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(72) **Inventors; and**
(71) **Applicants** : **RAINIS, Dov** [IL/IL]; 8 Y. L. Gordon Street, 46491 Herzlia (IL). **GINZBOURG, Eliezer** [IL/IL]; 2 Tavor Street, 55900 Ganey Tiqwa (IL).

(74) **Agent**: **BRONSTEIN, Rafi**; Daltan Consulting Ltd., P.O. Box 1146, 44110 Kefar Sava (IL).

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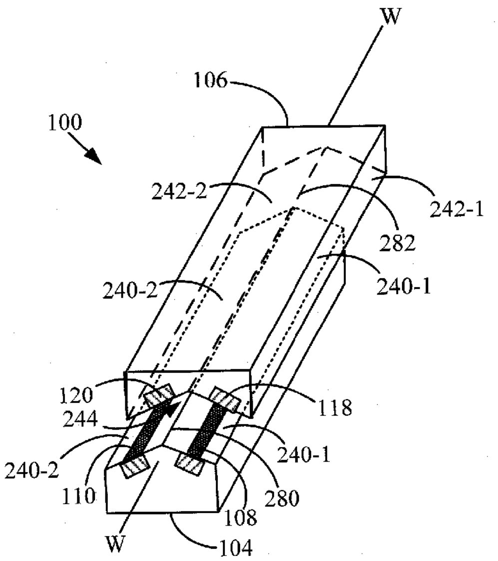

FIG. 2A

(57) **Abstract**: A support apparatus for a sliding frame including a stationary portion having a long axis parallel to a plane defined by the frame and including one or more magnetic insert disposed along a long axis defining a path of translation and a movable portion attached to the frame, including at least one magnetic insert and movable along the path of translation and wherein the magnetic field vector orientation of the stationary portion magnetic inserts and of the movable portion magnetic inserts are the same, generate repelling forces and maintain a single state of contactless equilibrium between the stationary portion and the movable portion at any point throughout the path of translation regardless of the orientation of said plane.

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A SUPPORT APPARATUS AND METHOD FOR A SLIDING FRAME

TECHNICAL FIELD

[0001] The present apparatus and method relate to sliding frame support apparatuses and more specifically to sliding frame magnetic support apparatuses.

BACKGROUND

[0002] Contrary to a hinged frame, such as that, for example, of a door or a window, which swings open about hinges, a sliding frame is a type of frame which commonly opens by sliding horizontally along, for example, a wall or into a pocket in a wall. Sliding frames are commonly either mounted on or suspended from a track employing a sliding frame gear mechanism.

[0003] Sliding gear mechanisms are commonly made of metal materials such as aluminum, plastic polymers or a combination of plastic polymers, such as Teflon®, that have a lower friction co-efficient than high density polyethylene and commonly include two basic types: the top hung mechanism, in which the frame is hung from a track by two trolley hangers or a bottom rolling mechanism. The top hung type sliding gear mechanism requires guides at the bottom of the frame to prevent lateral pendulous swinging of the frame. Such guides may include, for example, a stationary guide on which rides a groove cut into and along the bottom of the sliding frame, a groove in the threshold or sill and several horizontally rotatable wheels attached to the bottom of the frame and ride along the upright walls of the groove or similar mechanisms.

[0004] A bottom rolling apparatus consists of two or more rollers at the bottom of the frame which run on a track and a guide at the top which runs, for example, in a guide channel cut into the frame casing or header.

[0005] The above described sliding gear mechanisms have several drawbacks such as, for example, friction between the wheels and the track which increases the amount of force required to slide the frame back and forth. Another drawback is the sensitivity of these mechanisms to dust or debris which may be trapped either in the wheel axes or in the track impeding the wheels, preventing them from running smoothly and requiring periodical maintenance such as lubrication, cleaning and occasionally replacement of worn wheels.

[0006] Additionally, the above described sliding gear mechanisms are also affected by manufacturing imperfections, for example, imperfection of the rail such as a slightly curved track or minor protrusions or grooves along the riding track of the rail which may prevent the wheeled gear mechanism from running smoothly.

[0007] Several attempts have been made to develop reduced friction frame sliding gear mechanisms employing materials such as Teflon®, semi-frictionless frame sliding gear mechanisms employing magnets and wheels or contactless mechanism employing magnets alone.

[0008] Contactless, and frictionless magnet-based sliding gear mechanisms rely on the repelling forces which develop between two adjacent magnets, one located in the base of the frame and the second in the threshold or sill and having the same magnetic field orientation to overcome gravity and allow suspension of the frame in mid-air. The advantage of such mechanisms primarily lies in them being maintenance free having no moving parts such as wheels.

[0009] As in the mounted or suspended sliding frame gear mechanisms, contactless, magnet-based sliding gear mechanisms also require lateral stabilization of the frame to prevent it from swinging or deviating sideways. Attempts have been made to meet this requirement. Such attempts involve complex series of magnets vertically placed on the lateral aspects of the frame bottom or top aspects and along the vertical walls of a groove in the threshold or sill or in the header. Other attempts involve grooves and guides similar to those described above and other similar mechanisms.

[0010] The present apparatus and method present a simple and maintenance-free contactless and frictionless frame sliding gear mechanism, which is designed to continuously maintain an equilibrium between forces acting on the sliding frame at any point along the path of translation of the frame. This not only provides a solution for preventing the frame from swinging or deviating sideways, both in a stationary position as well as during translation, but also ensures smooth, unhindered translation of the frame, regardless of its spatial orientation.

SUMMARY

[0011] The current method and apparatus seeks to provide a support apparatus for a sliding frame that includes a stationary portion and a movable portion slidingly movable over the stationary portion along a path of translation.

[0012] The movable portion and the stationary portion each include a pair of angled-walls and permanent magnetic inserts oriented to generate a repelling force and maintaining a single state of contactless equilibrium between the stationary portion and the movable portion at any point throughout said path of translation regardless of the orientation of the plane defined by the frame.

[0013] In an embodiment of the current method and apparatus the frame also includes a T-shaped edge, opposing and parallel to the movable portion.

[0014] In yet another embodiment of the current method and apparatus there is provided a hanging sliding frame support apparatus.

[0015] In still another embodiment of the current method and apparatus there is provided a sliding frame supported by two support apparatuses located at opposite edges of the frame and in parallel to each other.

[0016] In another embodiment of the current method and apparatus a sliding frame is supported by two support apparatuses and attached by brackets or hinges so that to provide freedom in selecting the angle at which the frame is tilted.

[0017] In yet another embodiment of the current method and apparatus a sliding frame in a horizontal orientation is supported by two or more support apparatuses, which provide a fully contactless, frictionless, "floating", horizontally sliding frame.

[0018] In still another embodiment of the current method and apparatus the stationary portion may have a circular cross-section and a tube-like form into which are inserted one or more magnetic inserts.

[0019] The movable portion may have a crescent-like cross-section including one or more magnetic inserts also having a crescent-like cross-section or be itself a magnet. This embodiment allows a limited degree of tolerance for minor rotating of the movable portion about the stationary portion separately from or together with the frame.

[0020] In another embodiment of the current method and apparatus the support apparatus for a sliding frame also includes one or more ferromagnetic debris collecting magnets. Such debris may be present in house dust or in an industrial environment where such a sliding frame support apparatus may be installed. The support apparatus having ferromagnetic debris collecting magnets and no mechanically contacting moving parts is unaffected by accumulation of reasonable amounts of household dust and debris and is thus maintenance free.

[0021] In yet another embodiment of the current method and apparatus, stationary portion magnetic inserts may be segmented having gaps between segments designed to slow down or effect stepwise movement of the movable portion.

BRIEF DESCRIPTION OF THE DRAWINGS

[0022] The present method and apparatus will be understood and appreciated from the following detailed description, taken in conjunction with the drawings and wherein like reference numerals denote like elements:

[0023] Figures 1A, 1B and 1C are elevated oblique view and cross-section view simplified illustrations of exemplary embodiments of a sliding frame support apparatus in accordance with the current method and apparatus;

[0024] Figure 2A is an elevated oblique view simplified illustration of an exemplary embodiment of a sliding frame support apparatus in accordance with the current method and apparatus;

[0025] Figures 2B, 2C and 2D are cross-section view simplified illustrations of embodiments of the sliding frame support apparatus of Fig. 1;

[0026] Fig. 2E is a simplified cross-sectional view illustration viewed from above of another exemplary embodiment of a sliding frame support apparatus in accordance with the current method and apparatus;

[0027] Figures 3A, 3B and 3C are cross-section view simplified illustrations of exemplary configurations of the sliding frame support apparatus shown in Fig. 1 in accordance with the current method and apparatus;

[0028] Figure 4 is a cross-section view simplified illustration of an exemplary embodiment of a sliding frame support apparatus in accordance with the current method and apparatus;

[0029] Figure 5 is a cross-section view simplified illustration of another exemplary embodiment of sliding frame support apparatus in accordance with the current method and apparatus;

[0030] Figure 6 is a cross-section view simplified illustration of yet another exemplary embodiment of a sliding frame support apparatus in accordance with the current method and apparatus;

[0031] Figure 7 is a cross-section view simplified illustration of a configuration of the embodiment of Fig. 6 in accordance with the current method and apparatus

[0032] Figure 8 is a cross-section view simplified illustration of still another exemplary embodiment of a sliding frame support apparatus in accordance with the current method and apparatus;

[0033] Figures 9A and 9B are cross-section view simplified illustrations of an exemplary embodiment of the sliding frame support apparatus employing the movable portion 106 configuration shown in Fig. 3B in accordance with the current method and apparatus, and

[0034] Figures 10A and 10B are simplified cross-section view illustrations of another exemplary embodiment of support apparatus 100 in accordance with the current method and apparatus.

DETAILED DESCRIPTION

[0035] For the purpose of this disclosure the term "Frame" as used in this disclosure means any construction defining a single plane.

[0036] The term "Single Plane" as used in this disclosure includes a plane having a thickness and/or comprising one or more adjacent layers of material generally parallel to each other and enclosed by a single frame.

[0037] The terms "Sliding" and "Slidingly" as used in this disclosure mean contactless and frictionless movement along a surface, wherein the movement may be smooth or in a stepwise fashion.

[0038] The terms "Magnetic Inserts", "Permanent Magnetic Inserts", "Inserts" and "Magnets" as used in this disclosure are used interchangeably and mean permanent magnetic inserts.

[0039] Referring now to Fig. 1A, which is an elevated oblique view simplified illustration of an exemplary embodiment of the current method and apparatus. Fig. 1 illustrates a support apparatus 100 for a sliding frame 102 that includes a stationary portion 104 having a long axis W-W parallel to a plane defined by the frame and one or more permanent magnetic inserts 108/110 disposed along long axis W-W and defining a path of translation. A movable portion 106 of sliding frame 102 may also include one or more permanent magnetic inserts 118/120 having the same magnetic field vector orientation as the magnetic field vector orientation of magnetic inserts 108/110 of stationary portion 104 generating a repelling force therebetween so that movable portion 106 may be slidingly and frictionlessly movable over stationary portion 104 along the path of translation parallel to axis W-W in directions indicated by an arrow designated reference numeral 150. In this example, stationary portion 104 and frame movable portion 106 each include a pair of angled-walls, 104-1 and 104-2 in stationary portion 104 and 106-1 and 106-2 in movable portion 106. Each pair 104-1/104-2 and 106-1/106-2 forms an inverted V-type cross section which prevents dust and debris accumulation in support apparatus 100 and allows water runoff.

[0040] Wall pair 104-1/ 104-2 parallels corresponding wall pair 106-1/ 106-2. In this exemplary embodiment walls 104-1/ 104-2 and 106-1/106-2 may be equal in their dimensions and are tilted at an angle (α) (Fig. 2B).

[0041] Permanent magnetic inserts 108 and 110 may be embedded in or laid upon the surface of stationary portion 104 and may be in parallel to and of equal dimensions as corresponding magnets 118 and 120 embedded in movable portion 106 of frame 102. The magnetic field vector of magnets 108 and 110 is the same as the magnetic field vector of corresponding magnets 118 and 120 so that adjacent poles of magnet pairs 108/118 and 110/120 have the same polarity generating a repelling force between the magnets embedded in stationary portion 104 and the magnets embedded in frame movable portion 106, as will be explained in detail below. Alternatively, magnetic inserts 108/110 and 118/120 may form an integral part of stationary portion 104 and movable portion 106 respectively.

Stationary portion 104 and/or movable portion 106 of frame 102 may themselves be made of a magnetic material.

[0042] In the embodiment described in Fig. 1, which is a sliding frame being in a vertical/upright orientation, an edge 402 (Fig. 4) of frame 102 opposing movable portion 106 does not require a significant sliding gear mechanism since in absence of friction the forces acting upon the edge are minimal as will be described below. Alternatively and optionally, the edge 402 of frame 102 opposing movable portion 106 as well as the frame stationary portion 404 (Fig. 4) may be made of a sliding mechanism identical in structure to support apparatus 100, as will be described in detail below.

[0043] Support apparatus 100 for a sliding frame 102 may also include a sliding frame locking apparatus.

[0044] Typically, magnets 108 and 110, embedded in stationary portion 104 would span most if not the entire length of stationary portion 104. Magnets 118 and 120 may be constructed from one or more segments of a ferromagnetic metal or composite or a rare earth alloy such as samarium-cobalt or neodymium. Corresponding magnets 118 and 120 embedded in movable portion 106 of frame 102 may partially or fully span the length of movable portion 106. For example purposes only, magnets 118 and 120 may each be constructed of two magnet segments each segment located adjacent to one end of movable portion 106.

[0045] Referring now to Figs. 1B and 1C, which are simplified cross-section view illustrations of two embodiments of support apparatus 100 of Fig. 1A taken along Axis W-W. As shown in Fig. 1B, segments 112 constituting magnet inserts 108/110 may be inserted along the path of translation in stationary portion 104 in a gapless manner so that to form a single contiguous magnet spanning the length of the path of translation. In this configuration magnetic fields 114 effected by each individual segment join to form a single continuous magnetic field as indicated by a phantom-line cylinder 116. For illustration purposes only, magnetic fields not contributing to the forces discussed throughout the text have been omitted.

[0046] A continuous magnetic field spanning stationary portion 104 allows for a smooth, frictionless translation of movable portion 106 along the path of translation which requires minimal effort to effect.

[0047] Fig. 1C depicts a segmented magnetic insert 108/110 having a plurality of gaps 122 between segments 112. Gaps 122 break the continuity of continuous magnetic field 116 into separate individual magnetic fields 114 and generate local disturbances in between magnetic inserts 108/110 segments and magnetic fields 114 in the force and direction of the magnetic field as graphically symbolized by phantom-line circles 124. Local magnetic field disturbances 124 may affect repelling forces that may act in a direction other than parallel to the path of translation and hinder smooth translation of movable portion 106 and effect a stepwise or "ratchet-effect"- like translation of movable portion 106 over stationary portion 104.

[0048] Additionally, the repelling forces effected by magnetic field disturbances 124 may be effected in a direction opposite and parallel to the direction of translation of movable portion 106 thus slowing down the speed of translation thereof. Alternatively and optionally, the size of the gaps may be altered at specific locations along the path of translation (e.g., near either end of the path) thus slowing down the translation of the frame in a frictionless manner as the frame reaches the end of the path thus acting like contactless magnetic dampers.

[0049] The magnitude of the repelling forces effected by magnetic field disturbances 124 depends on the size of gaps 122 and may therefore be controlled by varying the size of gaps 122 to achieve a desired translation speed and/or degree of stepped translation of movable portion 106 over stationary portion 104.

[0050] The number of segments 112 per area and their distribution along the edge of movable portion 106 may be calculated and determined in accordance with the weight of frame 102.

[0051] Reference is now made to Fig. 2A which is an elevated oblique view simplified illustration of an exemplary embodiment of the current method and apparatus similar to that depicted in Fig. 1A. Stationary frame portion 104 may include two or more planes 240-1/240-2 each oriented along at least a portion of the length of frame portion 104 at an angle to each other and sharing an intersection line 280. Permanent magnetic inserts 108/110 may be attached to each of planes 240-1/240-2. Movable frame portion 106 may include a groove 244 spanning at least a portion of the length of portion 106 formed by at least two planes 242-1/242-2 each oriented in parallel to a corresponding plane located in the stationary portion 104 and forming an intersection line 282.

[0052] Permanent magnetic inserts 118/120 may be attached to each of the two planes 242-1/242-2 of moveable portion 106 wherein line 280 formed by the intersection of the planes 240-1/240-2 located in stationary frame portion 104 and line 282 formed by the intersection of the planes 242-1/242-2 located in moveable portion 106 are parallel to each other and in the same vertical plane. Line 280 is longer than or equal to line 282 and both lines are maintained parallel to each other and in the same plane parallel to a path of translation during translation of said sliding frame.

[0053] Reference is now made to Figs. 2B, 2C and 2D, which are cross-section view simplified illustrations of embodiments of the support apparatus 100 for a sliding frame 102 shown in Fig. 1A and taken along axis X-X.

[0054] As shown in Figs. 2B, 2C and 2D, permanent magnetic inserts 118/120/108 and 110 each include a first magnetic pole (North or South) indicated by a grey area 270 and a second, opposite magnetic pole (South or North) indicated by a white area 272. Inserts sharing the same frame portion (e.g., movable portion 106 or stationary portion 104) need not necessarily have the same polarity orientation. As shown in Fig. 2C, which is an embodiment in accordance with the current method and apparatus, inserts 118 and 120 are arranged to have the same polarity orientation. Accordingly, respective permanent magnetic Inserts 108 and 110 are also arranged to have the same polarity orientation.

[0055] As shown in Fig. 2D, which is another embodiment in accordance with the current method and apparatus, inserts 118 and 120 are arranged to have opposite polarity orientations. Accordingly, respective permanent magnetic inserts 108 and 110 are also arranged to have opposite polarity orientations.

[0056] As described in Fig. 1, Movable portion 106 of frame 102 slidingly translates over stationary portion 104 along axis W-W (Fig.1) in a frictionless manner. Magnets 108 and 110 in stationary portion 104 are in parallel and have the same magnetic field vector as corresponding magnets 118 and 120 embedded in movable portion 106 of frame 102.

[0057] The magnetic field vector orientation of permanent magnetic inserts 108 and 118 creates a repelling force between magnet pair 108 and 118 expressed by a vector indicated by an arrow designated reference numeral 250. The value of vector 250 may be resolved in the XY plane and its components 250-1 and 250-2 parallel to the X and Y axes may be determined.

[0058] The magnetic field vector orientation of permanent magnetic inserts 110 and 120 creates a repelling force expressed in Fig. 2B by a vector 120 indicated by an arrow designated reference numeral 252 between magnet pair 110 and 120. The value of vector 252 may be resolved in the XY plane and its components 252-1 and 252-2 parallel to the X and Y axes may be determined.

[0059] In this exemplary embodiment, designed for a sliding frame in a vertical or upright orientation, walls 104-1/ 104-2 and 106-1/106-2 (FIG. 1) are equal in their dimensions and are tilted at an angle (α). Magnets 108 and 110, embedded in stationary portion 104, are in parallel to and of equal dimensions as corresponding magnets 118 and 120 embedded in movable portion 106 of frame 102 and tilted at an angle (α). As a result a state of contactless equilibrium is created: the forces expressed by vectors 250 and 252 are equal. The force expressed by vector component 250-1 is equal and in opposite direction to the force expressed by vector component 252-1 laterally stabilizing frame 102 movable portion 106.

[0060] Furthermore, in light of permanent magnetic inserts 108, 110, 118 and 120 being oriented at an angle and the aforementioned description it will be appreciated that the current apparatus is designed to maintain continuous contactless frictionless equilibrium along the path of translation by, among others, laterally stabilizing movable portion 106. This lateral stability is maintained, for example, by creating a repelling force between magnetic insert pairs 108/110 and 118/120 opposing and equal to a force of disturbance which may develop in a direction, for exemplary purposes only, normal to the path of translation acting to divert sliding portion 106 from the path of translation.

[0061] In other words, the repelling forces generated by permanent magnetic insert pairs 108/110 and 118/120 both in a stationary and translational mode are effected opposite to and equal forces acting in directions other than parallel to the path of translation. This increases the smoothness of frictionless or almost frictionless translation and lessens the level of force required to slide frame 102 movable portion 106 over stationary portion 104.

[0062] The force expressed by vector component 250-2 is equal to and acts in concert with the force expressed by vector component 252-2 opposite in direction and potentially greater than or equal to the force of gravity acting on frame 102 thus creating an elevational force distancing frame 102 movable portion 106 from stationary portion 104. This state of contactless equilibrium is maintained at each and every point along path of translation 150 of frame 102 over stationary portion 104 regardless of the orientation of a plane defined by frame 102 as will be explained in more detail below.

[0063] In summary, the repelling forces generated within support apparatus 100 maintain a single state of contactless equilibrium between stationary portion 104 and movable portion 106 at any point throughout the path of translation regardless of the orientation of the plain defined by frame 102. Moreover, a plurality of points each being at the state of contactless equilibrium of the above described forces form a singular line of equilibrium in 3D space parallel to the path of translation.

[0064] Such a line may not only be straight forming a straight path of translation, but may also be curved so that to form a curvilinear path of translation. As shown in Fig. 2E, which is a simplified cross-sectional illustration, viewed from above of another embodiment of a sliding frame support apparatus depicting a rotatable sliding frame. The curvilinear sliding frame path of translation may be circular such as that of a rotatable sliding entrance door or a shower stall sliding door.

[0065] Fig. 2E depicts a round static enclosure 202 set within a wall 222 having openings 204 and 206. Sliding frame 208, internal to static enclosure 202 may slide clockwise, as indicated by arrow 260 to close opening 204 after which frame 208 may slide counter-clockwise, as indicated by arrow 262 to open opening 204.

[0066] Similarly, sliding frame 210, external to static enclosure 202 may slide clockwise, as indicated by arrow 260 to close opening 206 after which frame 210 may slide counter-clockwise, as indicated by arrow 262 to open opening 206.

[0067] Such a curvilinear translation path system may employ a fully contactless, frictionless "floating" sliding frame apparatus with enhanced lateral stability such as that depicted in Fig. 6 below.

[0068] As described above, permanent magnet inserts 108, 110,118 and 120 may be segmented. The surface area or number of segments per area of each of permanent magnetic inserts 108, 110, 118 and 120, their corresponding locations in movable portion 106 of frame 102 and stationary portion 104 and the angle (α) at which they are placed is dependent on the dimensions and mass of the frame. The following is an exemplary table, experimentally derived by applicants, of the effect of changes in the angle (α) on the ratio between the magnitude of vector components 250-1, 250-2 and the magnitude of vector components 252-1 and 252-2 expressing the magnitude of the corresponding repelling forces generated between magnetic insert pairs 108/110 and 118/120 measured for a 14kg frame:

Angle (α) (Degrees)	Magnitude of Vectors 250-2/252-2 (Kg)	Magnitude of Vectors 250-1/252-1 (Kg)
8	14	1.95
12	13.8	2.91
16	13.6	3.9
21	13.2	5
25	12.8	5.91
30	12.3	7
34	11.7	8
40	10.8	9
45	10	9.9

[0069] Reference is now made to Figs. 3A, 3B and 3C, which are cross-sectional simplified illustrations of exemplary configurations of the support apparatus for a sliding frame shown in Fig. 1 in accordance with the current method and apparatus. Fig. 3A shows a triple-walled groove one wall 106-3 being horizontal. This type of configuration provides an increased elevational force, further contributing to forces expressed by vector components 250-2 and 252-2, of frame 102 as described above. Fig. 3B illustrates a multiple angled-wall configuration. It will be appreciated by persons skilled in the art that the number of angled walls may vary and may be increased to provide a crescent–like appearance as will be described in greater detail below. Fig. 3C shows a double-grooved configuration of the support apparatus for a sliding frame. This configuration provides greater vertical support as well as greater lateral stability of the frame by providing a double path of translation. This configuration may include two or more grooves as necessary to further increase lateral stability.

[0070] Stationary portion and said movable portion may have a cross-section selected from either a group of geometrical shapes such as a circle, a crescent, a triangle and a quadrangle or a group of letters of the alphabet such as a "V", an inverted "V", a "W", an inverted "W", a "U" and an inverted "U".

[0071] Some configurations of the support apparatuses for a sliding frame such as those shown in Figs. 3A and 3C may also include a fluid collection basin (402, Fig. 4) and draining outlet (404, Fig. 4).

[0072] Referring now to Fig. 4, which is a cross-section view simplified illustration of an exemplary embodiment in accordance with the current method and apparatus. In Fig. 4 frame 102 is supported by a single support apparatus 100 included in stationary portion 104 and a frame movable portion 106. As described above support apparatus 100 provides both elevational support (Fig. 2B, Vectors 250-2 and 252-2) as well as lateral stabilization (Fig. 2B, Vectors 250-1 and 252-1) of frame 102. In Fig. 4, frame 102 also includes also includes a T-shaped edge 402, opposing and parallel to the movable portion 106.

[0073] Both tips of the horizontal T arms 406 run against a stabilizing means 408 such as a brush, a plastic rail etc. The forces acting on edge 402 of frame 102 are minor hence minimal means for lateral stabilization are required if at all. Such means may include any type of mechanism described above. It will be appreciated that due to the enhanced lateral stabilization of frame 102 effected by support apparatus 100 only periodical contact, if at all, exists between tips of the horizontal T arms 406 and stabilizing means 408 throughout translation of frame 102.

[0074] Support apparatus 100 may also include one or more fluid collection basins 402 and draining outlets 404.

[0075] Reference is now to Fig. 5, which is a cross-sectional simplified illustration of another exemplary embodiment in accordance with the current method and apparatus. Fig. 5 illustrates a hanging apparatus 500 for a sliding frame 102 that includes a stationary portion 502 and a movable portion 504.

[0076] In this example, stationary portion 502 and a movable portion 504 each include a pair of angled-walls forming a V-type cross section.

[0077] Permanent magnetic inserts 108 and 110 are embedded in stationary portion 502 , tilted at an angle to each other and at an angle (α) relative to an axis normal to the plane defined by frame 102 and are in parallel to and of equal dimensions as corresponding permanent magnetic inserts 118 and 120 embedded in frame 102 movable portion 504 . The magnetic field vector of permanent magnetic inserts 108 and 110 is the same as the vector of the magnetic field generated by corresponding permanent magnetic inserts 118 and 120 so that repelling forces develop between the permanent magnetic inserts embedded in stationary portion 502 and the permanent magnetic inserts embedded in frame 102 movable portion 504 as described in Fig. 2B above. Alternatively, stationary portion 502 and/or frame 102 movable portion 504 may themselves be made of a magnetic material.

[0078] Similar to support apparatus 100 and as described in Fig.2 above, hanging apparatus 500 provides both elevational support (Fig. 2B, Vectors 250-2 and 252-2) as well as lateral stabilization (Fig. 2B, Vectors 250-1 and 252-1) of frame 102. In hanging apparatus 500 having a V-type cross section as opposed to an inverted V-type cross section shown in Fig. 2B above, vectors (not shown) corresponding to vectors 250-1 and 252-1 (Fig. 2B) are effected towards axis Y (Fig. 2B) and not away from axis Y as shown in Fig. 2B. Nonetheless, the lateral stabilization effected in the configuration shown in Fig. 5 is identical to that effected by vectors 250-1 and 252-1 (Fig. 2B).

[0079] The forces acting on movable portion 106 of frame 102 are minor hence minimal means for lateral stabilization are required if at all. Such means may include any type of mechanism described above and have been omitted in Fig. 5 for reasons of simplification.

[0080] In Fig. 6, which is a cross-section view simplified illustration of yet another embodiment in accordance with the current method and apparatus that combines the embodiments of Figs. 4 and 5 to provide a fully contactless, "floating" sliding frame apparatus with enhanced lateral stability.

[0081] This embodiment may also include, when desired, one or more angled brackets, such as elbow brackets, or hinges 602 which provide freedom in selecting an angle of tilt of frame 102 as will be described below.

[0082] Fig. 7 is a cross-section view simplified illustration of a configuration of the embodiment of Fig. 6 in accordance with the current method and apparatus. As shown in Fig. 7, support apparatus 100 is not located on the same axis Y as hanging apparatus 500 and is shifted from axis Y in a direction indicated by an arrow designated reference numeral 700. Brackets 602 may be set in an angle to accommodate the shift of support apparatus 100 thus allowing the tilting of frame 102. Alternatively, brackets 602 may be replaced by hinges to provide freedom in selecting the angle at which frame 102 is tilted.

[0083] Fig. 8, which is still another embodiment of the current method and apparatus, illustrates a sliding frame in a horizontal orientation. Frame 102 is supported by two or more support apparatuses 100 which provide a fully contactless, "floating", horizontally sliding frame. Movable portions 106 may include brackets 602 set at a straight angle relative to the plane defined by frame 102. Alternatively, brackets 602 may be replaced by hinges to provide freedom in selecting the angle at which frame 102 is tilted.

[0084] In the configuration depicted in Figs. 6, 7 and 8 frame 102 may be detachable from movable portion 106 and/or movable portion 504.

[0085] Figs. 9A and 9B are cross-section view simplified illustrations of an exemplary embodiment employing the Movable portion 106 configuration similar to that shown in Fig. 3B in accordance with the current method and apparatus. In this embodiment, stationary portion 104 may have a circular cross-section and a tube-like form into which are inserted one or more magnetic inserts 108/110.

[0086] [0086] Movable portion 106 may have a crescent-like cross-section including a magnetic insert 118/120 also having a crescent-like cross-section.

[0087] In this embodiment, a limited degree of tolerance is allowed for minor rotating of movable portion 106 about stationary portion 104 separately from or together with frame 102. Fig. 9A indicates stationary portion 104 concentrically aligned with movable portion 106 around a center 900 along an axis Y. As shown in Fig. 9B, movable portion 106, being concentrically aligned has slightly rotated about center 900 in a direction indicated by arrow designated reference numeral 950.

[0088] Reference is now made to Figs. 10A and 10B, which are simplified cross-section view illustrations of another embodiment of support apparatus 100 in accordance with the current method and apparatus. Fig. 10A is a cross-section view illustration of support apparatus 100 of Fig. 1 taken along axis X-X. Fig. 10B is a cross-section view illustration of support apparatus 100 of Fig. 1 taken along axis W-W.

[0089] In the embodiment depicted in Figs. 10A and 10B, one or more ferromagnetic debris collecting permanent magnetic inserts 1002 are optionally inserted at least at one end of movable portion 106. The magnetic field vector orientation of ferromagnetic debris collecting permanent magnetic inserts 1002 is the same as the magnetic field vector orientation of magnetic inserts 118/120 but the magnitude of magnetic field force of permanent magnetic inserts 1002 is significantly greater than that of magnetic inserts 118/120.

[0090] The magnetic field vector orientation of ferromagnetic debris collecting magnet 1002, magnetic inserts 108/110 disposed along said long axis of stationary portion 104 and of movable portion 106 magnetic inserts 118/120 are the same, generate repelling forces and maintain a single state of contactless equilibrium of the repelling forces between stationary portion 104 and movable portion 106 at any point throughout said path of translation regardless of the orientation of said plane.

[0091] The magnitude of permanent magnetic inserts 1002 and the magnetic field force effected thereby is sufficiently large so that ferromagnetic debris is attracted and adheres to permanent magnetic inserts 1002 as movable portion 106 translates over stationary portion 104.

[0092] Support apparatus 100 having ferromagnetic debris collecting permanent magnetic inserts 1002 and no mechanically contacting moving parts is unaffected by accumulation of reasonable amounts of household dust and debris and is thus maintenance free.

[0093] It will be appreciated by persons skilled in the art that the present invention is not limited to what has been particularly shown and described hereinabove. Rather, the scope of the invention includes both combinations and sub-combinations of various features described hereinabove as well as modifications and variations thereof which would occur to a person skilled in the art upon reading the foregoing description and which are not in the prior art.

What is claimed is:

1. A support apparatus for a sliding frame, said apparatus comprising:

a stationary portion having a long axis parallel to a plane defined by said frame and including at least one magnetic insert disposed along said long axis defining a path of translation;

a movable portion fixedly attached to said frame, including at least one magnetic insert and movable along said path of translation; and

wherein the magnetic field vector orientation of said magnetic inserts inserted into the stationary portion and of said movable portion magnetic inserts are the same, generate repelling forces and maintain a single state of contactless equilibrium of said repelling forces between said stationary portion and said movable portion at any point throughout said path of translation regardless of the orientation of said plane.

2. The apparatus according to claim 1, wherein a plurality of points each at said single state of contactless equilibrium of said repelling forces form a singular line of equilibrium in 3D space parallel to said path of translation.

3. The apparatus according to claim 1, wherein said stationary portion magnetic inserts are disposed along at least two surfaces oriented along said long axis and at an angle to each other, said movable portion magnetic inserts are disposed along at least two surfaces oriented parallel to said long axis, at an angle to each other, each corresponding and close to parallel to at least one of surfaces of said stationary portion throughout said path of translation.

4. The apparatus according to claim 1, wherein said stationary portion magnetic inserts are an integral part of said stationary portion and said movable portion magnetic inserts are an integral part of said movable portion.

5. The apparatus according to claim 1, wherein said single state of contactless equilibrium is maintained by a repelling force effected by said magnetic

inserts opposite in direction and potentially greater than or equal to the force of gravity acting on said frame.

6. The apparatus according to claim 1, wherein said single state of contactless equilibrium is maintained by a repelling force effected by said magnetic inserts opposite and equal to a force of disturbance acting to divert said movable portion from said path of translation.

7. The apparatus according to claim 1, wherein said single state of contactless equilibrium is maintained by repelling forces effected by said magnetic inserts opposite and equal to forces acting in a direction other than parallel to said path of translation.

8. The apparatus according to claim 1, wherein said single state of contactless equilibrium is maintained by a repelling force effected by said magnetic inserts opposite and equal to a force of disturbance acting at an angle close to normal to said path of translation.

9. The apparatus according to claim 1, wherein said magnet inserts are segmented.

10. The apparatus according to claim 8, wherein said movable portion includes at least two magnetic insert segments.

11. The apparatus according to claim 1, wherein said movable portion is rotatively attached to said frame via adjustable brackets or hinges.

12. The apparatus according to claim 11, wherein the degree of tilt of said plane may be adjusted employing said brackets or hinges.

13. The apparatus according to claim 1, wherein said frame is detachable from said movable portion.

14. The apparatus according to claim 1, wherein said stationary portion has a circular cross-section and said movable portion has a crescent-like cross-section and is rotatable about said stationary portion.

15. The apparatus according to claim 1, wherein said stationary portion and said movable portion have a cross-section selected from either a group of geometrical shapes such as a circle, a crescent, a triangle and a quadrangle or a group of letters of the alphabet such as a "V", an inverted "V", a "W", an inverted "W", a "U" and an inverted "U".

16. A support apparatus for a sliding frame, said apparatus comprising:

a stationary frame one of said frame sides including at least two planes each oriented along at least a portion of the length of said side at an angle to each other and sharing an intersection line;

a magnetic material insert attached to each of said two planes;

a moveable frame one of said frame sides including a groove spanning at least a portion of the length of said moveable frame side formed by at least two planes each oriented in parallel to a corresponding plane located in the stationary frame and forming an intersection line;

a magnetic material insert attached to each of said two planes of said moveable frame; and

wherein the line formed by the intersection of the planes located in the stationary frame and the line formed by the intersection of the planes located in the moveable frame are parallel to each other and in the same vertical plane.

17. The apparatus for a sliding frame according to claim 16, wherein the line formed by the intersection of the planes located in the static frame is longer than or equal to the line formed by the intersection of the planes located in the sliding frame.

18. The apparatus for a sliding frame according to claim 1, further comprising at least one fluid collection basin and draining outlet.

19. The apparatus for a sliding frame according to claim 1, further comprising a sliding frame locking mechanism.

20. The apparatus for a sliding frame according to claim 17, wherein the line formed by the intersection of the planes located in the static frame and the line formed by the intersection of the planes located in the sliding frame are maintained parallel to each other and in the same plane parallel to a path of translation during translation of said sliding frame.

21. A maintenance free support apparatus for a sliding frame, said apparatus comprising:

a stationary portion having a long axis parallel to a plane defined by said frame and including at least one permanent magnetic insert disposed along said long axis defining a path of translation;

a movable portion fixedly attached to said frame, including at least one permanent magnetic insert and movable along said path of translation;

at least one ferromagnetic debris collecting magnet inserted at least at one end of said movable portion; and

wherein the magnetic field vector orientation of said ferromagnetic debris collecting magnet, said magnetic inserts disposed along said long axis of the stationary portion and of said movable portion magnetic inserts are the same, generate repelling forces and maintain a single state of contactless equilibrium of said repelling forces between said stationary portion and said movable portion at any point throughout said path of translation regardless of the orientation of said plane.

22. The apparatus according to Claim 21, wherein the magnitude of the magnetic field force of said ferromagnetic debris collecting magnet is greater than that

of said stationary portion and movable portion magnetic inserts and sufficiently large to attract and adhere ferromagnetic debris.

23. A method for supporting a sliding frame, said method comprising:

defining a path of translation of said frame by disposing at least one first set of magnetic inserts along a long axis of a stationary portion in parallel to a plane defined by said frame;

inserting at least one second set of magnetic inserts having a magnetic field vector in the same orientation as the magnetic field vector of said first set in parallel to said long axis into a movable portion of said frame movable along said path of translation; and

orienting said first set and said second set of magnetic inserts so that to maintain a single state of contactless equilibrium between said stationary portion and said movable portion at any point throughout said path of translation regardless of the orientation of said plane.

24. The method according to claim 23, wherein

defining a path of translation of said frame by disposing at least two first sets of magnetic inserts disposed opposite each other, sandwiching said frame along said long axis and in parallel to said plane;

inserting at least two second sets of magnetic inserts into corresponding two movable portions opposing each other, sandwiching said plane and being movable along said path of translation; and

orienting said first sets and said second sets of magnetic inserts so that to generate repelling forces and maintain a single state of contactless equilibrium between said stationary portion and said movable portion at any point throughout said path of translation regardless of the orientation of said plane.

25. A method of translating a sliding frame relative to a static frame, said method comprising:

providing a stationary frame one of said frame edges including at least two planes each having a magnetic material insert and oriented along the length of the frame edge at an angle to each other and forming an intersection line ;

providing a sliding frame one of said frame sides including a groove spanning at least a portion of the length of said sliding frame side formed by at least two planes forming an intersection line, each having a magnetic material insert and oriented parallel to the corresponding plane located in the static frame;

positioning the sliding frame in the static frame such that the line formed by intersection of the planes located in the static frame and the line formed by intersection of the planes located in the sliding frame are parallel to each other and in the same vertical plane and wherein the magnetic forces of magnetic inserts located in the static frame interact with the magnetic forces of magnetic inserts located in the sliding frame to suspend the sliding frame.

26. A method of translating a sliding frame relative to a stationary frame, said method comprising:

providing a static frame one of said frame sides including at least two planes each oriented along the length of said frame side at an angle to each other and forming an intersection line;

providing a sliding frame one of said sliding frame sides including a groove spanning at least a portion of the length of said sliding frame side formed by at least two planes forming an intersection line oriented parallel to the planes located in the stationary frame;

attaching magnetic material inserts to each of said two planes of the stationary frame and of the sliding frame;

contactlessly and frictionlessly translating said sliding frame relatively to said stationary frame; and

maintaining the line formed by intersection of the planes located in the stationary frame and the line formed by intersection of the planes located in the sliding frame parallel to each other and in the same vertical plane.

27. A method for lateral stabilization of a sliding frame during contactless translation, said method comprising:

providing a stationary frame one of said frame edges including at least two planes each having a magnetic insert and oriented along the length of said frame edge at an angle to each other and forming an intersection line;

providing a sliding frame one of said sliding frame edges including a groove spanning at least a portion of the length of said sliding frame edge formed by at least two planes forming an intersection line each having a magnetic insert and oriented in parallel to a corresponding plane located in the stationary frame; and

wherein said magnetic inserts interact to generate repelling forces between said stationary frame and said sliding frame in directions parallel and normal to a plane defined by said sliding frame and wherein said repelling forces normal to said plane laterally stabilize said sliding frame during contactless translation.

28. A method for controlling contactless translation of a sliding frame, said method comprising:

defining a path of translation of said frame by disposing at least one first set of segmented magnetic inserts along a long axis of a stationary portion in parallel to a plane defined by said frame;

inserting at least one second set of magnetic inserts having a magnetic field vector in the same orientation as the magnetic field vector of said first set in parallel to said long axis into a movable portion of said frame movable along said path of translation;

orienting said first set and said second set of magnetic inserts so that to maintain a single state of contactless equilibrium between said stationary portion and said movable portion at any point throughout said path of translation regardless of the orientation of said plane;

distancing said segments from each other so that to create gaps between said segments and generating local disturbances in at least one magnetic field between said segments; and varying the size of said gaps to achieve a desired speed of translation and/or degree of stepped translation of said movable portion over said stationary portion.

29. The apparatus according to any one of claims 1 and 21, wherein said stationary portion and movable portion each include at least two magnetic inserts having the same polarity orientation.

30. The apparatus according to any one of claims 1 and 21, wherein said stationary portion and movable portion each include at least two magnetic inserts having opposite polarity orientations.

31. The apparatus according to claims 16, wherein said stationary frame and sliding frame each include at least two magnetic inserts having the same polarity orientation.

32. The apparatus according to claims 16, wherein said stationary frame and sliding frame each include at least two magnetic inserts having opposite polarity orientations.

33. The apparatus according to claim 1, wherein said stationary portion magnetic inserts are laid upon the surface of said stationary portion and of said movable portion.

34. The apparatus according to claim 1, wherein said magnetic inserts are permanent magnetic inserts.

35. The apparatus according to claim 1, wherein the movement of said movable portion along said path of translation is at least almost frictionless.

AMENDED CLAIMS
received by the International Bureau on 08 June 2012 (08.06.2012)

1. A support apparatus for a sliding frame, said apparatus comprising:

a stationary portion having a long axis parallel to a plane defined by said frame and including at least one magnetic insert disposed along said long axis defining a straight or curved path of translation;

a movable portion fixedly or rotatively attached to said frame, including at least one magnetic insert and movable along said path of translation; and wherein a magnetic field vector orientation of said stationary portion magnetic inserts and of said movable portion magnetic inserts are the same, generate repelling forces and maintain a single state of contactless equilibrium of said repelling forces between said stationary portion magnetic inserts and said movable portion magnetic inserts at any point throughout said path of translation regardless of the orientation of said plane.

2. The support apparatus according to claim 1, wherein a plurality of points each at said state of contactless equilibrium of said forces form a singular line of equilibrium in 3D space parallel to said path of translation.

3. The support apparatus according to claim 1, wherein said stationary portion magnetic inserts are disposed along at least two surfaces oriented along said long axis and at an angle to each other, said movable portion magnetic inserts are disposed along at least two surfaces oriented parallel to said long axis, at an angle to each other, each corresponding and close to parallel to at least one of said stationary portion surfaces throughout said path of translation.

4. The support apparatus according to claim 1, wherein said stationary portion magnetic inserts are an integral part of said stationary portion and said movable portion magnetic inserts are an integral part of said movable portion.

5. The support apparatus according to claim 1, wherein said single state of contactless equilibrium is maintained by a repelling force effected by said magnetic inserts opposite in direction and potentially greater than or equal to force of gravity acting on said frame.

6. The support apparatus according to claim 1, wherein said single state of contactless equilibrium is maintained by a repelling force effected by said magnetic inserts opposite and equal to a force of disturbance diverting said movable portion from said path of translation.

7. The support apparatus according to claim 1, wherein said single state of contactless equilibrium is maintained by repelling forces effected by said magnetic inserts opposite and equal to forces acting in a direction other than parallel to said path of translation.

8. The support apparatus according to claim 1, wherein said single state of contactless equilibrium is maintained by a repelling force effected by said magnetic inserts opposite and equal to a force of disturbance acting at an angle close to normal to said path of translation.

9. The support apparatus according to claim 1, wherein said magnet inserts are segmented.

10. The support apparatus according to claim 8, wherein said movable portion includes at least two magnetic insert segments.

11. The support apparatus according to claim 1, wherein said movable portion is rotatively attached to said frame via adjustable brackets or hinges.

12. The support apparatus according to claim 11, wherein degree of tilt of said plane may be adjusted employing said brackets or hinges.

13. The support apparatus according to claim 1, wherein said frame is detachable from said movable portion.

14. The support apparatus according to claim 1, wherein said stationary portion has a circular cross-section and said movable portion has a crescent-like cross-section and is rotatable about said stationary portion.

15. The support apparatus according to claim 1, wherein said stationary portion and said movable portion have a cross-section selected from either a group of geometrical shapes such as a circle, a crescent, a triangle and a quadrangle or a group of letters of alphabet such as a "V", an inverted "V", a "W", an inverted "W", a "U" and an inverted "U".

16. A support apparatus for a sliding frame, said apparatus comprising:

a stationary frame at least one side of said stationary frame including at least two planes each oriented along at least a portion of the length of said side of said stationary frame at an angle to each other and sharing an intersection line;

a magnetic material insert attached to each of said two planes;

a sliding frame one of said sliding frame sides including a groove spanning at least a portion of the length of said sliding frame side formed by at least two planes each oriented in parallel to a corresponding plane located in the static frame and forming an intersection line;

a magnetic material insert attached to each of said two planes of said sliding frame; and

wherein the line formed by the intersection of the two planes located in the static frame and the line formed by the intersection of the two planes located in the sliding frame are parallel to each other and share the same vertical plane.

17. The support apparatus for a sliding frame according to claim 16, wherein the line formed by the intersection of the two planes located in the static frame is longer than or equal to the line formed by the intersection of the two planes located in the sliding frame.

18. The support apparatus for a sliding frame according to claim 1, further comprising at least one fluid collection basin and draining outlet.

19. The support apparatus for a sliding frame according to claim 1, further comprising a sliding frame locking mechanism.

20. The support apparatus for a sliding frame according to claim 17, wherein the line formed by the intersection of the two planes located in the static frame and the line formed by the intersection of the two planes located in the sliding frame are maintained parallel to each other and in the same plane parallel to a path of translation during translation of said sliding frame.

21. A maintenance free support apparatus for a sliding frame, said apparatus comprising:

a stationary portion having a long axis parallel to a plane defined by said frame and including at least one magnetic insert disposed along said long axis defining a path of translation;

a movable portion fixedly or rotatively attached to said frame, including at least one magnetic insert and movable along said path of translation;

at least one ferromagnetic debris collecting magnet inserted at least at one end of said movable portion; and

wherein a magnetic field vector orientation of said ferromagnetic debris collecting magnet, said stationary portion magnetic inserts and of said movable portion magnetic inserts are the same, generate repelling forces and maintain a single state of contactless equilibrium of said repelling forces between said stationary portion and said movable portion at any point throughout a path of translation regardless of the orientation of said plane.

22. The maintenance free support apparatus for a sliding frame according to Claim 21, wherein the magnitude of a magnetic field vector of said ferromagnetic debris collecting magnet is greater than that of said stationary portion and movable portion magnetic inserts and sufficiently large to attract and adhere ferromagnetic debris.

23. A method for supporting a sliding frame, said method comprising:

defining a path of translation of said frame by disposing at least one first set of magnetic inserts along a long axis of a stationary portion in parallel to a plane defined by said frame;

inserting at least one second set of magnetic inserts in parallel to said long axis into a movable portion of said frame movable along said path of translation; and orienting said first set and said second set of magnetic inserts so that to have the same magnetic field vector orientation and to maintain a single state of contactless equilibrium between said stationary portion and said movable portion at any point throughout said path of translation regardless of the orientation of said plane.

24. The method according to claim 23, wherein

defining a path of translation of said frame by disposing at least two first sets of magnetic inserts disposed opposite each other, sandwiching said frame along said long axis and in parallel to said plane;

inserting at least two second sets of magnetic inserts into corresponding two movable portions opposing each other, sandwiching said plane and being movable along said path of translation; and

orienting said first sets and said second sets of magnetic inserts so that to generate repelling forces and maintain a single state of contactless equilibrium between said stationary portion and said movable portion at any point throughout said path of translation regardless of the orientation of said plane.

25. A method of translating a sliding frame relative to a static frame, said method comprising:

providing a stationary frame at least one edge of said stationary frame including at least two planes each having a magnetic material insert and oriented along length of the stationary frame edge at an angle to each other and forming an intersection line ;

providing a sliding frame at least one side of said sliding frame including a groove spanning at least a portion of the length of said sliding frame side formed by at least two planes forming an intersection line, each having a magnetic material insert and oriented parallel to a corresponding plane located in the static frame;

positioning the sliding frame in the static frame such that the line formed by intersection of the two planes located in the static frame and the line formed by intersection of the two planes located in the sliding frame are parallel to each other and in same vertical plane and wherein the magnetic forces of magnetic inserts located in the static frame interact with the magnetic forces of magnetic inserts located in the sliding frame to suspend the sliding frame.

26. A method of translating a sliding frame relative to a stationary frame, said method comprising:

providing a static frame at least one side of said static frame including at least two planes each oriented along the length of said frame side at an angle to each other and forming an intersection line;

providing a sliding frame at least one side of said sliding frame including a groove spanning at least a portion of the length of said sliding frame side formed by at least two planes forming an intersection line oriented parallel to the planes located in the stationary frame;

attaching magnetic material inserts to each of said two planes of the stationary frame and of the sliding frame;

contactlessly translating said sliding frame relatively to said stationary frame; and

maintaining the line formed by intersection of the planes located in the stationary frame and the line formed by intersection of the planes located in the sliding frame parallel to each other and in the same vertical plane.

27. A method for lateral stabilization of a sliding frame during contactless translation, said method comprising:

providing a stationary frame at least one edge of said stationary frame including at least two planes each having a magnetic insert and oriented along the length of said frame edge at an angle to each other and forming an intersection line;

providing a sliding frame at least one edge of said sliding frame including a groove spanning at least a portion of the length of said sliding frame edge formed by at least two planes forming an intersection line each having a magnetic insert and oriented in parallel to a corresponding plane located in the stationary frame; and wherein said magnetic inserts interact to generate repelling forces between said stationary frame and said sliding frame in directions parallel and normal to a plane defined by said sliding frame and wherein said repelling forces normal to said plane laterally stabilize said sliding frame during contactless translation.

28. A method for controlling contactless translation of a sliding frame, said method comprising:

defining a path of translation of said frame by disposing at least one first set of segmented magnetic inserts along a long axis of a stationary portion in parallel to a plane defined by said frame;

inserting at least one second set of magnetic inserts having a magnetic field vector in the same orientation as the magnetic field vector of said first set in parallel to said long axis into a movable portion of said frame movable along said path of translation;

orienting said first set and said second set of magnetic inserts so that to maintain a single state of contactless equilibrium between said stationary portion and said movable portion at any point throughout said path of translation regardless of the orientation of said plane;

distancing said segments from each other so that to create gaps between said segments and generating local disturbances in at least one magnetic field between said segments; and

varying size of said gaps to achieve a desired speed of translation and/or degree of stepped translation of said movable portion over said stationary portion.

29. The apparatus according to any one of claims 1 and 21, wherein said stationary portion and movable portion each include at least two magnetic inserts having the same polarity orientation.

30. The apparatus according to any one of claims 1 and 21, wherein said stationary portion and movable portion each include at least two magnetic inserts opposite to each other in their polarity orientations.

31. The apparatus according to claims 16, wherein said stationary frame and sliding frame each include at least two magnetic inserts having the same polarity orientation.

32. The apparatus according to claims 16, wherein said stationary frame and sliding frame each include at least two magnetic inserts opposite to each other in their polarity orientations.

33. The apparatus according to claim 1, wherein said stationary portion magnetic inserts are laid upon the surface of said stationary portion and of said movable portion.

34. The apparatus according to claim 1, wherein said magnetic inserts are permanent magnetic inserts.

35. The apparatus according to claim 1, wherein movement of said movable

portion along said path of translation is at least almost frictionless.

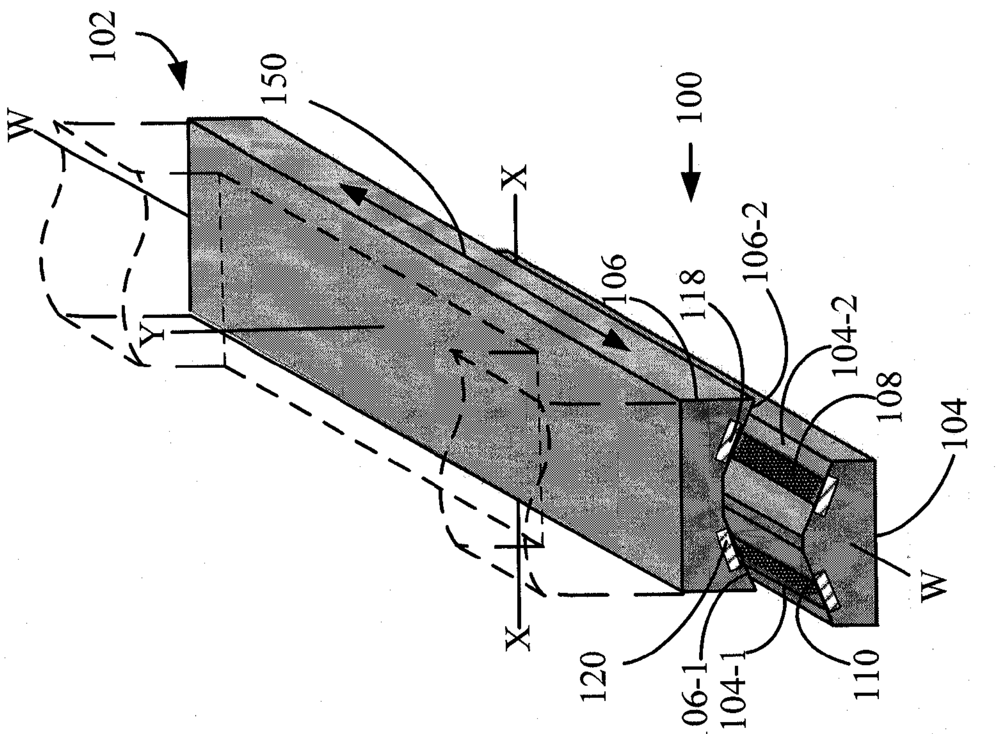


FIG. 1A

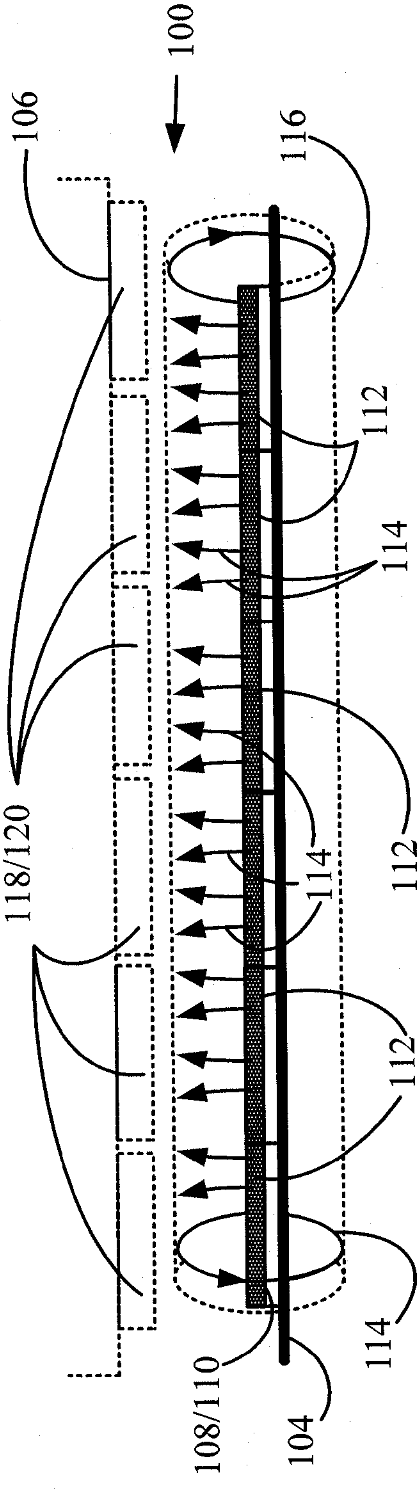
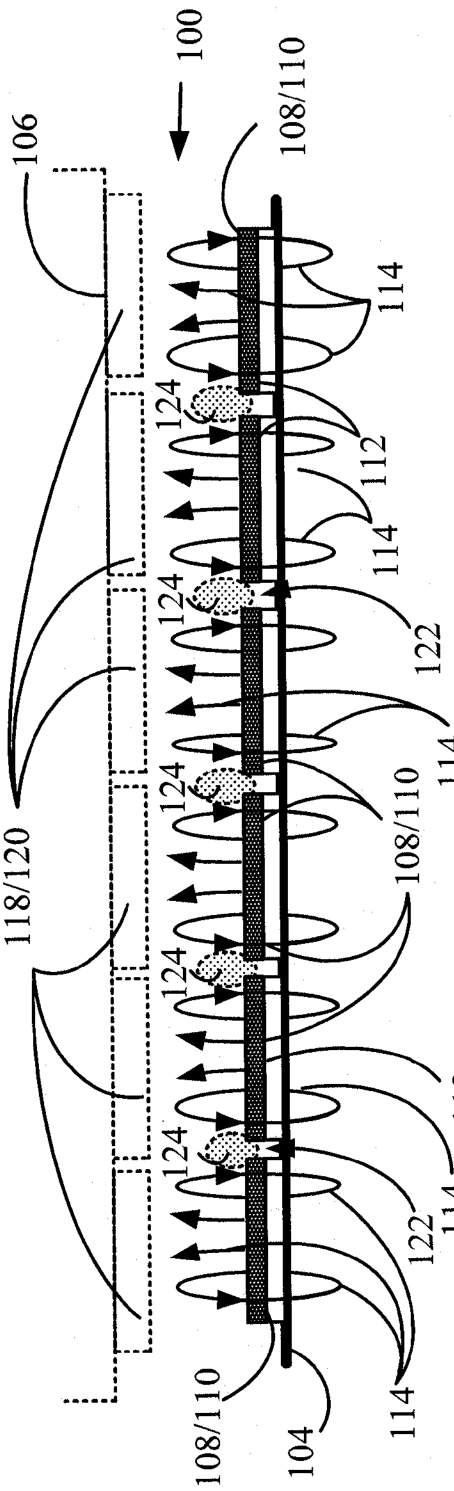

100
106
116
112
114
118/120
108/110
104

FIG. 1B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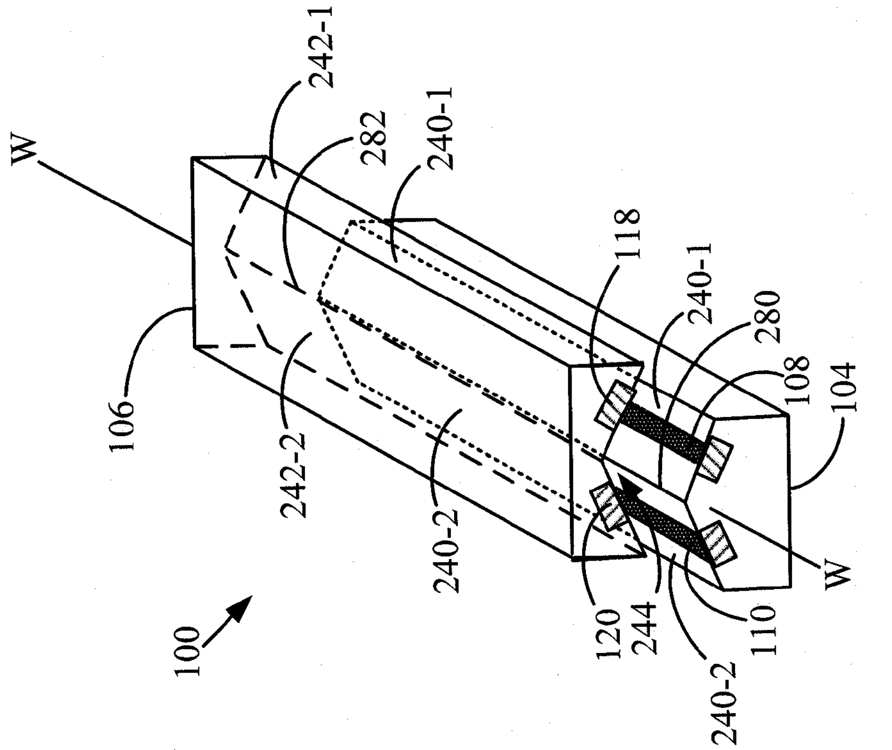
106
108/110
114
124
112
122
118/120
104

FIG. 1C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242-1
282
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118
240-1
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108
104
106
242-2
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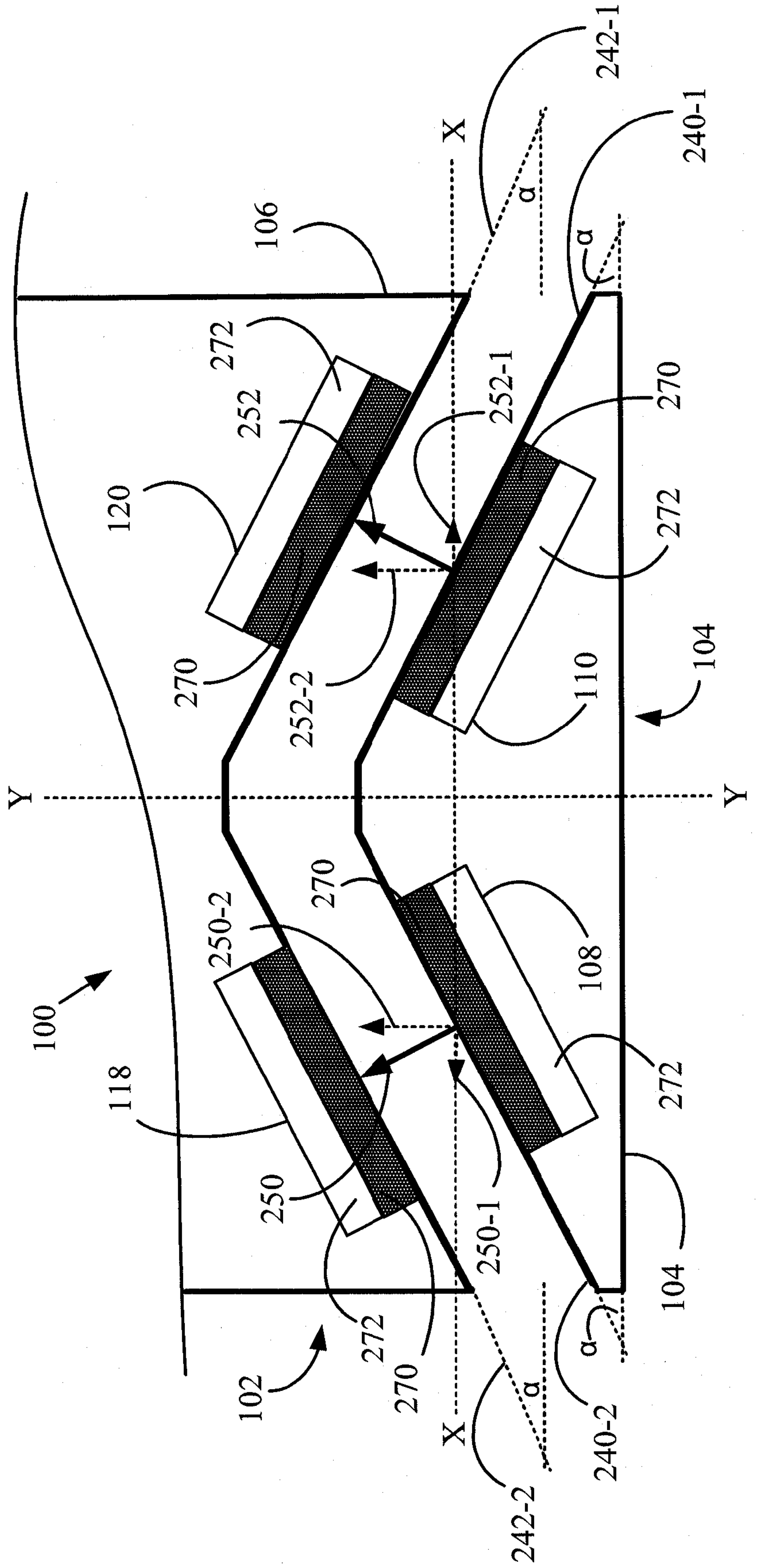
100
120
244
240-2
110
W

FIG. 2A


242-1
X
240-1
α
106
α
272
252-1
270
252
120
272
270
252-2
104
110
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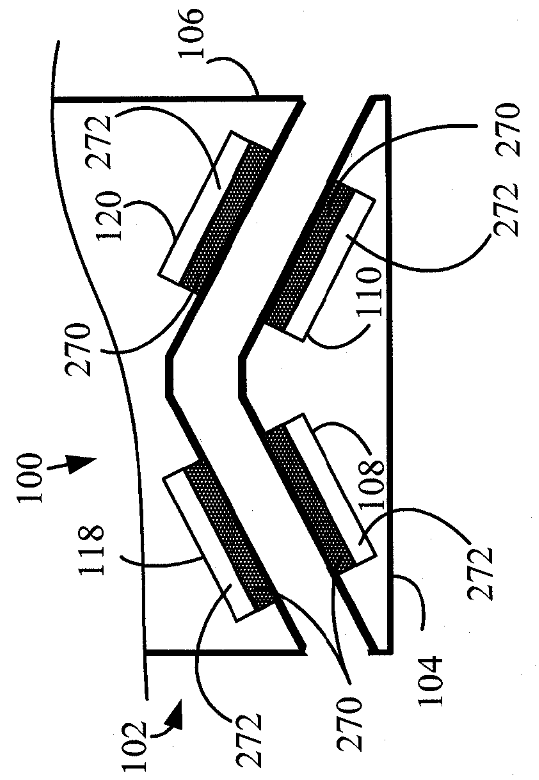
Y
270
250-2
108
100
118
272
250
250-1
104
272
102
270
α
X
α
240-2
242-2

FIG. 2B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272
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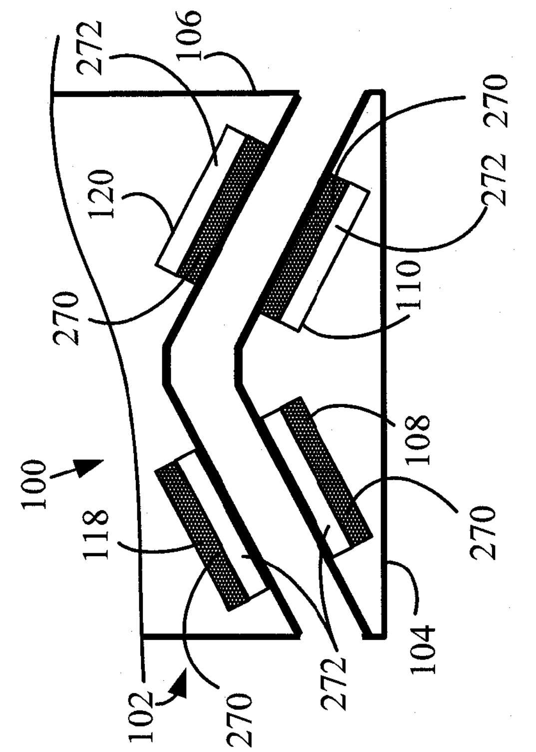
270
104

FIG. 2C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104

FIG. 2D

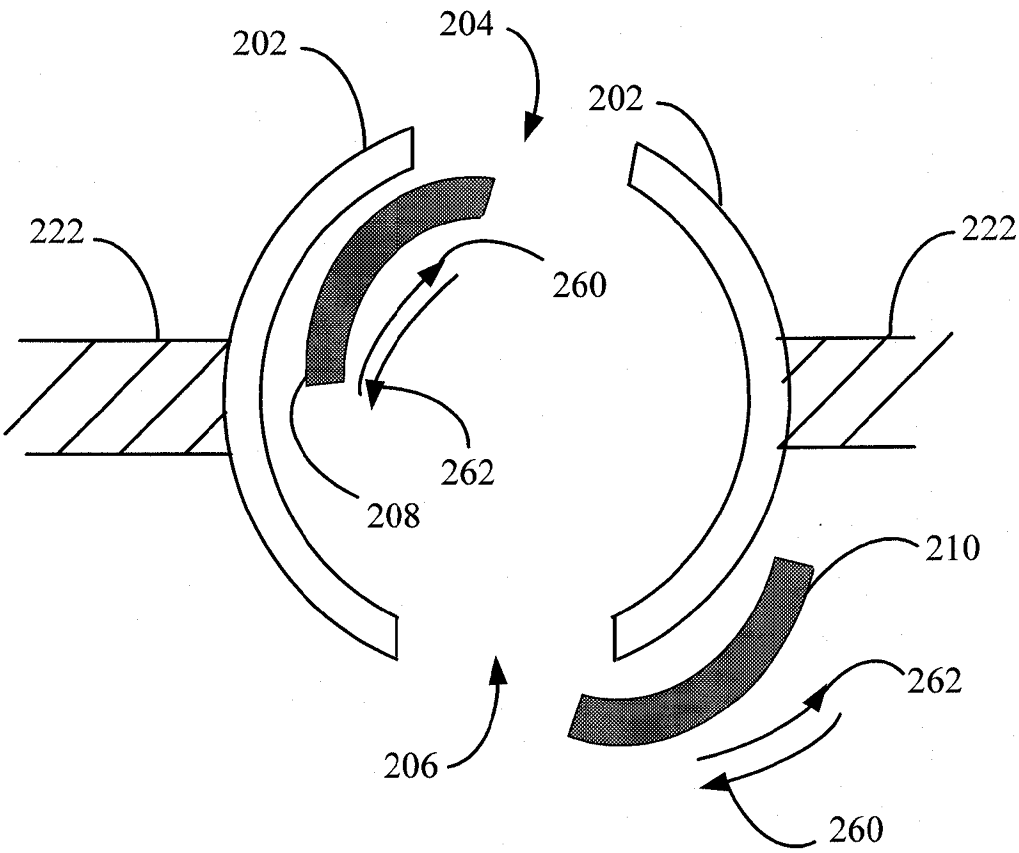


FIG. 2E

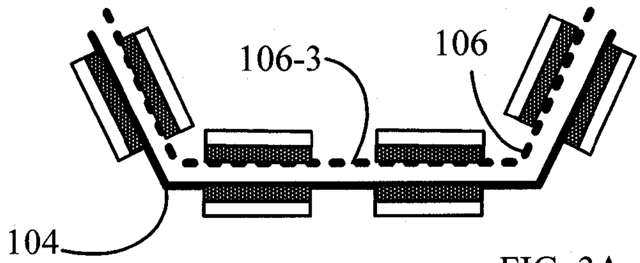


FIG. 3A

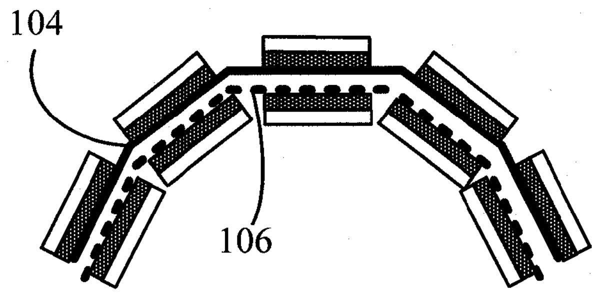


FIG. 3B

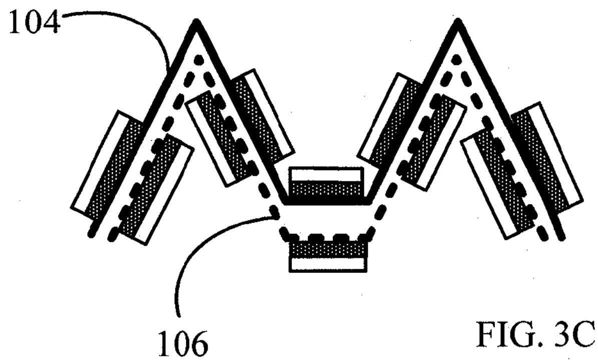


FIG. 3C

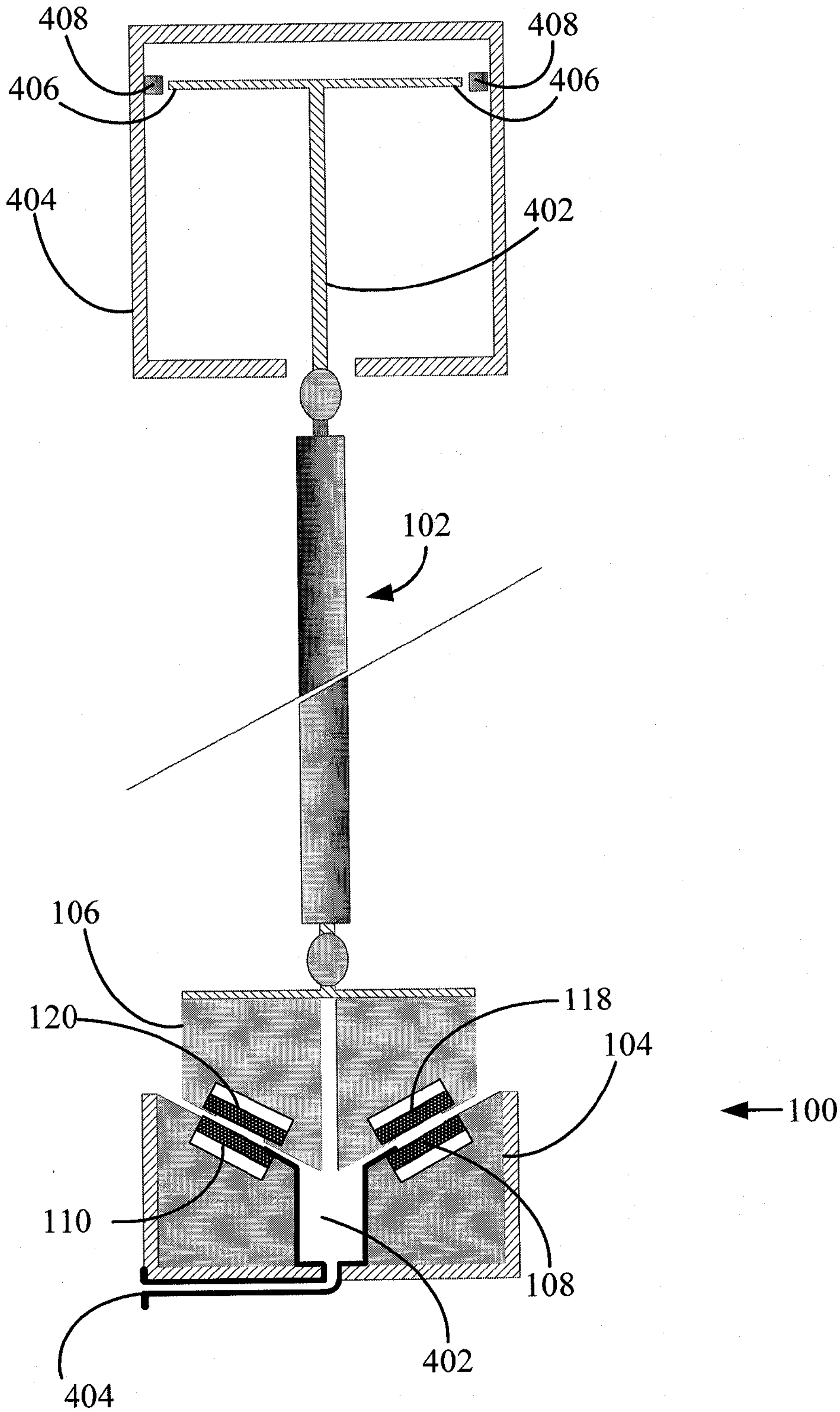


FIG. 4

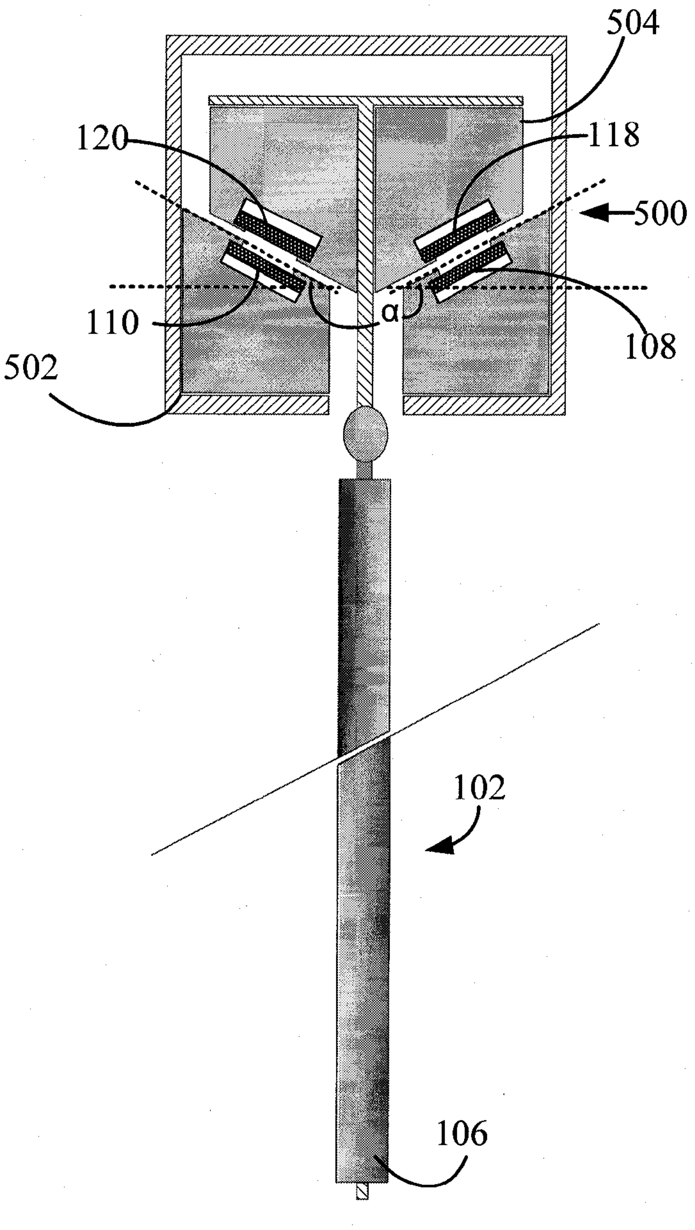
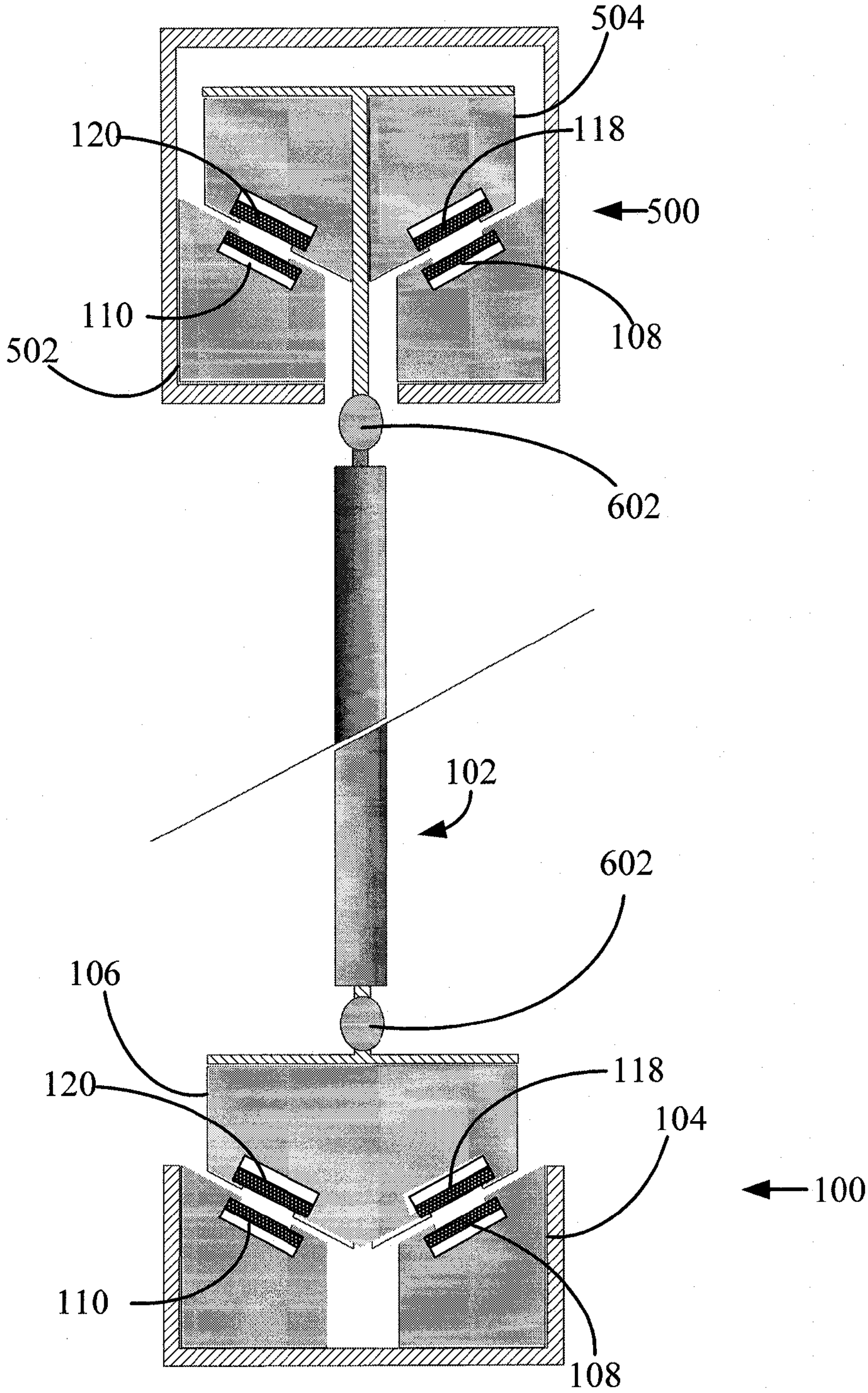


FIG. 5


504
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118
500
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108
502
602
102
602
106
120
118
104
100
110
108

FIG. 6

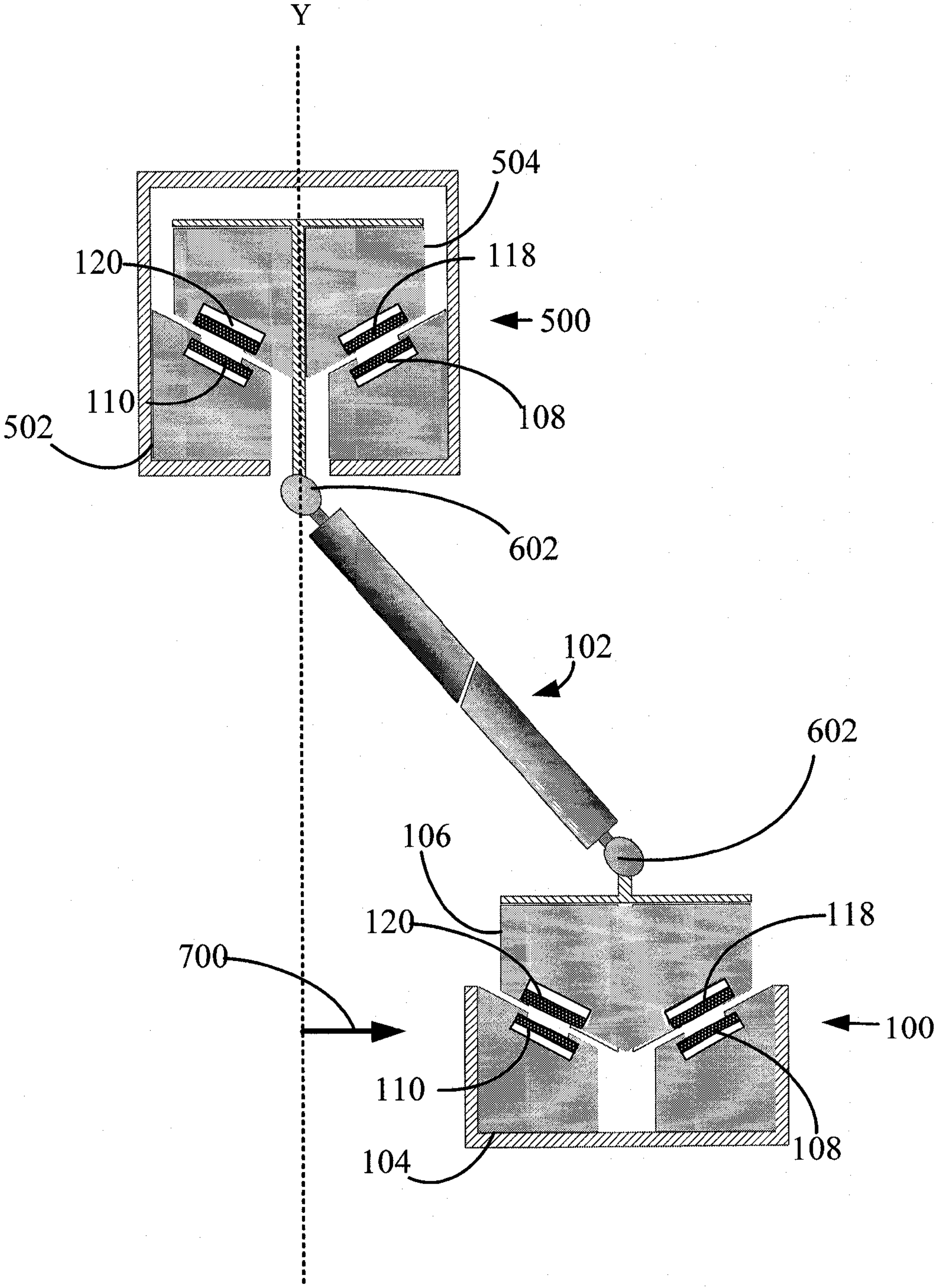
Y
504
120
118
500
110
108
502
602
102
602
106
120
118
700
100
110
108
104

FIG. 7

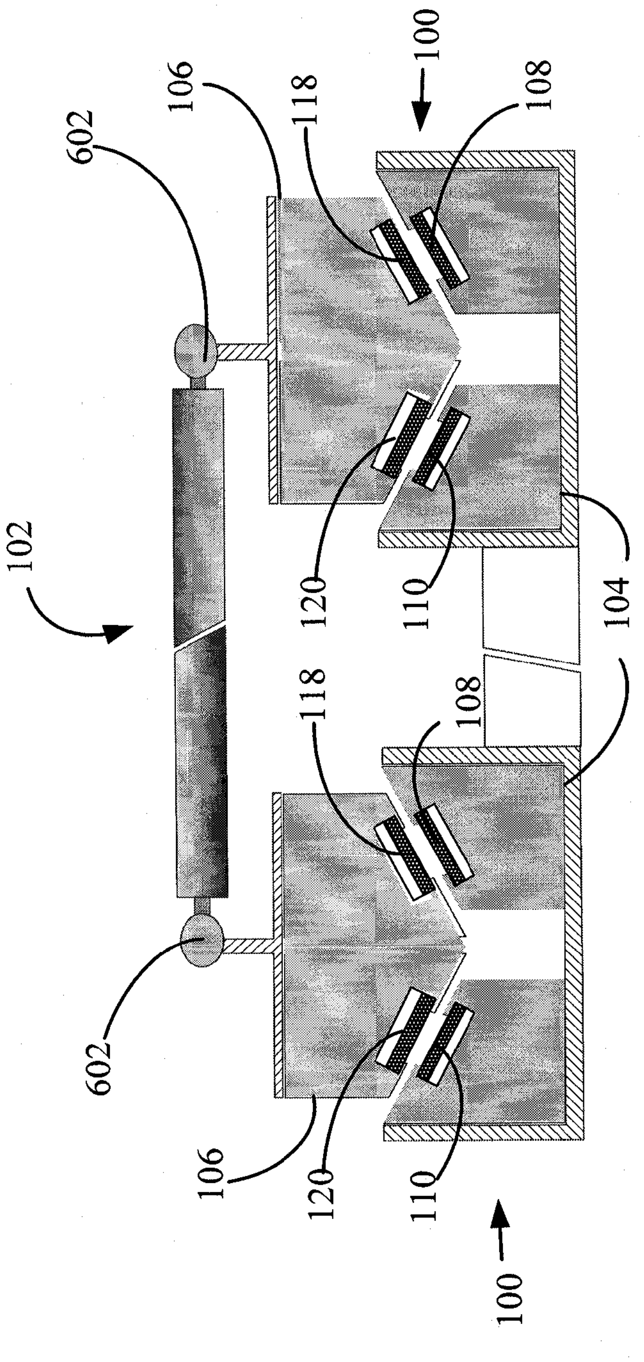

FIG. 8

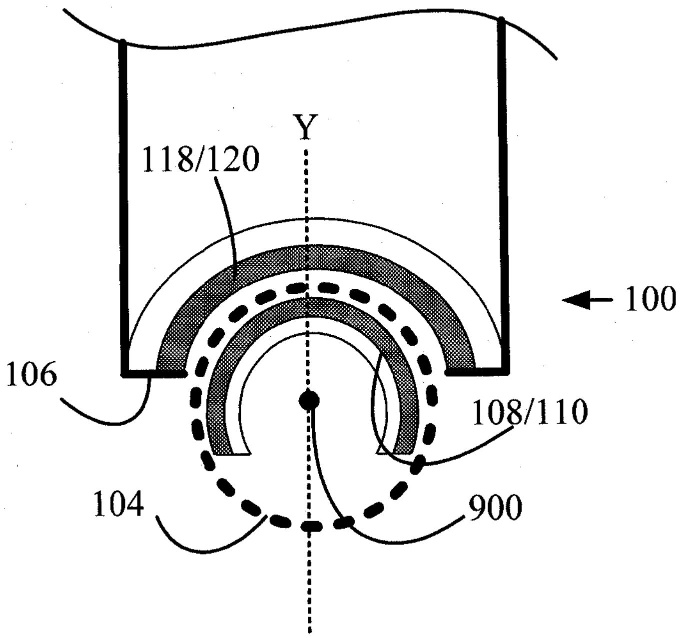
Y
118/120
100
106
108/110
104
900

FIG. 9A

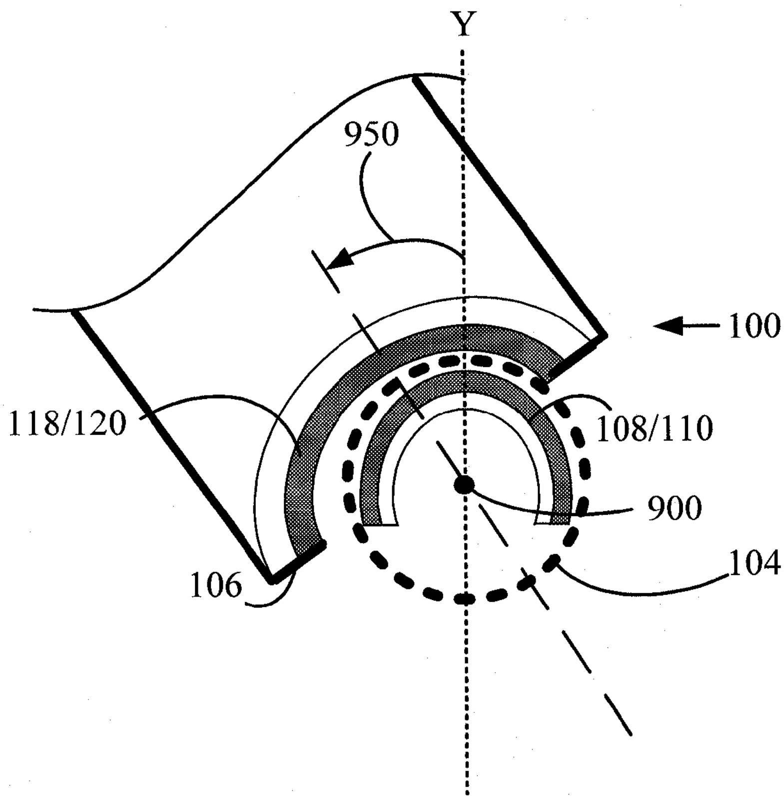
Y
950
100
118/120
108/110
900
106
104

FIG. 9B

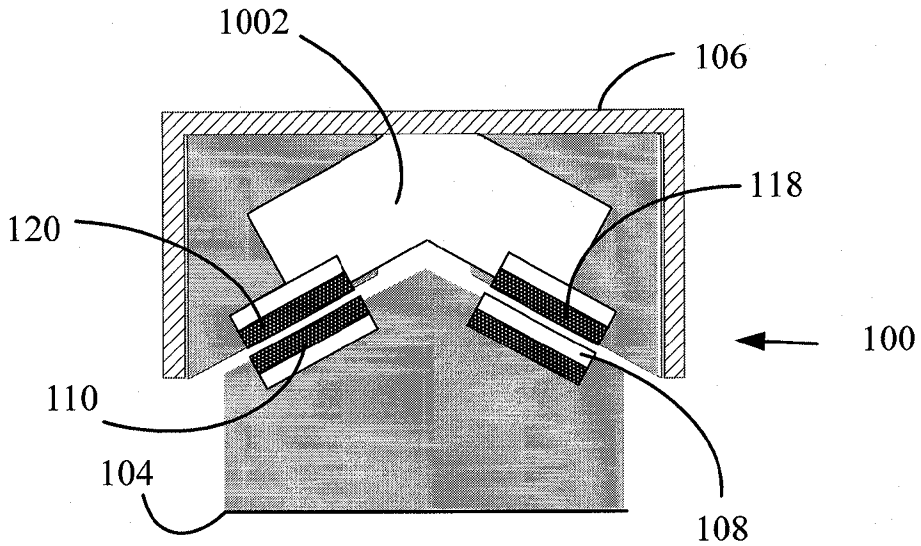

FIG. 10A

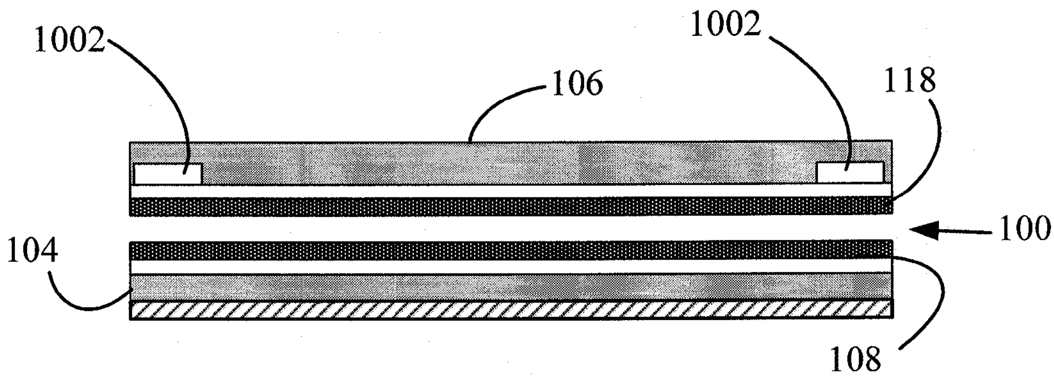

FIG. 10B

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IL 11/00969

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - A47F 5/00 (2012.01)
USPC - 211/162
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC(8) - A47F 5/00 (2012.01)
USPC - 211/162

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
USPC - 211/87.01, 94.01, 94.02; 49/324, 130; 248/200; 252/62.51R; 294/65.5 (text search - see terms below)

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
PubWEST(USPT,PGPB,EPAB,JPAB); Google Scholar; Google Patents
Search Terms: slide, support, frame, magnet, float, repel, oppose, stationary, rail, track, insert, slope, angle, door, window, V-shape, ferromagnetic, debris, dirt, dust, collect, drain, segmented, gaps,... etc.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y	US 2009/0044916 A1 (Singiser et al.) 19 February 2009 (19.02.2009), fig 1 and 2, para [0017], [0022], [0042]-[0043] and [0046]-[0047]	1-2, 4-5, 9, 13, 19, 23 and 33-35 --- 3, 6-8, 10-12, 14-18, 20-22 and 24-32
Y	US 3,464,158 A (Greene) 02 September 1969 (02.09.1969), fig 5 and 6, col 2, ln 66-70	3, 6-8, 10, 15-17, 20, 24-27 and 31-32
Y	US 5,194,309 A (Knudsen) 16 March 1993 (16.03.1993), fig 1, col 3, ln 55-65	11 and 12
Y	US 5,581,946 A (Lin) 10 December 1996 (10.12.1996), fig 3A and 3B, col 4, ln 30-34	14
Y	US 5,887,387 A (Dallaire) 30 March 1999 (30.03.1999), fig 4, col 6, ln 3-10	18
Y	US 4,208,755 A (Shepherd) 24 June1980 (24.06.1980), fig 1, col 2, ln 42-46	21-22 and 29-30
Y	US 4,790,358 A (Linka) 13 December 1988 (13.12.1988), fig 4, col 4, ln 58-62	28

☐ Further documents are listed in the continuation of Box C. ☐

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"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
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"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
05 May 2012 (05.05.2012)	16 MAY 2012

Name and mailing address of the ISA/US	Authorized officer:
Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	Lee W. Young PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774