AIR CUSHIONED VEHICLE

Inventor: Douglas W. Holland, 6851 N. Fremont Rd., East Syracuse, N.Y. 13057

Filed: July 12, 1973

Appl. No.: 378,696

U.S. Cl. .................................................. 180/120
Int. Cl. .................................................. B66V 1/14
Field of Search ............ 180/120, 117, 118, 116, 180/122, 125, 126

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Primary Examiner—Robert B. Reeves
Assistant Examiner—Thomas E. Kocovsky
Attorney, Agent, or Firm—Roylance, Abrams, Berdo & Karl

ABSTRACT
An air cushioned vehicle includes a control system for permitting the vehicle to move sideward and rearward and for accurately steering the vehicle during these movements. The control system also permits the vehicle to hover and have full control while the vehicle is under full power. An air stream produced by a power plant mounted on the vehicle body is directed substantially downward to provide lift and substantially horizontally to provide propulsion and steering thrust. Forward and aft vanes are connected to the control system and can be manipulated to deflect the air stream to move the vehicle sideward. Side vanes are connected to the control system and can be manipulated to deflect the air stream to move and steer the vehicle in the rearward direction and to permit the vehicle to hover while the airstream power plant is under full power.

12 Claims, 16 Drawing Figures
AIR CUSHIONED VEHICLE

This invention relates to air cushioned vehicles, and more particularly it relates to such a vehicle which can move forward, through turns, as well as sideward and rearward and which can hover in a fixed position.

Vehicles of the air cushioned type are commonly referred to as air cushion, ground cushion or ground effect vehicles and include an air pressure chamber open to the ground plane. An air stream is produced by a power plant on the vehicle and is directed into the chamber from which it leaks out around the bottom edges of the chamber. The directing of the air stream into the chamber causes an increased pressure in the chamber which lifts the vehicle slightly above the ground plane. In this slightly elevated position, only a small propulsive force is necessary to move and turn the vehicle since the cushion of air provides a very low frictional support to the vehicle. These types of vehicles may be used over such diverse ground plane surfaces as land, snow, swamps, beaches and water.

Although these types of air cushioned vehicles are well known in the art, they have consistently been lacking in various aspects. Specifically, many of the vehicles which utilize an air propeller to produce propulsion and lift are incapable of hovering while the propeller is being maintained at maximum power and others accomplish this only with complicated controls to vary the pitch of the propeller or complicated air vanes to neutralize the thrust emanating from the propeller. Additionally, air cushioned vehicles of this type are incapable of moving in a sidewards or lateral direction without any forward movement. Furthermore, these vehicles are incapable of accurate steering while they are being propelled backwards.

Therefore, it is a primary object of the present invention to provide a new and improved air cushioned vehicle.

A further object of the present invention is to provide an air cushioned vehicle which is capable of hovering while the power plant is at maximum throttle.

A further object of the present invention is to provide an air cushioned vehicle which is capable of moving in a lateral or sideways direction without forward or rearward movement of the vehicle.

Another object of the present invention is to provide an air cushioned vehicle which is capable of being accurately steered while moving in the rearward direction.

The foregoing objects are attained by providing an air cushioned vehicle which comprises a body assembly or member having a thrust producing power plant mounted thereon and formed to direct the thrust from the power plant both in a substantially downward direction to provide thrust for elevating the vehicle and in a substantially horizontal direction to provide thrust for propelling and steering the vehicle. An enclosed U-shaped conduit is formed in the body assembly for receiving the horizontal thrust from the power plant and has a pair of vanes in the forward portion, a pair of vanes in the mid-portion, and a series of vanes in the rear portion, all utilized to steer the vehicle. An open cockpit is provided in the center of the U-shaped conduit and contains a steering wheel, pedals, and throttles for controlling the vanes and the power plant. The forward and aft vanes are controllable by means of rotation of the steering wheel and the side vanes are controllable by pushing or pulling the steering wheel in a longitudinal direction. The aft and side vanes are additionally controllable by means of the pedals, wherein actuation of these pedals overrides the steering wheel control of these vanes.

In order to move the vehicle sideways, it is placed in a hover mode and the steering wheel is turned in the desired direction, thus causing the forward vanes to deflect the airstream in the opposite direction, and a pedal is depressed to cause the aft vanes to deflect the airstream in that same opposite direction. In order to cause the vehicle to hover while the power plant is at maximum throttle, the side vanes are manipulated, by means of pushing or pulling the steering wheel, to a position wherein substantially one-half of the horizontal thrust is deflected in a forward direction. To cause the vehicle to move rearwards, the side vanes are positioned to deflect substantially all of the horizontal thrust in a forward direction. In order to steer the vehicle during rearward movement, the steering wheel is manipulated and one of the pedals is depressed to vary the position of the side vanes.

Other objects, advantages, and salient features of the present invention will become apparent from the following detailed description, which, taken in conjunction with the annexed drawings, discloses a preferred embodiment of the present invention. Referring now to the drawings which form a part of this original disclosure:

FIG. 1 is a perspective view of a vehicle in accordance with the present invention;
FIG. 2 is a top plan view of the vehicle;
FIG. 3 is a side elevational sectional view of the vehicle taken substantially along lines 3—3 in FIG. 2;
FIG. 4 is an enlarged fragmentary sectional view taken along lines 4—4 of FIG. 3;
FIG. 5 is a top plan sectional view taken substantially along lines 5—5 in FIG. 3;
FIG. 6 is a diagrammatic view of the steering mechanism for the vehicle in partial section;
FIG. 7 is an enlarged top plan view of the forward vanes;
FIG. 8 is an enlarged top plan view of the series of side vanes;
FIG. 9 is an enlarged rear elevational view of the vehicle with parts cut away to show the aft vanes and their controlling linkages;
FIG. 10 is a fragmentary perspective view of a torque tube arrangement connected to one of the elevons used to correct the pitch and roll of the vehicle;
FIG. 11 is an enlarged fragmentary top plan view of one of the bell cranks used in controlling the side vanes;
FIG. 12 is a top plan view showing the operation of the bell crank and one of the side vanes which is in the hover position;
FIG. 13 is a view similar to FIG. 12 but showing the side vane in a position to provide full reverse thrust to the vehicle;
FIG. 14 is a view similar to FIG. 12 but showing the pedal actuated override used in accurately steering the vehicle during rearward movement;
FIG. 15 is a diagrammatic representation of the air flow through the vehicle during a forward right turn; and
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FIG. 16 is a diagrammatic representation of the air flow through the vehicle while it is moved sidewards. Referring now to the drawings in further detail, the vehicle in accordance with the present invention is shown in FIGS. 1 and 2 and is generally designated 20. The vehicle is comprised of a body member 22 having an upper portion 24, a lower portion 26 and a middle or platform portion 28 therebetwenn. As shown in FIG. 3, the vehicle 20 is resting on a horizontal ground plane designated 21. In this position it will be noted that a substantial part of the bottom of the lower portion 26 is in contact with the ground plane and is in a horizontally oriented plane, which plane will provide a reference relative to which the details of the vehicle will be described.

Referring to FIGS. 1, 2 and 3, the upper portion 24 is formed by a top surface 36, two depending side walls 32 and 34, and a rear wall 46. The top surface has a forward portion 39 which curves downwardly from its center and a rear portion 41 which is horizontally oriented and is substantially planar. The leading edge of the forward portion is elevated by an angle of approximately 18° relative to the plane of the rear portion 41. The side and rear walls are substantially vertically oriented and connect the top surface with the middle portion 28. A circular opening 30 in the upper portion of the body member is defined by the front of the side walls and the forward portion 39. The plane containing the opening is at approximately 72° to the horizontal plane defined by the bottom of the lower portion.

In each of the side walls there is an elongated, substantially rectangular cutout 37 and 38, each of which is located adjacent to but slightly rearward of the circular opening 30. As seen in FIG. 2, a rectangular cockpit 40 is provided in the top surface rear portion 41. Adjacent the cockpit 40 and formed in the walls on each side of the upper portion is a scoop, with the left scoop being designated 42, and the right scoop being designated 44. The scoops 42 and 44 are provided with forward openings 43 and 45, respectively. The bottom of each scoop rests on the platform 28, and the top and rear of each scoop is connected to the side wall, there being an extension of the side wall to, but not connecting to, a point 199 of each side vane and an opening 47 formed in each side wall adjacent each side vane, as seen in FIG. 5. As seen in FIG. 9, the upper portion 24 has a vertically oriented rear wall 46 having a substantially elongated rectangular outlet or opening 48 on the left side and a similar opening 49 on the right side.

As seen in FIGS. 1 and 2, the entire upper portion 24 rests on, and is preferably integral with, the platform portion 28 which has depending therefrom the lower portion 26. As thus seen in FIGS. 3 and 4, the lower portion 26 defines a pressure chamber 52 between a front wall 54, a rear wall 56, a left side wall 58, and a right side wall 60, all of which are located below and along the periphery of the platform 28 and which depend therefrom. Located in the platform 28 adjacent the forward half of the pressure chamber 52 is a vent or opening 62 which allows the pressure chamber 52 to communicate with the circular opening 30 in the upper portion 24.

As shown in FIG. 3, a floor member 64 extends from a position on the platform 28 just behind the opening 62 to a position above the center of the opening 62, and such floor member connects at its forward end to an upstanding curved front wall 66 of the cockpit 40. The floor member 64 is at an angle of approximately 18° relative to the horizontal. Extending forward from the front wall 66 and in the same plane as the floor member 64 is a support wall 68 which has mounted thereon a motor 70 which in turn carries a propeller drive shaft 71 and propeller 72, the propeller being located in the opening 30 in the front of the upper portion of the body member. Spaced below and parallel to the support wall 68 are two parallel, spaced deflecting members 74 and 76 which are located adjacent the bottom of the opening 30 between that opening and the vent 62. Preferably, the plane containing the propeller is at approximately 72° to the horizontal.

As seen in FIG. 5, a steering column 78 is horizontally supported in a vertically oriented transverse wall 80 which is supported on its top by the forward portion of the top surface 36 and on its sides by two side walls 82 and 84 which define the sides of the cockpit 40 below the top surface 36. These side walls are vertical and are each connected to the front wall 66 and an inner rear wall 67.

As best seen in FIG. 6, a steering wheel 86 is rigidly mounted on the rear end of the steering column 78. Depending from the surface 36, in a parallel spaced configuration, are four supports or plates designated 88, 90, 92, and 94. Supports 88 and 94 receive the steering column 78 in suitable bearings 96 for rotatably supporting the steering column therein. Extending along the steering column 78 a distance slightly less than the distance between supports 88 and 94 is a slot 98 for receiving a key 100 which is rigidly fixed to the hub 102. The hub 102 surrounds the steering column and supports a drum 105 and a time delay arm 107 on the column. This key and slot arrangement allows the drum 105 and the arm 107 to be rotated with the steering column 78 and yet allows simultaneous longitudinal movement of the column relative to the drum and arm. Encircling the steering column on both sides of the hub 102 and held against the ends of the hub by supports 90 and 92 are two thrust bearings 106, which are located adjacent apertures 108 and 110 located in the supports 90 and 92, respectively. The drum 105 receives a cable as will be described hereinafter. The arm 107 is an elongated bar rigidly mounted at its center to the hub and having a right-angled hook 109 at one end and a similar hook 111 at its other end. Both hooks face rearward and open outwardly as shown in FIG. 5. In the normal rest position, the arm lies horizontally and receives a cable as will be described hereinafter.

At the end of the steering column 78, opposite the steering wheel 86 is a swivel coupling 112 which connects the steering column with a bar 114. The bar 114 has connected thereto two cables which will be described in more detail hereinafter.

Referring again to FIG. 3, mounted above the rear half of the platform 28 is a false floor 116 having a seat 118 for the operator of the vehicle. Adjacent the front of the false floor 116 are two pedals, the left pedal being designated 120 and the right pedal being designated 122. Both of these pedals are shown in FIG. 5. As seen in FIG. 3, each pedal is pivotally supported on the top of the floor member 64 and is spring-biased rearwardly by means of a spring 124 which is connected between the pedal and a depending floor portion 126 extending from the front of the false floor 116 to the floor member 64. Stops 128 are provided for maintaining the
position of both pedals against the bias of springs 124. Each pedal is connected to a cable which will be described in more detail hereinafter.

Turning now to FIGS. 5 and 7, the forward vane assembly 140 and its control system will be described. Pivoted about a substantially vertical axis to the left side wall 32 in the cutout 38 is a substantially rectangular left forward vane 142 which is slightly curved in plan view and which is connected to a substantially vertical pivot rod 144 which is pivotally connected at its top and bottom to that side wall 32. A right forward vane 146 is similarly pivotally mounted in cutout 37 by means of a pivot rod 148 which is pivotally connected at its top and bottom to the right sidewall 34. Each of the pivot points for the forward vanes is located towards the rear edge of the substantially vertically oriented vane. Fixedly mounted to support wall 68 slightly rearward of each pivot rod is a vane stop 145 which permits each forward vane to pivot inwardly but prevents each from pivoting outwardly through their respective cutouts 37 and 38. Each stop can be in the form of a rod.

As shown in FIG. 7 a tube 150 is mounted on the vanes for transverse horizontal movement relative to the body member of the vehicle. The tube 150 has a plug 152 closing off each end with each plug receiving, in a central bore 154, a rod 156 having a diameter less than the inside diameter of the hollow tube 150. Each rod is capable of slidable movement through the central bore 154 and has at its outside end, a pivotal connection 158 with each vane located at a position spaced forward from the vane's pivot position. Spaced substantially one-third of the length in from each end of the tube 150 is a plug 160 which has a diameter equal to the inside diameter of the tube and which is nonmouvably connected to the inside of the tube 150 by a pin 161. Each plug 160 has a central bore 162 for slideably receiving an end of the rod 156. Rigidly connected at substantially the mid-portion of each rod 156 is a disk-shaped stop 164 which receives each rod 156 through a central aperture therein and which is rigidly connected to each rod by means of a pin 166 passing through the stop and the rod. Located between the plug 160 and the stop 166 is a helical compression spring 168 which is concentric to the rod 156. Located on opposite ends of the tube 150 on the rear side thereof are ring supports 170 and 182 which to a cable 172 is connected at its ends. As seen in FIG. 5, the cable 172 proceeds from the left ring support 170 transversely of the vehicle and around a pulley 174 and then rearwardly to and around a pulley 176, then once completely around the drum 105, from that drum transversely and around a pulley 178, then forwardly to and around a pulley 180, and finally is connected to the right ring support 182 on the other end of the tube 150. For sake of clarity, the supports for the pulleys 174, 176, 178, and 180 are not shown; however, they are to be supported in a conventional manner to the various structural parts of the vehicle adjacent thereto.

As shown in FIG. 5, side vanes are provided in each side wall opening 47 adjacent the scoops 42 and 44. A left side vane 186 is disposed within the left scoop 42 and a right side vane 188 is disposed within with the right scoop 44. Since the structure and control system for each of the two side vanes is the same, only one will be described.

The left side vane 186 is formed as a substantially rectangular plate which is slightly curved in the plan view. As shown in FIG. 5, the vane is pivotally mounted at its center point around a vertical axis by means of a pivot rod 190 which is rigidly connected thereto and which has a pivotal connection at the bottom with the platform 28 and at the top with the left side wall 32. The upper right-hand corner of the side vane is slightly rounded to conform to the rounded top of the scoop 42, this being shown in FIG. 1. Pivotedly connected to the inside surface of the vane 186 at a position slightly rearward of the pivot rod 190 is a horizontally oriented connecting rod 192 which passes through a suitable aperture in the cockpit sidewall 82 and is pivotally connected at 194 to the end of an arm of a bell crank 196. The bell crank is formed in a right angle, and as seen in FIG. 11, is pivotally mounted to the platform 28 by a pivot rod 198 and is horizontally oriented. The bell crank 196 is shown as consisting of a first arm 200 and a second arm 202, these arms being integrally formed at right angles and pivot around the pivot rod 198 located at the juncture of these arms. The arm 202 normally is positioned parallel to the longitudinal axis of the vehicle and the arm 200 normally points toward the center of the vehicle. The free end of the second arm 202 has a slight bevel 204 therein which bevel faces rearwardly. Adjacent thereto is a collar 206 which is mounted to the top of the end of the second arm 202 and which slideably receives a cable 208 therein. Although the cable is movable through the collar 206, a cable stop 210 is fixedly mounted on the cable and will not pass through the collar 206 since it has an outer diameter greater than the inner diameter of the collar 206. Midway between the pivot rod 198 and the collar 206 is a plate 212 which is pivotally mounted to the top of the second arm 202 by means of a pin 214 which is in the center of the plate. The plate 212 is normally perpendicular to the arm 202. At opposite ends of the plate 212 are upstanding guides 216 and 218 each having a central bore 220 therein with guide 216 being position at the rear of the plate 212. Rigidly connected to the top of the platform 28 and just forward of the bell crank 196 is a clamp 222 which rigidly supports the end of a push and pull cable assembly 224. This push and pull cable assembly is a conventional device which contains a wire cable surrounded by a rubber or plastic tubular covering wherein the cable can be pushed or pulled longitudinally through the tubular covering. As seen in FIG. 11, a cable 226 extends from the end of a tubular covering 225 and passes through guides 216 and 218. At the free end of the cable 226 is a rigidly connected collar 228 which is larger than the central bore 220 in the plate 216 and will prevent the cable from being pulled therethrough. Mounted between the rear edge of the clamp 222 and the front guide 218 is a helical compression spring 230 which surrounds the cable 226. As seen in FIG. 6 the other end of the push and pull cable assembly 224 is rigidly clamped adjacent the end of the steering column 78 by means of a clamp 232 which is rigidly secured to a convenient structural piece of the vehicle. The cable 226 extends from this end of the tubular covering 225 and is rigidly connected to the bar 114 and can therefore be pushed and pulled by longitudinal movement of the steering columns 78. Similarly, a cable associated with the other bell crank and side vane is attached to the bar 114.
Referring now to FIGS. 5, 8 and 9, which disclose the structure of the aft vanes, it is seen that there are two such vanes in each of the rear outlets or openings 48 and 49. Each one of these aft vanes which are designated 234 and 236 for the left aft vanes, and 238 and 240 for the right aft vanes, is pivotally supported in a vertical position between the rear part of the T-section 36 and the support platform 28 by means of a vertically oriented pivot rod 242 which passes through the middle of each aft vane. Each vane is substantially trapezoidal in shape with the larger base being at the bottom thereof. This shape is shown most clearly in FIG. 3.

As shown in FIG. 9 in phantom lines, each vane is pivotally connected via a horizontally oriented pin 244 to a rod 246 by means of having the pin 244 rigidly connected at one end to the front portion of each vane and pivotally connected via a downwardly extending end portion 245 to the top of the rod 246. On moving of the rod 246 to the left or right as viewed in FIG. 9 each of the four aft vanes will therefore pivot with their rear edges moving in a lateral direction opposite the movement of the rod 246.

Rigidly supported and spaced along the top of the rod 246 are two upstanding supports 248 and 250 each of which has a horizontally oriented central bore 252 formed therein for the reception of a rod 254 which is fixedly attached at its ends to each of the upstanding supports 248 and 250 and is parallel to the rod 246. A horizontally oriented T-shaped slide 256 has a central bore passing completely through the smaller section of the T-shape and upon which the slide 256 is slideably mounted on the fixed rod 254. Two helical compression springs 257 are concentrically positioned around the rod 254 between the slide and the supports 248 and 250 for normally maintaining the slide centered on the rod. The free end of the slide 256 is rigidly connected to a cable 258, which, as shown in FIG. 5, extends back to and is wrapped once around the time delay arm 107 and returns to the slide. Specifically, as seen in FIG. 5, one portion of the cable 258 extends laterally from the slide and around a pulley 260, then longitudinally of the vehicle and around a pulley 262. Then the cable extends above and past hook 109, over the steering column 1 to hook 111 where it is rigidly fastened. Then the cable extends back underneath the steering column 1 under and past hook 109 and to pulley 264. The cable returns to the slide 256 along a similar path by means of passing around pulley 264, pulley 266, and finally pulley 268. Each of these pulleys is rigidly supported to a convenient structural piece of the body member.

The rod 246 additionally has a connection with two other cables by means of ring supports 270 and 272. The cable connected to the ring support 272 is cable 208, previously described in connection with the left side vane 186 and the bell crank 196 and which cable passes around a pulley 274 and then extends through the collar 206 shown in FIG. 11 and continues in a forward direction to its final connection with left pedal 120. In a similar fashion a cable 209 passes around a pulley 275, proceeds through the bell crank corresponding to the right side vane 188 and continues in a forward direction to a rigid connection with the right pedal 122. This final connection is shown in FIG. 3.

Extending rearwardly from the center of the rod 246 is a horizontally oriented plate 277 which is pivotally connected, by means of a pin 279 passing through a central aperture therein, to a circular plate 281 which is pivotally supported on the platform 28 by means of a pin 282 passing through an aperture in the rearward end portion of the plate 281 and connected to the platform 28. As shown in FIG. 8 a right-hand cable 284 and a left-hand cable 286 are fixedly attached to opposite sides of the platform 281 mid-way between the pins 279 and 282. Each of these cables are associated with a tubular covering which together form two push and pull cable assemblies designated 288 and 290. As seen in FIG. 8, the ends of each of these cable assemblies are fixedly attached adjacent the plate 281 to the platform 28 by means of clamps 292.

The other ends of the push and pull cable assemblies 288 and 290 are used to manipulate elevons 294 and 296 which are shown in FIG. 5 with the details of one thereof being shown in FIG. 10.

As shown in FIG. 10, left elevon 294 is trapezoidal in shape and has rigidly connected thereto a hollow tube 300 which rotatably receives therein one end of a transversely positioned torque tube 302. As shown in FIG. 10, the torque tube 302 is horizontally oriented and pivotally supported by means of a support 304 which is in turn rigidly mounted to the platform 28. Extending downwardly from the inboard end of the tube 300 is a plate 306 which is welded thereto. Extending in the rearward direction from the portion of the torque tube 302 adjacent the end of the tube 300 is a right angle member 308 which has a clamp at its free end for fixedly supporting an end of the push and pull cable assembly 288 which was previously described and shown in FIG. 8. The cable 286 associated with the push and pull cable assembly 288 extends from the assembly and is rigidly connected to the bottom of the depending plate 306. As shown in FIG. 5 the right elevon 296 has a connection with the push and pull cable 290 which is similar to that of the left elevon 294.

Additionally connected to the torque tube 302 adjacent member 308 is a right angle member 310 which has its free end rigidly connected to a cable 312 which is associated with an additional push and pull cable assembly 314. The end of this assembly which is adjacent member 310 is rigidly clamped to the support platform 28 by means of a clamp 316. The other end of the assembly 314 is located on the inside of the cockpit wall 82 where it is clamped thereto by means of a clamp 318 and wherein the other end of the cable 312 is connected to a pivotal lever 320.

The elevons shown in FIG. 5 are advantageously mounted forward of the tube 246 in a direction transverse to the longitudinal axis of the vehicle and at a height above the platform 28 equal to about one-half the height of the aft vanes.

In operation, the operator of the vehicle takes his place in the cockpit 40 by sitting on the seat 118 and facing the steering wheel 86 and the pedals 120 and 122. These pedals 120 and 122 are self-neutralizing so that the rear vanes which they control are oriented as shown in FIG. 5 when there is no pressure on the pedals. The vehicle is initially resting on the ground plane as seen in FIG. 3. The motor 70 is started and can be conventionally manipulated by means of a throttle located in the cockpit, although not shown. The activation of the motor 70 causes the rapid rotation of the tilted propeller 72 which draws air in through the opening 30 and thereby produces an airstream extending from the propeller downwards and rearwards. A first portion of that airstream is directed through the de-
flecting members 74 and 76, and through the opening 62 into the air pressure chamber 52. This airstream builds up a pressure within the chamber 52 and then leaks out of the bottoms of the walls 54, 56, 58, and 60 which form the chamber. This resulting pressure causes the vehicle to be slightly elevated from the ground plane upon which it was resting.

The remaining portion of the airstream, i.e., the second portion, extends rearwardly towards the front wall 66 of the cockpit 40. At this point the airstream contacts the front wall and splits into two separate streams and both proceed rearwardly towards the aft vanes mounted on the vehicle through conduit means 322.

The conduit means 322 includes two branch conduits 324 and 326, the former being the left conduit formed between the walls 82 and 32 and the latter being the right conduit formed between the walls 84 and 34. The two branch conduits 324 and 326 merge together in front of the wall 66 to form an inlet portion 323 which receives the airstream from the propeller 72.

As shown in FIG. 5, the forward vanes 142 and 146 are in a position wherein they do not deflect any of the airstream created by the propeller, and the side vanes 186 and 188 and the aft vanes 234, 236, 238, and 240 are in similar non-deflecting positions. Therefore, the second portion of the airstream produced by the propeller 72 is conducted through the conduit means 322 in a rearward direction, through the branch conduits 324 and 326 and exits through the openings 48 and 49 in a substantially perfect rearward and horizontal direction. Since the vehicle is slightly elevated from the ground plane, the airstream exiting from these openings causes a concomitant movement of the vehicle in a forward direction.

In order to cause the vehicle to turn in the right direction, the forward vane 142 must be pivoted to the right and the aft vanes must be pivoted to the left. To accomplish this, the operator of the vehicle merely rotates the steering wheel 86 in a clockwise direction. Since the cable 172 is wrapped around the drum 105, which rotates with the steering column 78 and the steering wheel 86, a clockwise rotation of the steering wheel causes the tube 150 to move in the right-hand direction and causes the rod 156 connected to vane 142 to pivot that vane around its pivot rod 144. Because of the vane stop 145 adjacent forward vane 146 and the manner in which the vanes are connected to tube 150, vane 146 does not pivot outwardly. This position is shown in FIG. 15 wherein the now pivoted vane 142 deflects a portion of the airstream created by the propeller laterally out the opening 38 in the side wall 32 of the body member.

Additionally, since the aft vanes are pivotally connected to the rod 246 which is in turn connected to and moves with a lateral movement of the slide 256, when the time delay arm 107 is rotated with the steering column, cable 258 will be drawn in by contact with the upwardly rotating hook 109 connected at the end of the arm. This pulls the slide 256 in the left-hand direction thereby pivoting the aft vanes towards the right. A time delay is produced between the pivoting of the forward vanes and the pivoting of the aft vanes consisting of the time it takes for hook 109 to be rotated upwardly from its horizontal rest position to a position in which it contacts cable 258. The pivoted aft vanes are shown in FIG. 15 wherein those aft vanes deflect the airstream moving in both conduits 324 and 326 towards the right-hand direction. The sum of the thrust produced by the deflection of the airstreams in these directions causes the vehicle to turn toward the right.

To cause the vehicle to make a left turn as it is moving forward, the steering wheel is rotated in a counterclockwise direction and the forward right vane 146 deflects the airstream laterally out the right side of the body member and the aft vanes are pivoted towards the left and deflect the airstream towards the left.

Referring again to FIG. 5, it will be observed that all of the airstream indicated by the arrows is moving in a substantially rearward direction and therefore causes the vehicle to move forward. However, if it is desired to allow the vehicle to hover in one position, the side vanes can be manipulated to a position shown in FIG. 12 wherein substantially one-half of the airstream flowing in each of the conduits 326 and 324 is split and wherein one-half proceeds out of the rear openings 48 and 49 and another half of the airstream is deflected by the side vanes 186 and 188 and their associated scoops 42 and 44 in a substantially forward direction out openings 43 and 45 as indicated by the arrows in FIG. 12. In such a position, an equal thrust is created in both the forward and rearward directions, thereby allowing the vehicle to hover in one position.

To accomplish this positioning of the side vanes, the operator of the vehicle pushes the steering wheel 86 in a forward direction. This causes the cable 226 associated with the push and pull cable assembly 224 to extend past the guide 216 on the plate 212 as shown in FIG. 11 in phantom. However, since the spring 230 is a compression spring it will bias the plate 212 in the rearward direction against the fixed clamp 222. This causes a rotation of the bell crank 196 in a clockwise direction as viewed in FIG. 11 and causes the connecting rod 192 to extend outwardly towards the left side of the vehicle thereby pivoting the left side vane 186 to a position wherein one-half of the airstream is deflected forward and the rest of it is allowed to pass out the rear opening 48. In a similar manner, the right side vane 188 is manipulated with its corresponding bell crank and assumes a position shown in FIG. 12.

In order to brake or stop a vehicle moving in a forward direction and having a vane configuration as that shown in FIG. 5, all the operator of the vehicle need to do is push the steering wheel 86 completely forward. This allows a rearward extension of the ends of the push and pull cables connected to the bell cranks and allows the associated springs 230 to rotate the bell cranks in a fashion similar to that described above for hovering, but in this case to a position wherein the side vanes become fully rotated as shown in FIG. 13 and deflect forward all of the airstream moving rearwardly in the conduits 324 and 326. Thus, a thrust is created in the forward direction and this counteracts the forward movement of the vehicle thereby braking the vehicle's forward motion.

Once the vehicle's forward motion is completely stopped by means of positioning the side vanes as shown in FIG. 13, if those vanes are continued to be positioned thusly, the vehicle is caused to move in a rearward direction.

As the vehicle is moving in a rearward direction, the pedals 120 and 122 can advantageously be manipulated in order to accurately steer the vehicle. As shown in FIG. 13, the cable stop 210 on cable 209 is positioned adjacent the collar 206 in the bell crank 196.
Thus, if the pedal 122 is depressed by the operator, the cable 209 is moved in a forward direction causing the cable stop 210 to engage the bevel 204 in the bell crank. A further depression of the pedal 122 causes the bell crank associated with the right side vane to be rotated in a clockwise direction. This rotation causes a clockwise rotation of the right side vane to a position shown in FIG. 14 wherein part of the airstream conducted thereto is deflected in a forward direction and another part is allowed to pass by the right side vane and be expelled through the rear opening 49. Since the left side vane is still in a position similar to that of the right side vane shown in FIG. 13, it deflects all of the airstream in conduit 324 in a forward direction. Therefore, there is an unbalanced thrust created, with more of a thrust being directed in the forward direction by means of the left side vane then that directed by the right side vane. This causes the rear of the vehicle to tend to move in the right direction. Obviously, the severity of this turn can be adjusted by varying the manipulation of the right pedal 122. Because the side vanes 186 and 188 are advantageously located aft of the center of gravity of the vehicle, which is preferably located adjacent the motor 70, a highly accurate steering is accomplished during the rearward movement.

In order to steer the vehicle towards the left during rearward movement, the left side vane is similarly manipulated by the pedal 120 and the right side vane 188 is kept in a full deflecting position as shown in FIG. 13.

The control system and vane structure of the vehicle described herein also can advantageously permit the vehicle to move in a sideways or lateral direction without any forward motion being present. Specifically, the vehicle is first placed in a hover position by means of manipulating the side vanes to the position shown in FIG. 12 which has been described above. In this position the forward vanes and the aft vanes are initially in the position shown in FIG. 5 and thereby do not deflect the airstream created by the propeller in any lateral direction. If the operator wants to move the vehicle sideways to the right, as viewed in FIG. 5, he turns the steering wheel 86 in a clockwise direction and simultaneously depresses the left pedal 120. The clockwise rotation of the steering wheel positions the forward vanes and aft vanes as shown in FIG. 15 and as described above for a right turn. However, the depression of the pedal 120 causes a forward movement of the cable 208 connected thereto which in turn causes the rod 246, shown in detail in FIGS. 8 and 9 to move to the right. This can be accomplished because the slide 256 is readily movable along the rod 254 against the bias of springs 257. Thus, the depression of the pedal 120 overrides the positioning of the aft vanes by means of rotation of the steering wheel and causes those aft vanes to pivot to the left.

Thus, as shown in FIG. 16, the forward left vane, as well as the aft vanes, deflect in a left lateral direction. The combination of these deflected thrusts causes the vehicle to move sideways to the right. In order to make the vehicle move sideways to the left, the operator of the vehicle turns the steering wheel in a counterclockwise direction and depresses the pedal 122. If desired, the vehicle can be made to move sideways while it is moving forward. This is accomplished by manipulating the steering wheel and the pedals as just described but while the vehicle has forward movement.

In order to trim the vehicle along its pitch axis, the elevons 294 and 296 can be manipulated by means of the lever 320 which is mounted in the cockpit. Referring to FIG. 10, the manipulation of that lever causes a concomitant movement of the push and pull cable 312 which is connected via the right angled member 310 to the torque tube 302. Thus, the elevons can be adjusted so as to have their plane of orientation varied with the forward or leading edges being elevated above or below the horizontal. As seen in FIG. 10, the torque tube 302 transmits any rotation given to it to the elevons by means of the connection between the torque tube and the elevons via the right angled member 308 and the depending plate 306 which are connected by means of the cable 286.

Additionally, the elevons are individually movable in order to trim the vehicle along its roll axis by means of the push and pull cable assemblies 288 and 290, which, as shown in FIGS. 8 and 9, are connected to the circular pivoting plate 281. Specifically, when the vehicle is being turned to the right in a forward direction, the rod 246 is moved to the right which also causes the plate 281 to pivot around pin 282 in a direction which pushes on cable 284 and pulls on cable 286. This causes the leading edge of the left elevon 294 to drop and the leading edge of the right elevon 296 to be elevated since each of the elevons is independently pivotally supported on the opposite ends of the torque tube 302. In a left-hand turn the action just described is the opposite and the leading edge of the left elevon 294 is elevated and the leading edge of the right elevon 296 is lowered.

While one advantageous embodiment has been chosen to illustrate the invention, it will be understood by those skilled in the art that various changes and modifications can be made therein without departing from the scope of the invention as defined in the appended claims.

What is claimed is:

1. An air cushioned vehicle comprising: a body member; a power plant mounted to said body member capable of producing an air stream; means for directing a first portion of the air stream in a substantially downward direction to elevate said body member; conduit means, carried by said body member, for conducting a second portion of the air stream in a substantially horizontal rearward direction, said conduit means having an inlet for directly receiving the second portion of the air stream produced by said power plant; said conduit means additionally having an outlet enabling the air stream entering said inlet to pass through said conduit means and then to exhaust through said outlet to the atmosphere in a substantially rearward direction to propel said body member forward; air stream deflecting means, pivotally coupled to said body member between said inlet and outlet of said conduit means, for deflecting the second portion of the air stream in a substantially horizontal forward direction and to the atmosphere; control means, coupled to said body member, for manipulating said air stream deflecting means to a first position wherein none of the air stream is deflected so the vehicle moves forward, to a second position
wherein substantially one-half of the air stream is deflected forward so the vehicle hovers in a fixed position, and to a third position wherein substantially all of the air stream is deflected forward so the vehicle moves rearward;

forward vane means, pivotally mounted to said body member adjacent said inlet of said conduit means, for deflecting a part of the air stream to the atmosphere in either lateral direction;

aft vane means pivotally mounted to said body member adjacent said outlet of said conduit means, for deflecting another part of the air stream to the atmosphere in either lateral direction; and

second control means, carried by said body member, for positioning said forward and aft vane means to deflect the air stream in the same lateral direction, when said control means has manipulated said air stream deflecting means to the second position, causing the vehicle to move in the opposite lateral direction without forward movement.

2. An air cushioned vehicle according to claim 1 wherein said control means includes a steering column mounted on said body member for longitudinal and rotational movement.

means, coupling said steering column and said air stream deflecting means, for manipulating said air stream deflecting means to said three positions upon longitudinal movement of said steering column, and

means, coupling said steering column and said fore and aft vane means, for varying the positions of said fore and aft vane means upon rotation of said steering column.

3. An air cushioned vehicle according to claim 1 wherein said second control means includes

a steering column mounted for longitudinal movement relative to said body member;
a steering wheel rigidly connected at one end of said steering column;

first drum means, rigidly connected to said steering column, for pivoting said forward vane means in lateral directions;

arm means, rigidly connected to steering column, for pivoting said aft vane means in lateral directions which are opposite to the lateral directions to which said forward vane means are pivoted; and

override means, connected to said body member, for changing the lateral direction to which the aft vane means are pivoted by means of said arm means, to the same direction to which said forward vane means are pivoted by said first drum means.

4. An air cushioned vehicle according to claim 3 wherein said override means includes

a rod pivotally connected to said aft vane means and oriented transversely relative to said body member, a slide member connected for longitudinal movement along a portion of said rod but normally biased into a position midway of said portion;

a pair of pedals, pivotally mounted to said body member; and

a pair of cables, each connected at one end to one of the pedals and at the other end to one end of said rods, whereby when said arm means pivots said aft vane means in a first lateral direction, depression of one of said pedals causes said rod and said aft vane means to move in the opposite lateral direction.

5. An air cushioned vehicle according to claim 1, wherein said air stream deflecting means includes a left side vane and a right side vane;

wherein said conduit means includes a left portion and a right portion, each of these portions conducting substantially one-half of the second portion of the air stream; and

wherein said control means is also operative to manipulate one of said vanes so that it deflects substantially all of the air stream conducted thereto in the forward direction and to the atmosphere, and, at the same time, to manipulate the other side vane so that it deflects substantially one-half of the air stream conducted thereto in the forward direction and to the atmosphere, thereby causing the vehicle to move in a rearwards turn in the direction opposite said one of said side vanes.

6. An air cushioned vehicle according to claim 5 wherein said air stream deflecting means further includes

a pair of scoops, rigidly mounted to said body member, each having an opening in the forward end thereof and a connection with said conduit means.

7. An air cushioned vehicle according to claim 5 wherein said control means includes

a steering column mounted on said body member for longitudinal movement;
a pair of bell cranks pivotally mounted on said body member;
a pair of connecting rods, each pivotally connected at one end to one of said bell cranks and pivotally connected at another end to one of said side vanes; and

a pair of push and pull cable assemblies, each connected at one end to said steering column and at another end to one of said bell cranks, wherein longitudinal movement of said steering column causes said side vanes to pivot.

8. An air cushioned vehicle according to claim 7 wherein said control means further includes

a pair of pedals pivotally mounted to said body member; a pair of cables, each connected to one of said pedals and passing through a portion of one of said bell cranks;
a pair of stops, each rigidly connected to a cable; and each of said stops being larger than said portion and therefore cannot pass therethrough, wherein, when said side vanes are in said third position, a depression of one of said pedals causes the stop associated with the cable connected to that pedal to pivot one of said bell cranks to thereby cause one of said side vanes to be pivoted to said second position.

9. An air cushioned vehicle according to claim 1 and further including

elevon means, pivotally supported in said conduit means, for varying the orientation of the vehicle along the pitch and roll axes thereof.

10. An air cushioned vehicle according to claim 9 wherein said conduit means includes a left portion and a right portion, and

said elevon means includes a first elevon supported for pivotal movement around a substantially hori-
15. Horizontal axis in said left portion and a second elevon supported for pivotal movement around a substantially horizontal axis in said right portion.

11. An air cushioned vehicle according to claim 10 and further including means for pivoting said first and second elevons simultaneously in the same direction.

12. An air cushioned vehicle according to claim 10 and further including means for pivoting said first and second elevons simultaneously in opposite directions.

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