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(54) **Magnetic levitation toy**

(57) The invention relates to a toy consisting of a magnetic levitation vehicle, such as a toy train, a toy car or the like, with an associated glide track.

Along the latter there is at least one magnetic levitation trace (14, 15) preferably consisting of magnetic strips, whereas the vehicle (2) is equipped with at least

one skid (24, 25) cooperating with the magnetic trace (14, 15) for producing levitation.

Advantageously, the skid has a permanent magnet (24A, 25A) associated with at least one Halbach array (24B, 24C, 25B, 25C) for stabilizing the suspended condition of the vehicle in relation to the track.

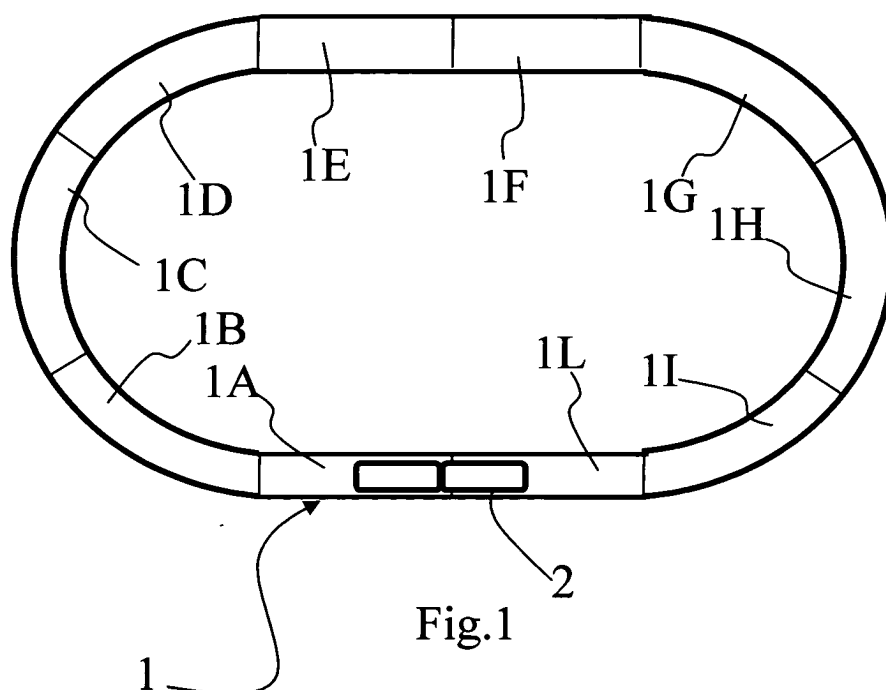


Fig.1

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Description

[0001] The present invention relates to a magnetic levitation toy according to the preamble of claim 1.

[0002] As known, magnetic levitation is a physical phenomenon through which an object can be kept suspended above a surface, or a track, a rail or the like, as in the case of a train travelling over a rail, by means of magnetic fields.

[0003] By overcoming the gravitational field, magnetic fields keep the object at a distance from the surface, track, rail or the like, thus eliminating any friction between the two.

[0004] The best-known application of this principle is perhaps found in trains; in order to obtain magnetic levitation, this application mainly uses two different types of technology: electromagnetic suspension (EMS) and electrodynamic suspension (EDS).

[0005] The former case (EMS) uses the magnetic attraction force (in substance, the train skids are arranged under the glide tracks, and the train levitates through the effect of the attraction force between the skids and the tracks); for this purpose it is appropriate to employ superconducting magnets, which offer no resistance (or more in general offer very low resistance) to the electric current flow, and which, due to the Meissner effect, are not crossed by the magnetic field; the superconducting condition is however attained at very low temperatures (about 139°C below zero), and it is therefore necessary to use liquid nitrogen or similar cooling systems, which for safety reasons are not applicable to a toy, as is the case of the present invention.

[0006] On the contrary, the latter case (EDS) uses the magnetic repulsion force (in substance, the train skids are arranged above the glide tracks, and the train levitates through the effect of the repulsion force between the skids and the tracks): both the rail and the train produce a magnetic field, and the train levitates due to the repulsive force generated between the two magnetic fields.

[0007] Two different types of EDS essentially exist: the so-called JR-MAGLEV, wherein (active, i.e. powered) electromagnets are installed on both the train and the rail, and the so-called INDUCTRACK, wherein a plurality of (passive, i.e. non-powered) electromagnets are installed on the rail, and arrays of permanent magnets in Halbach configuration are installed on the train, i.e. a set of permanent magnets which stabilize the direction of the magnetic force lines by increasing the magnetic field on one side of the arrays and suppressing it on the opposite side, without needing any electronic feedback control.

[0008] The application of the JR-MAGLEV technology to a toy is strongly limited by the fact that it requires that a certain quantity of electric power be supplied to the train for powering the electromagnets, e.g. by means of an overhead power line to which the train could be connected through pantographs: it is apparent that such an overhead line would give rise to construction problems,

leading to a level of complexity which would have no reason to exist in a toy, as well as safety problems which would make the toy unusable.

[0009] On the other hand, the INDUCTRACK technology is based on the fact that the train motion increases the levitation force: however, its use in a toy involves undesirable construction complexity, mainly due to the fact that a large number of electromagnetic windings are to be fitted to the rail which, though not electrically powered, would imply excessive costs and weight for a toy.

[0010] It follows that, since in principle the solutions adopted for the real magnetic levitation trains cannot be transposed to toys due to the aforementioned problems, it is necessary to find solutions which are applicable to this specific industry, wherein user safety, low cost, construction simplicity and strength are the main selection criteria.

[0011] Some examples of magnetic levitation toys already exist in the art, such as the one disclosed in international patent application WO 2005/118101 in the name of YUN Bong-Seok, which however describes a toy train equipped internally with a container for liquid nitrogen storage, with easily imaginable convenience and safety problems.

[0012] A second example of a magnetic levitation toy consists of a spinning top fitted with permanent magnets, which rotates freely while levitating magnetically above a plate (or a ring) also provided with a permanent magnet: this solution is clearly not applicable to a toy vehicle which has to move over a track, because the stability of the spinning top levitating above the plate is given by its gyroscopic effect.

[0013] Yet another example is provided by international application WO 2005/102487, again by YUN Bong-Seok, wherein a toy trolley levitates over a rail solely due to permanent magnets having the same polarity, arranged on both the rail and the trolley; side wheels are also provided in order to stabilize the trolley laterally in relation to the rail.

[0014] This solution implies that the trolley wheels always stay in contact with the rail, so as to balance the static magnetic field deriving from the permanent magnets placed on the trolley and on the rail.

[0015] As a matter of fact, balancing static magnetic fields is especially problematic; the simple adoption of permanent magnets having the same polarity arranged opposite to each other (North or South) will lead to an unstable equilibrium state, as emerges also from the formulation of Earnshaw's theorem.

[0016] The present invention aims at providing a magnetic levitation toy comprising a vehicle and a track over which the vehicle can translate in a condition of magnetic levitation, which toy overcomes the drawbacks of the prior art.

[0017] This object is achieved through a magnetic levitation toy in accordance with the appended claim 1.

[0018] The present invention is based upon the idea of providing a vehicle adapted to move over a track or

the like while in a magnetic levitation condition, which vehicle has at least one levitation skid cooperating with a corresponding magnetic levitation trace arranged on the track, so as to cause the former to remain suspended above the latter, wherein the skid comprises at least one permanent magnet extending longitudinally in relation thereto, flanked by at least one permanent magnet in Halbach array configuration.

[0019] The presence of a skid thus conceived allows to limit the destabilizing edge effects of the magnetic levitation traces for improved equilibrium.

[0020] Further features of the invention will be set out in the appended claims.

[0021] These features as well as the advantages deriving therefrom will become more apparent from the following description of an embodiment of the invention as shown in the annexed drawings provided by way of non-limiting example, wherein:

Fig. 1 shows a magnetic levitation toy according to the present invention, comprising a closed-loop track and a toy vehicle;

Fig. 2 shows a variant of the toy of Fig. 1, wherein the track has an open shape;

Fig. 3 shows a straight section of the track of Fig. 1 or 2;

Fig. 4 shows the vehicle associated with the track of Figs. 1 and 2;

Fig. 5 is a cross-sectional view of the track section of Fig. 3;

Fig. 6 is a plan view of a straight section of the track of Fig. 1 or 2;

Fig. 7 is a plan view of a curvilinear section of the track of Fig. 1 or 2;

Fig. 8 is a cross-sectional view of the lower portion of the vehicle of Fig. 4, coupled to the track section shown in the preceding Figures;

Fig. 9 is a plan view of one of the levitation skids provided on the vehicle of Fig. 4;

Fig. 10 is a sectional view along the X-X line of Fig. 8; Figs. 11 and 12 show the propulsion system installed on the vehicle of Fig. 4;

Fig. 13 shows an alternative embodiment of the track section of Fig. 3;

Fig. 14 is a cross-sectional view of the lower portion of the vehicle of Fig. 4 and of the track section of Fig. 13 according to an alternative embodiment;

Fig. 15 is a bottom view of the track section of Fig. 13;

Fig. 16 shows a diagram of a permanent magnet in the so-called "Halbach array" configuration;

Figs. 17 and 18 are cross-sectional views of the lower portion of a variant of the vehicle of

Fig. 4 and of the track of Fig. 13, wherein the vehicle is fitted with only one magnetic levitation skid;

Figs. 19 to 22 show further possible variants of the vehicle and track of the toy according to the invention.

[0022] Referring now to Figs. 1 and 2, there is shown an example of a toy according to the present invention, which comprises a track 1 consisting of a plurality of sections 1A-1L over which a toy vehicle 2 translates while in a magnetic levitation condition.

[0023] In this application, the track sections are shaped like a rail and vehicle 2 looks like a toy train; it should be pointed out beforehand that the track sections may nevertheless be configured as any kind of track travelled by a generic magnetic levitation vehicle, such as a track for toy cars, toy horses or whatever.

[0024] Track 1 shown in Fig. 1 has a ring-like shape, thus being a closed loop, so that toy vehicle 2 can run over it continuously; it should however be understood that it may have any other shape as well, e.g. a figure of eight or even an open shape.

[0025] This latter possibility is shown in Fig. 2, which illustrates an example of an open track 1' wherein toy vehicle 2 moves back and forth between two end points, just like a shuttle. Track 1' also consists of a plurality of sections 1'A-1'D, which can be assembled together at will to form a preferred course.

[0026] Fig. 3 shows a partially transparent view of a section of track 1A, which is supported by (optional) uprights 3 resting on a base plane, like a table, a floor or the like; for this purpose, each upright 3 has a base 31 and a head 32 adapted to be coupled fixedly to section 1A, e.g. through two complementary profiles joined together.

[0027] As an alternative, track 1 may be installed directly on a support plane without using any uprights.

[0028] More in detail, Fig. 5 shows a cross-section of the track: it is shaped like an upside-down "T" and comprises a horizontal flat portion 12 from the centre of which a vertical core 11 extends.

[0029] As can be seen, on vertical core 11 there is a first magnetic trace 13 consisting of a plurality of permanent magnets 13₁, 13₂, 13₃ ... 13_n aligned along the entire length of the track; likewise, on horizontal portion 12 there are two other magnetic traces 14 and 15 arranged in equidistant positions from the centre of symmetry of the structure, also extending for the entire length of track 1.

[0030] According to a preferred embodiment, magnetic traces 14 and 15 are strips consisting of a continuous flexible band having a width of 10 mm, a variable thickness between 3 and 6 mm, and a length equal to that of track sections 1A-1P, i.e. a few hundreds of millimetres (preferably 100 to 200 mm).

[0031] Strips 14, 15 feature axial magnetization, i.e. the North pole and the South pole are located on the top and bottom faces, respectively, when mounted on the rails or sections 1A-1P. Said strips performed unexpectedly well as far as levitation was concerned; the best ones have proven to be those produced by Spanish company IMA Ingegneria Magnetica Aplicada.

[0032] The functionality of magnetic traces 13, 14 and 15 will be discussed later on: suffice it to say for now that

those provided on horizontal portion 12 are used for levitating vehicle 2, whereas trace 13 provided on vertical core 11 is used for propelling vehicle 2: it is made up of several equal pieces obtained by cutting magnetic strips (such as the aforementioned IMA strips) to a size of 3 x 9 x 8 mm and then installed in succession with alternate polarity at a distance of 3 mm from one another.

[0033] Traces 13, 14 and 15 may be applied to the structure in the designated positions, for example, by glueing or, as in the case illustrated herein, by incorporating them into the plastic material of the track structure, e.g. by co-moulding or overmoulding the plastic structure and the strips.

[0034] It must be pointed out that, although so far the present description has tackled only straight section 1A, curvilinear sections 1B, 1C, 1D, etc. of track 1 are made in the same manner; therefore, reference should be made to the above description as regards these sections as well.

[0035] Referring now to Fig. 4, there is shown a toy vehicle 2, which comprises an upper portion 2A and a lower portion 2B, the latter facing the track 1 and cooperating therewith in order to allow vehicle 2 to levitate and move along track 1.

[0036] Lower portion 2B of vehicle 2 is shown in Figs. 8, 9 and 10: as can be seen in the cross-sectional view, it is essentially shaped like an upside-down "U" complementary to the shape of track 1, so that in the coupled condition vertical core 11 of the latter projects towards lower portion 2B of the vehicle.

[0037] The latter also comprises two levitation skids 24 and 25 in accordance with the invention, which are to face levitation strips 14 and 15 of the track.

[0038] Fig. 9 shows levitation skid 24, which comprises a central permanent magnet 24A extending longitudinally relative to the vehicle and flanked by two permanent magnets in Halbach array configuration 24B and 24C; the other levitation skid 25 is not shown in detail in the drawings, since it is identical to skid 24; therefore, it will comprise a central permanent magnet 25A extending along the skid, flanked by two permanent magnets in Halbach array configuration 25B and 25C.

[0039] The Halbach array configuration is a particular arrangement of permanent magnets discovered by Klaus Halbach, and is therefore per se known; in general, in this configuration several permanent magnets are arranged next to one another offset by 90° and oriented in a manner such that the total magnetic field along one face of the array is strengthened while the total magnetic field on the opposite face is suppressed by interference, in accordance with what is diagrammatically shown in Fig. 16.

[0040] This latter figure shows an arrangement of single permanent magnets 90 having a cubic shape and being positioned next to one another in a manner such that the North and South poles are offset, thus increasing the magnetic field above the Halbach array 91 and suppressing the magnetic field below it.

[0041] In the example taken into account, Halbach arrays 24B and 24C alongside the permanent magnet 24A of each skid have dimensions of 3 x 3 x 3 mm, and the magnetic fields are oriented in accordance with the arrows shown in Fig. 9.

[0042] The magnetic polarities of strips 14 and 15 and of skids 24 and 25 are oriented in a manner such that, when vehicle 2 is placed on track 1, they have the same polarity opposite to each other, thus generating a repulsive force that, in combination with the weight force exerted by the gravitational field, allows vehicle 2 to be kept stably suspended above the track, with a static clearance (when the train is still) varying between 3 and 1.5 mm.

[0043] The presence of two permanent magnets in inverse Halbach array configuration 24B and 24C arranged along each skid as shown in Fig. 9 optimizes the levitation effect, hence allowing to stabilize the vehicle's suspended condition in a surprisingly effective way: in fact, in such a configuration they concentrate the repulsive magnetic field (generated by permanent magnets 14, 24A and 15, 25A) at the centre of the skid, thereby limiting the edge effects of the strips and preventing vehicle 2 from rotating transversally relative to the rail.

[0044] In order to stabilize vehicle 2 against transversal translation with respect to the track 1, lower portion 2B is also equipped with stabilizer wheels 21 and 22 having a vertical axis of rotation, which in the event of a transversal movement of vehicle 2 will get in contact with the vertical core 11 of the track sections, thus stabilizing vehicle 2 even when the latter is moving.

[0045] Each vehicle 2 is preferably equipped with at least four stabilizer wheels 21, 22, 21A, 22A, as shown in Fig. 10, arranged in pairs at the opposite ends of lower portion 2B of the vehicle.

[0046] It should be noted that, due to the presence of the two permanent magnets in Halbach array configuration 24B, 25B and 24C, 25C, stabilizer wheels 21, 22, 21A, 22A are not constantly engaged with the flanks of vertical core 11, but only perform their function when the vehicle is subject to centrifugal forces which would otherwise induce a transversal translation thereof in relation to track 1, e.g. when the vehicle is going through a bend.

[0047] In this case as well, not all four wheels are normally in contact with core 11: as motion is taking place, most of the time the wheels are clear of the core (by a gap of approximately 1 mm) and there is pure levitation; the wheels get in rolling contact with core 11 only for short distances (when entering and exiting a bend).

[0048] If the toy vehicle is a toy train, as in the example illustrated herein, wagons 20 (only one of which is shown in Fig. 4) are provided with levitation skids 24 and 25 and with the stabilizer wheels just described; they may however lack the propulsion system, which will be described hereafter with reference to Figs. 11 and 12.

[0049] The propulsion system comprises a portion installed on vehicle 2, used as a tractor, and a portion integral with track 1.

[0050] To this end, vehicle 2 is fitted with an electric

motor 30 coupled to a drive disc 31 having a horizontal axis of rotation, at the periphery of which there are small blocks 34 consisting of permanent magnets arranged with alternate North (N) - South (S) polarity: said blocks are oriented in a radial direction, i.e. with the flow lines between the North - South polarities extending radially.

[0051] In the illustrated example, the electric motor is a three-phase motor 30 coupled to drive disc 31 by means of one or more reduction stages 32, 33.

[0052] As aforementioned, propulsion trace 13 comprises a set of permanent magnetic blocks $13_1, 13_2, 13_3 \dots 13_n$ having alternate North (N) - South (S) polarity.

[0053] The dimensions of magnetic blocks 18 of propulsion trace 13 and of blocks 34 of disc 31, as well as the distance between two adjacent blocks of strip 13 and disc 31, are preferably all the same.

[0054] Electric motor 30 is powered by batteries (rechargeable lithium batteries or any other suitable batteries) mounted in the vehicle itself; preferably the engine revolution speed is 1,500 rpm per Volt supplied, and in this case reduction gears 32 and 33 feature each a 1:6 reduction ratio, so that the maximum speed of the toy is set to a rather low safety value (approx. 1 metre/second) ensuring that no injury can be suffered by the users.

[0055] Of course, since it is a levitation toy train and there is virtually no friction, the speed may be higher than that of conventional electric toy trains.

[0056] Preferably, the toy according to the invention can be controlled remotely through any system commonly used for these applications, i.e. a radio control, an infrared control or the like.

[0057] For this purpose, the vehicle is equipped with a control unit 41 operationally associated with motor 30 to control the operation thereof; control unit 41, which is powered by batteries 42 (which may be distinct from those of motor 30), comprises the means necessary for receiving the signals sent remotely by a radio control (not shown in the drawings) operated manually by a user.

[0058] Said means, which are per se known, include an antenna, a signal demodulator, an amplifier, an inverter and more.

[0059] A magnetic levitation toy provided as described above allows to overcome the drawbacks suffered by prior-art magnetic levitation toys: in fact, the levitation effect is made optimal, as far as a toy is concerned, by the special construction of skids 24; the toy is also considerably safe due to the total absence of any dangers caused by electricity or operating temperatures, while also being inexpensive and durable.

[0060] Figs. 13, 14 and 15 show the main parts of a variant of the above-described toy.

[0061] In this variant as well, the toy comprises a track consisting of several sections 1A' on which a toy vehicle translates, just as previously discussed.

[0062] In this case, however, as can be seen in Fig. 13, the cross-section of every track section 1A' is shaped like an upright (not upside-down) "T" having a horizontal portion 12' from which a vertical core 11' extends down-

wards: magnetic levitation strips 14' and 15', similar to above strips 14 and 15, are arranged on horizontal portion 12'.

[0063] Vertical core 11' houses a magnetic propulsion trace 13' similar to above trace 13, i.e. consisting of permanent magnets $13'_1, 13'_2, 13'_3 \dots 13'_n$ arranged in succession in a manner such as to have alternate North - South polarity.

[0064] The lower portion of vehicle 20 is visible in Fig. 14. Its cross-section extends around and under horizontal portion 12', alongside core 11' of track section 1A'.

[0065] Magnetic levitation is obtained in this case exactly as described for the previous example.

[0066] It follows that also in this case the vehicle has two levitation skids 24' and 25' adapted to be arranged opposite to magnetic strips 14', 15'; the skids are made like those already described, i.e. with a central permanent magnet extending lengthwise and flanked by two permanent magnets in Halbach array configuration, for the same reasons explained above. A first difference between the example of Figs. 3 and 4 and the embodiment of Fig. 13 is found in the fact that the upright "T" shape of the track made up of multiple sections 1A' implies that the lower portion of vehicle embraces the track, resulting in an even more stable levitation of the toy vehicle: in point of fact, this prevents the vehicle from accidentally coming off the track (by virtue of shape interference).

[0067] A more important difference is found in the propulsion system: in fact, disc 31 and electric motor 30 of the previous example are replaced with electronically controlled solenoids (or coils) 31'.

[0068] More in particular, as shown in Figs. 14 and 15, in the front portion of the vehicle there are two triplets of solenoids 31' facing respective opposite sides of track core 11'.

[0069] Power is supplied to these solenoids in a sequential manner (under electronic control), de facto obtaining a linear three-phase electric motor; advantageously, the electronic control of the solenoid power supply is provided by unit 41' installed on board of the vehicle itself, which in this case will be equipped with adequate electronic means (processor, etc.) for controlling the power supplied to solenoids 31' as explained above.

[0070] It is apparent that this embodiment turns out to be particularly advantageous when the track has a "T" shape, in that core 11' can accommodate permanent magnets $13'_1, 13'_2, 13'_3 \dots 13'_n$ that interact with solenoids 31'; in particular, permanent magnets $13'_1, 13'_2, 13'_3 \dots 13'_n$ have alternate North - South polarity oriented transversally to core 11' in which they are housed (cfr. Fig. 14).

[0071] In other words, each magnet $13'_1, 13'_2, 13'_3 \dots 13'_n$ is reversed relative to the adjacent one along the track; it can be easily understood that in this solution solenoids 31' replace disc 31 of the previous example, thus making the toy quieter.

[0072] Another feature that differentiates this variant from the previous example, which is clearly visible in Fig.

14, is the absence of any transversal stabilizer wheels.

[0073] In fact, besides for vehicle propulsion, solenoids 31' may also be utilized for limiting the centrifugal thrusts acting upon the vehicle when going through a bend; in this case, in order to attain a better vehicle balance it may be appropriate to arrange two triplets of solenoids 31' in the rear region of vehicle 2' in addition to those arranged up front.

[0074] When the vehicle is moving in a straight line, the opposite pairs of solenoids 31' on both sides of central core 11' of track sections 1A' are supplied with the same current, so that they exert symmetrical forces due to the magnetic fields generated transversally to the track.

[0075] When the vehicle is going through a bend, on the other hand, centrifugal forces tend to move it transversally to itself; therefore, by supplying more current to the solenoids arranged on one side of the vehicle than to those on the opposite side it is possible to compensate for centrifugal forces through a different force generated by the magnetic fields associated with the different currents.

[0076] Of course, in this case the control unit will be provided with suitable means for supplying differential currents to the various solenoids; this applies to both those arranged in the front region and those arranged in the rear region of vehicle 2'.

[0077] If the toy vehicle is a toy train, this solution will preferably be applied to the tractor only; for the wagons it is conceivable to use stabilizer wheels as in the previously described solution.

[0078] The other features of this variant (e.g. batteries, control system, radio control and the like) are analogous to those described above with reference to the first embodiment shown in Figs. 1 and 2.

[0079] In this frame, it must be pointed out that by following the teachings of the present invention it is also possible to create further variants of the toy vehicle taken into account so far.

[0080] According to one of these, which is shown in Fig. 17 (where structurally or functionally equivalent elements retain the same reference numerals as in the previous examples, with the addition of a "0"), the vehicle is kept in the magnetic levitation condition by using a single skid, instead of two as in the previous examples.

[0081] In this case levitation skid 240, which is structurally identical to the skid 24 already described, i.e. comprising a permanent magnet flanked by Halbach arrays, is installed centrally on the vehicle and faces single levitation strip 140 of the track.

[0082] According to this variant, the propulsion system may be modified as necessary for preventing it from interfering with the levitation skid: it may therefore comprise two drive discs 310 (similar to disc 31) facing two propulsion strips 130 (similar to strip 13). Furthermore, even if propulsion is obtained through a solenoid system like the one described herein with reference to Figs. 13-15, it is also conceivable to provide a single central skid 240' (similar to skid 24) facing a corresponding levitation strip

140' (similar to strip 14), as shown in Fig. 18; in this case a solenoid-based propulsion system 310 like those discussed above can be employed, since it will not interfere with single skid 240' of the vehicle.

[0083] Further possible variants of the invention are shown schematically in Figs. 19, 20 and 21, which illustrate respective bottom views of different toy vehicles; in the first of these figures (Fig. 19), vehicle 200" has two levitation skids 240" at the front and at the rear (similar to skid 24) extending transversally to the vehicle itself.

[0084] In Fig. 20, vehicle 200'" has three skids 240'" (similar to skid 24), whereas in Fig. 21 vehicle 200'v has four skids 240'v (also similar to skid 24).

[0085] In all cases, the track associated with different vehicle types 200", 200'" or 200'v will be prearranged with corresponding levitation strips, positioned appropriately and made like strip 14 previously described.

[0086] As far as levitation strips are concerned, it is however conceivable, as an alternative to the solution taken into consideration so far, to arrange a plurality of permanent magnets 150" next to one another at a certain distance, as shown in Fig. 22, to form a strip 140"; magnets 150" are aligned together at a certain distance from one another and are arranged in a manner such that all of them face the vehicle with the same polarity (e.g. North, as shown).

[0087] Finally, a particularly simplified embodiment of the toy may have no propulsion system at all, in which case the user may simply push the levitated vehicle manually along the track. Of course, it is clear that a different number of skids or a different arrangement of the corresponding levitation strips on the track, as well as different embodiments of the levitation strips themselves, will still fall within the scope of the present invention.

Claims

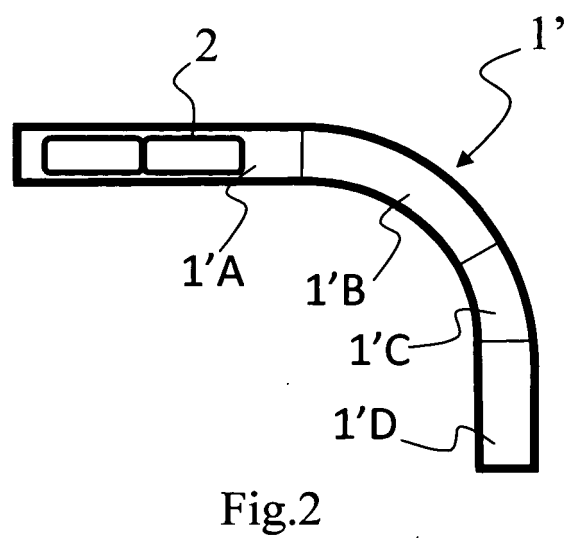
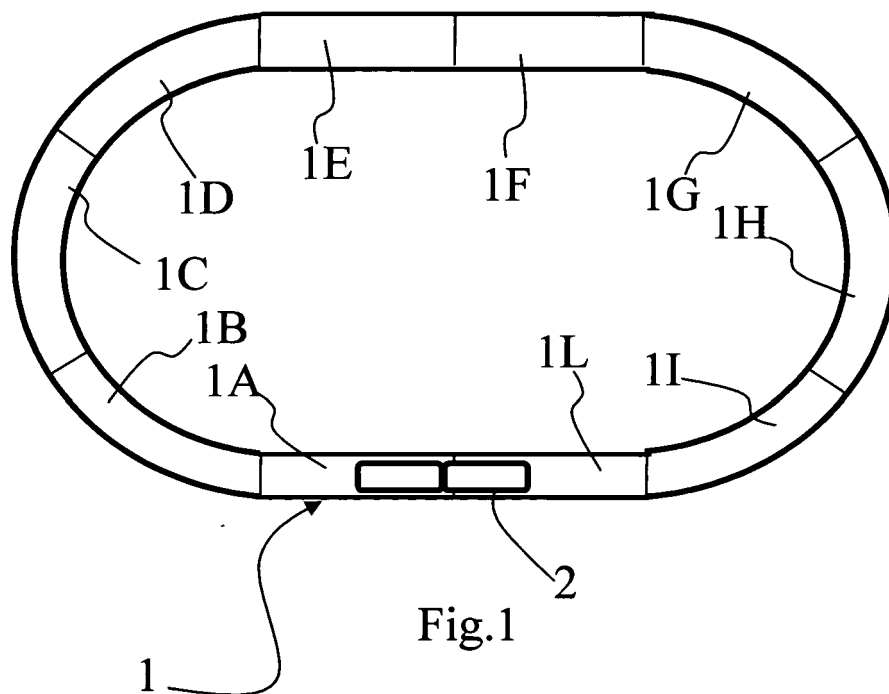
1. Toy comprising a track (1, 1') along which there is at least one magnetic levitation trace (14, 15; 14', 15'; 140; 140'; 140"; 140'") and a vehicle (2, 2', 20) adapted to move over it in a magnetic levitation condition, **characterized in that** the vehicle (1) comprises at least one skid (24, 25; 24', 25'; 240; 240'; 240"; 240'"; 240'v) cooperating with the magnetic trace (14, 15, 14', 15', 140, 140', 140"; 140'") for producing levitation, which includes a permanent magnet (24A, 25A) associated with at least one Halbach array (24B, 24C, 25B, 25C).
2. Toy according to claim 1, wherein the permanent magnet (24A, 25A) of said at least one levitation skid (24, 25; 24', 25'; 240; 240'; 240"; 240'"; 240'v) is interposed between Halbach arrays (24B, 24C, 25B, 25C) adjacent thereto.
3. Toy according to claim 1 or 2, wherein the magnetic trace comprises at least one permanent magnetic

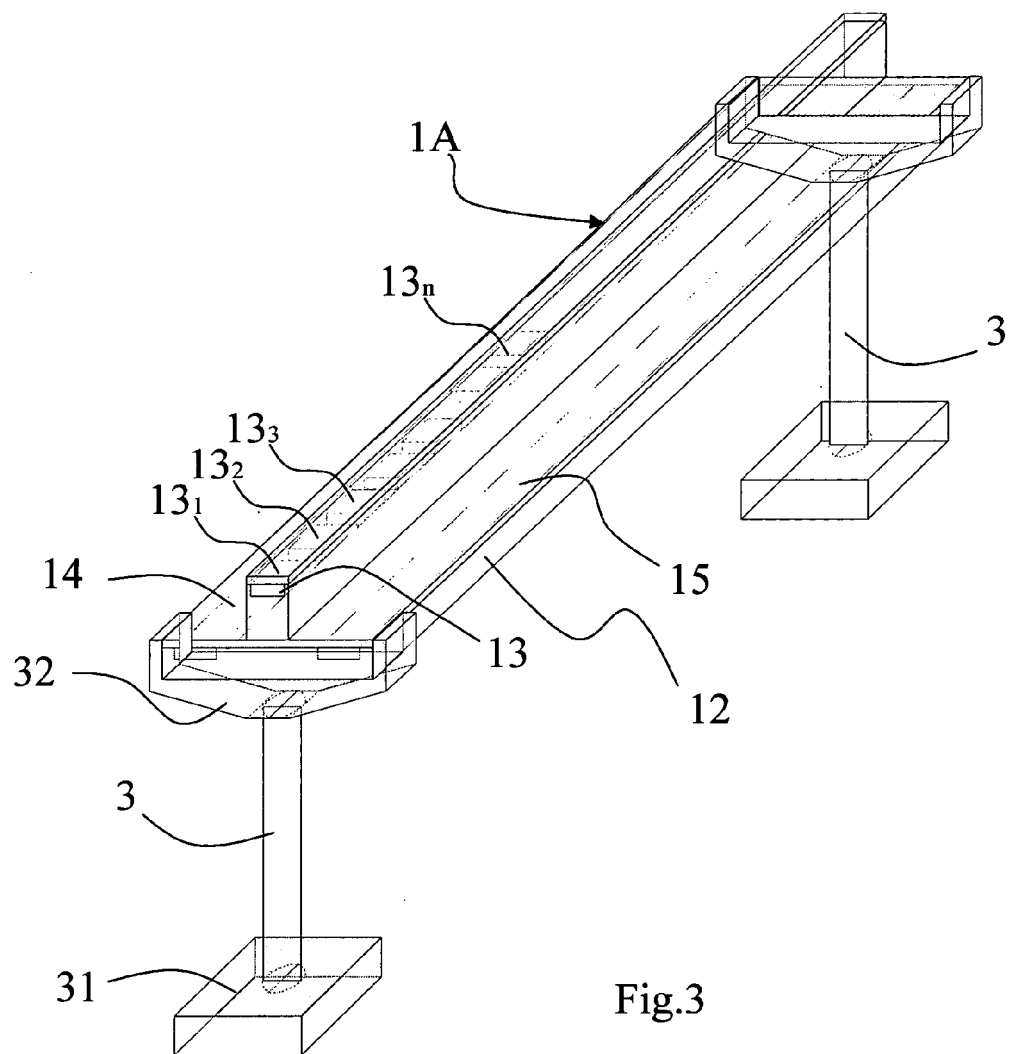
strip (14, 15; 14', 15') having a polarity (N, S) oriented substantially perpendicularly to said at least one skid (24, 25; 24', 25'; 240; 240'; 240"; 240"; 240'v) for causing the vehicle (2, 20, 2') to levitate.

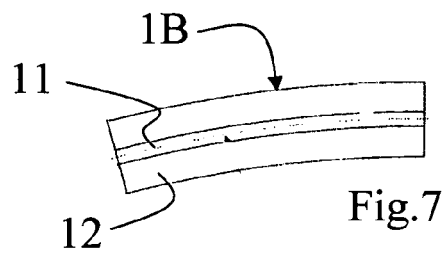
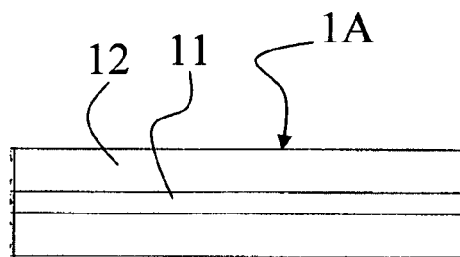
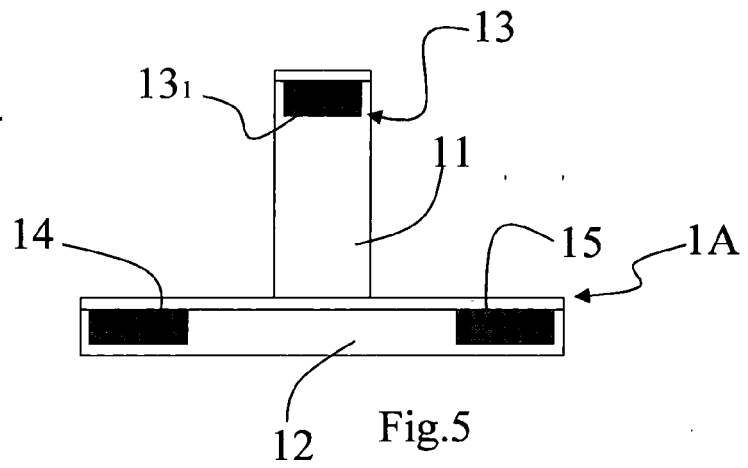
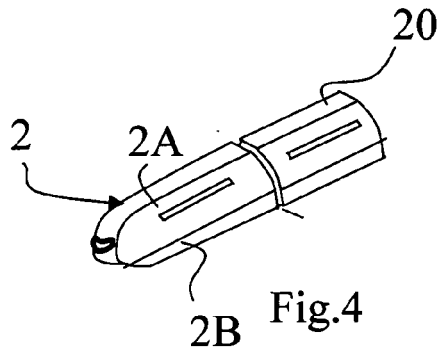
4. Toy according to claim 1 or 2, wherein the magnetic trace (140") comprises a plurality of permanent magnetic elements (150") aligned together and having a polarity (N, S) oriented substantially perpendicularly to said at least one skid (24, 25; 24', 25'; 240; 240'; 240"; 240"; 240'v) for causing the vehicle (2, 20, 2') to levitate.
5. Toy according to any of the preceding claims, wherein the track (1, 1') comprises a plurality of sections (1A-1L; 1A'-1L') which can be connected together in order to obtain a substantially continuous extension of the magnetic levitation trace (14, 15; 14', 15'; 140; 140'; 140"); 140").
6. Toy according to any of the preceding claims, wherein the track (1, 1') comprises a magnetic trace (13; 13'; 130) for propelling the vehicle (2, 20) which extends in a substantially central position relative to the track.
7. Toy according to claim 6, wherein the magnetic propulsion trace (13; 13'; 130) comprises a plurality of permanent magnets (13₁, 13₂, 13₃ ... 13_n; 13'₁, 13'₂, 13'₃ ... 13'_n) aligned together and having inverted polarities with respect to one another and oriented transversally to the track (1, 1').
8. Toy according to any of the preceding claims, wherein the track (1; 1') substantially has a "T" cross-section comprising a vertical core (11; 11') and a horizontal portion (12; 12').
9. Toy according to claim 8, wherein said at least one magnetic levitation trace (14, 15; 14', 15'; 140; 140'; 140") is arranged on the horizontal portion (12; 12'), whereas the magnetic propulsion trace (13, 13') is arranged on the vertical core (11; 11').
10. Toy according to any of claims 6 to 9, wherein the vehicle (2, 20) comprises a disc (31) driven by a motor (30), on which magnets (34) are peripherally arranged which cooperate with the magnetic propulsion trace (13, 13') for propelling the vehicle (2, 2').
11. Toy according to claim 10, wherein the vehicle (2, 20) comprises wheels (21, 22; 21A, 22A) arranged opposite to each other on both sides of the core (11, 11') of the track for stabilizing the vehicle transversally.
12. Toy according to any of claims 6 to 9, wherein the vehicle (2, 20) comprises pairs of solenoids (31, 310)

arranged on opposite sides with respect to the magnetic propulsion trace (13, 13') and cooperating therewith for propelling the vehicle (2, 20).

- 5 13. Toy according to claim 12, wherein the vehicle (2, 20) comprises solenoids (31, 310) in both its front and rear regions.
- 10 14. Toy according to claim 12 or 13, wherein, when the vehicle (2, 20) is equipped with solenoids (31, 310), the core (11, 11') of the "T" cross-section of the track points downwards and the lower portion of the vehicle (2, 20) substantially circumscribes the upper portion (12') of the "T" cross-section.
- 15 15. Toy according to any of the preceding claims, wherein the track structure is made of plastic material, and the propulsion trace (13, 13') and levitation traces (14, 15, 14', 15') are incorporated into the plastic structure of the track.
- 20 16. Track for a toy according to any of the preceding claims, comprising a plurality of sections (1A-1L; 1A'-1L') having substantially a "T" cross-section which can be connected together, with which magnetic traces (13, 14, 15; 13', 14', 15'; 130, 140; 140'; 140";) are associated for levitating and propelling a vehicle.
- 25 17. Track according to claim 16, wherein the magnetic traces (13, 14, 15; 13', 14', 15'; 130, 140; 140'; 140";) comprise magnetic strips extending along the sections (1A-1L; 1A'-1L').
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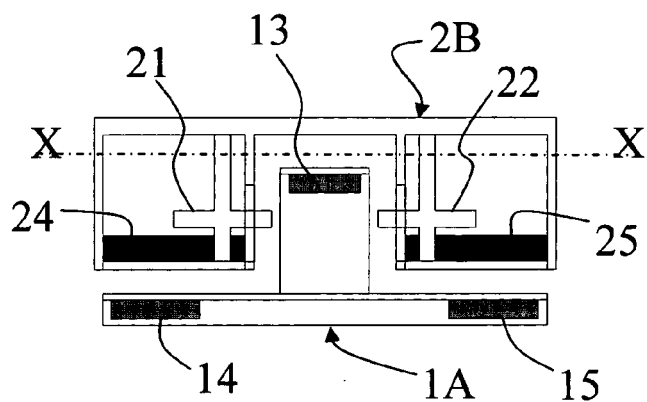


Fig. 8

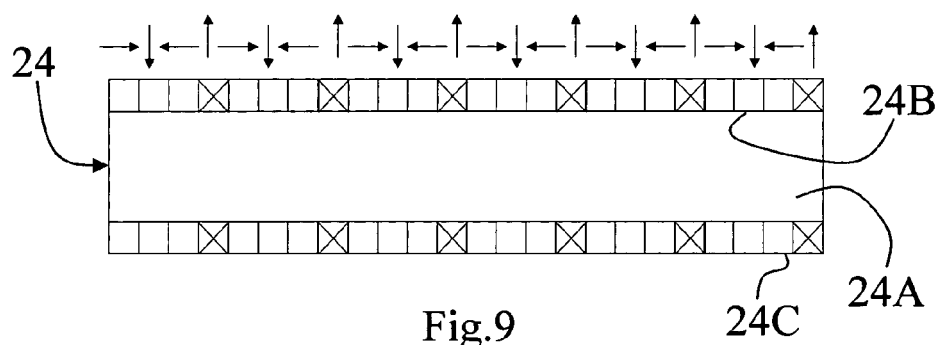


Fig. 9

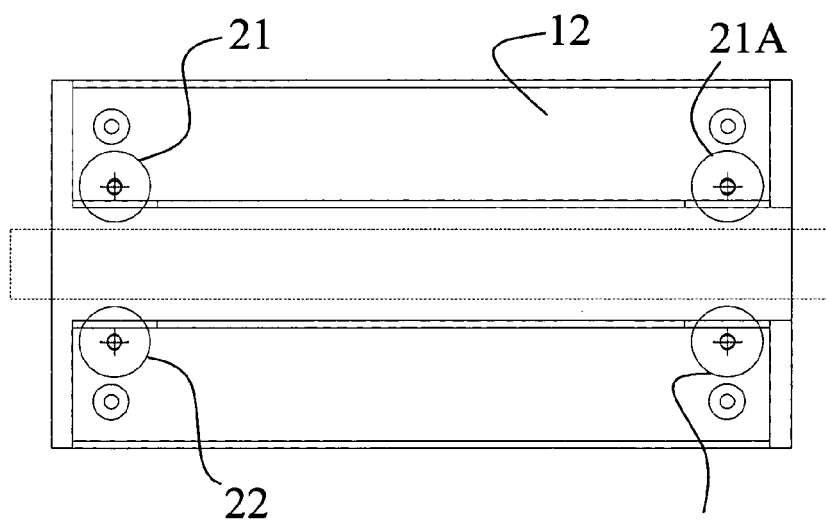
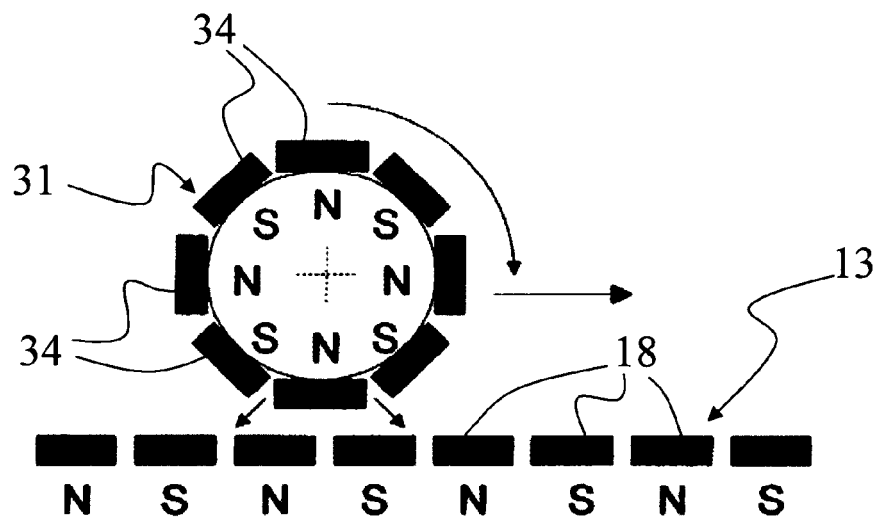
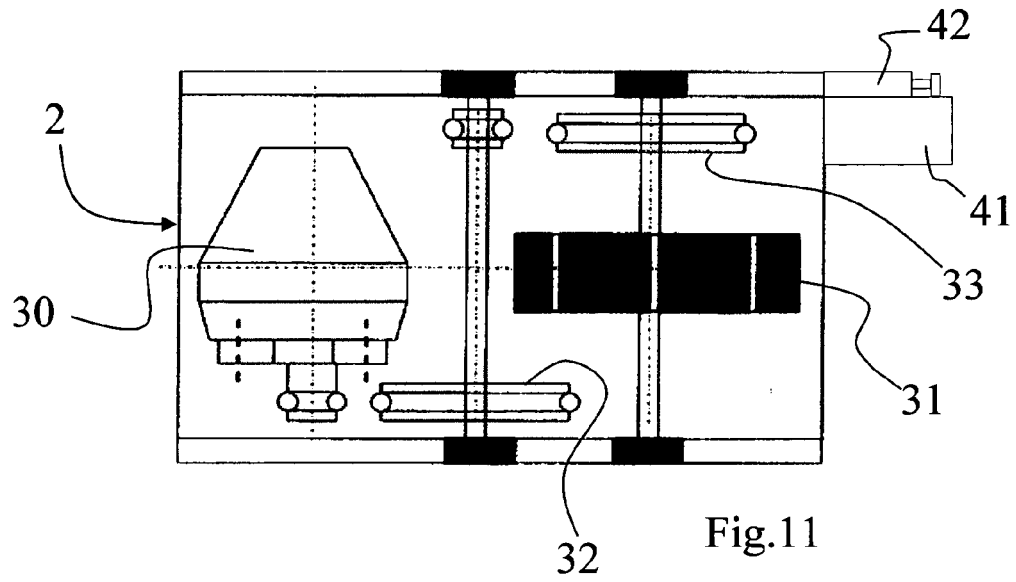


Fig. 10



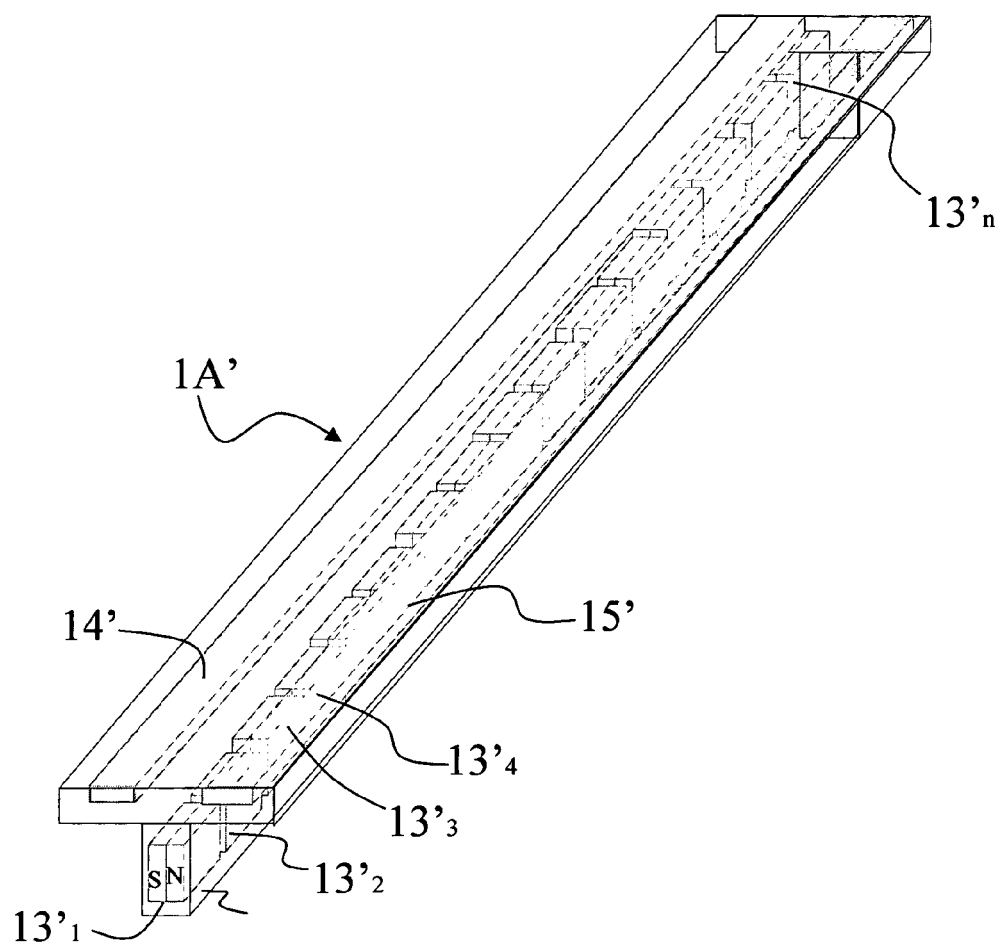
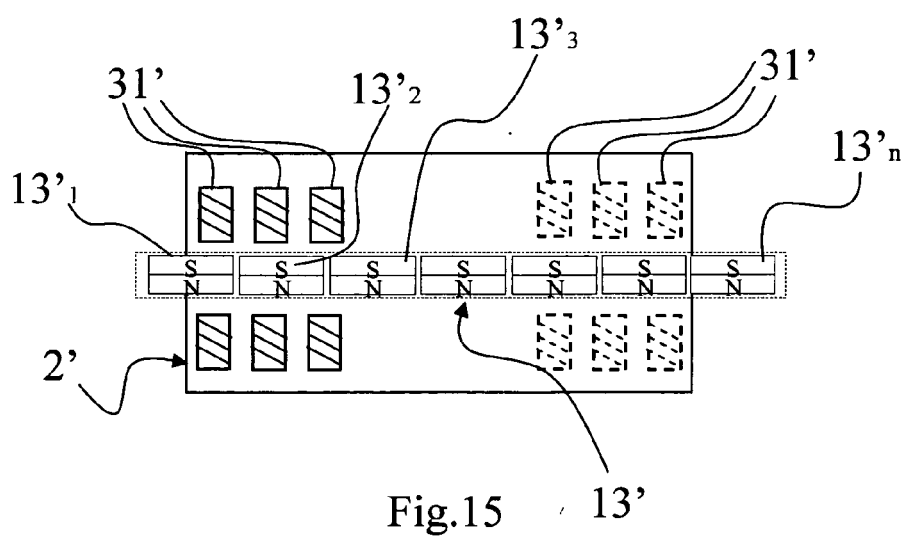
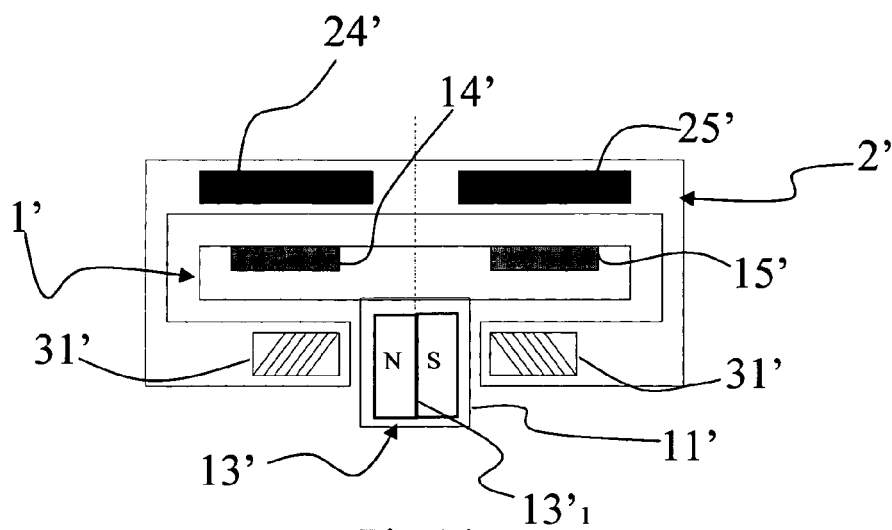


Fig.13



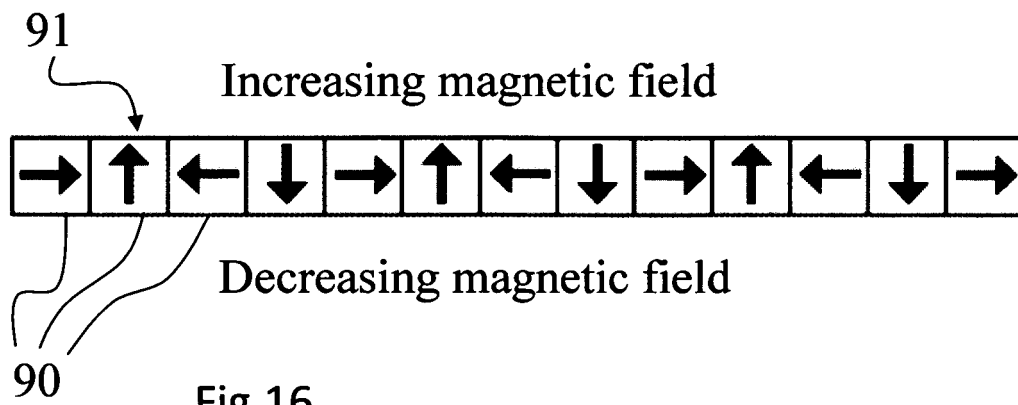


Fig.16

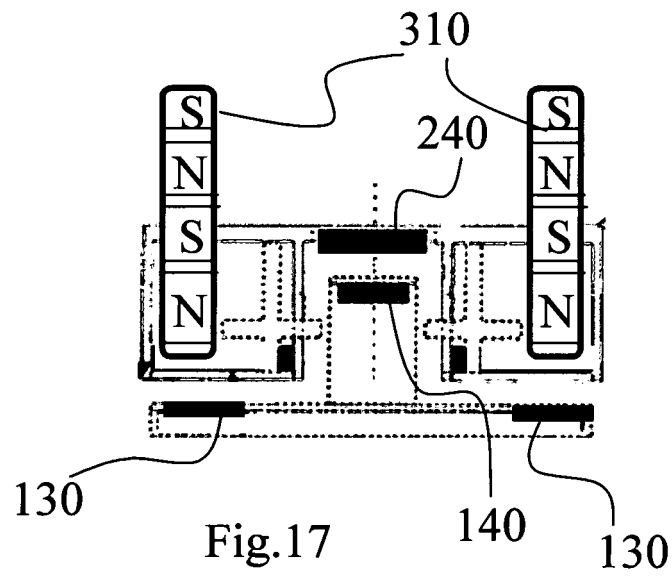


Fig.17

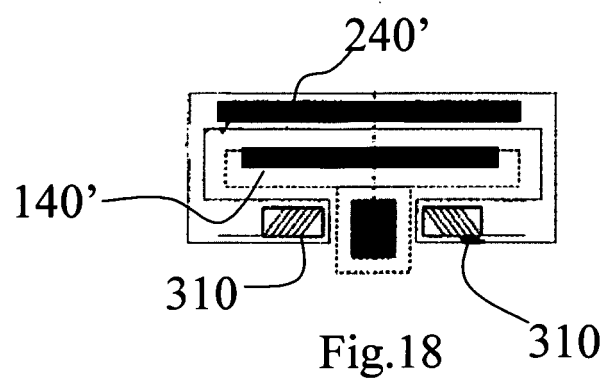


Fig.18

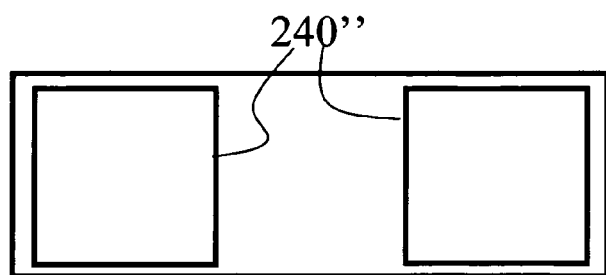


Fig.19

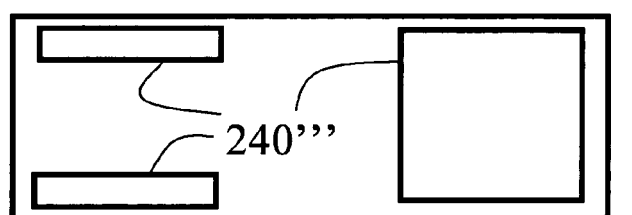


Fig.20

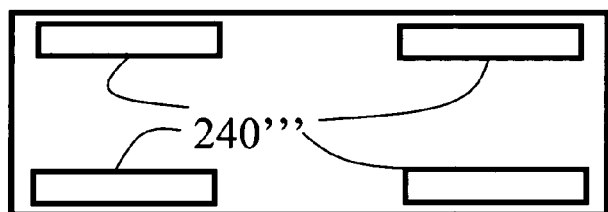


Fig.21

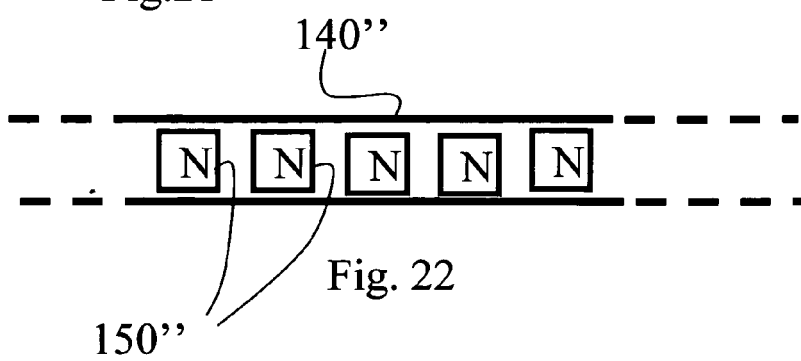


Fig. 22



EUROPEAN SEARCH REPORT

Application Number
EP 09 42 5208

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	WO 2007/032693 A (MAGLEVVISION CORP [PH]; GUARDO JOSE L JR [PH]) 22 March 2007 (2007-03-22) * the whole document *	1-15	INV. A63H21/04 A63H33/26 A63H18/10
A,D	WO 2005/102487 A (YUN BONG-SEOK [KR]) 3 November 2005 (2005-11-03) * the whole document *	1-15	
A,D	WO 2005/118101 A (YUN BONG-SEOK [KR]) 15 December 2005 (2005-12-15) * the whole document *	1-15	
X	GB 1 401 927 A (FISCHER ARTUR) 6 August 1975 (1975-08-06)	16	
Y	* page 1, line 32 - line 46 * * page 2, line 47 - line 75 * * figures *	17	
Y	FR 2 099 007 A5 (ALBA HENRI) 10 March 1972 (1972-03-10) * the whole document *	17	
			TECHNICAL FIELDS SEARCHED (IPC)
			A63H
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 19 January 2010	Examiner Turmo, Robert
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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EPO FORM 1503 03.82 (P04C01)



Application Number

EP 09 42 5208

CLAIMS INCURRING FEES

The present European patent application comprised at the time of filing claims for which payment was due.

☐ Only part of the claims have been paid within the prescribed time limit. The present European search report has been drawn up for those claims for which no payment was due and for those claims for which claims fees have been paid, namely claim(s):

☐ No claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for those claims for which no payment was due.

LACK OF UNITY OF INVENTION

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

see sheet B

☒ All further search fees have been paid within the fixed time limit. The present European search report has been drawn up for all claims.

☐ As all searchable claims could be searched without effort justifying an additional fee, the Search Division did not invite payment of any additional fee.

☐ Only part of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the inventions in respect of which search fees have been paid, namely claims:

☐ None of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims, namely claims:

☐ The present supplementary European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims (Rule 164 (1) EPC).



**LACK OF UNITY OF INVENTION
SHEET B**

Application Number

EP 09 42 5208

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

1. claims: 1-15

Toy comprising a vehicle cooperating with the magnetic levitation track for producing levitation, which includes a permanent magnet associated with at least one Halbach array.

2. claims: 16-17

Track comprising a plurality of sections having substantially a "T" cross-section which can be connected together.

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 09 42 5208

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

19-01-2010

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- WO 2005118101 A [0011]
- WO 2005102487 A [0013]