VECTORR™ Technical Overview

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The name VECTORR™ comes from vector, a mathematical term meaning direction and magnitude -- and Torr, a metric measurement of pressure. Torr is pressure or vacuum expressed in millimeters of mercury (mmHg). One Torr is equal to 1/760 of a standard atmosphere. One can calculate the amount of thrust developed by our system with Torr and the diameter of the power tube. As the diameter of the power tube is increased from pilot scale to full scale, the available thrust increases as the square of the diameter. Designs for a full-scale power tube with a 24 psi (165.36 kPa) pressure differential result in available thrust of approximately 200,000 pounds.

Overview

The patented VECTORR atmospheric transportation system uses vacuum and air pressure (differential pressure) to move along an elevated guideway. Stationary power systems create a vacuum in a continuous tube located centrally below the rails on the guideway. This tube (power tube) is held within a steel truss. Inside the power tube is a free piston that runs laterally on its own rails while creating a seal inside the tube. The VECTORR is magnetically coupled to this free piston through a non-magnetic, non-conductive window on the power tube. As the stationary power system pulls the air from the tube, it creates a vacuum in front of the free piston and air is able to enter behind the free piston. This creates the differential pressure that moves VECTORR.

The free piston inside the power tube incorporates two seal and throttle valve mechanisms called thrust valves. A thrust valve is located on each end of a series of magnetic couplers inside the power tube. The process of opening or closing the thrust valve provides throttle control and effective braking of VECTORR The speed and movement of VECTORR can be modulated by controlling the stationary power systems in coordination with the thrust valves. It is important to note that VECTORR is completely unlike Maglev technology. Instead of levitating the system, VECTOR depends on magnets for coupling the thrust valve/free piston from within the power tube to the VECTOR unit.

Since the VECTORR system is envisioned for high-speed applications and VECTORR is very light, then, as a necessary safety requirement, the truck wheels are locked onto the angle shaped tracks on the guideway at an appropriate locking angle. The configuration of the wheels does not require flanges. This flangeless design, when coupled with the angled rail configuration with lubricated rails, results in lower frictional losses - especially when negotiating curves in the guideway.

Elevated Guideway

VECTORR is designed to operate on an elevated guideway. The light weight of the system enables VECTORR to be economically elevated. The elevated guideway eliminates grade

crossings which allows a safer environment for passengers, pedestrians, maintenance workers, and vehicles while allowing the unit to run at constant speeds for longer stretches. This guideway also lessens the environmental impact to the land.

The VECTORR system does not require a catenary system. The view from an elevated position will be of the scenery and not the typical wires and support structures flashing by the windows. People driving or living near the guideway will also appreciate how eye appealing the system is without a catenary system. Because VECTORR does not depend on traction, the elevated guideway can be built with grades up to 10%. With this grade climbing capability, VECTORR will require fewer tunnels than some of the other high-speed conventional systems. The VECTORR system can integrate with many existing right-of-ways, but does not require using existing rail right-of-ways. VECTORR could be built within or adjacent to interstate right-of-ways as it can negotiate grades as steep as those normally found on the interstate system.

At present there are 2%, 6%, and 10% grades built into the middle of the guideway to determine the braking and speed control of the system, the optimal articulated module length, and the total transportation unit weight. A remote control system is used for operating the VECTORR™ up and down the guideway, applying brakes, reversing direction, and modulating speed. There are two sensitive analog manometers located along the guideway to measure vacuum and pressure differentials. Two stationary power systems are installed to generate the required thrust to move the VECTORR™ along the guideway. The pilot model currently operates at speeds up to 30 m.p.h. (48 km/h) which equates to a scale speed of 180 m.p.h. (290 km/h).

Power Systems

The cost of the power to develop the required thrust is significantly reduced by using stationary power systems along a given guideway. The VECTORR is lightweight because there is no on-board propulsion system or fuel. The stationary power systems eliminate the need for traction motors, locomotive, or other prime moving equipment attached to the system for propulsion. The transfer of this weight to stationary power systems reduces the overall weight of the system and the inefficiencies that are created when the power source is moving.

Depending on the terrain and the power needs of VECTORR these power systems can be located up to 50 miles (80.5 km) apart along the guideway and powered with electric motors or other power sources. The stationary system is adaptable to a variety of power sources including steam ejectors, air or water ejectors, gas turbine, diesel engines, and others. Since the power source is stationary, these stations can incorporate advanced pollution abatement systems when fossil fuels are required. The preferred system would be powered electrically.

Due to stored energy capability in the power tube, rapid starting acceleration can be accomplished without the occurrence of high energy spikes.

It is projected that only 10 poundforce per square inch (psi) (68.90 kPa) of vacuum is required to move a full-size, fully loaded 3-module VECTORR (440,000 pounds/199,760 kg) along a level section of guideway at speeds in excess of 200 m.p.h. (322 km/h). VECTORR has the capability to utilize not only vacuum (pull), but also pressure (push) or a combination of the two (push-

pull) to move along the guideway. Greater thrust can be generated in either direction by increasing the pressure differential across the thrust valves. To enable higher thrust, positive air pressure is introduced into the power tube by an aft power system as air is simultaneously evacuated (pull) from the power tube by a forward power system. This addition of positive air pressure is utilized as a form of "atmospheric boost" to maintain respectable speeds on steep grades. The system can add 15 psi (103.35 kPa) additional pressure to the 10 psi vacuum to result in 25 psi (172.25 kPa) differential pressure across the thrust valves. It is projected that this is enough thrust to propel a full-size, fully loaded VECTORR™ up a 10% grade at speeds in excess of 90 m.p.h. (145 km/h).

The Z-Valve, (patent pending) has been designed, built, and tested to enable isolating sections of the power tube between pressure and vacuum requirements. The Z-Valve can also be used in a throttling mode for braking when descending steep grades.

Passenger Cars

A full-size VECTORR is designed to accommodate between 240 and 800 passengers. The number of passengers depends on the number of modules comprising the VECTORR unit. A VECTORR can be up to ten modules long. Each module is 80 feet (24 m) long and accommodates 80 people. If necessary, wider modules can be utilized to increase the passenger capacity.

The unit's onboard power requirements relate only to passenger comfort (air conditioning, heating, lighting, etc.), control, and communications of about 80 Kw/module. This power could be readily provided by wheel-driven generators mounted on the thrust carriages and truck assemblies. A third rail power pick-up could provide for onboard electrical requirements in stations and service areas. Onboard batteries could supply transitional and emergency power.

For economic, environmental, and esthetic reasons, a catenary system has not been considered. Overall, VECTORR should have a very low weight per passenger requirement.

The outdoor pilot test guideway is 2,095 feet (638 m) long and includes all components of a working VAC TRAC system. VECTORR™260-01 is the 1/6 scale pilot model currently operating on the guideway. The VECTORR™260-01 unit consists of three modules for a coupled length of 46 feet (14 m) connected by common trucks. The unit weighs about 2000 pounds.

Braking

Since the VECTORR is moved by thrust developed by differential pressure in the power tube - not traction - our overall braking requirements differ from traction-driven equipment. We presently do no wheel braking on our 1/6 scale pilot model. We accomplish braking with a rail braking system and by modulating pressure or vacuum in the power tube. Under emergency conditions the brakes will apply on power or air failure. Recent developments have proven that we can use atmospheric braking to stop and reverse the unit or hold the unit on 6% and 10% grades without using contact-type brakes.

Environmental Benefits

1. Natural Ecosystems/Water Quality/Earth Friendly

The elevated guideway reduces environmental impact because its installation requires less earth moving, trenching, and tunneling. The design of the elevated guideway results in a small on-ground footprint with minimal surface area being impaired. The VECTORR system minimizes roadblocks to people, wildlife, and nature.

2. Energy Efficiency

VECTORR is lightweight and would preferably use electric power for propulsion. Air is ultimately moving the unit which is an efficient way to transmit energy.

3. CO2 Emissions

The CO2 emissions are minimal as the system would normally utilize electricity for propulsion and power for the interior of the module. The source of the electricity will determine the exact savings of CO2 emissions.

4. Decreased Noise

Without the use of a catenary system or pantographs on VECTORR we eliminate the aerodynamic and frictional noise created by that system. Without the use of a locomotive, we also eliminate the noise created by that power conversion system. VECTORR would be designed to lessen noise from air movement, and the lightweight features can also reduce noise levels. Lubrication of the wheel and rail interface will result in less rolling resistance and will lower noise pollution.

5. Visual Attributes

With no catenary system there are minimal visual distractions to the passengers. The VECTORR does not require the construction of heavy viaducts. The lightweight factor makes it easier to elevate on trusses that can be less visually obtrusive to those driving or living near the guideway.

Safety Features

VECTORR has safety features inherent to the system. It is designed for aerodynamic efficiency and has a low center of gravity. The angled wheels are designed to lock the unit to the rails on the guideway for high-speed capabilities. The high-speed braking system utilizes atmospheric braking and eddy current braking. Rail braking is utilized for slow speeds and emergency stops. When descending a hill, the compression of air in the power tube can also be used for braking. VECTORR can climb relatively steep grades without the wheels slipping because no traction is needed with the system. The elevated guideway eliminates grade crossings and the intersections of passengers, pedestrians, and at-grade vehicles. The possibility exists that the power tube may also enable de-icing and defrosting of the rail system in frigid climates.

Patents

Flight Rail Corp. has been awarded five strategic U.S. patents and seven foreign patents over the past several years related to the VECTORR transportation system with other patent applications pending.