure of the monorail train over an existing highway.

[0068] **FIG. 7** is a table showing weighed criteria comparing existing and proposed HSGT transportation type systems including the CATS system which is the subject of the present invention.

DETAILED DESCRIPTION OF THE DRAWINGS

[0069] Referring to the drawings and more particularly to **FIGS. 1-7** there is illustrated a rapid transit system generally designated by the numeral **1** for the movement of passengers between designated points of travel.

[0070] **FIG. 1** shows the transit system **1** including overhead monorail **10** with inner surface **11** of concave-down configuration. This configuration assures that snow, rain, and ice, or debris do not accumulate on inner surface **11**. Self-contained gas supply device **20** discharges a fluid stream. As herein illustrated, the device **20** is a gas turbine which receives air, compresses it, injects a metered amount of fuel and ignites the mixture to produce a high energy fluid stream, in this case compressed air. At the compressor stage of the gas turbine some of the compressed air is discharged to ducts to provide for the air bearings whereas the balance is discharged at the output thrust nozzle of the gas turbine to provide propulsion of the vehicle. It is to be understood that other devices may be used for generating a propulsive fluid stream. One example of this would be an electrically operated air compressor, another a propeller engine. Air leakage in the bearing must be minimized and clearances between the monorail surface and the vehicle are relatively small thus the active surfaces should preferably be close-fitting. This suggests a pipe of relatively precision inner surface but because the pipe is weather protected this inner surface can be long lasting.

[0071] Gas turbine **20** discharges from the compressor section of the turbine a propulsive fluid stream through outlets thereby supplying compressed air which is valved (not shown) by way of duct **21** to compressed air chamber **14** with outer surface **13** matched to conform to the configuration of monorail **10** inner-surface **11**. The spacing between surface **13** and **11** is of small distance d, shown in the Figure. Surface **13**, is of total area including the arc length shown (approximately 270°) and the width of the air bearing in longitudinal direction (not shown). Surface **13** contains numerous holes (not shown) allowing air to escape at velocity v forming air bearing **12** in the space between outer surface **13** of gas chamber **14** and inner surface **11** of monorail **10**. The moving air, or any fluid, if it is moving and issuing fast enough in velocity between the two surfaces **13** and **11** provides two important effects: first, a low friction fluid bearing is produced but secondly a reduced pressure region is formed in the fluid bearing. The cause of this reduced pressure region in air bearing **12** is lowered static pressure because of the dynamic pressure increase caused by the moving air in air bearing **12**. Thus the differential pressure created between the reduced pressure inside the air bearing region **12** and the external air pressure acting on the underside of pressure chamber **14** acts to cause some lift force acting on the vehicle. This differential pressure acts to lift passenger cabin **30** attached to the aerodynamic air bearing by means of support member **23**. Consequently aerodynamic lift acts to provide a force vector counter to the weight of passenger cabin **30**.

[0072] Summarizing, there is a force separating the air bearing surfaces due to the incoming air mass which is a function of the cubic feet per minute of incoming air each hole times the number of holes over the total surface area of the fluid bearing with a counterforce attracting the two surfaces caused by decreased static pressure as a consequence of the dynamic pressure increase caused by the moving air and governed by ½ the fluid density times the fluid velocity squared. This combined action we will call an aerodynamic fluid bearing.

[0073] **FIG. 1** also shows passenger cabin **30** at possible rotational positions about the center longitudinal axis of air bearing **12** whereby a 30 degree counterclockwise and a 20 degree clockwise rotation are illustrated. Crosswinds could cause this rotational movement of passenger cabin **30**. It is necessary to stabilize these rotation forces.

[0074] **FIG. 2** shows a rapid transit system whereby the upper aerodynamic bearing has added elements controlling rotational stability. If a crosswind acts against passenger cabin **30** to cause rotation of clockwise rotational direction around the longitudinal rotation axis of aerodynamic air bearing **12** then a decrease in spacing of surfaces A-B will occur and an increased spacing of surfaces C-D will occur. In effect the volume defined by surfaces A-B and the length of the air bearing surface in the longitudinal direction will decrease and the volume defined by surfaces C-D and the length of the air bearing in the longitudinal direction will increase. An increase of volume allows increased fluid flow from air bearing **12** with consequent decreased static pressure, measured generally as $\frac{1}{2}\rho v^{2,}$ where ρ is the fluid density and v is the fluid velocity, occurring because of the dynamic pressure increase. This decreased static pressure causes surface C, which is free-floating because of air bearing **12** to approach fixed surface D of monorail **10** until an equilibrium pressure is attained. Consequently, automatic rotational stabilization occurs by use of these aerodynamic surfaces. Similarly, crosswind forces acting counterclockwise on passenger cabin **30** are countered by similar aerodynamic changes in surfaces A-B and C-D.

[0075] **FIG. 3** shows a rapid transit system **1** of upper aerodynamic air bearing **12** and lower hydrostatic air bearing **42** providing added vehicle lift and rotational stabilization. Gas turbine **20** supplies compressed air through duct **23** to lower compressed air chamber **40**. Outer surface **41** of compressed air chamber **40** is shaped concave-down and contains holes (not shown) allowing compressed air to issue and form hydrostatic air bearing **42** to provide lift force reaction against convex-up active surface **43** of monorail pipe **44**. In combination air bearing **12** and **42** provide rotational stabilization.

[0076] The general equation describing the vehicle forces, with gravity down in the plus direction, is:

$$F_{down}(\text{Upper Air Bearing})-F_{up}(\text{Aerodynamic Bearing Lift})-F_{up}(\text{Lower Air Bearing})+F_{down}(\text{Gravity})=F_{up}\text{-}(\text{Safety Factor}),\text{ or}$$

$$(cfm_{hole}*N*S)_{aero}-(C_L*\tfrac{1}{2}\rho v^2)-(cfm_{hole}\cdot N\cdot S)_{hydrostatic}+mg=S.F,$$

[0077] where cfm_{hole} is the cubic feet per minute of air flow through a hole (determined by hole size), N is the number of holes, S is the surface area of the air bearing, C_L is the lift coefficient for the air bearing shape, ρ is the air density, v is the velocity, m is the mass of the vehicle and g the acceleration due to gravity. The sum of these forces act to stabilize and provide for a vehicle isolated from the monorails by the air bearing regions at equilibrium pressure.

[0078] A hydrostatic fluid bearing differs from an aerodynamic fluid bearing by the speed and pressure of the incoming fluid with the aerodynamic fluid bearing having fluid velocity sufficient to provide a significant dynamic pressure. The efficiency of the hydrostatic bearing is a factor of the total area of the air bearing surface plus the size of the holes and the number of holes allowing air to issue. For the aerodynamic fluid bearing the combined upward force lift vector reacts against the downward acting force of the incoming air mass plus the weight of the vehicle. Theoretically, the aerodynamic air bearing has more effective lift than a conventional wing because the reaction forces set up by the directed air are vertically downward contrary to the only partially downward directed lift vector in conventional wings as a consequence of circulatory lift forces at the Kutta condition. After sufficient forward speed is attained by thrust forces provided by the gas turbine then conventional aerodynamic lift could be employed as provided by conventional wings (not shown) on the vehicle

[0079] To balance the action of transverse forces, such as centrifugal forces generated in curved track sections, the alignment of the hydrostatic bearing with the aerodynamic fluid bearing must necessarily be canted and this inclination must be imposed by conformity with centrifugal forces during a turn. This position is determined by the resultant of the transverse centrifugal forces and the relative weight of the vehicle at the virtual axis about which the vehicle rotates. Centrifugal force in curved track at several hundreds mph for a one-kilometer radius equals the force of gravity at 196 m.ph. and twice that value at 300 mph. A 500-meter radius causes a centrifugal force equal to gravity at 160 m.ph. and twice that at 225 mp.h.

[0080] **FIG. 4** is a partial sectional view of a monorail train **1** of the present invention elevated over an existing highway by means of posts **51** positioned periodically along cement barrier **52**. Frame **50**, also positioned periodically, provides separation of upper monorail pipe **10** from lower monorail pipe **44**. It should be noted that monorail **44** being a closed pipe is rigid. However, upper monorail **10**, a pipe section, aligned to pipe **44** by frame **50** can desirably allow some flexibility as by spring loading to frame **50**. This flexibility is desirable to allow dampening shock forces acting on the vehicle. In the embodiment illustrated gas turbine air compressor **20** is positioned centrally between upper air bearing **10** and lower air bearing **44** thereby eliminating torque around an axis transverse to the longitudinal direction of the monorail. Thereby better stabilization of the vehicle is achieved. Another possible configuration would be two gas turbines as power plants positioned each side of the passenger cabin. A further embodiment for monorail train **1**, the subject of the present invention, could be two aerodynamic air bearings positioned each side of the passenger cabin with the gas turbine power plant in the middle or an aerodynamic air bearing and a hydrostatic bearing positioned each side where the intent is to achieve rotational stability. Numerous other embodiments of specific form other than shown or described do not depart from the spirit or essential characteristics of the subject invention.

[0081] **FIG. 5** shows a cutaway view of the linear gas turbine **20** showing aerodynamic fluid bearing **12** of surface area **13** with holes (not shown) generally positioned at the center ⅔ of the total surface area **13** with upper monorail **10**, passenger cabin **30**, lower hydrostatic fluid bearing **42**, and monorail tube **44** also shown. Conventionally, gas turbine **20** comprises input fan section **24**, compressor section **25**, turbine section **26** and thrust nozzle **27**. Gas turbine **20** is well-protected within monorail pipe **10**. Thrust nozzle **27** of gas turbine **20** provides forward propulsion of the vehicle by conventional gas jet reaction forces. Ducted from compressor section **25** of gas turbine **20** is upper air bearing duct **21** supplying compressed air to aerodynamic bearing **12** whereas duct **23** (shown in **FIG. 3**) provides pressurized gas for lower air bearing **42**. Valving (not shown) at each duct input, suitably controlled by electronic sensor means (not shown), determines the amount of compressed gas optimally supplied each duct. Lower air bearing **42** of concave-down outer surface **41** containing numerous holes (not shown) allows injection of compressed air of relatively low velocity to air bearing **42** from lower air chamber **40**. This action forms hydrostatic air bearing **42** consisting of the space defined by the convex-up surface **43** of monorail pipe **44** and concave-down surface **41** of lower air chamber **40**. The resultant air bearing **42** aids lifting of passenger cabin **30** and also acts to counter rotation of the vehicle about the axis of aerodynamic air bearing **12**. Thus combined use of air bearings **12** and **42** provide rotational stability and shock absorbing capability for passenger cabin **30**. The fact that the vehicle is entirely air-isolated from the monorail surfaces allows gas turbine **20** to provide very effective high speed because of the very low friction achieved.

[0082] **FIG. 6** shows a perspective view of the transit system **1** of the present invention elevated over an existing highway thus eliminating the requirement for right-of-way purchase. Lower monorail **44** is of rigid closed pipe construction providing excellent strength in support of passenger cabin **30** although some of the weight of the vehicle is transmitted from the upper air bearing **12** to frame **50** to support poles **51** and in turn to cement barrier **52**. Upper monorail **10** is also of pipe construction but with open bottom. Pipe for both monorails is a desired low construction cost component. Cement barrier **52** is narrow and constructed at the center of the highway while elevation poles **51** hold up lower monorail pipe **44** well above existing truck traffic. Frame **50**, spaced periodically, holds overhead pipe **10** in proper alignment to pipe **44** but analysis shows upper pipe **10** should be allowed some positioning flexibility as by spring loading to frame **50** because upper air bearing **12** in forming a reduced pressure region automatically attracts monorail **10** until pressure equilibrium occurs. In fact, flexibility of overhead pipe **10** is desirable for shock absorption of passenger cabin **30** to provide a smoother ride. More specifically, it is rotational stability about the longitudinal axis of tube **44** that is the chief function of overhead tube **10** and not their precise spacing, if monorail **10** is spring-loaded to frame **50**.

[0083] It can be observed that upper monorail **10** and lower monorail **44** are weather resistant. That is, in neither case can snow, rain nor ice collect on the active surface. The tiny amount of snow or ice that could collect on the top of pipe **44** could easily be completely avoided by using monorail pipe **44** to independently transmit warmed water, or better yet warmed fuel that will be used at the next transit station.

[0084] **FIG. 9** compares the main features of the CATS transportation system, the subject of the present invention compared to both existing and proposed HSGT transportation systems. Using transportation statistics provided by DOT and using 1 as the lowest score for a desired transportation criteria with 10 for the highest, weighting factors can be applied for each attribute as judged from the passengers viewpoint. For example, jet airplanes have the highest speed advantage because they fly through a low friction ambient so we can assign a value about 8 for this attribute (a transportation system based on rockets might be faster but we'll not be considering them). With regard to weather concerns jet planes are grounded during snowstorms and when sleet and ice conditions are severe. Severe wind conditions ground jet planes from takeoff. But jet planes can fly high above weather and can use instruments for flying through clouds and low visibility conditions when airborne. On the other hand, from the passengers standpoint that doesn't help if their destination is an airport closed due to bad weather. So considering all these ramifications and factors let's assign a weight of 5 for this criteria for jet planes. As far as safety is concerned, jet plane passengers worry obsessively about crashing in the event of power failure but actually jet planes have a good safety record so let's use a factor of 8 for this attribute. Terrorists see jet planes, because they hold a lot of people, as attractive in-flight targets. After 9/11 and Gulf War II passengers worried so much about this factor that some airlines went bankrupt. Also, it is worrisome that at take off and landing commercial jets are especially vulnerable to hand-launched missile attack. Let's use a weighing factor of only 4 for this attribute. As far as construction costs are concerned jet planes cost millions each, airports cost billions. Lets use a weighing factor of 3 for this attribute. To assure safety and reliability, jet plane maintenance costs are huge. Let's use 3 for this factor. Jet planes have effective long-range operation, especially over water, but they have very poor short-range efficiency. Let's use 8 overall for this factor. Jet planes have poor effective travel time; especially post 9/11 because inspections and delayed flight add considerable wait time to actual transit time. Let's use only 3 for this factor because it is a considerable source of passenger agitation. As regards freight capacity jet planes are very sensitive to fuel efficiency which is in turn sensitive to total jet plane weight so jet planes are not very efficient freight carriers except for moderate weight cargo over long distances. Jet planes can best be financially justified for high-value cargo (i.e., passengers). For high efficiency jet planes must be large so that a large number of people can be carried each flight (which unfortunately makes them attractive terrorist targets). Let's use a factor of 4 for jet planes as freight carriers.

[0085] A good HSGT system should have an effective range intermediate short range automobiles and long distance airline travel. The effective range should be about 500 miles, medium distance between low speed short travel automobiles and fast speed long distance jet aircraft. The requirement for high speed operation eliminates the use of wheels of any kind so there must be some method of vehicle levitation. For all-weather operation some method of shielding the monorail surface from snow and ice is absolutely necessary. This rules out any kind of conventional monorail system wherein the track is exposed to snow, rain, or ice. Installation cost must be kept low and especially right-of-way costs should be eliminated. Passenger safety must be a top consideration so safe stopping of the vehicle in the event of power failure must be an inherent feature of the system. Continuing maintenance and repair costs must be minimized. The total travel time must take into consideration not only the transit speed but passenger wait time. Transit speed should be high and transit wait time low. Total transit time must be optimized. The system should not be an attractive terrorist target and this requires good security and not a considerable number of passengers. Ideally, the transit system should allow heavy freight transport or at least cargo or freight transportation during times of minimum passenger use. Finally, the passengers should enjoy using the system. The thrill of the ride would be a plus. Meeting all these criteria is a daunting task.

[0086] By analyzing each of these desired attributes for a transportation system we can come up with overall scores to compare of how well they perform. Table 9 shows that Tube Transport and Maglev systems have the lowest overall scores while trains, automobiles and boats have surprisingly high scores. The CATS HSGT system, specifically designed to meet the needs of high speed operation, with all-weather capability, low installation cost, assured passenger safety in the event of power failure, low maintenance cost, good effective range, low passenger wait time, reduced possibility of terrorist attack, moderate freight capacity, and passenger enjoyment shows high overall scoring.

[0087] The HSGT transportation system of the present disclosure will be called CATS (Constrained Airplane Transportation System) and by the invention all HSGT criteria are met including high speed operation, all-weather capability, assured passenger safety, plus low installation cost. The CATS system disclosed is designed for 500-600 mile trips (i.e., 300 mph effective ground speed) although short trips are also efficiently accomplished. In effect the invention is a safe, all-weather, constrained airplane

[0088] The CATS system is the first practical transportation method particularly designed to use existing highway and railroad right-of-ways while adaptable to both urban and intercity transportation. By far the most expensive aspect of a new ground transportation system is the cost of right-of-way. All operational transportation systems presently moving people and materials including airlines use vast amounts of valuable land area often hard to come by, especially in metropolitan areas. Because the CATS vehicles are overhead existing right-of-ways land use is minimized. The CATS system, using overhead monorails over existing highways would give air travelers a competitive option, take cars off roads, cut air pollution and bring needed industry outside crowded cities. Thus the CATS system is preeminently affordable because it uses existing highway right-of-ways yet is capable of being implemented piece-wise while augmenting existing rail systems. This greatly reduces costs for implementation because right-of-way cost is the main expense of any new transportation system. It does not require huge investments in infrastructure before it can be used because pipe construction is used and it is capable of being implemented piece-wise while augmenting systems currently in use with minimum testing and startup costs. Maintenance is minimized by the elimination of wear and tear on the track surface.

[0089] A feature of the CATS system is dividing passenger from freight operation. Trucks and trains carry heavy freight down below while passengers and goods travel at very high travel speed above. Vehicle availability is computer-controlled at stations according to real-time needs. Thus high speed transit is allowed with minimal passenger wait time at stations.

[0090] HSGT operation is possible because the passenger vehicle is separated from the overhead monorail "track" by an air bearing which accomplishes extremely low friction for high-speed, power-efficient vehicle motion. Forward propulsion of the vehicles on the track is accomplished by conventional reaction forces obtained by a self-contained linear gas turbine. The air bearings not only allow very high speed but there is no physical contact between the vehicle and the guide rails. This innovative low friction method assures maximum propulsion power efficiency while insulating the passenger cabin from shock and vibration. During high speed free-flight forward propulsion the aerodynamically contoured vehicle, with added wings, could contribute additional conventional aerodynamic lift. There is never the danger of the vehicle crashing in the event of power failure because the monorail catches the vehicle thus eliminating one of the main fears of airplane flight.

[0091] CATS is an all-weather transit system. The CATS transit system is not susceptible to the hazards associated with adverse weather conditions, including darkness or the weather hazards that typically hazard automotive and air transportation because the CATS vehicle aerodynamic air bearing is inside the upper monorail. The monorail acts as a roof to protect the inside "track" from weather. Thus the vehicle is protected from rain, snow, sleet and hail and the constrained vehicle can travel even in fog, dense snow, or dense rain obscuring visibility. Adverse weather cannot disrupt the computer-controlled operation of the CATS system. It is designed to minimize loss of life in case of earthquake, landslide, tornadoes and even terrorist activity. The CATS system does not require that individuals own special vehicles yet encourages use of hybrid and electric cars at the destination. It does not interfere with pedestrians or other surface traffic. It maximizes energy use and minimizes pollution while being quiet, convenient, and enjoyable to use. Present systems make inefficient use of energy. Two hundred six million automobiles, designed for six passengers, almost entirely carry only one. They contribute materially to pollution of the atmosphere. Ground-based vehicles interfere with and endanger other surface traffic, not just automobiles and trucks, but pedestrians, and bicycles. They kill 500,000 deer each year. Because it is overhead existing highway traffic the CATS transit system is safe and does not interfere with trucks, pedestrians and other surface traffic below. Congestion and intersection accidents are entirely eliminated. Individual drivers are factored out by computer-controlled ground speed. Finally, no transportation system can be useful that is not utilized by the public. Passengers must enjoy the speed and comfort of an efficient transit system; they must enjoy the ride. The CATS experience will lure auto drivers away from highways and the thrill of the high speed journey will make passengers enjoy using it.

[0092] In conclusion there is provided a high speed ground transportation system with all the features desired for a successful passenger transportation system. The CATS transportation system, the subject of the present invention, may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The present embodiments are therefore considered in all respects illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather then by the foregoing description or discussion.

1. A high speed ground transportation system of the overhead monorail type with cargo vehicle suspended from a fluid bearing wherein the improvement comprises:

a. said cargo vehicle containing fluid dispersive means providing compressed fluid to,

b. a fluid emission surface above said cargo vehicle of convex shape matched in spaced configuration to,

c. said monorail inner-surface of concave shape of arc larger than width of said convex emission surface, wherein

d. said fluid emission mass acts to separate said surfaces whereas reduced static pressure caused by increased dynamic pressure of the moving fluid acts to bring said surfaces together resulting in equilibrium separation, thereby providing

e. a high speed transit system of low friction and vehicle lifting capability, of configuration shielding and protecting from adverse weather, wherein in the event of fluid dispersive failure the vehicle comes to a safe stop, construction cost is low because the monorails are constructed of pipe, and maintenance cost is minimized because the vehicle never contacts the monorail surface.

2. A high speed ground transportation system of claim 1 wherein said fluid is air and said surfaces are cylindrical.

3. A high speed ground transportation system of claim 1 wherein,

a. said moving fluid from said aerodynamic fluid bearing issues downward to

b. spaces of equal volumes on opposite sides of said support attachment to said passenger cabin whereas,

c. said volumes are defined by surfaces comprising the flat sides of said support attachment of fixed structure and vertical surfaces attached to said monorail and corresponding in spaced configuration to said support attachment surfaces whereby the corresponding surfaces act to provide aerodynamic differential pressure and thereby provide,

d. rotational stability of said vehicle.

4. A high speed ground transportation system of claim 1 wherein the improvement comprises:

a. a second fluid bearing below said cargo vehicle wherein a fluid emission surface is of concave shape and matched in spaced configuration to,

b. a second monorail below said cargo vehicle with outer-surface of convex shape whereby in cooperation,

c. said fluid emission thereto said surfaces acts to hydrostatically separate the surfaces, thereby providing

d. added vehicle lift and elimination of vehicle rotation around the longitudinal axis of the aerodynamic fluid bearing of claim 1.

5. A high speed ground transportation system of claim 4 wherein the improvement comprises:

a. said fluid dispersive means centered between upper and lower air bearings, thereby providing

b. minimized torque about an axis transverse to the longitudinal direction of the monorails, low friction for high speed operation, and elimination of vehicle rotation around the longitudinal axis of said aerodynamic fluid bearing.

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