By utilizing a track bed of the type described, the train vehicle is not only suspended above the ground surface; it is also self-stabilized vertically and horizontally about an equilibrium position over the centerline of the track bed. If displaced in any direction away from equilibrium, a powerful electromagnetic restoring force is generated such that the vehicle is returned to the equilibrium position. Calculations indicate that, in order to displace the train only a few inches from equilibrium, forces of a magnitude comparable to the weight of the train itself would be required. For example, wind forces would deflect the train at most a half an inch from the equilibrium position.

In more refined embodiments of the electromagnetic suspension system of the present invention, alternative track loop arrangements are used. Additional loops are added to the track array to provide more effective lateral, or horizontal, and torque restoring forces and to provide rapid damping of displacements from the equilibrium position due to transient perturbations. With the minor exception of some arrangements of the optional damping loops, none of the track loops in an array carry current except when the train vehicle is passing directly above that portion of the track bed.

It is, therefore, a principal objective of the present invention to provide a new form of electromagnetic suspension and stabilization system for a high-speed ground vehicle which is more economically and technically advantageous than other magnetic suspension systems heretofore known.

It is an important objective of the present invention to provide a new form of high-speed train which is electromagnetically suspended and stabilized at high speeds, and is supported on conventional wheel means for low speed transitional periods of operation and when the vehicle is at rest.

It is a further important objective of the present invention to provide a novel electromagnetic suspension system for a high-speed ground vehicle which requires a relatively small power expenditure for levitation of the vehicle above the ground surface.

It is a principal feature of the present invention to utilize the interaction of powerful magnetic fields generated by superconductor materials to stabilize and guide a heavy high-speed ground vehicle.

It is a further principal feature of the present invention to provide a novel electromagnetic suspension system for a high-speed ground vehicle utilizing a longitudinal track bed wherein the moving vehicle is stabilized thereover against vertical, lateral, rotational and oscillatory displacements.

It is a specific feature of the present invention to provide a new form of electromagnetic suspension system for a high-speed train in which the interaction of current-carrying superconductor loops with electromagnetically induced currents in a series of oriented arrays of closed loops composed of non-magnetic metal conductors generates suspension and stabilizing forces.

The foregoing and other objects, features and advantages of the invention will be more readily understood from a consideration of the following detailed description of preferred embodiments of the invention, as illustrated in the accompanying drawings.

Brief description of the drawings

FIG. 1 is a pictorial perspective view of an exemplary train vehicle electromagnetically suspended and stabilized according to an illustrative embodiment of the present invention.

FIG. 1A is a diametric cross-sectional view of an illustrative construction for a superconductor cable useful in the electromagnetic suspension system of the present invention.

FIGS. 2–4 are perspective, front and top schematic views, respectively, of an illustrative arrangement of a lifting track loop array for vertically suspending a train according to the present invention.

FIGS. 5–7 are perspective, front and top schematic views, respectively, of an illustrative arrangement of a track loop array for horizontally stabilizing an electromagnetically-suspended train according to the present invention.

FIGS. 8–10 are perspective, front and top schematic views, respectively, of an illustrative arrangement of a track loop array for damping horizontal and vertical perturbations in an electromagnetically-suspended train according to the present invention.

FIG. 11 is a front schematic view showing the lifting, horizontal stabilizing, and damping track loop arrays of FIGS. 2–10, combined to form a complete electromagnetic suspension and stabilization system for a train according to the present invention.

FIGS. 12, 12A, 13, and 14 are perspective, detail, front and top schematic views, respectively, of an alternative form of lifting track loop array for providing vertical suspension of a train.

FIGS. 15, 16, and 17 are perspective, front and top schematic views, respectively, of an alternative form of track loop array for imparting horizontal stability to a magnetically-suspended train.

FIGS. 18, 19, and 20 are perspective, front and top schematic views, respectively, of another alternative form of lift and horizontal stabilizing track loop arrays for an electromagnetically-suspended train which are level with the roadbed and do not require any above-ground support structure.

FIGS. 21 and 22 are schematic diagrams of an illustrative circuit arrangement of external inductance means for limiting the amplitude of the current induced in the lifting track loop array.

Detailed description of the preferred embodiments

Referring initially to FIG. 1, an illustrative form of train, represented generally as **30**, is shown equipped with the electromagnetic suspension and stabilizing system of the present invention. Typically, the two-car train might be 100-feet long, carrying 100 passengers and weighing 60,000 pounds fully loaded. This is approximately the same as the fuselage section of a jet airliner of comparable capacity. The train would be propelled by any suitable means such as a rear-mounted turbin-driven propeller **40**, and while at rest, or operating at transitional speeds before the magnetic suspension system is fully effective, the weight of the train body would rest in ordinary fashion on spaced sets of rubber-tired wheels **45** which might, if desirable, be retractable at high speeds to cut down on air resistance to the moving vehicle.

As shown in the figure, each side of the train is provided with a plurality of laterally-extending pontoons **50** carrying respective superconductor loops **55** which cooperate through electromagnetic induction with arrays of shorted conductor loops of non-magnetic metal, indicated collectively as **60**, contained in a supporting track structure **70**. At starting, as the train accelerates, the train body begins gradually to lift above the roadbed **25** by reason of the magnetic suspension effect which will subsequently be described herein. At speeds starting from about 35 miles per hour on up (e.g., 100 to 300 miles per hour, and higher), the train **30** is magnetically suspended above its roadbed **25** at an elevation of about one-foot, and is guided along under the influence of the track loops **60** extending on either side of the train which, in addition to a suspension force, generate stabilizing and damping forces serving to firmly maintain the train at a fixed equilibruim position relative to the cross-section of the track bed **70**. The train travels in an essentially friction-free environment, except for air friction, since it is levitated above the roadbed completely free of contract with either the roadbed or the track.