[0086] FIG. 33~~C~~F illustrates an example motor for the swing apparatus of FIG. 31A, with two permanent magnets and two electromagnets.

[0087] FIG. 34A illustrates an example motor for the swing apparatus of FIG. 31A, with two permanent magnets and one electromagnet.

[0088] FIG. 34B illustrates the example motor of FIG. 34A with a partial stator.

[0089] FIG. 34C illustrates the example motor of FIG. 34A with a partial stator formed as a bracket.

[0090] FIG. 35A is a front perspective view of a user interface panel of a swing apparatus, according to another inventive implementation.

[0091] FIG. 35B is a side perspective view of the user interface panel of FIG. 35A.

[0092] FIG. 35C is a bottom perspective view of the user interface panel of FIG. 35A.

[0093] FIG. 35D is a top perspective view of the user interface panel of FIG. 35A.

[0094] FIG. 35E is a front view of the user interface panel of FIG. 35A.

[0095] FIG. 35F is a side view of the user interface panel of FIG. 35A.

[0096] FIG. 35G is a top view of the user interface panel of FIG. 35A.

[0097] FIG. 36A illustrates a connection between the swing frame arm and a base member of a swing apparatus as disclosed herein.

[0098] FIG. 36B illustrates the connection of FIG. 36A with the cover removed.

[0099] FIG. 36C is another view of the connection of FIG. 36A with the cover removed.

[00100] FIG. 36D illustrates details of the stalk and base member useful to form the connection illustrated in FIGS. 36A-36C.

[00101] FIG. 36E illustrates another view of the base member and shows a cutout for receiving the stalk.

[00102] FIG. 36F illustrates areas of weld formation to secure the stalk to the base member.

[00103] FIG. 36G illustrates, prior to insertion, bolts useful to secure the frame arm to the stalk.

[00104] FIG. 36H illustrates a cutout view of the connection illustrated in FIGS. 36A-36C, and shows detail of the connection as formed between the frame arm, the stalk, and the base member.

[00105] FIG. 37 illustrates the side view of FIG. 2 and references additional aspects of the swing apparatus.

CLAIMS

1. A swing apparatus (10), comprising:

a magnetic drive (20), comprising:

an electromagnet (51); and

a plurality of permanent magnets (52, 53); and

a controller (2102), coupled to the electromagnet (51) to activate the electromagnet (51) by applying an activation current having a polarity selectable from a first polarity and a second polarity and thereby initiating a motion of at least a portion of the swing apparatus (10), the controller (2102) being configured to:

A1) apply the activation current having one of the first polarity and the second polarity;

A2) determine if at least the portion of the swing apparatus (10) has moved at least a predetermined amount;

A3) if, after a predetermined time period, at least the portion of the swing apparatus (10) has not moved by at least the predetermined amount, then switch the polarity of the activation current to the other of the first polarity and the second polarity; and

A4) repeat A2) and A3) until it is determined, at A2), that the swing apparatus (10) has moved by at least the predetermined amount.

2. The swing apparatus of claim 1, further comprising:

a plurality of optical sensors coupled to the controller, the plurality of optical sensors comprising:

a first light source to emit a first light beam propagating along a first optical path;

a first detector, spaced from the first light source and disposed in the first optical path to detect the first light beam;

a second light source to emit a second light beam along a second optical path substantially parallel to the first optical path and offset from the first optical path by a separation distance;

a second detector, spaced from the second light source and disposed in the second optical path to detect the second light beam; and

an optical encoder strip disposed in the first optical path and the second optical path to modulate detection of the first light beam by the first detector to affect a change in state of the first detector, and to modulate detection of the second light beam by the second detector to affect a change in state of the second detector,

wherein the controller is further configured to determine, at A2), if at least the portion of the swing apparatus has moved at least a predetermined amount by detecting a change of state of at least one of the first detector and the second detector.

3. The swing apparatus of claim 1, wherein the controller is further configured to, when it is determined at A2) that the swing apparatus has moved by at least the predetermined amount:

A5) determine if the portion of the swing apparatus has changed direction of swing motion.

4. The swing apparatus of claim 3, wherein the controller is further configured to, when it is determined at A5) that the portion of the swing apparatus has not changed direction of swing motion, repeat A2) and A3).

5. The swing apparatus of claim 3, wherein the controller is further configured to, when it is determined at A2) that the swing apparatus has moved by at least the predetermined amount:

A6) increment a swing angle measure associated with the motion of the portion of the swing apparatus.

6. The swing apparatus of claim 5, wherein the controller is further configured to, when it is determined at A5) that the portion of the swing apparatus has changed direction of motion:

A7) switch the polarity of the activation current being applied to the electromagnet.

7. The swing apparatus of claim 6, wherein the controller if further configured to, after A7):

A8) if the swing angle measure exceeds a predetermined setpoint, set the activation current to zero.

8. The swing apparatus of claim 7, wherein the controller is further configured to, after the activation current is set to zero at A8), repeat A2) and A3).

9. The swing apparatus of claim 7, wherein the controller is further configured to, after A7):

A9) if the swing angle measure is less than the predetermined setpoint, modulate the activation current.

10. The swing apparatus of claim 9, wherein the controller is further configured to modulate the activation current at A9) by:

computing an error value based on the swing angle measure and the predetermined setpoint;

computing one or more of a proportional term, a derivative term, or an integral term based on the error value; and

modulating the activation current based on the one or more of the proportional term, the derivative term, or the integral term.

11. The swing apparatus of claim 9, wherein the controller is further configured to, after the activation current is modulated in A9), repeat A2) and A3).

12. The swing apparatus of claim 1, wherein the controller is further configured to determine when the portion of the swing apparatus changes direction during the motion without determining when the portion of the swing apparatus passes through an equilibrium position of the motion.

13. A swing apparatus (10), comprising:

an electromagnet (51);

a plurality of permanent magnets (52, 53) positioned proximate to the electromagnet (51) such that, upon electrical activation of the electromagnet, magnetic forces are generated between the electromagnet and each permanent magnet of the plurality of permanent magnets; and

a controller (2102), coupled to the electromagnet, to electrically activate the electromagnet and thereby initiate swing motion of the swing apparatus without manual intervention by a user of the swing apparatus.

14. The swing apparatus of claim 13, wherein neither the electromagnet nor any of the plurality of permanent magnets is formed on the seat.

15. The swing apparatus of claim 13, wherein adjacent permanent magnets of the plurality of permanent magnets are arranged to have opposing polarities facing the electromagnet, and wherein, upon electrical activation, the electromagnet attains a predefined polarity on a face of the electromagnet facing the plurality of permanent magnets, and such that attractive magnetic forces and repulsive magnetic forces are concurrently generated between the electromagnet and the plurality of permanent magnets.

16. The swing apparatus of claim 13, wherein in a neutral position, the electromagnet is disposed in a pivot plane that includes the pivot axis, and each permanent magnet of the set of permanent magnets is disposed outside the pivot plane.

~~17. A swing apparatus (10), comprising:~~

~~a controller (2102) to control a motion of at least a portion of the swing apparatus (10);~~

~~a plurality of optical sensors (46, 47)) coupled to the controller (2102), the plurality of optical sensors (46, 47) comprising:~~

~~a first light source to emit a first light beam (46a) propagating along a first optical path;~~

~~a first detector, spaced from the first light source and disposed in the first optical path to detect the first light beam (46a);~~

~~a second light source to emit a second light beam (47a) along a second optical path substantially parallel to the first optical path and offset from the first optical path by a separation distance;~~

a second detector, spaced from the second light source and disposed in the second optical path to detect the second light beam; and

an optical encoder strip (35) disposed in the first optical path and the second optical path to facilitate detection of the motion of at least the portion of the swing apparatus.

18. The swing apparatus of claim 17, further comprising:

an arm assembly including a seat, wherein the optical encoder strip is mechanically coupled to the arm assembly; and

a frame assembly coupled to the arm assembly and defining a pivot axis) about which the arm assembly rotates during motion of the swing apparatus, wherein the plurality of optical sensors are mechanically coupled to the frame assembly.

19. The swing apparatus of claim 19, wherein the optical encoder strip is a curved slotted strip having a curvature that is centered about the pivot axis.

20. A swing apparatus (10), comprising:

a controller (2102) to control a motion of at least a portion of the swing apparatus (10);

a plurality of optical sensors (46, 47) coupled to the controller (2102), the plurality of optical sensors (46, 47) comprising:

a first light source to emit a first light beam (46a) propagating along a first optical path;

a first detector, spaced from the first light source and disposed in the first optical path to detect the first light beam (46a);

a second light source to emit a second light beam (47a) along a second optical path substantially parallel to the first optical path and offset from the first optical path by a separation distance;

a second detector, spaced from the second light source and disposed in the second optical path to detect the second light beam; and

a slotted strip (35) disposed in the first optical path and the second optical path to facilitate detection of the motion of at least the portion of the swing apparatus based on

alternately blocking and unblocking of the first light beam (46a) and the second light beam (47b), the slotted strip (35) comprising:

a plurality of optically transparent slots (36); and

a plurality of photointerrupters (37) respectively disposed between successive slots (36) of the plurality of optically transparent slots (36).

21. The swing apparatus of claim 20, wherein the slotted strip is a curved slotted strip including the plurality of optically transparent slots and the plurality of photointerrupters.

22. The swing apparatus of claim 20, further comprising:

an arm assembly including a seat, wherein the slotted strip is mechanically coupled to the arm assembly; and

a frame assembly coupled to the arm assembly and defining a pivot axis about which the arm assembly rotates during motion of the swing apparatus, wherein the plurality of optical sensors are mechanically coupled to the frame assembly.

23. The swing apparatus of claim 22, wherein the slotted strip is a curved slotted strip having a curvature that is centered about the pivot axis).

24. The swing apparatus of claim 20, wherein at least one slot of the plurality of slots is fully disposed between the first optical path and the second optical path during the motion of at least the portion of the swing apparatus.

25. The swing apparatus of claim 20, wherein at least one photointerrupter of the plurality of photointerrupters is fully disposed between the first optical path and the second optical path during the motion of at least the portion of the swing apparatus.

26. The swing apparatus of claim 20, wherein an angular separation between adjacent slots of the plurality of slots is from about 1 degree to about 3 degrees.

27.17. A swing apparatus (10), comprising:

an arm assembly (15) including a seat (18);

a frame assembly (12) coupled to the arm assembly (15) and defining a pivot axis (P--P') about which the arm assembly (15) rotates during operation of the swing apparatus (10);

an electromagnet (51) disposed on the frame assembly (12); and

a plurality of permanent magnets (52, 53) disposed on the arm assembly and positioned to define an arc centered on the pivot axis (P--P'),

wherein the electromagnet (51) has an angular offset about the pivot axis (P--P') relative to the plurality of permanent magnets (52, 53) positioned along the arc when the swing apparatus is in a neutral position.

~~28.~~18. The swing apparatus of claim ~~27~~17, wherein neither the electromagnet nor any of the plurality of permanent magnets is formed on the seat.

~~29.~~19. The swing apparatus of claim ~~27~~17, wherein adjacent permanent magnets of the plurality of permanent magnets are arranged to have opposing polarities facing the electromagnet.

~~30.~~20. The swing apparatus of claim ~~29~~19, further comprising a controller to electrically activate the electromagnet such that the electromagnet attains a first magnetic polarity on a face of the electromagnet facing the plurality of permanent magnets, and such that attractive magnetic forces and repulsive magnetic forces are concurrently generated between the electromagnet and the plurality of permanent magnets.

~~31. The swing apparatus of claim 27, wherein in the neutral position, the electromagnet is disposed in a pivot plane that includes the pivot axis, and each permanent magnet of the set of permanent magnets is disposed outside the pivot plane.~~

~~32. A swing apparatus (10), comprising:~~

~~an arm assembly (15) including a seat (18);~~

~~a frame assembly (12) coupled to the arm assembly (15) and defining a pivot axis (P--P') about which the arm assembly (15) rotates during operation of the swing apparatus (10);~~

an electromagnet (51) disposed on one of the frame assembly (12) and the arm assembly (15); and

a plurality of permanent magnets (52, 53) disposed on the other of the frame assembly (12) and the arm assembly (15), the plurality of permanent magnets (52, 53) positioned to define an arc centered on the pivot axis (P - P'),

wherein, when the swing apparatus (10) is in a neutral position, the electromagnet (51) and the plurality of permanent magnets (52, 53) are disposed on a first side of the pivot axis and the seat is disposed on a second side of the pivot axis.

33. The swing apparatus of claim 32, wherein neither the electromagnet nor any of the plurality of permanent magnets is formed on the seat.

34. The swing apparatus of claim 32, wherein adjacent permanent magnets of the plurality of permanent magnets are arranged to have opposing polarities facing the electromagnet.

35. The swing apparatus of claim 34, further comprising a controller to electrically activate the electromagnet such that the electromagnet attains a predefined polarity on a face of the electromagnet facing the plurality of permanent magnets, and such that attractive magnetic forces and repulsive magnetic forces are concurrently generated between the electromagnet and the plurality of permanent magnets.

36. The swing apparatus of claim 32, wherein in the neutral position, the electromagnet is disposed in a pivot plane that includes the pivot axis, and each permanent magnet of the set of permanent magnets is disposed outside the pivot plane.

37. The swing apparatus of claim 32, wherein the first side of the pivot axis includes a space vertically above the pivot axis, and wherein the second side of the pivot axis includes a space between the pivot axis and a surface that the swing apparatus sits on.

38. A swing apparatus (10), comprising:

an arm assembly (15) including a seat (18);

a frame assembly (12) coupled to the arm assembly (15) and defining a pivot axis (P--P') about which the arm assembly (15) rotates during operation of the swing apparatus (10);

a plurality of permanent magnets (52, 53) disposed on the arm assembly and positioned to define an arc centered on the pivot axis (P--P'), wherein a linear distance between each permanent magnet of the plurality of permanent magnets and the pivot axis is at most from about 0.5 inches to about 5 inches; and

an electromagnet (51) disposed on the frame assembly (12).

39. A swing apparatus (10), comprising:

an arm assembly (15) including a seat (18);

a frame assembly (12) coupled to the arm assembly (15) and defining a pivot axis (P--P') about which the arm assembly (15) rotates during operation of the swing apparatus (10);

a plurality of permanent magnets (52, 53) disposed on the arm assembly and positioned to define an arc centered on the pivot axis (P--P'); and

an electromagnet (51) disposed on the frame assembly (12), wherein a linear distance between the electromagnet and the pivot axis is at most from about 1 inch to about 6 inches.

40. A swing apparatus (10), comprising:

an electromagnet (51); and

a plurality of permanent magnets (52, 53) positioned proximate to the electromagnet (51) so as to generate a magnetic force upon electrical activation of the electromagnet (52, 53) and thereby control a swing motion of at least a portion of the swing apparatus (10),

wherein a separation gap (AG) between the electromagnet (51) and a first permanent magnet (52) of the plurality of permanent magnets (52, 53), when in magnetic alignment during operation of the swing apparatus (10), is less than or equal to 0.15 inch.

41. A swing apparatus (10), comprising:

an arm assembly (15) including a hub (16), a swing arm (17) coupled to the hub, and a seat (18) coupled to the swing arm;

~~a frame assembly (12) coupled to the hub and including a frame arm, the frame assembly defining a pivot axis (P–P') about which the hub rotates during operation of the swing apparatus (10);~~

~~an electromagnet (51) disposed on the frame assembly (12);~~

~~a plurality of permanent magnets (52, 53) disposed on the hub and positioned to define an arc centered on the pivot axis (P–P'); and~~

~~a housing enclosing the electromagnet and the plurality of permanent magnets.~~

~~42. The swing apparatus of claim 41, the frame assembly further including an electromagnet bracket coupled to the frame arm and disposed within the housing, wherein the electromagnet is disposed on the bracket.~~

~~43. The swing apparatus of claim 42, the electromagnet bracket further including a shaft disposed adjacent to the frame arm and defining the pivot axis.~~

~~44. The swing apparatus of claim 43, wherein the shaft is nested in an indentation formed in a portion of the frame arm.~~

~~45. The swing apparatus of claim 41, the hub further including a plurality of permanent magnet brackets, wherein the plurality of permanent magnets are disposed in the plurality of permanent magnet brackets.~~

~~46. The swing apparatus of claim 41, further comprising:~~

~~an optical sensor disposed on the electromagnet bracket;~~

~~an optical encoder disposed on the hub, wherein the optical sensor and the optical encoder collectively facilitate detection of swing motion of the swing apparatus,~~

~~and wherein the electromagnet, the plurality of permanent magnets, the optical sensor, and the optical encoder are each disposed above the pivot axis when the swing apparatus is in a neutral position.~~

47. The swing apparatus of claim 41, wherein the hub protrudes through the housing, and wherein the swing arm is coupled to the hub outside the housing.

48. A swing apparatus (10), comprising:

a controller (2102) to determine when at least a portion of the swing apparatus (10) changes direction during a swing motion without detecting when the portion of the swing apparatus (10) passes through a neutral position of the swing motion.

49. The swing apparatus of claim 48, further comprising:

a plurality of optical sensors coupled to the controller, the plurality of optical sensors comprising:

a first light source to emit a first light beam propagating along a first optical path;

a first detector, spaced from the first light source and disposed in the first optical path to detect the first light beam;

a second light source to emit a second light beam along a second optical path substantially parallel to the first optical path and offset from the first optical path by a separation distance;

a second detector, spaced from the second light source and disposed in the second optical path to detect the second light beam; and

an optical encoder strip disposed in the first optical path and the second optical path to modulate detection of the first light beam by the first detector to affect a change in a first state of the first detector, and to modulate detection of the second light beam by the second detector to affect a change in a second state of the second detector,

wherein the first state and the second state collective transition through a first sequence of states when the portion of the swing apparatus is in motion in a first direction and through a second sequence of states when the portion of the swing apparatus is in motion in a second direction, the second sequence of states being the reverse of the first sequence of states,

and wherein the controller is further configured to determine that the portion of the swing apparatus changes direction during the swing motion by detecting a change in the first state and

the second state from one of the first sequence of states and the second sequence of states to the other of the first sequence of states and the second sequence of states.

50. The swing apparatus of claim 48, further comprising:

a magnetic drive comprising at least one electromagnet and at least one permanent magnet,

wherein the controller is coupled to the electromagnet and is further configured to selectively switch a polarity of an activation current applied to the electromagnet upon determining when the portion of the swing apparatus changes direction during the swing motion.

51. A swing apparatus (10), comprising:

a panel (3522) having a surface (3522a) and including a dial (3525) to facilitate a user input specifying an extent of swing motion of at least a portion of the swing apparatus during use, the surface defining a hole and a recessed portion (3530) within the hole, wherein the dial (3525) is disposed in the recessed portion ; and

a controller (2102) communicably coupled to the dial to control the swing motion based on the user input.

52. The swing apparatus of claim 51, further comprising a circuit board mechanically coupled to the dial, wherein the controller is disposed on the circuit board and communicably coupled to the dial.

53. The swing apparatus of claim 51, wherein the dial does not protrude beyond the surface of the panel.

54. The swing apparatus of claim 53, the panel further including a set of set of selection buttons to control operation of the swing apparatus.

55. The swing apparatus of claim 54, wherein the set of selection buttons is disposed to be flush with the surface of the panel.

56. The swing apparatus of claim 53, the panel further including a set of light indicators communicably coupled to the controller.

57. The swing apparatus of claim 56, wherein the set of light indicators is disposed to be flush with the surface of the panel.

58. The swing apparatus of claim 51, wherein the dial protrudes beyond the surface of the panel.

59. The swing apparatus of claim 51, further comprising:

an arm assembly including a seat;

a frame assembly defining a pivot axis about which the arm assembly undergoes the swing motion during operation of the swing apparatus, as the portion of the swing apparatus;

an electromagnet coupled to the frame assembly and coupled to the controller, wherein the controller is further configured to electrically activate the electromagnet;

a plurality of permanent magnets coupled to the arm assembly and positioned to define an arc centered on the pivot axis; and

a housing enclosing the electromagnet and the plurality of permanent magnets, wherein the panel is coupled to the housing.

60. The swing apparatus of claim 51, where a maximum depth of the recessed portion from the surface of the panel is from about 0.25 inches to about 1 inch.

61. A kit including a plurality of components for assembly into a swing apparatus (10), the kit comprising:

a first component including:

a frame assembly (12);

a magnetic drive (20) coupled to the frame assembly (12); and

a power delivery circuit to couple an external power supply to the magnetic drive (20);

a second component including a swing arm (17) configured for coupling to the magnetic drive (20); and

a third component including a seat (18) configured for coupling to the swing arm (17),

wherein the power delivery circuit is wholly contained within the first component.

62. The kit of claim 61, the power delivery circuit including a cable partially disposed outside the frame assembly and coupled to an adapter, wherein the adapter couples to the external power supply during use.

63. The kit of claim 61, wherein there is no electrical coupling between the first component and the second component or between the first component and the seat.

64. The kit of claim 61, wherein the seat includes a power-consuming component and a power source, independent of the power delivery circuit, to power the power-consuming component.

65. The kit of claim 61, further including a fourth component and a fifth component configured for coupling together to form a base of the swing apparatus, wherein the first component is configured for coupling to the base via the frame assembly.

66. A swing apparatus (10), comprising:

an arm assembly (15) including a seat (18);

a frame assembly (12) to support the swing apparatus on a ground surface during operation of the swing apparatus, the frame assembly coupled to the arm assembly (15) and defining a pivot axis (P--P') about which the arm assembly (15) swings during operation of the swing apparatus (10), wherein the pivot axis forms an angle of from about 15 degrees to about 45 degrees with respect to a horizontal plane parallel to the ground surface; and

a drive (20), disposed about the pivot axis (P–P'), to control a swing motion of the arm assembly (15) about the pivot axis during operation of the swing apparatus.

67. The swing apparatus of claim 66, wherein a lateral distance traversed by the arm assembly between maximum extents of the swing motion, as projected onto the horizontal plane parallel to the ground surface, is in a range of from about 1 foot to about 3 feet.

68. The swing apparatus of claim 66, further comprising:

a housing to at least partially enclose the drive; and

an interface panel coupled to the housing, the interface panel defining an interface plane (II') angled at 90 degrees or more with respect to the pivot axis.

69. The swing apparatus of claim 66, wherein the angle formed by the pivot axis with respect to the horizontal plane is from about 30 degrees to about 45 degrees.

70. A swing apparatus (10), comprising:

a base (13) to rest on a substantially level ground surface during operation of the swing apparatus, the base defining a vertical footprint of the base member on the ground surface;

a frame assembly (12) including a frame arm (14) having a lower portion (14a) coupled to the base, the lower portion (14a) of the frame arm (14) extending upward from the base and inclined from vertical such that the lower portion (14a) of the frame stalk extends away from the vertical footprint of the base and lies outside of the vertical footprint of the base; and

a swing arm assembly (15) coupled to the frame assembly (12), the swing arm assembly (15) including a seat (18) to hold a child during operation of the swing apparatus.

71. The swing apparatus of claim 70, further comprising a stalk to receive the lower portion of the frame arm and couple the frame arm to the base, wherein the stalk is welded to the base via a full perimeter weld.

72. The swing apparatus of claim 71, wherein the frame arm is hollow and wherein a wall thickness of the frame arm is from about 1.2 mm to about 1.6 mm.

73. The swing apparatus of claim 71, wherein a first end of the lower portion of the frame arm includes a set of tabs, and wherein the base includes a set of tab openings to receive the set of tabs upon insertion of the stalk into the base.

74. A swing apparatus, comprising:

a base (13) to rest on a ground surface during operation of the swing apparatus, the base having an outside perimeter with a curved shape;

an arm assembly (15) including a swing arm and a rotatable seat (18) coupled to the swing arm to hold a child during operation of the swing apparatus, the rotatable seat having a rotation axis normal to the ground surface; and

a frame assembly (12), coupled to the arm assembly (15) and the base, and defining a pivot axis (P--P') about which the arm assembly (15) swings during operation of the swing apparatus,

wherein the rotatable seat is positioned on the arm assembly such that a combined center of gravity of the swing apparatus and an anthropomorphic test device (ATD) (40) disposed in the seat is laterally offset from the rotation axis of the rotatable seat by less than 1 inch.

75. The swing apparatus of claim 74, wherein the ATD is one of a newborn test dummy and a six-month old infant test dummy.

76. A swing apparatus (10), comprising:

a base (13) to rest on a horizontal surface during use, the base (13) defining a vertical footprint;

a frame assembly (12) including a frame arm (14), the frame arm defining an upper portion and a lower portion, the lower portion of the frame arm (14) coupled to the base (13) via a stalk, and inclined at an angle with respect to the vertical footprint at a point of interconnection, such that the lower portion of the frame arm (14) lies outside the vertical footprint; and

~~a swing arm assembly (15) coupled to the frame assembly, the swing arm assembly including a seat (18) to hold a child during use,~~

~~wherein the lower portion and upper portion collectively define a curvature such that the upper portion of the frame arm (14) intrudes into the vertical footprint.~~

~~77. A swing apparatus (10), comprising:~~

~~a base member (13) to rest on a horizontal surface during use, the base member (13) defining a vertical footprint;~~

~~a frame assembly (12) including a frame arm (14), the frame arm (14) defining an upper portion and a lower portion, the lower portion of the frame arm (14) coupled to the base member (13) via a stalk and inclined at an angle with respect to the vertical footprint at the point of interconnection, such that lower portion of the frame arm (14) lies outside the vertical footprint;~~

~~a drive (20) coupled to the upper portion, wherein at least a portion of the drive (20) lies inside the vertical footprint; and~~

~~a swing arm assembly (15) coupled to the drive, the swing arm assembly including a seat (18) to hold a child during use.~~

~~78. A swing apparatus (10), comprising:~~

~~a frame assembly (12);~~

~~a hub (16) rotatably coupled to the frame assembly (12) at a pivot axis (P – P');~~

~~a seat (18);~~

~~a swing arm (17) having a first end that is attached to the seat (18), and a second end attached to the hub (16) such that rotation of the hub (16) relative to the frame assembly (12) about the pivot axis (P – P') causes the swing arm (17) and seat (18) to rotate;~~

~~at least one permanent magnet (52, 53) disposed on one of the frame assembly (12) and the hub (16);~~

~~at least one electromagnet (51) being disposed on the other of the frame assembly (12) and the hub (16), wherein the at least one electromagnet (51) and the at least one permanent magnet (52, 53) are configured to apply a magnetic force to one another so as to cause the hub (16) to rotate about the pivot axis (P-- P') relative to the frame assembly (12).~~

79. The swing apparatus of claim 78, comprising a housing, wherein the at least one permanent magnet and the at least one electromagnet are housed in the housing.

80. The swing apparatus of claim 79, wherein at least a portion of the hub that comprises the at least one permanent magnet or the at least one electromagnet is housed in the housing.

81. A swing apparatus (10), comprising:

an arm assembly (15) including a seat (18);

a frame assembly (12) coupled to the arm assembly (15) and defining a pivot axis (P–P') about which the arm assembly (15) rotates during operation of the swing apparatus (10);

at least one permanent magnet (52, 53) disposed on one of the arm assembly (15) and the frame assembly (12) and positioned to define an arc centered on the pivot axis (P–P'); and

an electromagnet (51) disposed on another one of the arm assembly (15) and the frame assembly (12),

wherein the at least one permanent magnet (52, 53) is arranged to have opposing polarities facing the electromagnet (51), and wherein the swing apparatus (10) is configured such that, when the arm assembly (15) is in a neutral position and the electromagnet (51) is electrically activated, attractive magnetic forces and repulsive magnetic forces are concurrently generated between the electromagnet (51) and the at least one permanent magnet (52, 53).

82. The swing apparatus of claim 81, wherein the at least one permanent magnet defines a north pole and a south pole, each facing the electromagnet.

83. The swing apparatus of claim 82, wherein the at least one permanent magnet comprises a single magnet that defines both the north pole and the south pole.

84. The swing apparatus of claim 82, wherein the at least one permanent magnet comprises first and second magnets that define the north pole and the south pole, respectively.

85. The swing apparatus of claim 82, wherein a distance between the north pole and the south pole along a linear direction is less than width of the electromagnet along the linear direction.

~~86. A swing apparatus (10), comprising:~~

~~an arm assembly (15) including a seat (18);~~

~~a frame assembly (12) coupled to the arm assembly (15) and defining a pivot axis (P--P') about which the arm assembly (15) rotates during operation of the swing apparatus (10);~~

~~an electromagnet (1945) disposed on the frame assembly (12); and~~

~~at least one permanent magnet (1931) disposed on the arm assembly and positioned such that a north pole (1931a) of the at least one permanent magnet (1931) and a south pole (1931b) of the at least one permanent magnet (1931) can attain magnetic alignment with the electromagnet (1945) during operation of the swing apparatus (10),~~

~~wherein the electromagnet (51) has an angular offset about the pivot axis (P--P') relative to the north pole (1931a) and the south pole (1931b) of the at least one permanent magnet (1931) when the swing apparatus is in a neutral position.~~