ABSTRACT: A toy air cushion vehicle comprising a hull the lower portion of which carries a skirt bounding the air cushion space, an electrically driven lift fan having a substantially vertical axis, at least one propulsion unit mounted on the hull and comprising an electrically driven propeller, and at least one movable weight for balancing the vehicle on its air cushion both in the transverse and longitudinal directions. The skirt has parts subdividing the cushion space. The hull has a compartment with a door automatically closed by the lift fan through a pneumatic device. The propeller may be a flexible member maintaining its shape partly by centrifugal force and may have a torque limiter including a magnetic or friction coupling.
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TOY GROUND EFFECT VEHICLE WITH ADJUSTABLE STABILIZING WEIGHT

This invention relates to toy air cushion vehicles. Air cushion vehicles which can travel over land or water have now gone beyond the prototype test stage and are going into routine commercial use. It is an object of the invention to provide a toy which also operates on air cushion and which is a replica of the real air cushion vehicle. A toy which reproduces the external appearance of a real vehicle on a reduced scale exercises great fascination for children, and there is particular interest in a toy which can move equally well over a floor indoors or in a yard or playground outdoors, the toy being self-propelled and requiring no track or specially prepared surface for its movement.

A toy of this kind cannot just be a reduced model of the actual vehicle, even in a simplified form, and it is a further object of this invention to provide a number of original technical solutions to the problems to which the construction of such a toy gives rise.

According to the present invention a toy air cushion vehicle comprises a hull the lower portion of which carries skirt means bounding the air cushion space, an electrically driven lift fan having a substantially vertical axis, at least one propulsion unit mounted on the hull and comprising an electrically driven propeller and at least one movable weight for balancing the vehicle on its air cushion both in the transverse and longitudinal directions.

Preferably the electric motors for the fan and for the propulsion unit or units are supplied from a distance from a suitable source, such as a battery, through an agency of a flexible multiconductor supply cable. In such cases the vehicle may be controlled by varying the current supplied to the various motors. In a variant, the batteries may be mounted in the hull. In some expensive toys a radio-control unit may be used.

The movable weight may be mounted slidably on a horizontal rod adapted to pivot about a vertical axis. Thus, by swinging the horizontal rod to one side or the other, the center of gravity of the vehicle can be shifted laterally. By adjusting the position of the weight along the rod the center of gravity can also be adjusted in the direction of the length of the rod, i.e., longitudinally when the rod is substantially parallel with the longitudinal axis of the vehicle. Adjustment of the position of the center of gravity enables the toy vehicle to be properly balanced on its air cushion when stationary. By introducing unbalance when the vehicle is in motion and in a direction of motion can be further controlled. Preferably, therefore, the position of the weight is adjustable by external means, e.g., by a remote control mechanism.

The skirt means may comprise a main skirt disposed around the periphery of the lower portion of the hull bounding the air cushion space and secondary skirts which divide the air cushion space into compartments between the lift fan outlet and the main skirt. These secondary skirts may also afford mechanical support for the main skirt.

Wheels may be provided beneath the hull on which the toy can be rolled over the ground when the lift fan is inoperative, without damaging the skirt or skirts. When the fan is operative the air cushion raises the vehicle sufficiently to lift wheels well clear of the ground.

There may be at least one bellows connected to the lift fan outlet so that the bellows expands or contracts as the lift fan is, or is not, in operation, which bellows actuates a movable component of the toy, for example, a door which is opened and closed by the bellows.

For safety reasons the propeller or propellers are preferably made from a flexible material and maintain their shape partly by centrifugal force when the propulsion units are operating. For the same reasons, each propeller may be driven by its electric motor through a torque limiter. Thus, if the propeller meets an obstruction it will stop even though its driving motor continues to turn.

The invention may be performed in various ways and a specific embodiment, with a modification, will now be described by way of example with reference to the accompanying drawings, in which:

FIG. 1 is a longitudinal section of a toy air cushion vehicle embodying the invention;
FIG. 2 is a bottom plan view of the toy showing the skirt system;
FIG. 3 is a cross section on the line III-III in FIG. 1;
FIG. 4 is a cross section on the line IV-IV in FIG. 1;
FIG. 5 is a perspective view of the movable weight system;
FIG. 6 is a variant of FIG. 5 wherein the weight is connected to a directional control system;
FIG. 7 is an axial section showing the assembly of a propeller on a propulsion unit using a magnetic torque limiter;
FIG. 8 shows two half-sections similar to FIG. 7 for two embodiments in which the propeller twist is obtained by clamping a flat propeller shape;
FIG. 9 is a section on the line IX-IX in FIG. 8;
FIG. 10 is a view in the direction of the arrow X in FIG. 8; and
FIG. 11 is a section on the line XI-XI in FIG. 10.

The toy air cushion vehicle or hovercraft shown in FIGS. 1, 2, 3 and 4 is externally a reduced-scale copy of an actual hovercraft. The toy is manufactured from a lightweight material, e.g., polystyrene or polyethylene. It comprises a hollow hull 1 at the bottom of which a skirt system 20 is disposed. Two compartments 2 and 3 are provided at the two ends of the hull to receive toy automobiles, the compartments being closed at both ends by doors 2a, 3a, pivotable about bottom horizontal axes 2b, 3b, so that they can serve as access ramps. The hull 1 also has a compartment 5 to receive a movable weight, as will be described hereinafter. The central part of the hull has a vertical duct 6 for the blowing of lift air, the duct housing a four-blade lift fan 7 driven by an electric motor 8. The superstructure at the top of the hull comprises a cover 9 simulating a cabin with lateral apertures 9a representing windows and a pilot's station 10. On each side of the cabin 9, level with the central duct 6, two left and right propulsion units 11 are mounted on supports 11a, each propulsion unit comprising a reversible electric motor 12 driving a propeller 13. Two rudders 14 are disposed at the rear of the superstructure.

As well as being a replica of the external features of the actual hovercraft, the toy behaves in a similar way. When the lift fan 7 is started, it draws in air through the apertures in the superstructure (and more particularly the windows 9a) and blows it down through the duct 6 so that the entire toy lifts on the air cushion, the pressure air being forced beneath the hull and bounded by the skirts 20. In this position, rotation of the propellers 13 will cause the toy to move. If the two motors 12 rotate at the same speed, the toy will move in a straight line. It will turn on itself if the speeds of rotation differ. Because the motors 12 are reversible, a very rapid turning movement can be obtained by rotating the two propellers 13 in opposite directions to one another.

The various motors receive their supply from electric batteries. These are preferably part of a unit which is separate from the toy itself, connection to the motors being via a flexible multiconductor cable. In such cases the toy can be very easily controlled from a control unit incorporating a switch for the supply circuit to the lift motor 8 and two rheostats for controlling the two reversible propeller motors 12.

In a variant, the batteries may be incorporated in the toy and the control may be a radio-control, a radio-control receiver unit being incorporated in the toy and the transmitter unit being available for the user.

As will be more apparent from FIG. 2, the skirt system 20 comprises an outer peripheral or main skirt 21 around the bottom part of the hull 1. Between the outlet of the central duct 6 and the main skirt 21 are disposed two longitudinal skirts 22 and 23 formed with communicating apertures 22a, 23a, and two "front" and "rear" transverse skirts 24 and 25, the central part of each skirt 22 and 23 also being connected to the sides of the main skirt 21 by skirt partitions 26 and 27. The inner
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3, 22, 23, 24, 25, 26 and 27 preferably have a height less than that of the main skirt 21, as will be apparent from FIGS. 3 and 4. The various skirts are preferably made from a flexible and noncreeping impermeable fabric. The arrangement of the skirt system to form compartments has two advantages. First, the inner skirts help to support the main skirt so that the skirt system has satisfactory mechanical characteristics regarding the weight of the toy and the flexibility of the skirt material. Second, the compartmentalization of the lift air cushion improves the stability of the toy. The air leaving the duct 6 passes from a central cushion compartment to lateral cushion compartments via communicating apertures, such as 22, 23, 24, 25, 26 and 27 which are formed along the edge of the inner skirts which are shorter than the main skirt.

To enable the toy to be rolled over the ground without damage to the skirts when the lift fan is not in operation, the hull is provided with wheels, namely a front pivoting wheel 30 and two rear nonpivoting wheels 31.

An auxiliary duct 40 extends through the hull slightly to the rear of the central duct 6 and in it is mounted a bellows 41 closed by a plate 42 mounted to pivot about an axis 42a (FIG. 1). The end of the plate 42 which is remote from the pivot 42a is connected by two wires 43 to the rear door 3a which is mounted to pivot about an axis 3b. When the lift fan 7 is in operation, the air emerging from the duct 6 inflates the bellows so that the plate 42 pivoting about the pivot 42a passes from one position (which is the height at which the bellows is not operating) into a top position. During this movement, as a result of the connection by the wires 43, the door 3a pivots about the pivot 3b between an open position and a closed position. In other words, it is the operation of the lift fan which causes the door to close. Small magnets may be used in known manner to lock the doors. Of course a bellows such as 41 could be used to control the movement of any other movable component.

As already mentioned, the hull compartment 5 contains a movable weight, as will be seen more clearly in FIG. 5. It has been found from a number of tests that it is essential to provide the toy with a movable weight which can be displaced both laterally and longitudinally in order to provide accurate balance when the fan lifts the toy on its skirt without any movement. To this end (FIG. 5), a weight 50 is mounted slidably on a horizontal rod 51 which is mounted to pivot about a vertical axis by means of a vertical rod 52 rigidly connected to the rod 51 and mounted in a bearing 53 secured to the hull on the rear wall of the compartment 5. The vertical rod 52 terminates in a milled head 52a which is readily accessible from outside and can be turned by the edge of a coin. The right-hand face 53a is secured in retention on the horizontal rod 51 by a locking screw 50a. The end 51a of the rod 51 cooperates with a toothed circular segment 53 concentric with the vertical axis of the rod 52. With this arrangement, the position of the weight 50 on the rod 51 can be adjusted and the orientation of the rod 51 can be changed by turning the vertical rod 52, the orientation being maintained by cooperation of the end 51a with the notches between the teeth of the segment 53.

In the variant shown in FIG. 6, the provision of a movable weight system is used to control yawing. To this end, the vertical rod 52 is connected to a reduction gear 60 driven by reversible electric motor 61. The angular travel of the horizontal rod 51 connected to the vertical rod 52 is advantageously limited by adjustable stops (not shown) which can be fitted by screws to apertures 62a formed on a support 62 which itself incorporates fixed stops 62b. The motor is controlled from the control station by the lever 65 of a reversing switch connected to the motor 61 by leads 66, for reversing the direction of operation. The unbalance voluntarily produced by movement of the weight causes the toy to move over a circular or other nonrectilinear path. By moving the weight alternately to the left and to the right of the toy by means of the switch lever 65, a yawing motion is obtained. Additionally, the rod 52 may be associated with a rocking lever 70 which can be connected by two wires 71 to two external aerodynamic rudders.

The propeller assemblies should be designed to minimize the risk of accident to children. To this end it is advantageous to limit the speed of rotation of the propellers, to provide propeller blades made from a flexible material, such blades assuming their operative shape partly as a result of centrifugal force, and to connect the propellers to the shaft of the motors of assembly, units through torque limiting devices.

FIG. 7 shows a magnetic torque limiting device. The propeller 80 is mounted on the shaft 12a of its motor 12 as follows: a bush or a covering is fitted on the shaft 12a, a metal washer 81a being rigidly secured to the bush. A magnetized washer 82 is secured to the hub of the propeller. On assembly, the propeller is engaged over the bush 81, the magnetized washer 82 being applied against the metal washer 81a. A thrust washer 83 and a lock washer 84 cooperating with a notch in the bush 81 complete the assembly. The propeller is not clamped tightly on the shaft, and the main connection between the shaft and the propeller being a magnetic connection which limits the torque transmission. As a result the propeller can be stopped manually without harm.

FIGS. 8 (top half-section), 9, 10 and 11 illustrate a friction torque limiting system.

The propeller 90 is made from a flat blank of flexible plastic material and the blade of the propeller results from the clamping of the blank between inclined surfaces 92a and 93a of plates 92 and 93. The assembly is held together by a locking member 91 introduced into a cutout 91c in the plates 92 and 93. The locking member 91 is given a quarter of a turn to bring it into its locking position in which it fits into notches 91a and 91b formed in the plates 92 and 93. The assembly is then fitted over the shafts 90, 91, 92 and 93 is fitted over a bush 12a which is force-fitted onto the shaft 12. The assembly 90, 91, 92, 93 rotates freely on the bush 12a. A friction washer of elastic foam 95 is put into place and is held in position by a plate 94 which is secured to the bush 12a by a pin 96 which fits into a notch 94a in the plate 94.

A variant comprises replacing the resilient washer 95 by a magnetic washer 95a, as shown in the bottom half-section in FIGS. 8 to 10.

A propeller cowl 97 is fixed over the plate 92 to protect the complete assembly and also improve appearance.

What we claim as our invention and desire to secure by Letters Patent is:

1. A toy air cushion vehicle comprising a hull, skirt means carried by said hull for bounding and defining an air cushion space below said hull, a lift fan having a substantially vertical axis, duct means affording communication between said lift fan and said air cushion space, electrical driving means for said lift fan, at least one propulsion unit mounted on said hull, said propulsion unit comprising a propeller and electrical driving means for said propeller, means comprising at least one movable weight for balancing said vehicle on an air cushion generated in said air cushion space by said lift fan, means mounting said weight on said vehicle for movement both in the transverse and longitudinal directions of the said vehicle to a selected fixed position in said vehicle to a selected fixed position in said vehicle.

2. A toy air cushion vehicle according to claim 1 wherein said mounting means includes a horizontal rod, means supporting said rod for pivoting about a vertical axis, and said movable weight being slidably mounted on said rod.

3. A toy air cushion vehicle according to claim 1 including control means for moving said movable weight to control the direction of motion of said vehicle.

4. A toy air cushion vehicle according to claim 1 in which said skirt means comprises a main skirt bounding the periphery of said air cushion space and secondary skirts which divide said air cushion space into compartments disposed between said duct means and said main skirt.
5. A toy air cushion vehicle according to claim 4 in which said secondary skirts are connected to said main skirt to afford mechanical support for said main skirt.

6. A toy air cushion vehicle according to claim 1 including wheels mounted beneath said hull and adapted to support said vehicle when said lift fan is inoperative.

7. A toy air cushion vehicle according to claim 1 including at least one bellows, means connecting said bellows to said duct means whereby said bellows is extended when said fan is operative, said bellows being normally contracted when said fan is inoperative, said toy also including a movable component and an operative actuating connection between said bellows and said movable component.

8. A toy air cushion vehicle according to claim 1 in which said electrical driving means for said propeller of said propulsion unit is a reversible electric motor.

9. A toy air cushion vehicle according to claim 1 in which said propeller of said propulsion unit is made from flexible material and is adapted to maintain its shape partly by centrifugal force when said electrical driving means of said propulsion unit is operating.

10. A toy air cushion vehicle according to claim 1 in which said propulsion unit includes a torque limiter interposed between said propeller and said electrical driving means of said propulsion unit.

11. A toy air cushion vehicle according to claim 10 in which said electrical driving means of said propulsion unit has a drive shaft and said propeller has a hub and in which said torque limiter comprises magnetically coupled washers one on said drive shaft and the other on said propeller hub.

12. A toy air cushion vehicle according to claim 1 in which said electrical driving means of said propulsion unit has a drive shaft and in which there is an elastically deformable washer between said drive shaft and said propeller of said propulsion unit.

13. A toy air cushion vehicle according to claim 1 in which said hull has a superstructure defining apertures constituting air inlets for said lift fan.