United States Patent

[11] 3,604,361

[72] Inventors Arney J. Harbert
Denner;
Robert M. Towner, Boulder, both of, Colo.

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[73] Assignee Aerial Transit Systems, Inc.
Los Angeles, Calif.

[54] **AERIAL GUIDEWAY SYSTEM**
23 Claims, 28 Drawing Figs.

[52] U.S. Cl. **104/123,** 104/91, 104/124, 104/125
[51] Int. Cl. **B61b 3/00,** E01b 25/22
[50] Field of Search 104/89–94, 123–125; 14/17–19

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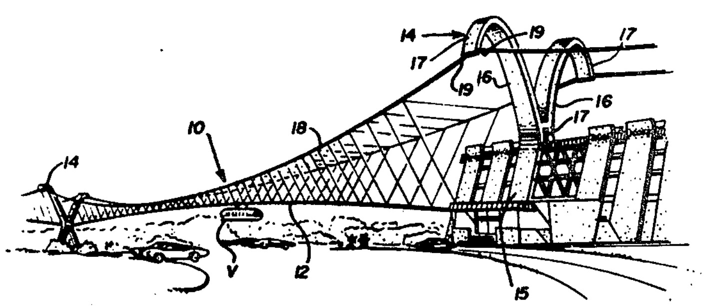
Primary Examiner—Arthur L. La Point
Assistant Examiner—D. W. Keen
Attorney—John E. Reilly

ABSTRACT: A vehicle transport system has elevated single or double tracks which are suspended by cable and transverse suspender elements in the form of an inverted delta from and between spaced supporting towers. In order to establish uniform flexibility in the track over its entire span, notwithstanding variations in temperature and in static and dynamic loading, the track structure is suspended indirectly from the supporting towers by suspension elements both along straight and curved sections, and a unique combination of takeup and suspension members is incorporated in the system.



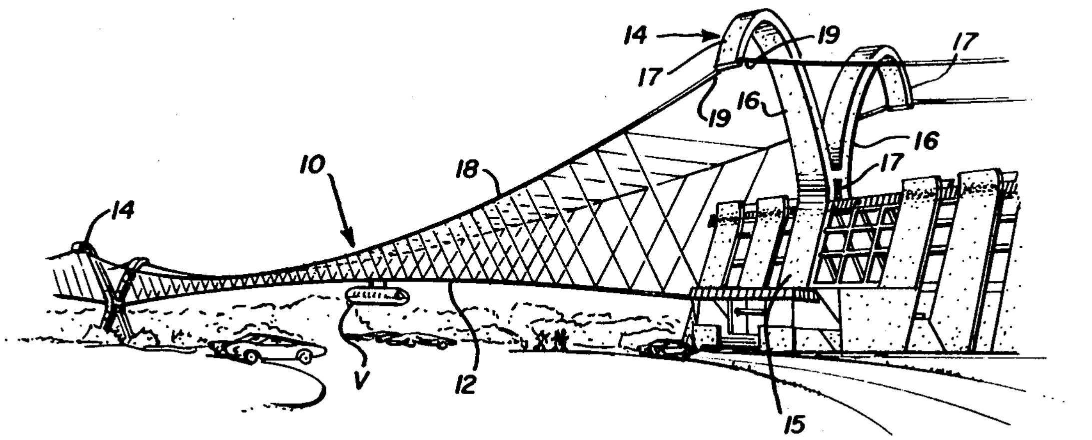


FIG. 1

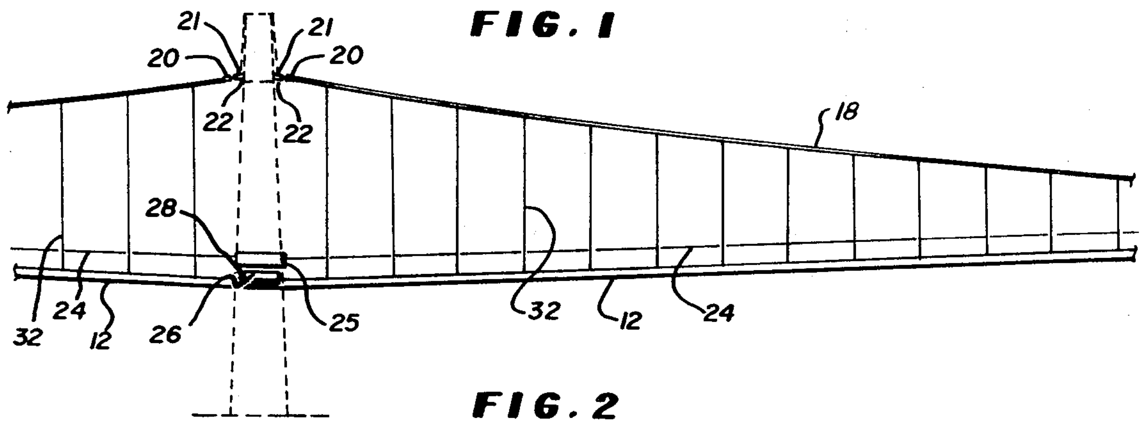


FIG. 2

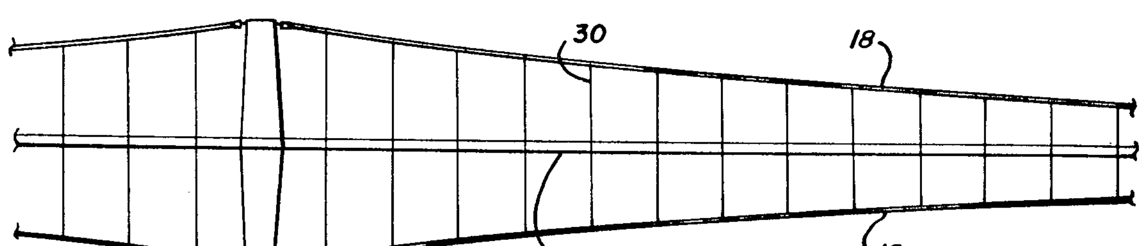


FIG. 3

INVENTORS
ARNEY J. HARBERT
ROBERT M. TOWNER
BY
John E. Reilly
ATTORNEY

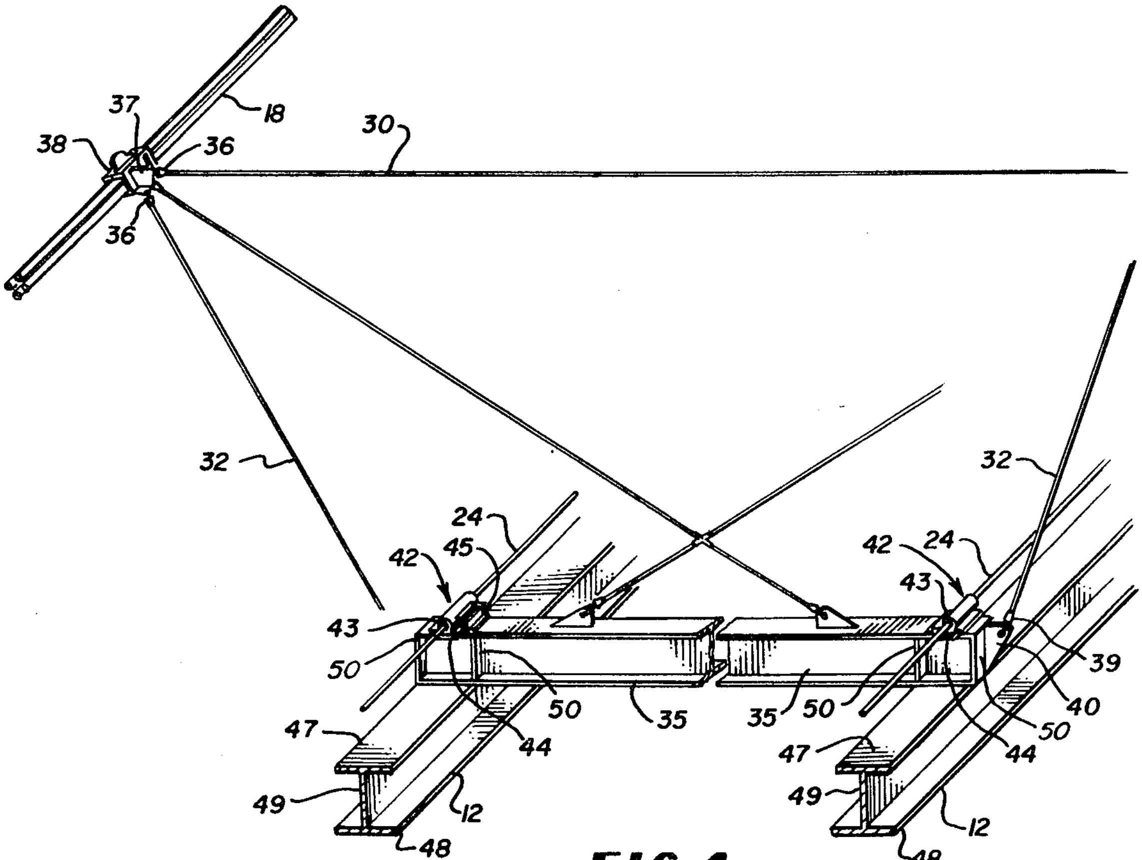


FIG. 4

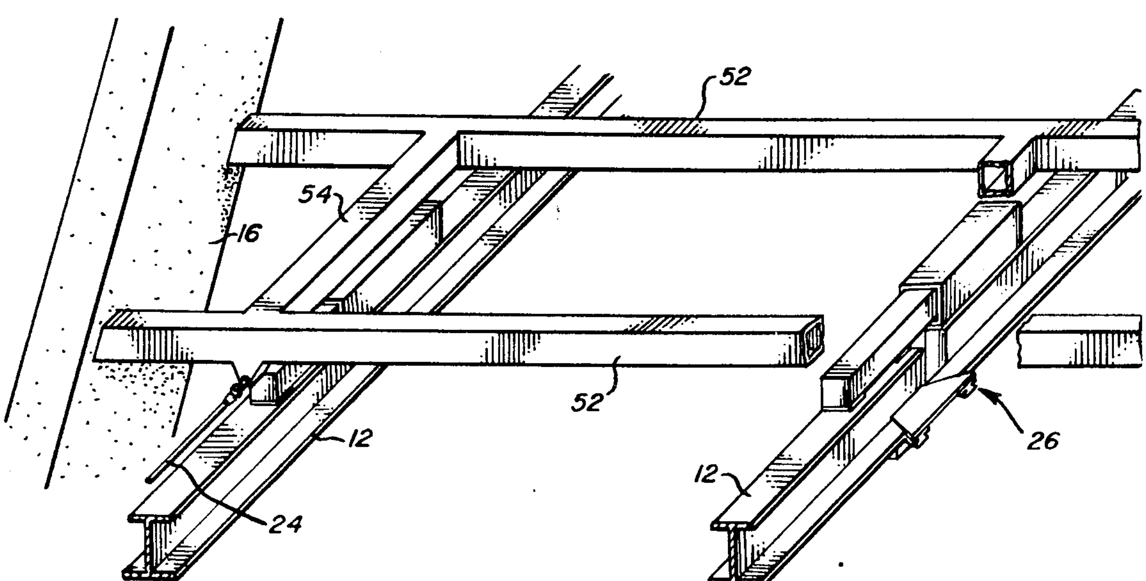


FIG. 5

INVENTORS
ARNEY J. HARBERT
ROBERT M. TOWNER
BY
John E. Reilly
ATTORNEY

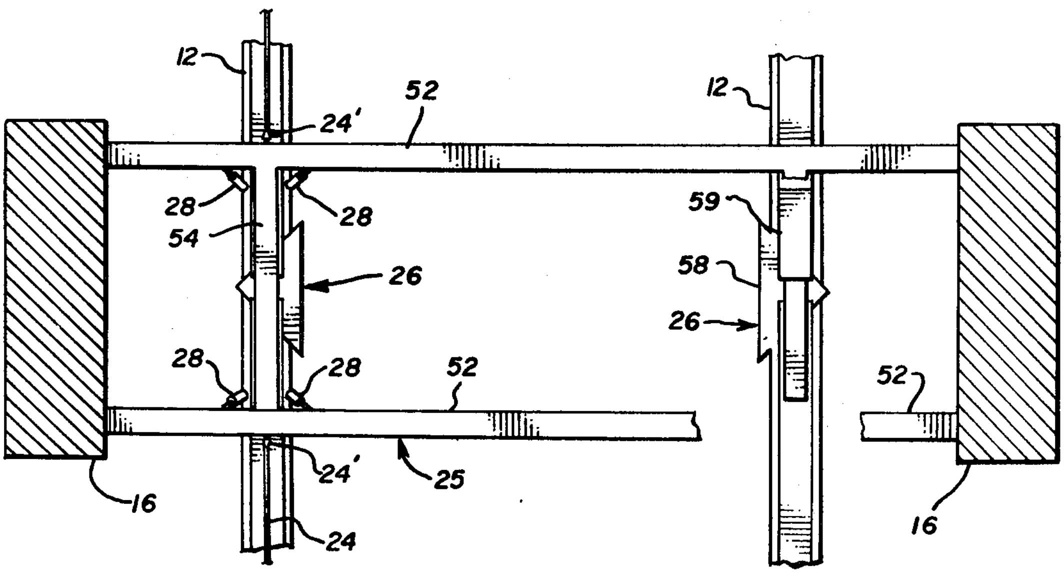


FIG. 7

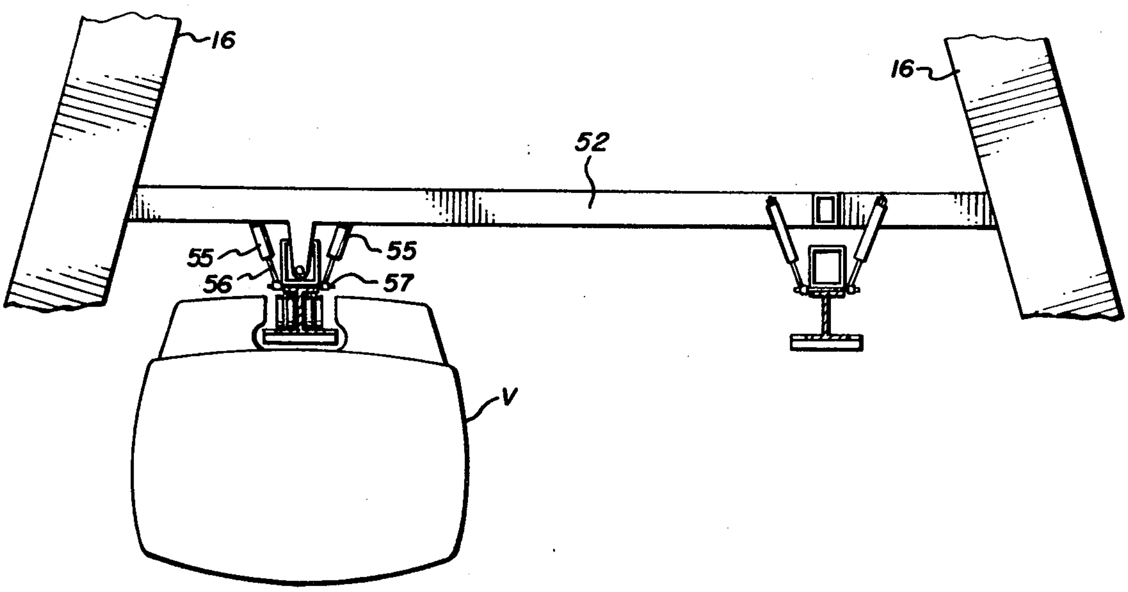


FIG. 6

INVENTORS
ARNEY J. HARBERT
ROBERT M. TOWNER
BY
John E. Reilly
ATTORNEY

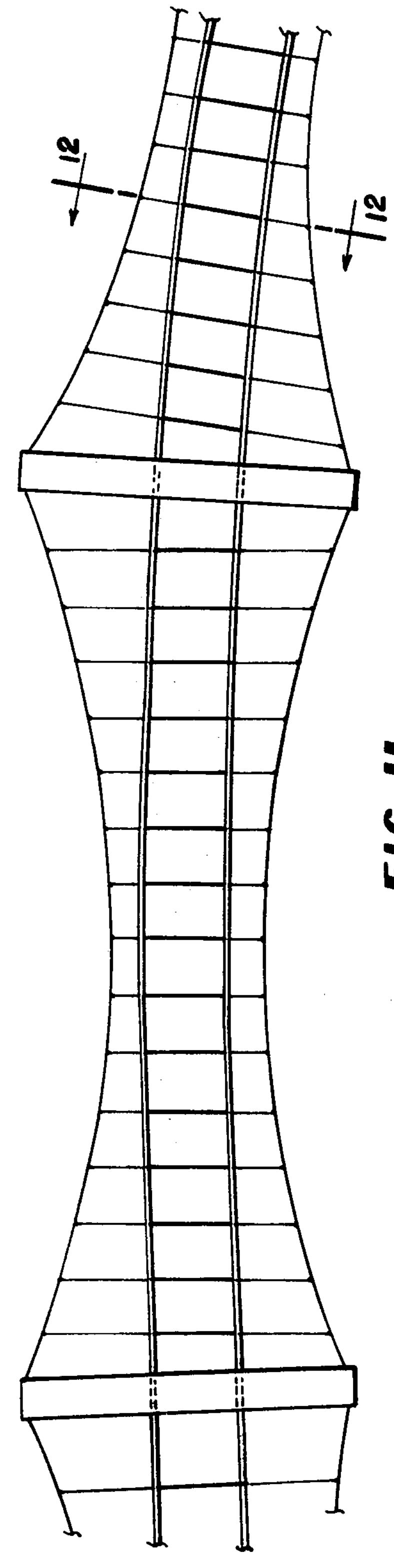


FIG. 11

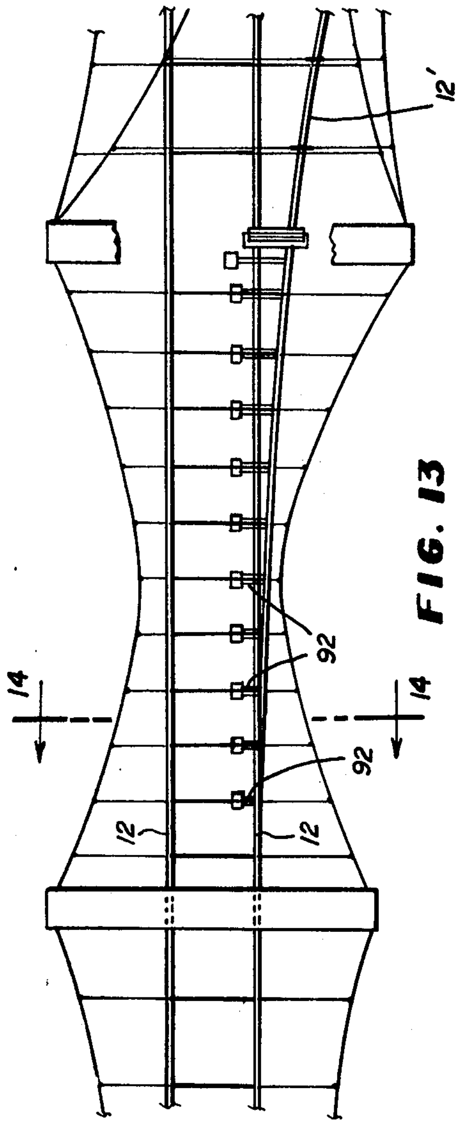


FIG. 13

INVENTORS
ARNEY J. HARBERT
ROBERT M. TOWNER
BY
John E Reilly
ATTORNEY

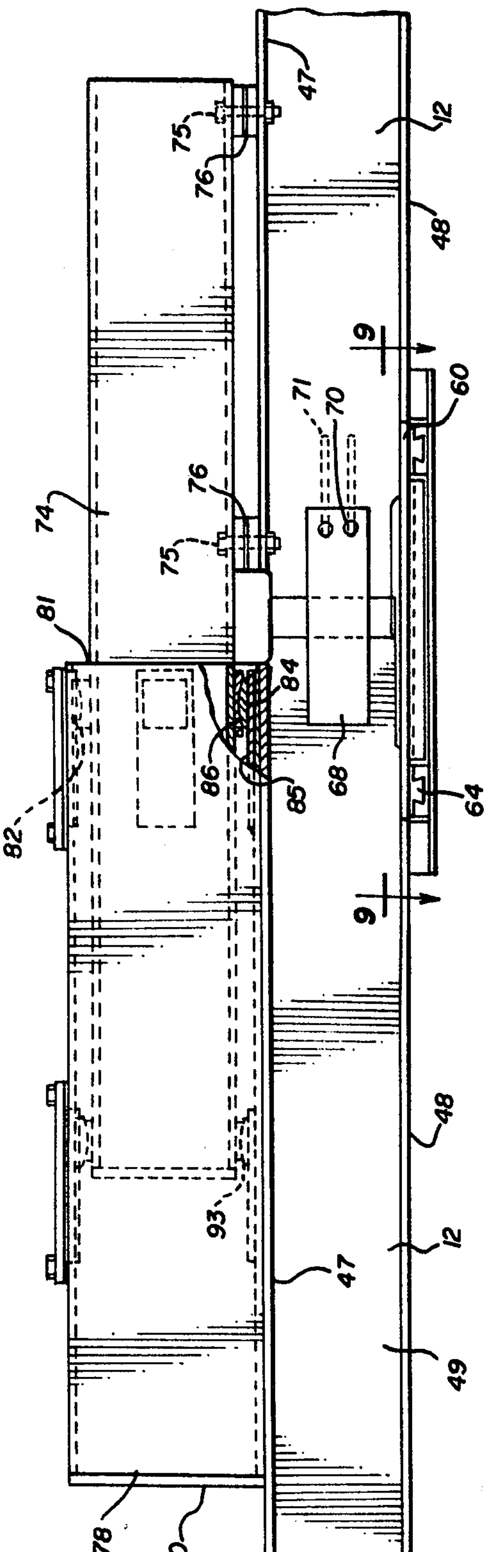


FIG. 8

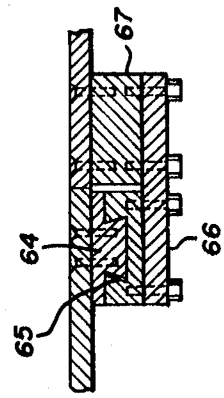


FIG. 10

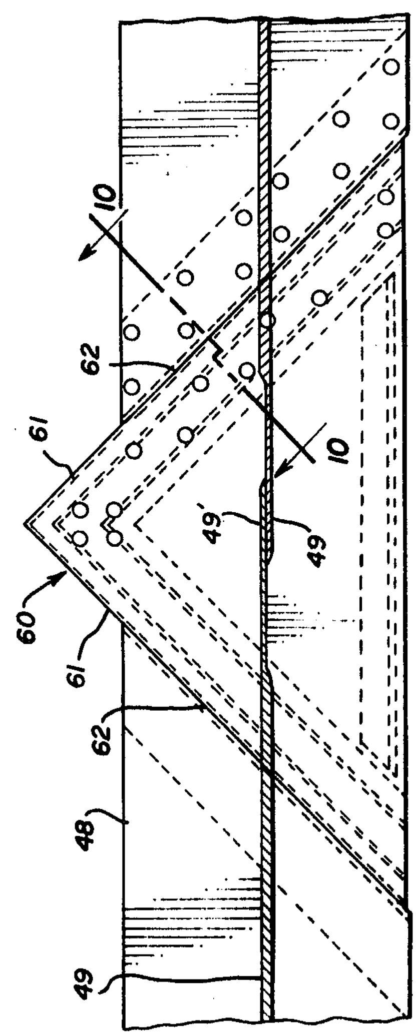


FIG. 9

INVENTORS
ARNEY J. HARBERT
ROBERT M. TOWNER
BY John E. Reilly
ATTORNEY

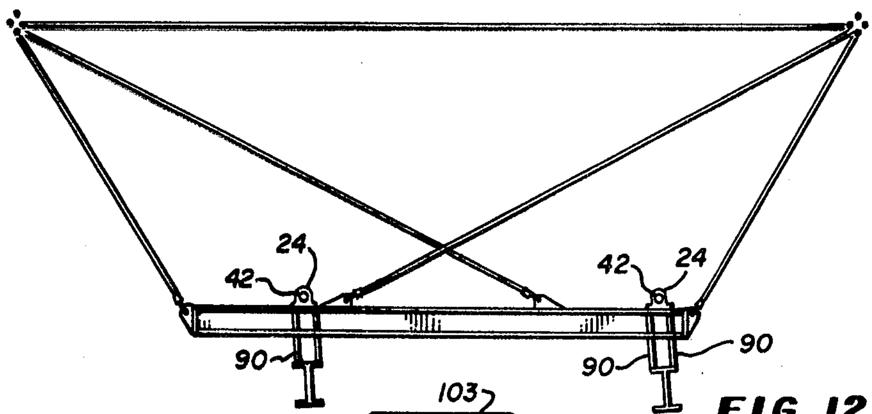


FIG. 12

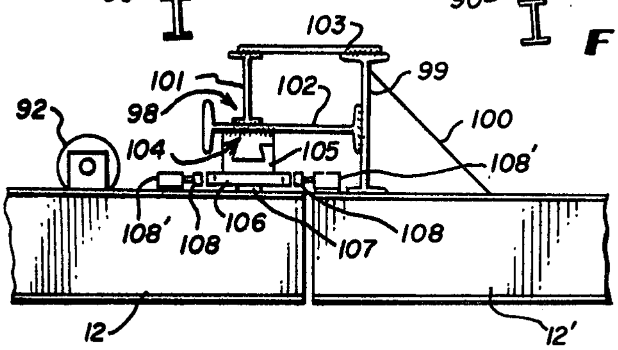


FIG. 15

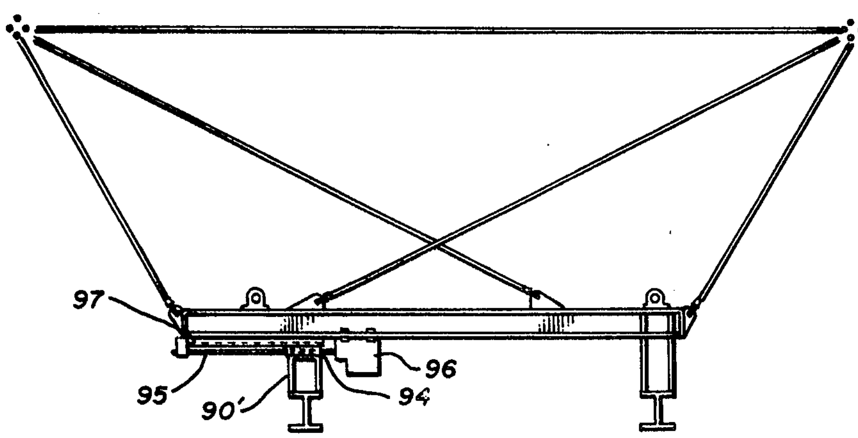


FIG. 14

INVENTORS
ARNEY J. HARBERT
ROBERT M. TOWNER
BY
ATTORNEY

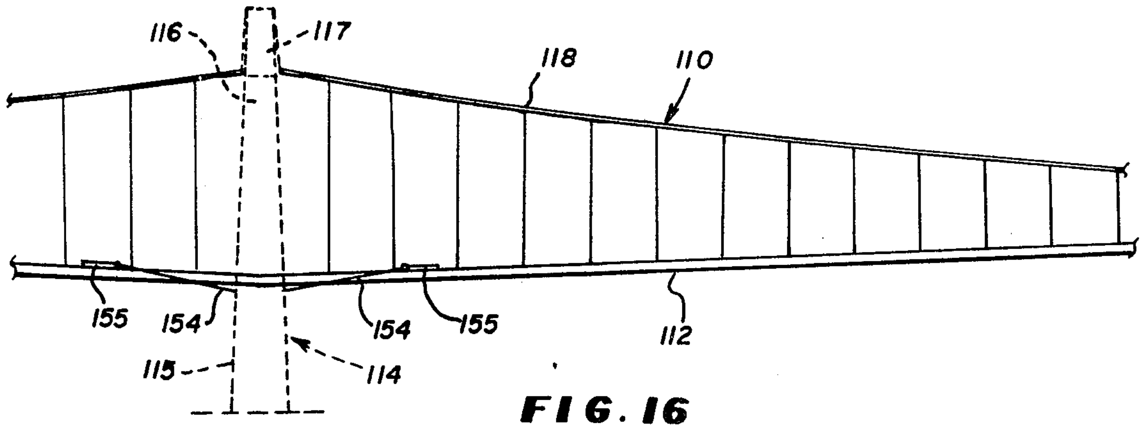
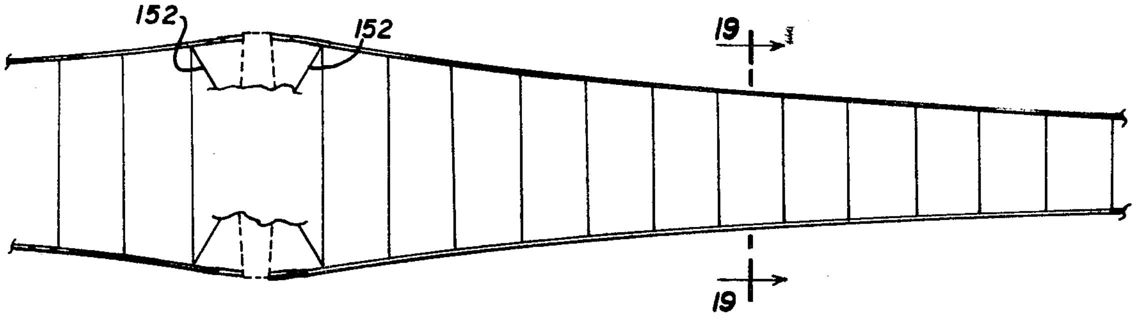


FIG. 16



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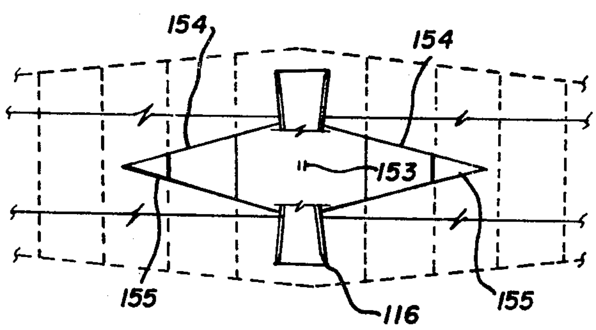

FIG. 18

INVENTORS
ARNEY J. HARBERT
ROBERT M. TOWNER
BY John E. Reilly
ATTORNEY

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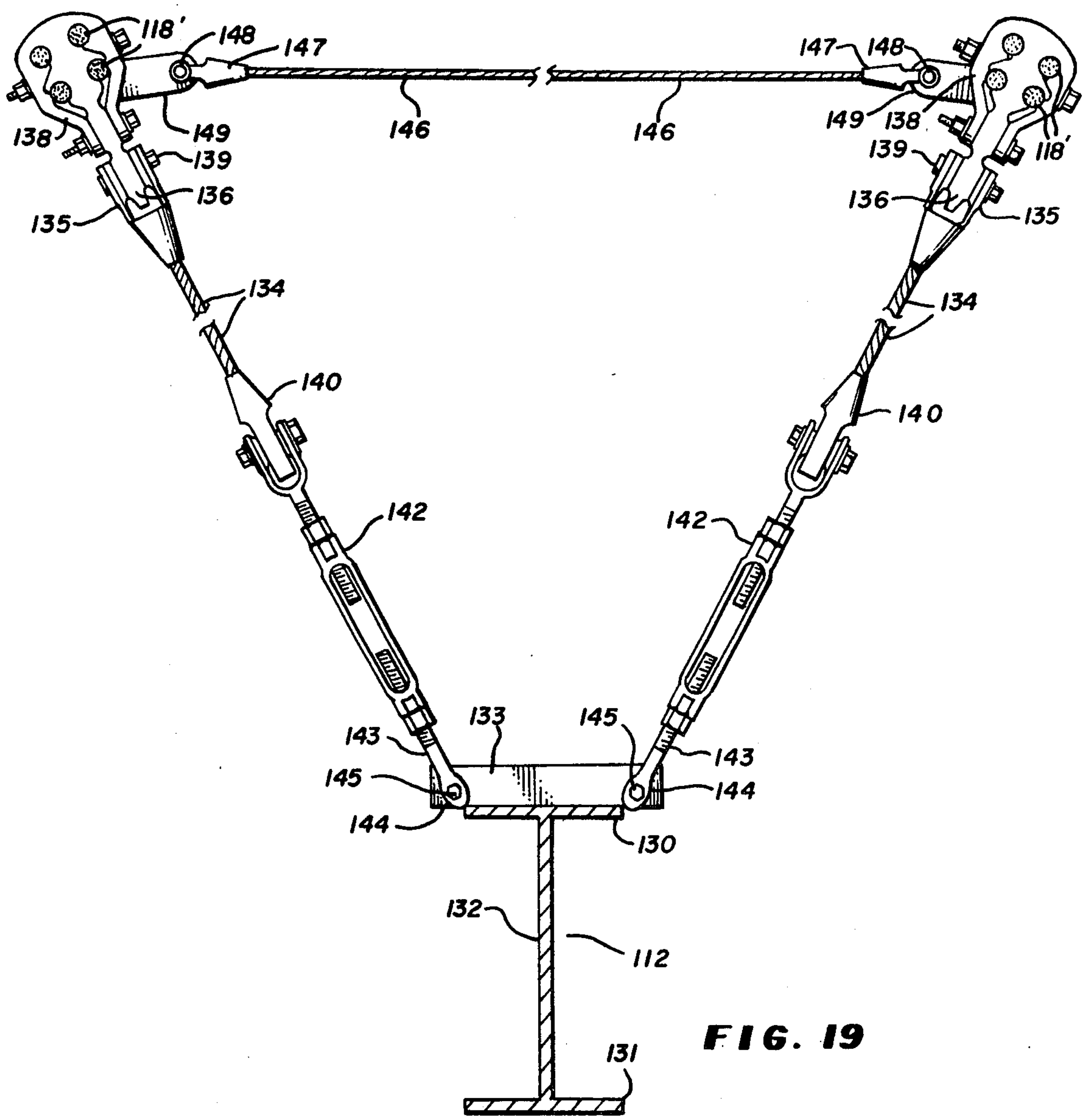

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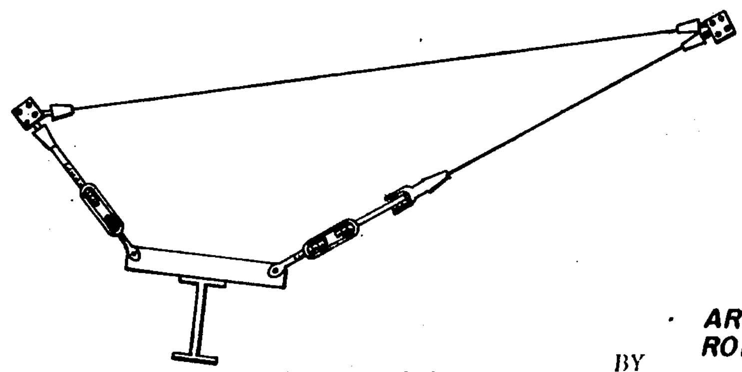


FIG. 23

INVENTORS
ARNEY J. HARBERT
ROBERT M. TOWNER

BY

John E. Reilly

ATTORNEY

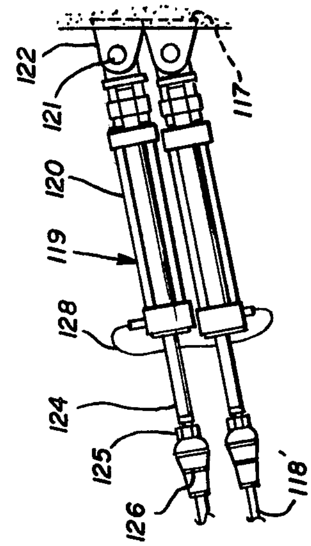
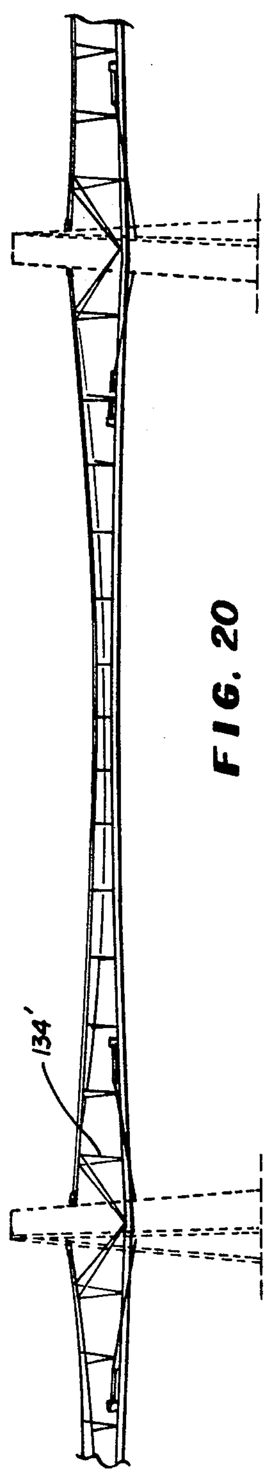


FIG. 24



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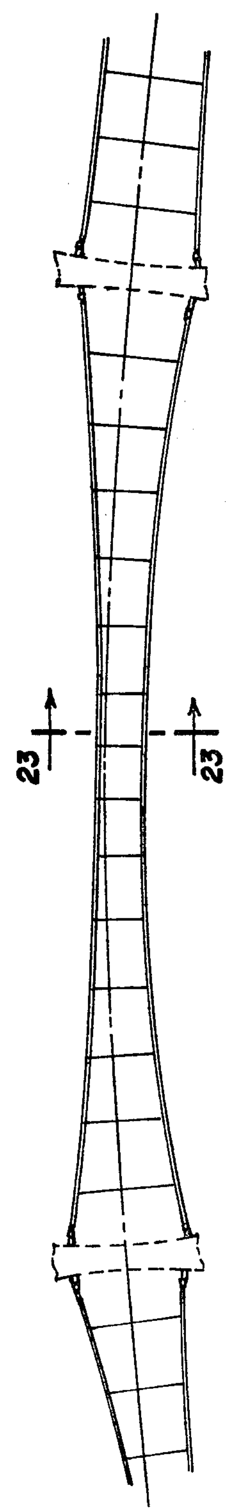

FIG. 21

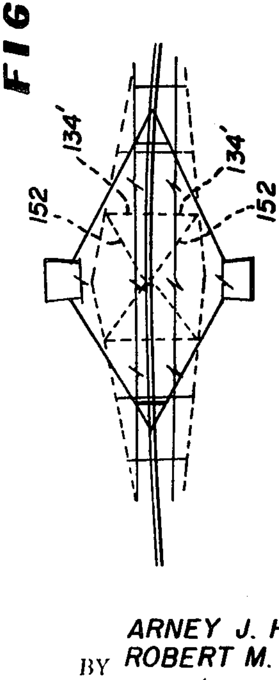

FIG. 22

INVENTORS
ARNEY J. HARBERT
ROBERT M. TOWNER
BY [signature]
ATTORNEY

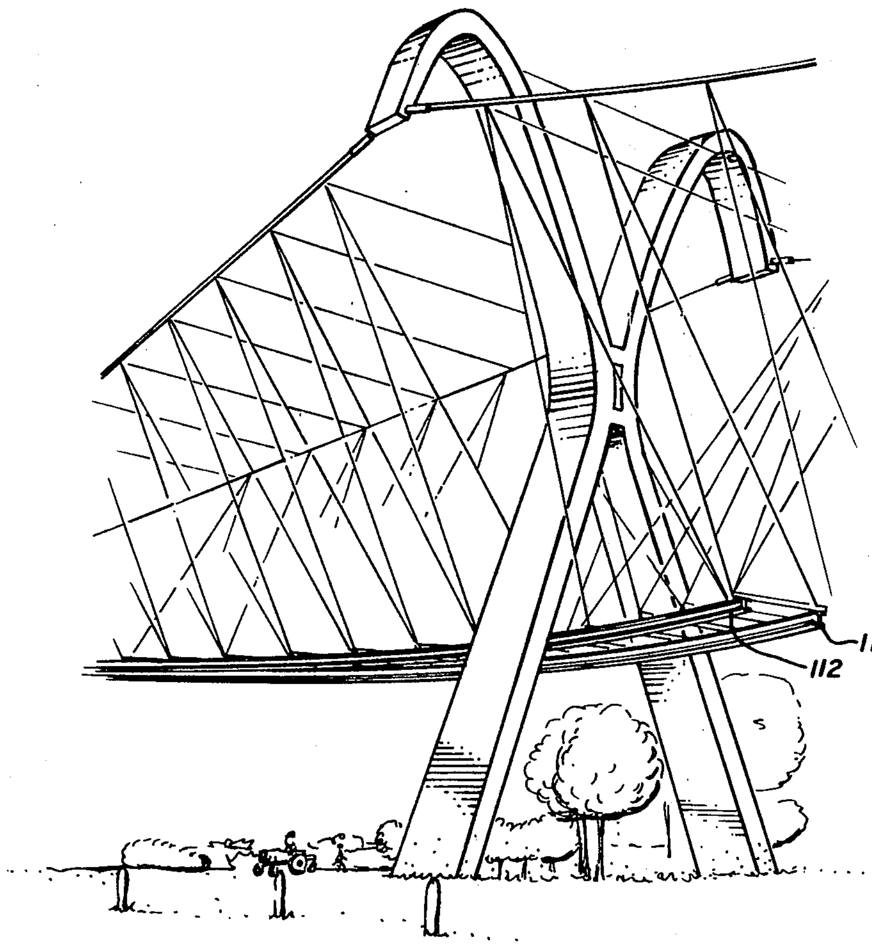

FIG. 25

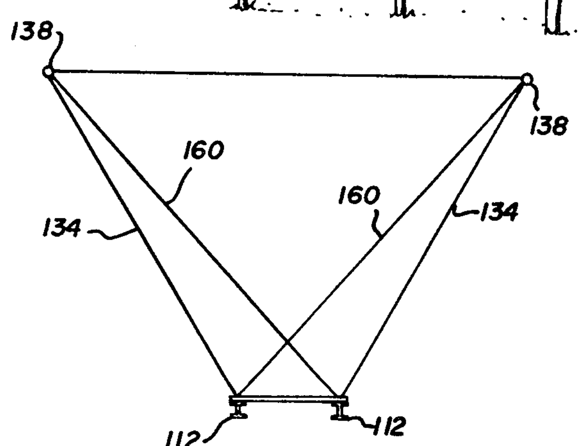

FIG. 26

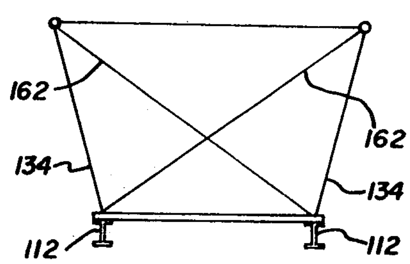

FIG. 27

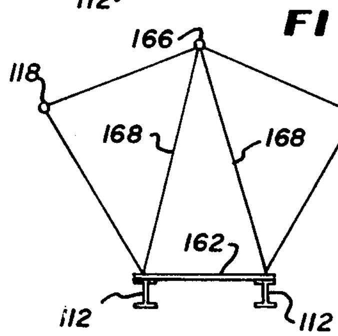

FIG. 28

INVENTORS
ARNEY J. HARBERT
ROBERT M. TOWNER
BY
ATTORNEY

AERIAL GUIDEWAY SYSTEM

This invention relates to a novel and improved vehicle transport system, and more particularly relates to an elevated track structure for conveyance of vehicles of the type adapted for overhead suspension from a rail.

There is an ever increasing demand and need for rapid transportation facilities in and around large metropolitan areas and in linking together adjacent metropolitan areas. Most desirably, the system adopted should be capable of installation with minimum disruption of existing ground and air transportation facilities. Thus, elevated track systems afford a logical choice and an effective means for rapid, mass transportation; and, while such systems have been proposed in the past, they have not possessed the requisite stability and safety for high speed travel at the rates of speed now under consideration, for example, on the order of 300 miles per hour. Not only must the system be safe and dependable in use, but also must insure maximum comfort while permitting installation in densely populated areas with a minimum of disruption of, or interference with, existing facilities. It is therefore proposed to provide in accordance with the present invention a new and improved elevated vehicle transport system which is characterized by possessing maximum safety and stability under static and dynamic loading of a vehicle, and requires a minimum of supporting towers per unit length of the span with a low cost of installation and maintenance throughout.

It is another object of the present invention to make provision for an elevated structure for high speed vehicles which offers maximum stability, uniform flexibility throughout and automatic compensation for temperature and load changes for suspension and travel of the vehicle.

It is a further object of the present invention to provide an elevated track structure for high speed travel of a vehicle over short or relatively long distances which affords maximum safety and comfort for the passengers; furthermore, to provide in an elevated track structure for means to automatically compensate for temperature and load variations at and between supporting towers.

It is a still further object of this invention to provide in an elevated track structure for a novel and improved form of expansion joint between track sections which is capable of maintaining alignment between adjacent ends of the track sections while closely compensating for changes in length without interference with the ride characteristics of the vehicle over the track, and further to provide for improved means of suspension of the track from the supporting towers particularly at the expansion joints.

It is an additional object of the present invention to provide in a vehicle transport system for a novel and improved cable suspension means and configuration for straight or curved sections of a single or double track which will afford maximum stability and uniform flexibility throughout.

In accordance with the present invention, a preferred form of aerial guideway system is made up of single or double track members elevated by a suspension cable structure arranged in an inverted delta configuration. The spaced supporting columns or towers serve as rigid upstanding supports for upper primary cables and a lower dampening cable, the latter extending directly above and parallel to the track and being connected independently of the track to the support towers. The track, or tracks, is suspended from the upper primary cables by inclined suspender elements directed downwardly from the primary cables for attachment to the track at spaced intervals between the supporting columns, and horizontal tie cables extend laterally between the primary cables to form with the inclined cables the inverted delta configuration. The track is laid end to end and in sections terminating at the supporting columns, and expansion joints serve to interconnect adjacent ends of the sections at the supporting towers. Shock absorbers serve as a means of suspension of the track from the supporting columns. Where double tracks are employed in laterally spaced parallel relation to one another, rigid struts serve to interconnect the track, and auxiliary suspension cables are criss-crossed, or intersect one another, for extension from each primary cable to the opposite track. As an additional means of support and suspension, a center primary cable may run between and somewhat above the primary cables and be secured at spaced intervals to the primary cables.

In an alternate form, the expansion joints may be eliminated and the track freely suspended throughout by the primary cables both at and between the supporting towers, and takeup elements at the supporting towers automatically compensate for temperature variations to maintain a selected track configuration with the desired ride characteristics both along straight and curved sections of the track.

The above and other objects, advantages and features of the present invention will become more readily understood and appreciated from a consideration of the following detailed description when taken together with the accompanying drawings, in which:

FIG. 1 is a perspective view of a single track structure in accordance with the preferred form of system.

FIG. 2 is an elevational view of the preferred form of structure shown in FIG. 1.

FIG. 3 is a top plan view of the form shown in FIGS. 1 and 2.

FIG. 4 is a cross-sectional view of a preferred form of double track structure.

FIG. 5 is an enlarged perspective view of expansion joint of the preferred form of invention.

FIG. 6 is an elevational view of the double track structure, with portions broken away.

FIG. 7 is a top plan view with portions broken away, of the double track structure.

FIG. 8 is a side view in detail of the expansion joint.

FIG. 9 is a sectional view taken about lines 9—9 of FIG. 8.

FIG. 10 is a sectional view taken about lines 10—10 of FIG. 9.

FIG. 11 is a plan view of a curved section of a double track structure.

FIG. 12 is a sectional view taken about lines 12—12 of FIG. 11.

FIG. 13 is a plan view schematically showing the use of incremental positioners, in accordance with the present invention.

FIG. 14 is a sectional view taken about lines 14—14 of FIG. 13.

FIG. 15 is a detailed view of the switching device.

FIG. 16 is a side elevational view of a modified form of track structure in accordance with the present invention.

FIG. 17 is a plan view of the modified form shown in FIG. 16.

FIG. 18 is an enlarged plan view of the modified form of track structure at the supporting column.

FIG. 19 is an enlarged cross-sectional view taken on lines 19—19 of FIG. 17.

FIG. 20 is a side elevational view of the modified form of track structure along a curved section.

FIG. 21 is a plan view of a curved section of the modified form of track structure.

FIG. 22 is an enlarged plan view of the curved section at one of the supporting columns.

FIG. 23 is an enlarged cross-sectional view taken about lines 23—23 of FIG. 21.

FIG. 24 is a detail view of the cable takeup members employed in the modified form.

FIG. 25 is an enlarged perspective view of a modified form of double track structure.

FIG. 26 is a cross-sectional view of an alternate form of double track structure.

FIG. 27 is another cross-sectional view of the alternate form of double track structure taken approximately midway along the span between supporting towers; and

FIG. 28 is a cross-sectional view of still another modified form of suspension cable arrangement for a double track structure.

Referring in detail to the drawings, there is shown by way of illustrative example in FIGS. 1 to 3 a single track structure 10 in accordance with the present form of invention wherein a vehicle represented at V is guided for travel along a single track 12. Substantially rigid, upstanding support columns or towers 14 are installed at widely spaced intervals over the intended course of travel of the vehicle, each tower including downwardly divergent legs 15 and arms 16 diverging upwardly from an intermediate web section 17, the arms 16 terminating in, downwardly and outwardly extending extremities 17'. Primary support cables 18 are defined preferably by multiple steel bridge strands and each end is anchored as at 19 to the outer extremity 17' of a tower arm 16. Any suitable means of connection may be employed, such as, for example, an eye bolt 20 swaged to the end of the cable and a flange 21 on the supporting tower provided with an opening for insertion of a common pin 22 through the opening and through the eye bolt 20.

In addition, a horizontal dampening cable 24 is arranged for extension in closely spaced, parallel relation to the upper surface of the track and has opposite ends connected to cross beams 25, each cross beam assembly extending transversely between and supported by the downwardly depending legs 15 at each supporting tower. The ends of the dampening cables are suitably anchored or fastened to the cross beams in the same manner as the attachment of the upper main support cables to the outer extremities of each support tower.

An expansion joint to be hereinafter described with reference to the double track system of the present form is represented at 26 in FIGS. 1 to 3 and serves to interconnect adjacent ends of the track sections beneath the cross beam 25, and shock absorbers represented at 28 define yieldable suspension or dampening means between the track and cross beam 25.

An important feature of the preferred form resides in the suspension of the track from the cable structure both by sliding connection between the track and the dampening cable to be described and by suspender cables which cooperate to interconnect the upper main cables 18 and to connect the upper cables 18 to the track 12. Thus, horizontal tie cables 30 extend laterally between the upper spaced cables, and inclined suspender cables 32 extend downwardly from a common point of connection of the horizontal tie cable with the main cable at connection points located across from one another on opposite sides of the track. Thus when viewed in transverse section, the horizontal tie cable in cooperation with the inclined suspender cables defines an inverted delta suspension between the main cables and the track and which serves to integrate the suspension of the track by the dampening cables and upper main support cables. As generally seen from FIGS. 1 to 3, the suspender cables are installed at equally spaced intervals throughout the length of the track.

In a manner which is treated in greater detail in copending application entitled "Pretensioned Elevated Track and Cable Structure," Ser. No. 702,953, filed 5 Feb., 1968, now U.S. Pat. No. 3,541,964 and assigned to the assignee of the present invention, the main support cables, dampening cable and suspender cables are most desirably pretensioned to introduce a predetermined amount of upward camber into the track, the degree of camber being sufficient that the track will remain in tension under dynamic loading of the vehicle. As a result, it will be observed that the suspender cables 30 and 32 are progressively reduced in length toward the center of the span between the supporting towers so as to draw the track and main support cables progressively closer together and again to deflect the track upwardly under a sufficient degree of tension that the track will assume a predetermined camber or upward curvature reversed to the downward curvature of the main support cables 18.

A double track structure is illustrated in more detail in FIGS. 4 to 7 wherein the general layout, disposition and cooperation between elements correspond to that illustrated for the single track structure in FIGS. 1 to 3, and accordingly like elements are correspondingly enumerated. Of course the double track structure is intended for two-way traffic where the spacing between tracks 12 is sufficient to afford safe travel of the vehicles in opposite directions. To this end the track members are spaced apart by transverse struts 35 affixed to the top surfaces of the tracks at longitudinally spaced intervals between the supporting towers, and it will be noted that the spacing between struts is the same as the spacing between the horizontal and inclined suspender cables 30 and 32.

FIG. 4 illustrates in more detail the mounting and disposition of the suspender cables 30 and 32 with respect to the main supporting cable 18 and to the tracks 12, as well as the connection of the horizontal dampening cables 24 to the track members 12. Specifically, the horizontal and inclined suspender cables 30 and 32 are each provided with an eye bolt 36 for connection to a common flange 37 on a cable clamp assembly 38 on each of the main supporting cables. Similarly, the lower ends of the inclined suspender cables 32 are each provided with an eye bolt fitting 39 for connection to a flange 40 at the end of the strut 35. Each of the horizontal dampening cables 24 passes through a sliding cable connection 42, the latter including an upper frictional sleeve 43 which may be in the form of a neoprene cable grip having a lower lubrite slide plate 44 horizontally slidable in the direction of extension of the cable 24 through spaced-apart brackets 45. In this way, the dampening cables 24 will aid in suspension of the tracks and in defining an integrated structure while permitting differential expansion and contraction between the tracks and cables. In the form illustrated, the track members are each I-shaped in cross section having upper and lower flange portions 47 and 48 interconnected by a web 49. The transverse strut 35 is similarly I-shaped in cross section with reinforcing plates 50 extending between the upper and lower flanges at the end portions and spaced inwardly of the ends with the lower flange of the strut being welded to the top flanges of the track members. It will be readily apparent that in the single track structure, in the absence of the strut 35, the sliding cable connection 42 may be secured to a connecting block affixed to the top flange 47 of the track with the inclined cables 32 secured to lateral flanges 40 on the sides of the connecting block; or, if desired, the dampening cable 24 as well as the suspender cables 32 may be affixed directly to the track member.

As shown in FIGS. 5 to 7, the track sections 12 have their ends interconnected by an expansion joint 26, and the ends of the track sections, together with the expansion joint, are suspended beneath a crossbeam assembly 25 by shock absorbers 28. Here the beam assembly consists of a pair of crossbeams 52 extending laterally between the legs 16 of the tower and interconnected by longitudinal beams 54 which are aligned above each of the track members 12. The beams are of hollow rectangular configuration, or box-shaped, with the shock absorbers 28 extending downwardly from the cross beams 52 on opposite sides of the area of connection between the longitudinal beams 54 and the cross beams. The shock absorbers are each defined by a cylinder 55 and a piston rod 56 provided with a piston not shown within the cylinder which is spring-biased in an upward direction against a damping fluid within the cylinder, and the lower end of the piston rod is swiveled to an end of a cross arm 57 which is attached to the top flange surface of the track member 12. The shock absorbers incline downwardly and inwardly from their connections to the cross beam assembly so as to effect free suspension of the track from the rigid beam assembly while stabilizing the track both against vertical and laterally applied forces. In addition, the ends of the horizontal dampening cables 24 are anchored to opposite sides of the beam assembly by an eye bolt connection, designated at 24', which corresponds to the type of connection employed between the ends of the main supporting cable and the outer extremities of the supporting tower.

Each expansion joint 26 between adjacent ends of the track sections underlies the longitudinal beam 54 of the beam assembly and is broadly comprised of a laterally sliding wedge assembly 58 interposed between adjacent ends and a telescoping assembly 59 mounted on the upper surfaces of the ends of the track sections to maintain proper vertical, lateral and torsional alignment between the ends of the track sections. Specifically referring to FIGS. 8 to 10, it will be seen that the wedge assembly includes a generally triangular wedging plate 60 provided with convergent side edges 61 complementary to inclined side edges 62 formed at the ends of the lower flange portions 48 of the track members 12. A sliding dove tail bearing assembly is made up of a dove tail bearing plate portion 64 which is bolted to the underside of the wedge plate 60 for extension along opposite convergent side edges 61 of the plate, and the plate members 64 are inserted in dove tail sockets 65. Each socket in turn is attached to a plate 66 which forms an extension of a connecting block 67 secured to the underside of the track flange 48 parallel and adjacent to the respective side edges 62. The vertical web portions 49 of the track sections have overlapping ends 49', and plates 68 are permanently fastened to one of the web sections for extension beyond the overlapping ends for slidable connection to the other web section by bolts 70 which extend through slots 71 in the other web portion.

The upper flange portions 47 terminate in spaced relation to one another short of the overlapping ends of the web portions 49' so as to afford ample clearance for expansion of the track sections. Under expansion, as the ends of the track sections tend to draw closer to one another the side edges 62 of the lower flange portions 48 will press against the side edges 61 thereby forcing the wedge plate 60 to slide laterally in a direction to cause the dove tail bearings 64 to slide outwardly through the slide sockets 65. Conversely, under contraction, the side edges 62 will tend to draw away from the edges 61 and in a similar manner the socket portion 65 will follow movement of the track sections thereby forcing the wedge plate 60 to slide in the opposite direction. In either direction of movement, the wedge plate will maintain positive interconnection between the flange portions while compensating for any variation in length of the track sections.

The telescoping assembly 59 includes a longitudinally extending male slide beam member 74 of hollow rectangular configuration which is fastened by bolts 75 to the upper flange portion 47 of one of the track sections. Suitable shims or spacers 76 are placed between the undersurface of the member 74 and the flange portion 47 to align the portion for longitudinal extension through socket portion 78 which is mounted on the end of the other track section. Socket 78 is also of hollow rectangular configuration but of enlarged cross section with respect to the slide member 74 having a closed end 80 and an open end 81, the latter to receive the end of the slide member. To facilitate sliding movement of member 74 through the socket, suitable bearing assemblies 82 and 83 are arranged in spaced relation to one another along the inner walls of the socket portion and each bearing assembly includes a convex bearing 84 resting on a bearing plate 85 affixed to the inner wall surface of the socket, and the bearing 84 mates with a concave bearing 86 attached to the outer surface of the male slide member 74. The bearing assemblies will remove any play between the telescoping slide members while permitting free sliding movement therebetween in a longitudinal direction under expansion and contraction of the track sections thereby to maintain exact alignment between the ends of the track section.

Referring to FIGS. 11 and 12 a curved section of a double track structure is illustrated in which a double track structure includes track members 12 spaced beneath the struts by spacer beams 90 which extend downwardly in spaced parallel relation to one another from opposite sides of the slide connections 42 for the horizontal dampening cables 24. Here the beams are extended at a predetermined angle to the vertical with their lower edges affixed to the upper flange surfaces of the tracks thereby tilting the tracks laterally in order to cause the vehicle to lean into the curve in either direction of travel. Effectively the spacer beams define in combination with the struts and upper flanges of the track members a structure to afford adequate clearance for electrical pickup devices on the vehicle, not shown.

A preferred form of incremental positioner assembly is illustrated in FIGS. 13 to 15 in which one of the tracks 12 is to be laterally shifted from its original line of travel into a branch line as represented at 12'. In order to effect a gradual divergence away from its original line, a series of incremental track positioners 92 are activated to laterally shift the track section into the branch line wherein the degree of lateral shifting is progressively increased by the track positioners along a predetermined curve approaching the branch line. As shown in detail in FIG. 14, a spacer beam 90' has an internally threaded sleeve 94 at its upper end to receive a drive screw 95 which is rotated by a gear drive motor 96. The upper surface of the sleeve is flattened to firmly bear against the under surface of a linear bearing 97. In the form shown, an incremental track positioner is mounted beneath each of the strut members over the greater length of the track section, and the degree of lateral shifting of each incremental track positioner may be regulated by a common control system, not shown.

At the end of the track section abutting the branch line 12', the track positioner 92 is positioned on the top flange portion of the movable track section 12 directly ahead of the track alignment assembly 98 which is mounted on the abutting ends of the movable and stationary track sections 12 and 12'. The alignment assembly includes a welded plate section 99 reinforced by a gusset plate 100 both of which are affixed to the top flange portion of the stationary track, and welded plate sections 101 and 102 along with a reinforcing plate 103 form with the plate section 99 a laterally extending box beam assembly with the lower plate section 102 having a dovetail linear bearing 104 affixed thereto. The dovetail bearing is inserted in a mating socket formed in a lower bearing 105 which is positioned on support plate 106 journaled for rotation on a bearing 107 mounted on the top flange portion of the movable track 12. The bearing member 104 is rigidly connected to the box beam assembly and the lower bearing 105 is free to slide laterally of the upper bearing until the movable track 12 is advanced into exact alignment with the end of the stationary track section 12'. Suitable locking keys 108 are positioned in facing relation to one another on adjacent ends of the track sections and are selectively actuated by solenoids 108' for inward movement into notches, not shown, on opposite sides of the support plate 106 to lock the movable track in the aligned position.

In the switch arrangement described, positive registry and electric interlock is afforded for maximum safety, and a large radius curve through the flexibly mounted switch section results in a soft ride through the switch at normal operating speeds. It will be seen that a single guideway is connected to one side of the tower and two separate guideways connected to the other side with the track of the single guideway being deflected in the lateral direction to engage either of the two connecting tracks. The incremental track positioners provide the necessary lateral support to assure proper curved configuration for the track in either position, and the gear motors are electrically interlocked and synchronized so that all must operate simultaneously at the proper speeds as the track moves from one position to the other; and when the track has reached its assigned configuration the gear motors will lock in position. The switch guide mechanism which is located at the joint, as illustrated in FIG. 15, works in cooperation with the track positioners to assure accurate alignment at the joint and again is accomplished by positive track registry and electric interlock by the electrically actuated locking keys 108 that engage the baseplate as the tracks approach alignment. The electrical components may be interlocked in such a manner that until the locking keys are properly engaged and all track positioners are locked in proper position the current in the electric contact rails near the switch is reversed to bring the vehicle to a stop automatically before it reaches the switch.

In the alternate form of invention shown in FIGS. 16 to 28 single and double track structures are suspended in such a way as to achieve uniform flexibility both along straight and curved sections of the track. A single track structure is illustrated in FIGS. 16 to 24 with a straight span of a single track structure 110 being illustrated in FIGS. 16 to 19. Thus a vehicle represented at V is guided for travel along a single track 112. Upstanding support columns or towers 114 are installed at spaced intervals over the intended course of travel of the vehicle, each tower again including downwardly divergent legs 115 and arms 116 diverging upwardly from an intermediate web section and the arms terminating in an outer, outwardly and downwardly extending extremities 117 which serve as anchor points for main support cables 118. Support cables 118 are comprised of multiple steel bridge strands 118', and the strands at each end of the main support cable are anchored to the outer extremities 117 by cable takeup members 119 as shown in detail in FIG. 24. Each takeup member comprises a hydraulic cylinder 120 pivotally connected by pin 121 to flange 122 projecting from the extremity 117 of the support tower. A piston rod 124 extends from the hydraulic cylinder, and its outer free end 125 is journaled within a socket at the end of fitting 126 which is permanently attached to the end of the bridge strand 118'. A servo closed loop control system is represented at 128 and is connected to a source of hydraulic fluid under pressure, not shown, and to strain gauges mounted on the vehicle track to sense internal stresses in the track and, through the hydraulic takeup system, compensates for variations in stress by regulating the tension applied to the main support cables by the takeup members 119. For the purpose of illustration, where a vehicle track is designed to accommodate internal stresses, induced by expansion and contraction, within the limit of 1,000 p.s.i. and 3,000 p.s.i., the takeup control system can correspondingly maintain a track stress within the same limits. For instance, this stress range may correspond to an ambient temperature increment of from 17° F. at low temperatures to 29° F. at high temperatures. At moderate temperatures the takeup mechanism will be actuated only once with each increase or decrease of temperature in excess of approximately 20° F. to 25° F. In the closed loop control system a signal delay may be incorporated to avoid actuation of the takeup mechanism by short term vehicle and wind-gust loading.

A detailed cross-sectional view of the track structure is illustrated in FIG. 19 wherein it will be observed that the single track 112 includes top and bottom flanges 130 and 131 connected together by an intermediate web 132. The track is suspended from the upper support cables 118 through inclined suspender cables 134 each of which has an upper bifurcated end 135 provided with transverse openings which are aligned with a transverse opening in flange 136 which forms an extension of a cable clamp assembly 138 for the strands 118 of the main support cable. A pin 139 is inserted through the aligned transverse openings in members 135 and 136 to effect swiveled connection therebetween. A swivel connection is similarly made between the lower end 140 of each suspender cable and a turnbuckle 142, and the lower end of the turnbuckle has a connecting rod 143 provided with an eye 144 for insertion of bolt 145 to effect swiveled connection of the turnbuckle to a connection block 133 which is permanently attached at the suspension points to the upper flange portion 130 of the track. A horizontal tie cable 146 has opposite bifurcated ends 147 which by pins 148 are connected in swiveled relation to laterally projecting flanges 149 on each of the cable clamp assemblies. The inclined suspender cables 134 and the horizontal tie cables are once again mounted at spaced intervals throughout the length of each span between the supporting towers and, as set forth in the preferred form of the invention, the main support cables as well as the suspender cables are pretensioned to introduce a predetermined amount of camber or upward deflection into the track supporting towers, the degree of camber being sufficient that the track will remain in tension under dynamic loading of the vehicle. To this end, the suspender cables 134 as well as the horizontal tie cables 146 are progressively reduced in length toward the center of each span between supporting towers so as to draw the track and main support cables progressively closer together with the track held under a sufficient degree of tension to assume a predetermined camber which is reversed to the downward curvature of the main support cables 118.

It is important to note that the track 112 is continuous and is supported throughout by the suspension cable system to lend the desired flexibility to the system. At the supporting towers, to lend additional support to the track, auxiliary suspension cables 152 are inclined downwardly and inwardly from connection to the main support cables through a central connecting point 153 on the upper track surface centrally of the support towers. To lend additional support for the track system against lateral sway, auxiliary suspension cables 154 are inclined upwardly and outwardly away from the divergent legs 115 of the support towers and are anchored on opposite sides of the support towers by a common connection element 115.

A curved section of the single track structure is illustrated in FIGS. 20 to 22 wherein like elements are correspondingly enumerated. In order to lend additional support to the track through curved spans, additional suspender cables 134' are extended downwardly from the point of connection of the upper ends of the auxiliary suspension cables 152, and the suspender cables 134' are connected to a common connecting block on the upper flange surface of the track in the same manner as described with reference to FIG. 19.

A double track structure is illustrated in FIGS. 25 to 29 which is intended for two-way guided travel of a vehicle along the track. The free suspension and mounting of the continuous track members 112 as shown incorporates the same basic elements and method of installation as described with reference to FIGS. 16 to 24. Accordingly, those elements are designated with the same numerals in FIGS. 25 to 28. It is desirable however in the double track structure to employ auxiliary suspension members to lend additional stability to the track members while permitting free suspension and uniform flexibility throughout. Accordingly, as best seen from FIG. 25, the intermediate span of track between supporting towers includes auxiliary suspension cables 160 which are inclined downwardly from the cable clamp assemblies 138 for the main support cables for swiveled connection above the track member on the side of the track structure opposite to its point of connection to the main support cable. Here the tracks are suspended in spaced-apart relation by a transverse strut 162, and the manner of interconnection of the auxiliary suspender cables 160 to the cable clamp assembly and to the connecting block corresponds to that described with reference to the main suspender cables 134. FIG. 27 merely illustrates the relationship between the auxiliary suspension cables 162 and main suspender cables 134 at a point closer to the midsection of the span between supporting towers.

Still another configuration is illustrated in FIG. 28 wherein a third main support cable 166 extends between and somewhat above the main support cables 118 and is provided with auxiliary suspender cables 168 inclining downwardly from a common point of connection to the main support cable 166 for swiveled connection to the strut 162 above each of the track members 112.

In the preferred and alternate forms of invention described, the single or double track structures are freely suspended by main support cables and suspender cables arranged in an inverted delta configuration independently of the main supporting towers. In the preferred form, where the track is made up in sections, the expansion joints at the adjoining sections will compensate for expansion and contraction of the track sections without the necessity of takeup systems since expansion and contraction of the cables relative to the track will be minimal. In addition, the track sections are suspended by the cable members preferably in cooperation with a shock absorber assembly at the supporting towers to provide the desired uniform flexibility throughout. Of course in the alternate form, the track is continuous and, in the absence of expansion joints, the cable takeup system is employed to compensate for expansion and contraction in the track resulting from temperature changes. As in the preferred form however the alternate forms of track structures, whether employing a single or double track, are suspended independently of the supporting towers both along straight and curved sections of the track. Auxiliary suspender cables may be utilized either in the preferred or alternate forms to lend additional support to the track when necessary.

Although the present invention has been described with a certain degree of particularity, it is understood that the present disclosure has been made only by way of example and that changes in details of structure and system components may be made without departing from the spirit thereof.

We claim:

1. In a high speed vehicle transport system, a track structure comprising
- substantially rigid supporting columns at spaced intervals along the span of said track structure,
- an elongated, flexible vehicle-carrying track,
- main longitudinal suspension cables extending in spaced relation to one another between said supporting columns and connected to said supporting columns including cable takeup means for maintaining predetermined tension in said cables notwithstanding expansion and contraction of said track members,
- transverse suspender elements extending between said longitudinal suspension cables and between each of said longitudinal suspension cables and said track for suspension of said track in spaced relation to and beneath said longitudinal suspension cables, and
- said track suspended by said transverse suspender elements from said longitudinal suspension cables independently of said supporting columns whereby to maintain uniform flexible suspension of said track from said longitudinal suspension cables throughout the length of the track structure under static and dynamic loading of a vehicle.

2. In a high speed vehicle transport system according to claim **1**, said main longitudinal suspension cables consisting of at least two pretensioned longitudinal suspension cables.

3. In a high speed vehicle transport system according to claim **2** said interconnected cables and track being in the cross-sectional form of an inverted delta.

4. In a high speed vehicle transport system according to claim **1**, said cable takeup means disposed between said supporting columns and each of said cables whereby to maintain predetermined tension in said cables notwithstanding expansion and contraction of said track members.

5. In a high speed vehicle transport system according to claim **4**, said cable takeup means including suspender elements extending at a relatively low angle to the longitudinal axis of said track between each column and a main suspension cable member.

6. In a vehicle transport system, a track structure comprising
- an elongated, flexible vehicle-carrying track member, said track member consisting of a continuous track dampening cable and a segmented steel section parallel and adjacent to said track dampening cable, said steel section segments expanding and contracting with changes in temperature, said track dampening cable maintaining a constant length and undergoing changes in tensile stress with changes in temperature,
- main longitudinal suspension cables extending in spaced relation to one another between said supporting columns,
- transverse suspender elements extending between said main longitudinal suspension cables and between each of said main longitudinal suspension cables and said track for suspension of said track member in spaced relation to and beneath said main longitudinal suspension cables, and
- said tracks suspended by said transverse suspender elements from said longitudinal suspension cables independently of said supporting columns whereby to maintain uniform flexible suspension of said track from said longitudinal suspension cables throughout the length of the track structure under static and dynamic loading of a vehicle.

7. In a high speed vehicle transport system, a track structure comprising
- a pair of elongated, flexible vehicle-carrying track members rigidly interconnected in horizontally spaced parallel relation to one another,
- main longitudinal suspension cables arranged for lengthwise extension of said track structure in substantially horizontally spaced parallel relation to one another,
- transverse suspender elements extending between said longitudinal suspension cables and between said longitudinal suspension cables and said track members under a predetermined degree of tension,
- substantially rigid supporting columns at spaced intervals along the span of said track structure, said longitudinal suspension cables being anchored at said supporting columns and said tracks being suspended from said longitudinal suspension cables, and
- dampening means connecting said tracks to said supporting columns whereby to cooperate with said longitudinal suspension cables in maintaining uniform flexible suspension of said tracks throughout the length of said track structure.

8. In a high speed vehicle transport system according to claim **7**, said suspension cables consisting of two main longitudinal suspension cables, said transverse suspender elements extending between said cables and between each of said cables and each of said track members in the substantial form of an inverted delta.

9. In a vehicle transport system, a track structure comprising
- a pair of elongated, flexible vehicle-carrying track members rigidly interconnected in horizontally spaced parallel relation to one another,
- main suspension cables arranged for lengthwise extension of said track structure in substantially horizontally spaced parallel relation to one another, said suspension cables consisting of three suspension cables defined by one principal suspension cable and two secondary suspension cables,
- transverse suspender elements extending between said cables and between said cables and said track members, in the substantial form of an inverted delta, and p**1** substantially rigid supporting columns at spaced intervals along the span of said track structure, said cables being anchored at said supporting columns and said tracks being freely suspended from said cables and flexibly connected to said supporting columns whereby to maintain uniform flexible suspension of said tracks from said cables throughout the length of said track structure.

10. In a high speed vehicle transport system according to claim **9** said transverse suspender elements extending between said principal suspension cable and each of said secondary suspension cables and between said principal suspension cable and each of said track members and between each of said secondary suspension cables and the said track member nearest said secondary suspension cable and between said track members.

11. In a vehicle transport system, a track structure comprising
- a pair of elongated, flexible vehicle-carrying track members rigidly interconnected in horizontally spaced parallel relation to one another, each of said track members having a segmented steel section and a continuous track dampening cable parallel to and above said steel section whereby said steel section segments expand and contract with changes in temperature and said track dampening cables maintain a constant length and undergo changes in tensile stress with changes in temperature,

main suspension cables arranged for lengthwise extension of said track structure in substantially horizontally spaced parallel relation to one another and to said track members,

transverse suspender elements extending between said cables and between said cables and said track members, and

substantially rigid supporting columns at spaced intervals along the span of said track structure, said cables being anchored at said supporting columns and said tracks being freely suspended from said cables and flexibly connected to said supporting columns whereby to maintain uniform flexible suspension of said tracks from said cables throughout the length of said track structure.

12. In a high speed vehicle transport system according to claim 11, said steel section segments being interconnected by expansion joints, and yieldable suspension means between said steel section segments and said supporting columns.

13. In a high speed vehicle transport system having an elongated vehicle-carrying track defined by a plurality of track sections arranged in end-to-end relation to one another and suspension means including support columns at spaced intervals for suspending the track in elevated relation to the ground, the combination comprising:

an expansion joint between adjacent ends of the track sections including a wedge provided with convergent side edges aligned with and complementary to laterally inclined edges at the ends of the track sections,

a slide bearing assembly between adjacent ends of the track sections and said wedge member causing said wedge to be laterally slidable along the inclined side edges between the adjacent ends of the track sections in response to expansion and contraction of said track sections, and

alignment means between the adjacent ends of the track sections to permit expansion and contraction of the track sections while preventing displacement therebetween.

14. In a vehicle transport system according to claim 13 in which said track sections span adjacent support columns, and yieldable suspension means extending between said support columns and said tract sections for flexible suspension of said track sections from the support columns.

15. In a vehicle transport system according to claim 13, said track sections each including a horizontal dampening cable slidably secured to the upper track surfaces for extension between adjacent support columns.

16. In a vehicle transport system according to claim 13, each wedge member being of generally triangular configuration having convergent sides extending laterally between inclined side edges arranged opposite one another along the lower surfaces of each of the adjacent ends of said track section, said bearing assembly including bearing members mounted on said wedge member parallel and adjacent to each of the convergent sides, and bearing support portions attached to adjacent ends of the track sections parallel to the inclined edges, said bearing support portions being provided with sockets for insertion and slidable movement of said bearing members on said wedge.

17. In a vehicle transport system according to claim 16, said alignment means being defined by male and female telescoping elements connected to adjacent ends of said track sections

for longitudinal slidable movement with respect to one another under expansion and contraction of said track sections.

18. In a vehicle transport system according to claim 13 wherein said track sections include a series of track sections defining a branch line in laterally spaced relation to a main line, one of the track sections in the main line movable between the main line and the end of the branch line, said transport system further including incremental track positioners arranged at longitudinally spaced intervals along at least a portion of said movable track section to impart progressively increased lateral movement to said movable track toward the end nearest the branch line for switching said movable track section from the main line to the branch line.

19. In a vehicle transport system according to claim 18, further including a switch guide mechanism between adjacent ends of the branch line and the movable track section to effect locking engagement between adjacent ends when the end of the movable track section is advanced by said incremental track positioners into alignment with the branch line.

20. In a vehicle transport system according to claim 18, said incremental track positioners being defined by drive means engageable with the undersurface of the movable track section for advancement of said movable track section into a predetermined curvature leading from the main line into the branch line.

21. In a high-speed elevated track transport system for overhead suspension of a vehicle comprising:

a pair of elongated, vehicle-carrying track members arranged for extension in horizontally spaced parallel relation to one another,

substantially rigid, upright supporting columns mounted at spaced intervals along the span of said track members,

rigid strut members extending transversely between said tracks,

a pair of main suspension cables extending in horizontally spaced, parallel relation to one another between adjacent supporting columns,

transverse suspender elements extending between said main suspension cables and between each of said track members under a predetermined degree of tension whereby to deflect said track members upwardly into cambered position between said supporting columns, said main suspension cables being connected to said supporting columns with said track suspended from said cables independently of said supporting columns whereby to maintain uniform flexible suspension of said track throughout its length.

22. A vehicle transportation system according to claim 21, further including cable takeup means between the ends of each of said main suspension cables and said supporting column whereby to maintain a predetermined tension in said cables notwithstanding expansion and contraction of the track members.

23. A vehicle transportation system according to claim 21 further including first auxiliary suspension cables extending in a substantially vertical direction between said supporting columns and said track and second auxiliary suspension cables extending substantially horizontally from said supporting columns for connection to said track.