(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
2 March 2006 (02.03.2006)

PCT

(10) International Publication Number
WO 2006/021572 A1

(51) International Patent Classification:
A63G 29/00 (2006.01)

(21) International Application Number:
PCT/EP2005/054170

(22) International Filing Date: 24 August 2005 (24.08.2005)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
2004/0410 24 August 2004 (24.08.2004) BE

(71) Applicant *(for all designated States except US)*: **LE BATELEUR S.A.** [BE/BE]; Avenue Beau-Séjour 57, B-1180 BRUSSELS (BE).

(72) Inventor; and

(75) Inventor/Applicant *(for US only)*: **HUMBEL, LUC** [BE/BE]; Avenue Beau-Séjour 57, B-1180 BRUSSELS (BE).

(74) Agents: **QUINTELIER, Claude** et al.; Gevers & Vander Haeghen, Holidaystraat 5, B-1831 Diegem (BE).

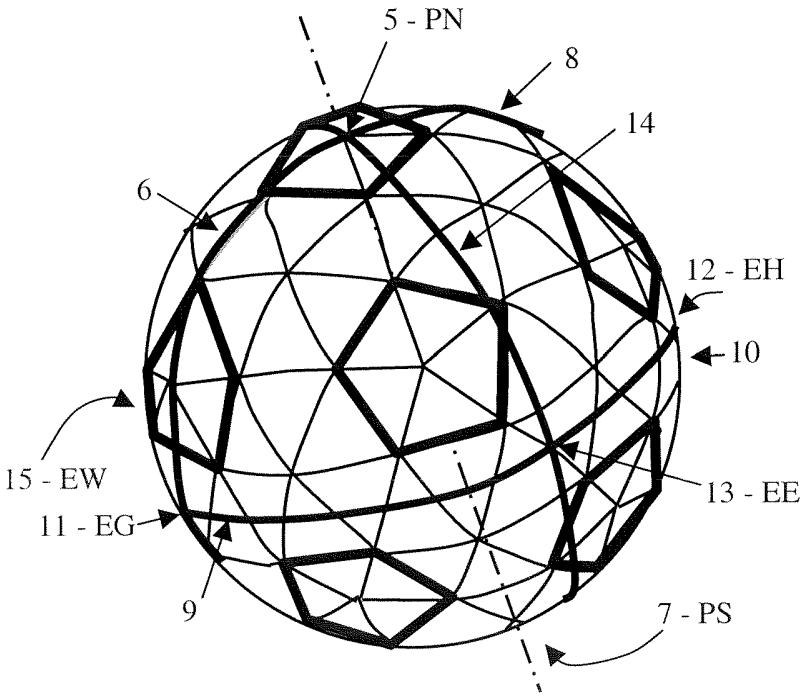
(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SM, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report*
— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: DEVICE FOR TRANSPORTING PERSONS



(57) Abstract: Device for transporting persons, in particular for the purpose of entertaining them, said device being in the form of a spherical vehicle and comprising at least one seat disposed inside the vehicle, said device being intended to travel on a track, said vehicle being formed by a sphere that comprises a spherical envelope of geodesic structure formed by a assembly of rigid spherical polygonal shapes connected together, said spherical envelope being provided with an access for said persons, said access being integrated in an external wall of said spherical envelope.

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DEVICE FOR TRANSPORTING PERSONS

The present invention concerns a device for transporting persons, in particular for the purpose of entertaining them, said device being formed by a spherical vehicle and comprising at least one seat disposed inside the vehicle, said device being intended to travel over a track.

Such a device is known from patent application DE 36 24 591 and can be used in an amusement park.

One drawback of the known device is that it is not truly spherical and that it is generally complex to manufacture if the safety of the persons sitting in it is to be met. This is because its structure requires a complex assembly of beams that must be connected together by means of nodes. This assembly would become even more complex if it was necessary to come close to sphericity.

The object of the invention is to realise a device for transporting persons that is less complex to manufacture whilst guaranteeing safety of the persons and coming closer to sphericity.

To this end a device according to the invention is characterised in that the said vehicle is formed by a sphere that comprises a spherical envelope of geodesic structure formed by an assembly of rigid spherical polygonal shapes connected together, the said spherical envelope being provided with an access for said persons, said access being integrated in an external wall of the spherical envelope. Using an assembly of rigid spherical polygonal shapes connected together make it possible to have to assemble fewer parts whilst offering better sphericity to the vehicle and not sacrificing the rigidity thereof.

Other preferential embodiments are set out in the dependent claims.

The invention will be described in more detail with reference to the drawings, which illustrate preferential embodiments of a device according to the invention. In the drawings the following figures illustrate respectively:

Fig 1: an icosahedron respectively in perspective and as an exploded view;

Fig 2: division of a triangle at frequencies respectively 1, 2, 3, 4, 5 and 6;

Fig 3: Soccer ball or frequency three geodesic sphere;

Fig 4: noteworthy circles of the spherical envelope;

Fig 5: noteworthy circles and points in a frequency three geodesic sphere;

Fig 6: opening of the sphere into three sub-assemblies;

Fig 7: “boiled egg” sphere with integrated opening mechanism;

Fig 8: pentagonal and hexagonal elements of the frequency six sphere;

Fig 9: spherical pentagonal element of frequency six;

Fig 10: spherical hexagonal element of frequency six;

Fig 11: spherical trapezium junction element of frequency six;

Fig 12: spherical equatorial trapezium element of frequency six;

Fig 13: structure of the equatorial ring with equatorial trapezia and junction pieces;

Fig 14: detail of a cable with junction pieces;

Fig 15: exploded view of the spherical envelope;

Fig 16: passage of the cables for a frequency six sphere;

Fig 17: cross section at the junction between pentagonal and hexagonal shape in the case of a single material;

Fig 18: cross section at the junction between two hexagonal shapes – case of a single material;

Fig 19: cross section of a diagonal beam of elementary shape – single material;

Fig 20: cross section of a cross piece, respectively with and without cable – single material;

Fig 21: cross section of a beam with metal skeleton and covering material;

Fig 22: cross section at the junction between pentagonal and hexagonal shape – case of two materials;

Fig 23: junction between two hexagonal shapes;

Fig 24: cross sections at the junction between two hexagonal shapes – case of two materials;

Fig 25: cross section of a cross piece, respectively with and without cable passage – case of two materials;

Fig 26: assembly of the elements of the spherical envelope;

Fig 27: environment of a cable junction element;

Fig 28: junction piece with integrated tension eccentric mechanism;

Fig 29: functioning of the eccentric mechanism of the junction piece;

Fig 30: equator cable tension eccentric on admission shaft of the junction piece in the respectively slack and tensioned positions;

Fig 31: junction piece with two movable plates and integral passive-safety cable tensioner;

Fig 32: mechanism of the passive-safety junction piece and two movable plates;

Fig 33: functioning of the cable junction piece lock without integral tensioner;

Fig 34: double tensioning hexagon;

Fig 35: single tensioning hexagon;

Fig 36: triple tensioning hexagon;

Fig 37: cable fixing ring;

Fig 38: noteworthy passenger axes;

Fig 39: structure of six seats with its transverse shaft Y;

Fig 40: six passengers arranged in articulated seats – seen from above;

Fig 41: structure of two carriages with rollers and seat shaft;

Fig 42: details of carriages and rollers in fig 41;

Fig 43: sphere with front opening: front view;

Fig 44: skeleton of equator ring;

Fig 45: curved-beam articulation: general view (to the right) and detail in line with a pair of rollers (to the left);

Fig 46: conventional articulation of a cardan drive with three-axis frames – general view and detail in transverse section;

Fig 47: articulation with two axes and bearings – general view and detail in transverse section;

Fig 48: articulation with inner bearing, intermediate axis and outer bearing – general view and detail in transverse section;

Fig 49: bearing–axis-bearing articulation – variant – general view and detail in transverse section;

Fig 50: front bearing-vertical axis-bearing articulation – general view;

Fig 51: front bearing-vertical axis-bearing articulation – detail of the mechanism at the top of the central seat;

Fig 52: hinges of the sphere with articulated seats, in the respectively closed and open positions;

Fig 53: the “boiled egg” sphere with six passengers arranged in articulated seats;

Fig 54: structure of the seats for the option with opening with a top hemisphere (boiled egg);

Fig 55: confinement enclosure respectively with sphere closed and sphere open (boiled egg);

Fig 56: confinement enclosure in the secure closed position (boiled egg);

Fig 57: confinement enclosure in the open position at the boarding platform (boiled egg);

Fig 58: confinement enclosure, respectively sphere closed and sphere open (front opening);

Fig 59: sphere with fixed seats – ten passengers arranged in opposite orientations;

Fig 60: fixed seats – fixing of seats;

Fig 61: sphere with fixed seats – external view of passengers;

Fig 62: protective wire-netting on hexagonal element;

Fig 63: integrated opening mechanism for sphere with fixed seats; and

Fig 64: hinge mechanism, respectively closed, semi-open and open, for the sphere with fixed seats;

In the drawings, a same reference sign has been allotted to a same or analogous element.

Geodesic spheres are a family of polyhedrons best approaching the sphere, constructed on the basis of an icosahedron. The latter is a polyhedron consisting of 20 equilateral triangles, which will be referred to as a geodesic sphere of frequency one. It is shown in fig 1, respectively in perspective and exploded view.

The other geodesic spheres will be obtained by sub-dividing the elementary triangles of the icosahedron into equilateral triangles of smaller size, in a square progression, by projecting their points of intersection (nodes) onto the surface of the sphere. The progression of this division is what is referred to as the frequency of the geodesic

sphere. Fig 2 shows this division in frequencies respectively 1, 2, 3, 4, 5 and 6.

The more this division is refined, the more the frequency of the geodesic sphere increases. If this frequency tends towards infinity, this polyhedron approaches the perfect sphere. Because of its various facets, the polyhedron does not have a continuous surface and its travelling movement over a surface or rails will present slight impacts, which will be attenuated by increasing the frequency.

Although the present invention in general covers all geodesic shapes in all their frequencies in the context of the design of a rigid-envelope spherical vehicle, it concerns particularly, for its visual aspect, the frequency three geodesic sphere, namely the one that corresponds to a football (or soccer ball - fig 3), and the frequency six geodesic sphere with regard to its construction architecture. Large-diameter spheres may require a frequency nine structure or possibly twelve for their architecture, whilst preserving the visual appearance of the frequency three sphere.

More detailed information on geodesic spheres can be obtained by consulting in particular the site www.desertdomes.com (© Desertdome 2002).

The football (soccer ball) or more scientifically put the frequency three geodesic sphere (fig 3) consists of a set of one hundred and eighty elementary triangles, divided into twelve pentagonal shapes (normally coloured black on a soccer ball – 1) and twenty hexagonal shapes (normally coloured white on a soccer ball – 2) all inscribed on the surface of the sphere.

Observing this ball, it can also be noted that this form reveals six pairs of “parallel” circles 3, therefore describing six “rings” or “annuli” each inscribed symmetrically around a great circle 4 (which will be referred to hereinafter as the six noteworthy great circles), which delimit between them the pentagons (fig 4). These parallel circles will

always pass through the sides of the pentagonal shapes and will cut the hexagonal shapes in two along their diagonals.

By convention, by associating the sphere with a map of the world in order to use the noteworthy reference elements (fig 5), the north pole 5 of the sphere (PN) will be defined as being situated at the centre of one of the pentagons. The Greenwich meridian 6, or 0^{o} meridian, passes through one of the vertices of this pentagon. The south pole 7 (PS) is also situated at the centre of a pentagon, and therefore one of the vertices will have the 180^{o} meridian (or "date line") 8 pass through it. With regard to fig 5, this occurs "at the rear" and is therefore not shown graphically.

The equator 9 of the sphere will correspond to one of the noteworthy great circles described above, whose plane is perpendicular to the axis of the poles through the centre of the sphere. The two "parallel circles" on each side of this great circle will delimit a ring which will be referred to as the "ring of the equator" 10, which will run along one of the sides of each of the pentagonal shapes, to the exclusion of the polar pentagons.

All the noteworthy great circles will intersect each other in pairs at two intersection points. The great circle of the equator for example will therefore have a total of ten points of intersection with the other five noteworthy great circles of the sphere, which will have its importance in the construction.

By convention, certain noteworthy points on the spherical envelope will be designated by two letters, namely (fig 5):

- § PN: north pole 5;
- § PS: south pole 6;
- § EG: point 11 situated at the intersection of the equator and the Greenwich meridian;

§ EH: point 12 situated on the equator opposite to the Greenwich meridian, where by convention the hinges of the sphere will be situated;

§ EE: point 13 situated on the equator at the east meridian 14 (90° from point EG);

§ EW: point 15 situated on the equator at the west meridian (–90° from point EG).

In order to facilitate access to the boarding platform for the passengers, the sphere will in principle not be constructed in a single piece but divided into the ring of the equator 10 on the one hand, and two hemispheres or shells on the other hand, which will be able to open on each side of it, referred to as the "northern hemisphere" 16 and the "southern hemisphere" 17 (fig 6).

By convention, the sphere will open along its Greenwich meridian, the hinges between elements being situated in line with the 180° meridian. For a sphere with fixed seats (described below) in the open position (fig 6), the Greenwich meridian will therefore be tear apart and will be situated "at the top". By analogy, during opening/ closing movements of the hemispheres, these will be placed at all times on a point which will travel over the "date line" meridian (180°). When the sphere is completely open in its three sub-assemblies, it will rest on its two poles.

In the embodiment of the sphere described above, the ring of the equator will remain in the vertical position between the north and south shells. In another embodiment of the sphere (referred to as the "boiled egg"), the southern hemisphere will be permanently fixed on the ring of the equator. Only the shell constituting the northern hemisphere will be movable (fig 7).

Two major options exist for implementing the opening and closing mechanisms of the sphere. On the one hand, a mechanism external to the sphere, the preferred solution for the sphere with fixed

seats (described below), a mechanism using external jaws slaved to hydraulic actuators. On the other hand, a mechanism integrated in the sphere, which has great advantages for the sphere with articulated seats also described below. It is based on the use of two rams 18 situated on each side of the rails of the ring of the equator. One of the ends will be fixed to the ring of the equator, the other to the hemisphere serving as a movable cap (fig 7).

The spherical envelope will be constructed at the start from the spherical elementary shapes, pentagonal 1, hexagonal 2 (fig 8) and at certain points trapezoidal (semi-hexagonal), thus able to visually reproduce the frequency three geodesic sphere (football or soccer ball).

As illustrated in fig. 8, these shapes will be formed from beams 19 delimiting the contour of these elementary shapes and other beams 20 constituting their diagonals. With regard to the pentagonal and hexagonal shapes, these diagonals will intersect each other at their centre. The triangular windows thus delimited will also preferably be reduced by adding “cross pieces” 21 to them, namely three internal beams disposed in a triangle. All these beams can be straight, but will preferably have a curved shape (arcs of a circle) so that their external surface best matches the spherical shape. Each node 22, namely each point of intersection between beams, will be taken back to the surface of the sphere. The structure constructed will thus be that of a frequency six geodesic sphere.

The sphere will be formed from the following basic elements:

a) for each of the two hemispheres:

§ Six pentagonal shapes 1 (fig 9), including five ring shapes and one pole, the latter being able to be identical or different from the other five. They will all be centred with spherical edges and diagonals, with cross pieces in the windows, that is to say, per pentagon, a total of thirty five arcs between the successive nodes.

§ Five centred hexagonal shapes 2 (fig 10) with spherical edges and diagonals, with cross pieces in the windows, that is to say, per hexagon, a total of fourthy two arcs between the successive nodes. Each hexagonal shape can have three tension cables 23 pass through it (see below).

§ Five trapezoidal shapes (semi-hexagons) referred to as "junction trapezia" 24 (fig 11) with spherical edges and diagonals, with cross pieces in the windows, that is to say, per trapezium, a theoretical total of 23 arcs between the successive nodes. They will serve as a junction between the hemisphere to which they belong, and the ring of the equator. They can have two tension cables 23 pass through them and in this case contain two sheaths 25 for receiving within them special junction equipment (a ring) for connecting and disconnecting these cables within them.

b) For the ring of the equator:

§ Ten trapezoidal shapes (semi-hexagons) referred to as the "equator trapezia" 26 (fig 12) with spherical edges and diagonals, consisting of twenty three spherical arcs between successive nodes described in detail below. They will be able to have a tension cable 27 pass through them, which in this case will be referred to as the equator cable.

§ Ten junction pieces 28 (fig 13) for connecting the hemispheres to the ring of the equator. They are also described below.

According to the option chosen with regard to the seats (described below), all the pentagonal elements or some of them (the pentagons of the poles), will be equipped with a coupling mechanism for releasing the element in question from the spherical envelope without rupture of the cables, and thus serving as an emergency door (manhole) for the passengers in the event of any serious problem on the ride.

The edge of the pentagonal, hexagonal and trapezoidal elements will have a cross section such that they will be able to fit in one another (figs 17 and 22). These elements will be fixed to one another.

The edge of the hexagons in contact with another hexagon will be straight and the assembly between them will be of the male/female type (figs 18 and 24).

The rigidity of the spheres and their "sphericity" can be improved by six tension cables 23 and 27 preferably made from steel (or stainless steel) with a diameter of approximately 4 to 5 mm, and extending on the outside of the spherical envelope of the geodesic structure, over its six noteworthy great circles. Put under tension, they will transmit this tension to the materials of the spherical envelope. Through this structure, each hexagonal element of the sphere will have three cables pass through it (shown as axis lines in figs 8, 10 and 15). They will be superimposed on certain beams of the aforementioned cross members. The cables will be parallel to the sides of the pentagons, without passing through them.

These cables will be housed in grooves or sheaths provided in the thickness of the beams concerned, so that they do not project beyond the spherical surface in order not to reduce the running of the sphere on a track, and to protect them against any wear during this movement (figs 16, 18, 24 and 25).

The cables can be surrounded by a protective sheath so as to prevent the slight tension and release movements wearing the grooves or sheaths where they are positioned.

The diameter of these grooves or sheaths will be provided at corresponding size of the cables and their protective sheath so that the latter match their housing whilst being almost jammed therein and thus participate in the rigidity of the beam concerned, without their tensioning causing any sagging of the beams concerned (fig 18, 20, 24 and 25). Passing one over the other at each junction between two hexagons or

between a hexagon and a junction trapezium, these cables will thus be literally woven together on the surface of the sphere. The depths of the grooves or the sheaths will be variable, having regard to the fact that the cables must along their travel keep a certain distance from the external surface in line with the crossings (figs 10, 11 and 16). The depth of the grooves will be such that, once the cables are in place, a slight free space will remain between the edge of the cable and the external surface, corresponding to a thickness of the material of the envelope considered to be a wearing layer.

The junction between the shells and the ring of the equator assumes a junction of the tension cables, which will always take place between the junction trapezia and the ring of the equator, which will be designed accordingly.

The ring of the equator will consist of two types of element: ten equator trapezia 26 and ten junction pieces 28 with their mechanism. Various configurations of the equator ring have been studied, in particular:

§ equator trapezia through which two junction pieces pass with connection of the cables at three points;

§ equator trapezia through which there passes a junction and connection piece for the cables at two points;

§ inert equator trapezia (without integrated junction elements), separated from each other by the junction pieces with also connection of the cables at two points (fig 13).

Each tension cable 23 (except for the equator cable 27) comprises two sections of cables 30, each section running through a north or south hemisphere. The two ends of each section will terminate in a junction ring 29. These junction rings will fit in the junction pieces 28, on each occasion separating the two sections of cable, which is shown in fig 14.

Fig 15 shows an exploded view of the spherical envelope with its various elements. These have been drawn in the visual aspect of the frequency three sphere, without their internal cross pieces. Fig. 15 shows on the one hand the ring of the equator 10 with its ten equator trapezia 26 and its equator cable 27, and on the other hand the two north and south hemisphere with, per hemisphere: the polar pentagon, the other five pentagons, the five hexagons and the five junction trapezia.

The cables have also been shown symbolically by axis lines of different forms. The drawing pursues the objective of showing the passage of the various cables, and of course does not depict them in their actual length. It shows nevertheless how each of the five hemisphere cables passes at two points over the ring of the equator. It also shows how the hemisphere cables intersect each other at the junction of two hexagons, that is to say at the junction between a hexagon and a trapezium. It also shows how the equator cable passes over the other five cables in line with the ten cable junction pieces.

It is only to facilitate the reading of the drawing and to reproduce the visual appearance of the football (soccer ball) that the lines of the twelve pentagons have been reinforced in the diagram.

The frameworks of the spherical envelope will have to withstand a high compression and crushing force. Their cross section will be optimised in order to offer the best resistance for the lowest cross section, in order to avoid making it heavier in an unconsidered fashion.

The pentagonal, hexagonal and trapezoidal elements of the spherical envelope will be produced either at the start from a single material (such as for example polyamide, polyurethane or composite material type, etc – figs 17 to 20), or at the outset from two materials combining an internal metallic structure (for example: aluminium alloy) with a covering in its external part of a more flexible material such as polyurethane for example (figs 21 to 25).

These solutions will preferably have the following advantages:

§ the materials will be easy to mould and remove from the mould;

§ they may be fairly light, although their weight is not a determining factor;

§ they can be slightly flexible, and above all will not break;

§ they will dampen shocks, preventing excessively rapid degradation;

§ they will dampen noise;

§ they will resist the sun and rain;

§ they can be self-pigmented without this pigmentation affected their physical and chemical properties;

§ they will make it possible to produce moulded pieces of a size which may range up to more than 60 cm wide approximately for hexagonal, pentagonal and trapezoidal structures intended for spheres of large size;

§ manufacture will be easy to implement, allowing the production of small series (a few tens to a few hundreds of pieces).

These two major options in the choice of the materials will give rise to different structural choices. Although more complex to implement, the second solution has our preference.

In the case of a single material, it will be considered that the cross section of the beams forming the border of the pentagonal forms will have a recess, enabling the corresponding beam of the adjacent hexagonal shape to fit therein.

Fig 17 repeats the junction between a pentagonal shape on the one hand and a hexagonal shape or junction trapezium on the other hand. Two cross sections have been shown: the first at any point on the beams, the second in line with the fixing mechanisms for the elements

(bolts, etc). Note that the bottom part of the cross section contains as an option a lug for positioning the protective wire-netting 31, which can be used in the fixed-seats option as described below.

Fig 18 depicts the cross section of a junction between two hexagonal shapes, or between a hexagonal shape and a junction trapezium. These beams will in principle be adjacent. Note here also the optional positioning lug 31 for the protective wire-netting. Two embodiments are shown: the first at the point of a male/female connection 32, the second at the crossing point of the tension cables 23.

Fig 19 depicts the cross section of the diagonals of the pentagonal and hexagonal shapes. Fig 20 depicts the cross section of the window cross members, in two embodiments respectively with and without positioning groove for the tension cables 23. The cross section can be in a Y shape in order to offer the best rigidity with a saving in material.

In the case of a structure with two materials, which has our preference, the principle is to start from a metal structure 33 cast in an alloy (aluminium for example), constituting a T-shaped beam for example, which will be partially (or possibly totally) covered by moulding with a more flexible material 34 (polyurethane for example) as depicted in fig 21. This combination, which requires double moulding, offers the great advantage of a more rigid structure using a smaller quantity of material.

The dimensions of the beams will be similar to or possibly smaller than those of the single-material structure. The quantity of material and the total weight will in any event be lower.

With regard to the junction between a pentagonal and hexagonal shape, only the beam belonging to the pentagonal shape will be covered with polyurethane 34. The hexagonal beam, being situated within a spherical envelope, will be metal (fig 22).

Figures 23 and 24 depict the junction between two hexagonal shapes or between a hexagonal shape and a junction trapezium. Three sections are shown in these two figures: the first (AA') at the point of a male/female assembly 32, the second (BB') at the point of entry of the cables into the beams, the third (CC') at the intersection of the tension cables 23.

Figure 25 for its part depicts the cross section of the cross members, respectively with and without cable passage. Note the recess provided for the passage of the cables, within both the surface layer and the metal core.

Using beams with a metal skeleton also makes it possible to envisage another method of construction avoiding the use of tensioning cables on the spherical envelope whilst ensuring sufficient sphericity and rigidity for the whole. This will also make it possible to avoid the cable tensioning elements and will require another mechanism for closing and locking the sphere.

Whatever the choice of structure (with one or two materials), the elements will be connected together as shown in the diagram in figure 26. The elementary pentagons 1 will be fixed (for example bolted) to each of the conjoined hexagons 2. The head of the fastening will disappear inside the spherical surface in order not to be in contact with the running surface (fig 22). It will thus be possible to have ten fastenings per pentagon, except in line with the junctions between the movable elements, that is to say between each shell and the ring of the equator. These will be fixed to the corresponding drillings in the hexagonal elements and the junction trapezia.

In the embodiment with tensioning cables, the aforementioned six cables (23 and 27) surrounding the spherical envelope (fig 14) participate in the rigidity of the whole, the sphericity of the sphere and the safety of the passengers. To fulfil this remit, they are tensioned during the movement of the sphere. On the other hand, five of

them must be able to be disconnected on each side of the equator ring in order to provide the opening of the hemispheres. For this purpose, they are provided with fasteners enabling them to be locked, as well as a tensioning mechanism. These functions will be fulfilled by the cable junction piece 28 (fig 26 and 27).

This piece will exist in ten samples per sphere, five oriented to the left and five oriented to the right, constituting, with the equator trapezia 26, the structure of the equator ring 10 (figs 14, 15, 26 and 27). This piece is shown in a single orientation in the diagrams concerning it.

This equipment will have to be integrated within the equator annulus. It will be necessary for it to be as flat as possible, so as to be integrated in the thickness of this annulus, while leaving a thickness of covering of flexible material towards the external surface of the sphere, in order to dampen the noise during running. It can on the other hand slightly project beyond the inside of the annulus if necessary. It should be noticed that the thickness of covering will also have cut in it a transverse groove allowing passage of the cable of the equator 27. This cable will either be permanently tensioned by an adjustable system or tensioned by an appropriate mechanism connected to the mechanism for tensioning the hemisphere cables.

Each section of cable 30 (fig 14) (except for the equator cable) runs round one hemisphere and is connected to two junction pieces 28 at the equator ring, these same two pieces being connected to another cable section 30 running round the other hemisphere. This leaves two options on the way of tensioning the cables within the junction pieces:

§ either each cable is tensioned at both ends, and the cable tensioning function is fulfilled by two moving pieces within each of the junction pieces (the preferred solution);

§ or each cable is tensioned at only one of its ends, which makes it possible now to have only one moving piece within the junction pieces.

Various options exist with regard to the way of ensuring the safety of the tensioning:

§ An active-safety tensioning, the tension of the cables being provided directly by a mechanism (actuators for example).

§ A passive-safety tensioning, the tension in the cables being given by means of a spring, this being compressed by the ad hoc actuators when it is wished to release the cables for opening the sphere (fig 31).

§ An active-safety and locking tensioning: the tension will be transmitted to the cables by means of an ad hoc mechanism, these being actuated until the mechanism moves beyond a locking position (fig 28). The tension in the mechanism can then be released, the safety being provided by this locking.

In a first preferred embodiment (fig 28), meeting this last principle of active safety and locking, a cable junction piece 28 has attachment hooks 42 and an integral eccentric tensioning mechanism for fulfilling these two functions.

Figure 28 shows such a mechanism in a situation with cable locked and tensioned, which comprises the following elements:

§ a casing 35, for example made from sheet metal, having an external shape such that it fits in the adjacent “junction trapezium” elements 24 of the two hemispheres.

§ A shaft 36 with a cross section that is for example square at its centre, actuating an eccentric mechanism described below, and connected to a motor (pneumatic, electrical or other) via a worm gear for example, the whole being situated outside the casing of the junction piece on the inside of the sphere (assembly not drawn).

§ An eccentric mechanism comprising a disc 37 driven in rotation by the aforementioned shaft, which disc is provided with two eccentric spindles 38 each receiving the end of an arm 39.

§ The other end of each of the arms is connected firstly to a sliding plate 40 and secondly to the base of a locking clip 41, described below;

§ On each sliding plate 40, the hook 42 pivots about a spindle 77, forced towards opening by a suitable spring 78 and a locking clip 41 for said hook, also pivoting about its own spindle 79, making it possible to lock the hook in the closed position.

§ The locking clip 41 is held in the activated position by a suitable spring 80, and is connected at its base to the arm of its eccentric mechanism.

The functioning of such a mechanism will be as follows (fig 29):

§ At the start (diagram A), the sphere is open. The eccentric mechanism is completely loose (anti-clockwise position on the diagram) in the open position. In the actual position of the eccentric mechanism, its two arms 39 have released the locking clip 41 of the hooks 42 and pushed the two sliding plates 40 as far as the outer boarder of the casing.

§ Before the closure of the hemispheres, or at the start of this movement (diagram B), a slight rotation is imparted by means of the geared motor to the disc 37 of the eccentric in the clockwise direction in the drawing, which makes it possible to reactivate the locking clips 41 of the hooks without moving the two sliding plates 40, as the arms 39 are connected with the disc and the locking clips. The mechanism is at this moment activated.

§ The two hemispheres are closed. The cable termination rings 29 (described below) will push the leg of the hooks 42, which has the corresponding effect of causing a rotation of the

head of the hooks until they engage the cable junction ring 29 (diagram C). This movement will continue until the base of each hook is locked in the closed position by the corresponding locking clips 41. The hooks gripping the rings make it possible to apply the tension to the cables 23.

§ The clockwise rotation of the eccentric mechanism is continued until the end of travel, which, via the geared motor, the shaft, the disc and the two arms, makes the two sliding plates 40 slide towards the centre of the casing, thus imparting the appropriate tension to the cables 23 (diagram D). The shape of the arms and the position of the eccentric spindles for pivoting on the disc ensure that the tensioning mechanism, having passed a high equilibrium point (the axis of the cables) is itself locked through the tension imparted to the cables. The sphere is then secure and ready to travel on the track.

§ For opening the sphere, a movement that is the reverse of that of closure is imparted to the mechanism, until there is complete slackening of the cables and release of the hooks (diagram E). The sphere is then ready to be opened (diagram A).

Provision will also be made for the eccentric mechanism with its transmission shaft and geared motor to form a sub-assembly of the system, which also will be able to slide with respect to the casing of the junction piece, in line with the cables. The shaft 36 of the junction piece will pass through the casing 35 through a slot cut in it, allowing this movement. The geared motor will slide in guides provided on the external surface of this casing. This embodiment will ensure a uniform tension between the cable sections of the two hemispheres, even if one of them were to slacken slightly or be disturbed.

Finally, it can also be envisaged that the end of the transmission shaft 36, on the external side of the sphere, be cut in the form of a special eccentric (fig 30), through which the equator cable 27

passes in the idle position (sphere open) and which, through its shape, provides a slight tension to this cable when the mechanism is locked in the closed position.

An alternative solution of the "passive safety" type consists of replacing the eccentric with a spring 44 which will provide the tension of the cables (fig 31). This solution is similar to the previous one with regard to the casing and its sliding plates with its hooks and locking clips. The cable sections will terminate in the same junction rings.

What differentiates this mechanism from the previous one is that each of the sliding plates 40 will be subdivided into a head receiving the hook 42 and the locking clip 41, and a base. The tension of the cables will be provided by a spring 44 acting between the bases of the two sliding plates 40 so as to move the heads closer to each other. This tension will be released by a pair of main actuators 45 acting on the heads of the said plates, making it possible to separate them. Two additional secondary actuators 46 will act on the bases of the locking clips of the hooks so as to release them for opening the sphere.

Except for these differences, the operating method of this mechanism is similar to the previous one, and is shown diagrammatically by figure 32, which depicts respectively:

§ diagram A, the mechanism in the open and armed position;

§ diagram B, the lock closed and locked, the plates still separated by the main actuators, the cables still slack;

§ diagram C, the lock closed and locked, cables tensioned, main actuators released;

§ diagram D, the cables slackened by the actions of the main actuators, the lock unlocked by the secondary actuators, the sphere being ready to be opened.

A third solution consists of providing a junction piece which will only have the role of cable junction to the exclusion of any tensioning function, the latter function being shifted to the hexagonal elements of the hemispheres. The cable locking function is similar to the previous two options. Figure 33 shows it respectively open and activated (diagram A), lock closed and locked (diagram B) and lock unlocked for opening (diagram C).

In such a context, the tensioning of the cables is delegated to the hexagonal elements of the hemispheres, and there also various options exist. It should be noted that these elements have been depicted graphically for a frequency three geodesic sphere and should be adapted to the structure of a frequency six sphere.

Each hexagonal element has three tensioning cables passing through it (figs 8 and 10). In each option, the tension will be exerted by an actuator, which will act simultaneously either on one cable or on two cables, or on the three cables passing through the element. The following three types of tensioners will therefore be envisaged, single (fig 35), double (fig 34) or triple (fig 36).

A double tensioner (fig 34) will consist of an actuator 47 fixed to the structure of the hexagonal shape. This actuator will be equipped at its end with a pair of rollers 48 gripping two of three cable sections 30.1 and 30.2 passing through the hexagonal shape. This third cable section 30.3 for its part will be tensioned by a similar mechanism situated in another hexagonal shape. The tension will be imparted by a retraction of the actuator, causing by means of the rollers a lateral movement of the cable within the hexagonal shape, which will ensure its tensioning.

In a passive safety context, this tensioning will be provided by a spring, which will act on the stem of an actuator, causing the tensioning of the cables via the pulleys. The slackening of the cables will be provided by the actuator when the latter is pressurised.

A single tensioner (fig 35) will also contain an actuator fixed to the structure of the hexagonal shape and will act on only one of the cables of this structure. A triple tensioner (fig 36) will have an actuator whose base will be fixed by means of an ad hoc roller to one of the cable sections of the structure and will act on the other two cable sections of the structure in the same way as the double tensioner.

Whatever the option chosen with regard to junction and tensioning, the cable sections 30 enveloping the hemispheres will terminate at both ends in a junction ring 29, which will be gripped when the sphere is closed by the fixing hook 42 integrated in the cable junction piece (fig 37). This termination can be equipped with a mechanism for adjusting the tension in the cables 49. It will be housed in the sheath 25 of the junction trapezia (fig 11) and will have to be able to slide freely in this sheath so as to allow suitable tensioning of the cables.

As expressed above, two important options exist with regard to the arrangement of the passengers and their seat within the sphere, either with seats articulated with respect to the spherical envelope or with seats fixed to this same envelope.

Each of these options is described separately. They both have recourse to conventional secure ride seats 50 (fig 38), able to be provided with a restraint bar meeting current safety standards. The method of fixing the seats will depend on the two options described above.

Let us consider by convention a reference system related to the passengers, in the form of three axes (fig 38):

- § X axis: frontal forwards;
- § Y axis: lateral towards the right;
- § Z axis: vertical upwards.

The objective of the articulated-seat option is to enable the passengers to maintain their Z-axis in the vertical position during the movement (except for any rocking), without being concerned about the

direction with which they will describe the travel of the ride, this direction being random and variable because of the very principle of the ride. The system will therefore have to compensate, at the passenger level, for the rotation movement of the sphere, by generating a relative movement of the passengers with respect to the spherical envelope, reverse to the first, about their X- and Y-axes. This relative movement will be caused by gravity. To this end, the seat structure will be designed so that its centre of gravity with and without passengers is always situated below the aforementioned X- and Y-axes.

To do this, an in principle even number of seats will be assembled back to back in a uniform rigid structure. The following various configurations can in particular be envisaged: two seats side by side, four seats in two pairs back to back, six seats in two triplets back to back (figs 39 and 40) or eight seats in two groups of four back to back.

The external seats may be turned slightly towards the centre in order to reduce the space requirement, with regard to the knees and feet of the passengers, fig 40. The central seat may be removable (fig 53) so as to facilitate the operation of getting on and off at the boarding platform. The bottom part of the structure will comprise a horizontal plate enabling the passengers to rest their feet thereon (fig 39). This bottom part may return over the front of the passengers as far as the abdomen, adopting a spherical shape, thus protecting the legs from any moving part (fig 54).

Two options exist with regard to the articulation of the seats with respect to the spherical envelope: an articulation with two or three degrees of freedom. In addition, for each degree of freedom, two options exist with regard to the rotation mechanism: either the one about a physical axis, or the one like a ball bearing (virtual axis). It is by combining these two options with regard to rotation at the level of each degree of freedom that various solutions are created with regard to the articulation of the seats.

The recommended solution (fig 40) is an articulation with two degrees of freedom, combining the use of a rotation axis (Y-axis) associated with a bearing mechanism (of the ball bearing type – X-axis) the outer race of which is fixed to the equator ring 10 of the spherical envelope. In this case the rigid structure 51 and the seats which make it up (fig 39) will pivot freely by gravity about a horizontal shaft 52 that extends along the Y-axis, passing transversely through this structure at the back of the passengers. A brake mechanism will be provided on this shaft, actuated by the operator in charge, making it possible to immobilise the seat structure and the boarding platform when the passengers are getting on and off.

Each of the two ends of this "Y" shaft 52 will be fixed to a circular carriage 53 equipped with several rollers 54 (for example eight rollers per carriage), the two carriages facing each other, these three parts being able to form together a rigid structure 55 (figs 41 and 42). This pair of carriages will run by gravity on a single, or better a double, tubular rail 56, each rail being curved in a circle (general view at fig 43 and detail at fig 42). These two circular rails would preferably be situated level with the two circles delimiting the equator ring.

The two carriages 53 supporting the rollers will therefore be continuously opposed with respect to the centre of the sphere. The running in complete freedom of these two carriages on the circular pair of rails 56 will impart to the shaft 52 of the structure and therefore to the passengers a rotation about their longitudinal axis X (perpendicular to the diagram in figure 43 at its centre).

During the running movement of the sphere, the passengers will therefore maintain their Z-axis in the vertical position, on the one hand through the running by reverse reaction of the structure 55 formed by the shaft 52 and the carriages 53 on the curved (double) rail of the equator ring (pivoting about the X-axis), and on the other hand on the

pivoting by reverse reaction of the seat structure 51 about its transverse shaft 52 (Y-axis).

In such an embodiment, all the weight of the passengers and their seats are supported by the equator ring 10, since it is the equator ring which supports the internal circular rail accepting the seat structure. This load will then be distributed about the point of contact of the spherical envelope 56 with the ground, which may be situated at any time in line with the equator ring or at any point on a hemisphere. In the latter case, the load will be distributed in the hemisphere concerned via the various elements of the envelope and the tensioning cables. Contrary to the option of the fixed seats described below, the two hemispheres will contain only their own structure and will therefore be relatively light with respect to the whole.

In order to bear this load, the equator ring 10 can be constructed around a skeleton formed by the two circular rails 56 which will be directly attached to the ten cable junction pieces 28 (fig 44). The assembly will form a rigid structure, to which there will be fixed the moulded elements of the equator trapezia 26 and the various items of equipment necessary for opening the sphere.

One advantageous alternative solution relating to the movement of the passengers about their X-axis (fig 45) consists of replacing the two carriages 53 described above with a circular frame 59 whatever its cross section. It will be curved in a circle with a diameter slightly smaller than that of the aforementioned tubular rail or two rails, whilst being connected to these by a set of pairs of rollers 54. The shaft 52 receiving the structure 51 of the seats will be fixed to this frame at two diametrically opposed points. The whole therefore will describe a rotation movement by running inside the aforementioned rail 56, providing the rotation of the passengers about their X- axis.

During any movement of the sphere having an articulation of the seat with two degrees of freedom of the “shaft + rollers” type (figs

40 to 45), the passengers will experience the following sensations. If the sphere moves in the direction of the X-axis of the passengers, the latter will see it turn about them longitudinally. The pivoting of the seats about the Y-axis will enable them to maintain their verticality. The passengers will see the internal roller-carrier frame 59 turn about them integrally with the equator ring (fig 45). There being no pivoting movement of this internal frame with respect to the rails 56 fixed to the equator ring.

With an equator ring that is vertical at the start, if this sphere moves in the direction of the Y-axis of the passengers, the latter will see the sphere turn about them transversely. The rotation of the roller-carrier frame on the rails fixed to the equator ring will compensate for this movement, enabling the passengers to maintain their verticality. There will be no pivoting of the seat structure about its transverse shaft.

Any movement aslant will take place through a combination of the two movements mentioned above.

If, in a very particular case, the equator ring 10 is situated in a horizontal position at the start, and if at this moment the sphere moves transversely in the direction of the Y-axis of the passengers, the latter will be able to be carried by the movement until they experience a complete transverse summersault (whilst nevertheless being secure in their seat). This summersault will have an unstable equilibrium, any slight deviation of the movement of this sphere with respect to this Y-axis returning the passengers by gravity to an equilibrium position (vertical Z-axis).

This totally random disequilibrium with a low probability of occurrence experienced by the passengers can be perceived as an entertaining aspect of the ride. If it were to be considered to be a nuisance and that it was necessary to eliminate it, it would then be necessary to change to an articulation with three degrees of freedom. This mechanism will be more complex to produce, will make this sphere heavier and will require a slightly greater outside diameter than a

mechanism with two degrees of freedom for an identical number of passengers.

Various proposals with three degrees of freedom are described below, which combine the "axis of rotation" and "running mechanisms" embodiments for each degree of freedom. They are given by way of example and have no exhaustive character. The description of the various options below will always go from the structure of the seats towards the external spherical envelope.

The conventional approach for a system with three degrees of freedom is the cardan drive with three frames and three axis (fig 46). There will be, from the structure of the seats 51:

- § a horizontal transverse shaft 52 for pivoting of this structure (Y-axis) connecting the latter to the inside of a first internal circular frame 59 constituting the first degree of freedom;
- § two spindle ends 62.1 perpendicular to the aforementioned shaft 52, connecting the outside of this first frame 59 to the inside of a second intermediate circular frame 60, enabling these two frames to pivot with respect to each other, constituting the second degree of freedom;
- § two other spindle ends 62.2 perpendicular to the second connecting the outside of this second intermediate frame 60 to the inside of a third external circular frame 61, consisting of a sub-frame or two parallel sub-frames fixed to the equator ring 10, enabling the second frame to pivot with respect to this equator ring constituting the third degree of freedom.

This system has the great advantage of being the articulation with three degrees of freedom that is the most simple to produce. It is compatible with the confinement enclosure mechanism described below. It has the drawback of being the system that puts the most frames in movement in the field of vision of the passengers, which may constitute a nuisance.

The cardan drive with two axes and running mechanism is an alternative option that also includes a pivot shaft 52 at the seats. What differentiates this structure (fig 47) from the previous one is that the third degree of freedom will be provided by rollers 54 fixed to the second frame, running on one or two circular rails 56 fixed to the equator ring, similar to the recommended mechanism with two degrees of freedom.

Another embodiment is that of lateral-bearing seats, with external shaft and bearing (fig 48). Here the structure of the seats is no longer provided with a pivot shaft. This shaft will be replaced by a set of rollers 54.1 fixed to the lateral periphery of the structure of the seats 51. The latter will run on a circular rail 56.1 serving as a first internal frame 57. The outside of the latter will be connected to the inside of the second intermediate frame 60 by means of two horizontal shaft ends 62. This intermediate frame will be equipped with rollers 54.2 on its periphery, running on a pair of rails 56.2 fixed to the equator ring, as described in the previous option.

The drawback of this embodiment is that the rollers fixed to the seat structure prevent the use of a confinement enclosure surrounding the seats and retracting under these when the sphere is at the boarding platform, as described below. It will be necessary to work with front confinement enclosure portions, which will no longer be balanced.

The embodiment that follows (fig 49) is a variant of the previous one. In this embodiment the two internal 59 and external 61 frames will both be circular rails 56.1 and 56.2 on which a set of rollers will bear. The ones 54.1 bearing on the internal frame 59 will be fixed to the seat structure 51 as in the previous embodiment. The ones (54.2) resting on the external frame 61 will themselves be fixed to the trapezoidal elements 26 of the equator ring 10, which will have been adapted accordingly. The two frames 59 and 61 will pivot with respect to each other by means of a pair of spindles 62. The equator ring 10 will

not be equipped with a skeleton as depicted in fig 44 in this embodiment. This solution has the same drawback as the previous option with respect to the confinement enclosure (see below).

The last embodiment described here (figs 50 and 51) resolves the problem of the confinement enclosure 64. It is based on the principle of a double front bearing on the inside on the structure of the confinement enclosure, an intermediate shaft and an external bearing mechanism.

The structure of the seats will here be equipped with two internal circular frames 59 parallel to each other, distant by approximately 70 cm, perpendicular to the aforementioned "Y-axis". These frames serve as a running rail 56, like those surrounding the pods on the "London Eye" Ferris wheel in London. A fixed confinement enclosure 64.1 will be fixed between each of these two frames at the lateral end of the seat structure. The middle part between these two frames will be equipped with an annular confinement enclosure element 64.2, able to run by means of rollers 54.1 on these same frames and thus retract under the seats when the sphere is immobilised at the boarding platform.

A second intermediate frame 60 will surround this structure. It will be provided, vertically in line with the internal frames connected to the seat structure, with four circular-shaped lateral arms 63, equipped with rollers 54.2, gripping the internal frames 59 described above, enabling this internal structure to travel.

The outside of this second intermediate frame 60 for its part will be connected to the inside of a third external frame 61 by means of two vertical shaft ends 62.

This third frame 61 will itself be a rail 56, being gripped in a set of rollers 54.3 fixed to the trapezoidal elements of the equator ring 10 and making it possible to run with respect to this ring.

The passengers will be confronted with moving parts inside a spherical envelope whatever the method of articulating the seats. In

order to ensure their safety, it will be necessary to provide a grilled confinement enclosure 64 around the structure of the seats and fixed to these, preventing them from touching, by hand or foot, this envelope or any moving frame inside it. This enclosure will be removable for operations at the boarding platform. It will consist of a wire-netting in the form of a spherical segment (wine cask) in a suitable frame, which will be able to retract when the sphere is open to enable the passengers to get in or out. The structure will depend on the type of opening of the sphere (see below).

With regard to emergency exits, the random position of the spherical envelope with respect to the seats in the event of an incident does not make it possible to predict which will be the pentagonal shapes best indicated for the evacuation of passengers, namely those facing the seats. It is also necessary to consider that the seats are assembled in two groups back to back. This is why each of the twelve pentagonal shapes constituting the spherical envelope will be designed as a safety gate and will be able to be removed according to requirements.

It will also be necessary to provide a mechanical emergency release of the confinement grille 64 in addition to that for the passenger safety bars, these unlocking means having to be accessible through the aforementioned emergency gates.

A sphere with articulated seats will require simple hinges for opening the hemispheres, combined with a parallelogram system 65 for off-centring this access during the opening or closing movement of the hemispheres (fig 52).

What follows concerns the opening mechanism and the confinement enclosure for a sphere with articulated seats with two degrees of freedom combining a pivot shaft 57 with a mechanism running on the equator ring, but can be extrapolated to the other options with regard to articulation of the seats.

Two major options are available with regard to the way of opening the sphere and keeping it at the boarding platform. The first envisages the opening of a simple hemisphere acting as a shell above the head of the passengers, the second hemisphere remaining permanently fixed to the equator ring. This is the solution that is recommended and that we have referred to as the "boiled egg" option (fig 7).

The second option envisages an opening of the sphere through the two faces frontal to the passengers, which assumes an opening movement for each of the two hemispheres. It will be described below.

In the "boiled egg" option (figs 7 and 53), only the northern hemisphere will be movable with respect to the equator ring, the other (southern hemisphere) being permanently fixed.

In this arrangement, the equator ring and the rails, which are fixed thereon will remain in a horizontal position whilst people get in and out (figs 54 and 55).

To this end, the bottom part of the seat structure, which can be produced for example from polyester moulding, will rise up in front of the feet of the passengers as far as the height of the abdomen (in the seated position) and will serve as the bottom part of the confinement enclosure (fig 54). It will contain, on each side on its middle part, two to three steps 66, which may be removable. The lateral parts of this enclosure (on the sides of the end seats) will also be fixed up to the top of the structure. The central seat 64 on each side of the structure will be able to be pivoting in order to facilitate getting in and out.

The confinement enclosure is a wire-netting envelope with sub-frame, constituting a kind of grilled cage around the passengers, in the form of a spherical half barrel, which in the closed position surrounds the top part of the passenger seats, preventing any part of their anatomy

coming into contact with the moving spherical envelope and any frame of the articulation (figs 49 and 50).

In the "boiled egg" option, this enclosure has a uniform rigid structure. Described here in the closed position (figs 55 and 56), its skeleton consists of a sub-frame made from tubes, for example metal, curved and fixed to each other. There are thus four circular tubes perpendicular to the "Y-axis": two lateral tubes of small diameter 68 constituting the flanks of the enclosure and two central tubes of large diameter 69 on each side of the central seat. This structure is supported by three other tubes in an arc of a circle: one (70) perpendicular to the "X-axis" forming the top of the structure and two (71) substantially perpendicular to the "Z-axis", closing the enclosure in its bottom part. This structure is covered with a wire-netting 64 in its top part (fig 56).

This enclosure has the seat pivot shaft 52 passing right through it, and can also pivot about this shaft, under the control of the operator in charge of manoeuvres at the boarding platform. This will enable the wire-netted part 64 of the enclosure to tilt under the seats (open bottom position), then totally leaving clear the top part of the sphere (except for certain tubes able to serve as a handrail) to enable people to get in and out (figs 55 and 57). A suitable mechanical system will make it possible to lock the enclosure in the top position in the phase of making the passengers secure, and in the bottom position in the phase when they get in and out. This locking is a mechanism, which will engage either on the seat structure or on the shaft 52.

An alternative solution to the "boiled egg" is the opening of the sphere by a pivoting of the two hemispheres disposed facing the passengers. This option requires, for its opening, equipment external to the sphere that is heavier than the other option, but would be particularly indicated for passengers who are handicapped or have reduced mobility, since access to the seats would be greatly eased.

Three sub-options also exist here, namely a pivoting of the two hemispheres, either downwards (fig 16), sideways or upwards.

In this arrangement, the equator ring and the rails, which are fixed thereto remain in a vertical position during the opening (figs 40 and 43), which also assumes equipment external to the sphere enabling it to be immobilised, and possibly a vertical movement of this ring during this operation.

Once this sphere is open, the space in front of the passengers will be totally left clear on each side of the sphere (fig 58).

In such a configuration, it will be necessary to provide a movable confinement wire-netting 73 for each of the two faces of the seat structure as well as a fixed wire-netting 72 above the seats. These spherical segments will have a radius less than that of the aforementioned two rails, in order not to cause space to be taken up during movements of the spherical envelope.

Each movable wire-netting will be articulated about the axis of the seats 52 and will be able to be retracted under the seats whilst the passengers are getting in or out. One of them will have a slightly smaller radius than the other so that they can retract concentrically under the seats.

In the option of fixed seats introduced above in this document, the secure seats are rigidly fixed to the structure of the spherical envelope, and therefore accompany its rotation movement.

Several arrangements of the passengers have been studied for this option. Amongst these arrangements, one of them, which shall be called the “opposite orientation arrangement” (or “head-to-toe” arrangement), is adopted.

In this arrangement each of the two north and south shells is provided with an identical number of seats (in principle 5), disposed in a circle, the passengers facing each other, the centre of their face

coming in the plane of the equator, and their feet level with the pole at the bottom of the shell (fig 59).

The number of seats 74 that can be installed is obviously variable and will depend on the diameter of the sphere. Nevertheless, the natural structure of the geodesic sphere emphasising the pentagonal shape suggests the use of ten seats, which will be fixed "in phase" with respect to the structure. Any other configuration will make more complex the method of fixing the seats, which will be out of phase with respect to the architecture of the spherical envelope.

When this sphere is open (figs 6 and 59), the seats are situated in a vertical position, with the safety bar open, and the passengers can freely get in or out.

When the sphere is closed, after making the seats secure, the heads of the passengers in the northern hemisphere will be interposed at the equator ring between the heads of the passengers in the southern hemisphere enabling the passengers to be mutually in "opposite orientations" with respect to each other. The heads will be situated almost side by side in the plane of the equator, and the feet of the passengers will be distributed equitably between the north pole and south pole.

This arrangement offers an additional entertainment advantage compared with any other, namely that, as soon as the sphere is closed, the passengers will immediately be disoriented by this arrangement, each passenger having his two immediate neighbours "with his feet on the ceiling".

In this embodiment, the moulded structure of the sphere with its tensioning cables will support the load of the passengers, seats and equipment, this load being uniformly distributed at numerous points as described below.

The load supported by the equator ring, in particular in the open position, would be very small and limited only to the equipment specific to the spherical envelope (hinges, cable junction elements etc).

Each secure seat 74 will be fixed simultaneously to a hexagonal element (cable tensioner or not) and a junction trapezium (fig 60). In order best to distribute in this structure the forces related to the weight of the passenger in the seat, these will be fixed to the structure at various fixing points 75, and it will be possible to use for this purpose the fixing elements connecting together the elements of the spherical envelope. By disposing the seats in line with each pair formed by a hexagon 2 and a junction trapezium 24, it will thus be possible to have up to six (possibly eight) fixing points per seat. Using the fixing points of the pole pentagon for the seats will in principle be avoided, in order to allow easy opening of the emergency door in this element should this be needed.

It will also be ensured that the fixing of the seats to the structure can be sufficiently flexible (for example mounted on rubber) in order to allow a certain deformation of the structure by the tension of the cables and the running movements, without this causing excessively great local tensions. This will also make it possible to avoid deformation of the structure causing it to deviate from its sphericity, when the seats are fixed.

In addition, the closure movement will act on shells loaded with their passengers (rather than on empty shells as in the articulated seat configurations). This risks causing tensions and deformations at the spherical shells that the tensioning cables (in the slackened position at this moment) will not be able to take up alone. It will therefore be necessary to fix the seats to each other, so that it is they that take over part of the rigidity and strength of the structure of hemisphere, in particular in the phases of opening and closing the sphere.

By adopting such a seat architecture and fixing the seats in this way to the structure, each passenger will have a view towards the outside of the sphere through the ten pentagons disposed on each side of the equator ring, in particular the one facing him (fig 61). He will also have a partial vision through the equator trapezia, although these may be encumbered with mechanical parts.

The sphere with fixed seats has the great advantage that during travel there is no moving part inside it that can prevent a risk for the passengers. The passenger confinement enclosure is consequently formed by the spherical envelope itself. One of the dangers that it is nevertheless necessary to prevent with regard to the passengers consists of the openings (windows) through this envelope, that an arm or a foot could pass through, causing a high risk of serious injury during the movement of the sphere.

However, the passenger distribution configurations within the sphere in this “fixed seat” option, and in particular the reverse-orientation arrangement, leave the passengers close to the walls, and therefore this risk is real. This is why the elements of the spherical envelope must be masked, in any event in the areas that may be accessible to the hands or feet, namely in principle all the pentagons and equator trapezia. The junction trapezia and hexagons are in fact covered by the seats and could be free from protection.

Between the various solutions envisaged, namely Plexiglas windows, protected glass windows or wire-netting, the last solution (shown in a hexagonal shape in fig 62) has been adopted, in order in particular to leave good ventilation in the sphere. The wire-netting (in principle square or triangular meshes, maximum 1 cm) will be fixed to a thin aluminium frame for example, which will be set in the elements of the structure, in the lugs 31 provided for this purpose in the contour beams 19 of these shapes (figs 17 and 18). Such a mounting will also protect

the passengers with respect to the hemisphere closure and locking mechanisms.

The closure movement of the hemispheres will act on shells loaded with their passengers (rather than on empty shells as in the articulated-seat configurations), which will require a high power for the closure mechanism, which will in principle be external to the sphere. It is possible nevertheless to envisage an integral closure mechanism (fig 63). In this case, each of the shells is provided with a fixed actuator articulated on its pole, called a "pole actuator" 77 directed in the axis of the hemisphere. Its end is connected to the edge of the shell by two tensioners 78, consisting of cables or articulated linkages. They will be fixed on each side of the "Greenwich meridian" of this sphere, that is to say on each side of the back rest of the seat 74.1 opposite to the closure (northern shell 16, fig 59), or on the side of the back rests of the two seats 74.2 and 74.3 situated on each side of this meridian (southern shell 17, fig 59). These tensioners will be tensioned when the sphere is open, thus providing a triangulation for better distribution of the forces during the sphere opening and closing movement. A third horizontal actuator called the "junction actuator" 76 connects the first two (fig 63).

The sphere is closed by first actuating the horizontal junction actuator 76 until it is completely folded, the movement being transmitted to each of the shells by the linkage formed by its pole actuator 77 in the deployed position and its tensioned cables 78. The two shells will pivot towards the ring of the equator, until the diagonal is passed.

Next the two pole actuators 77 will be actuated. These will pivot at the pole, keeping the cable in the tensioned position. At the end of the movement, the two hemispheres will thus close again on the equator ring, the three folded actuators being aligned in a mast connecting the two poles, and not together exceeding the inside diameter of the spherical envelope.

The equator ring will be connected to the two hemispheres by a pair of hinges, which will be special (fig 64). They will be designed so that the two hemispheres open symmetrically with respect to the equator ring, the latter remaining in a strictly vertical position during the movement. The two angles “N” and “S” formed on the one hand by the northern hemisphere 16 and the equator ring 10 and on the other hand the equator ring 10 and the southern hemisphere 17 will remain substantially identical with respect to each other throughout the opening and closing movement, thus guaranteeing verticality of the equator ring. For this purpose, the hinges of the northern hemisphere will be integral with the hinges of the southern hemisphere by means of a system of parallelograms provided with runners 79 (resembling furniture drawer runners) in order to fulfil this function. These hinges will be designed so as to occupy the least space possible at the equator ring in the closed position.

Such an arrangement will avoid providing, for the fixed-seats sphere, suitable guides for the equator ring external to the sphere at the boarding platforms, as will have to be provided in the “articulated seat” option with front opening of the hemispheres. This is because the option studied here sends the major part of the weight of the assembly onto the hemispheres, and the hinges as described here will be sufficient to keep the equator ring straight because of its low weight.

In addition, it will be important at the start of opening of the hemispheres and at the end of closure for this movement to take place in a translation perfectly directed in the axis of the poles in order to have a perfect junction without rupture of the edges of the hemisphere or of the equator ring. To this end, a runner can be provided between each hinge and its fixing on one of the hemispheres. It will also be possible to provide four small actuators providing this runner movement on the hinges. It will also be possible to provide, in the top part of the equator ring in the open position, two (perhaps four) small double actuators

disposed in a square with respect to the aforementioned other actuators, which, by opening simultaneously, will disconnect over a few centimetres in translation the two hemispheres in the axis of the poles. The pivoting movement of the hemispheres will begin only afterwards.

Finally, at the end of the closure movement of the hemispheres, the latter will come to abut on these four small actuators in the open position. These will then close again simultaneously, also enabling this movement to be a simple translation in the axis of the poles. The hinges will therefore be designed to allow this slight translation of the hemispheres before pivoting (by means of the aforementioned runners).

The four so-called “runner” actuators and the two double “end of travel” actuators will therefore be slaves to the pole actuators and to a junction actuator in order to ensure a harmonious opening and closing movement of the hemispheres.

CLAIMS

1. Device for transporting persons, in particular for the purpose of entertaining them, said device being in the form of a spherical vehicle and comprising at least one seat disposed inside the vehicle, said device being intended to travel on a track, characterised in that said vehicle is formed by a sphere that comprises a spherical envelope of geodesic structure formed by a assembly of rigid spherical polygonal shapes connected together, said spherical envelope being provided with an access for said persons, said access being integrated in an external wall of said spherical envelope.

2. Device according to claim 1, characterised in that said sphere comprises first and second hemispheres connected together by a ring, said assembly comprising, for each hemisphere, elements of pentagonal and hexagonal shape as well as junction trapezia connected between them, said ring being formed by further trapezia connected together.

3. Device according to claim 2, characterised in that each element of said assembly is formed by a first set of beams forming a contour of said element and a second set of beams forming diagonals within the contour, said diagonals each time delimiting a triangular window in said element.

4. Device according to claim 3, characterised in that each element of said assembly comprises a third set of beams forming cross pieces in each of said windows.

5. Device according to claim 2, 3 or 4, characterised in that each element has a base structure covered with a flexible material.

6. Device according to one of claims 2 to 5, characterised in that at least one of said elements is mounted removably in order to form an emergency exit.

7. Device according to one of claims 2 to 6, characterised in that said trapezia of said ring are connected together by cable junction pieces, said hexagonal shapes and junction trapezia being connected together by sections of cables, which are joined at said cable junction pieces.

8. Device according to claim 7, characterised in that said cable sections comprise at each end a first connecting element, said cable junction pieces comprising at each end a second connecting element arranged to co-operate with said first connecting element so as to couple each end of a cable section to one of said junction pieces for cables.

9. Device according to claim 7 or 8, characterised in that each cable junction piece comprises an eccentric mechanism arranged to put said cable sections connected thereto under tension, said eccentric mechanism having a disc arranged so as to be driven in rotation, said disc being provided with two arms mounted eccentrically thereon, each of the arms being connected to a sliding plate on which said second connecting element is mounted, each of arms being connected so that a rotation of the disc at a first angle causes a movement of said second connecting element and a rotation of said disc at a second angle causes a sliding of said plate.

10. Device according to claim 7 or 8, characterised in that each cable junction piece comprises a spring disposed between two sliding plates on which each time said second connecting element is mounted, said sliding plates each being provided with an actuator arranged so as to apply a sliding movement thereto.

11. Device according to one of claims 2 to 10, characterised in that each hemisphere comprises five cables which intersect in pairs at a junction between a hexagonal shape and a junction trapezium, or a junction between two hexagonal shapes, said trapezia

forming said ring being connected by a sixth cable that extends along the periphery of said ring.

12. Device according to one of claims 7 to 11, characterised in that said cable sections are each time housed in a groove provided in the spherical envelope.

13. Device according to one of claims 7 to 12, characterised in that each cable section is provided with a tensioner.

14. Device according to one of claims 2 to 13, characterised in that said first and second hemispheres are mounted on pivoting means so as to make them pivot with respect to said ring between a first position in which the hemispheres are connected to said ring in order to close said sphere and a second position in which said hemispheres are detached from said ring in order to form said access.

15. Device according to claim 14, characterised in that said pivoting means comprise a junction actuator and a first and second pole actuator, said first pole actuator being mounted between a first end of said junction actuator and a pole of said first hemisphere, said second pole actuator being mounted between a second end of said junction actuator and a pole of said second hemisphere, said pivoting means being arranged so as to sequentially actuate said junction actuator and said first and second actuators when said sphere is opened and closed.

16. Device according to one of claims 2 to 13, characterised in that said first hemisphere is mounted on pivoting means so as to make it pivot with respect to said ring between a first position in which it is connected to said ring in order to close said sphere and a second position in which it is detached from said ring in order to form said access.

17. Device according to claim 16, characterised in that said pivoting means comprise two actuators each seated on said ring on the one hand and on said hemisphere on the other hand, said pivoting

means also comprising a set of hinges having a mechanism in a parallelogram also connecting said ring to said hemisphere.

18. Device according to one of claims 2 to 17, characterised in that each element of said assembly is formed by a beam structure, in particular rectilinear beams or beams in a spherical arc, forming a chassis for said element, a space between these beams being left transparent to view.

19. Device according to claim 18, characterised in that said space between said beams is arranged to allow circulation of air.

20. Device according to claim 18 or 19, characterised in that said space is partitioned by a wire-netting.

21. Device according to one of claims 1 to 20, characterised in that said seats are disposed in such a manner inside the sphere that said passengers are disposed in opposite (head-to-toe) orientations when said sphere is closed.

22. Device according to one of claims 1 to 21, characterised in that said seat or seats are mounted in an articulated fashion.

23. Device according to claim 22, characterised in that said seat or seats are mounted so as to rotate about a shaft that extends substantially parallel to a bottom part of a back rest of said seat or seats, said shaft comprising a first end on which a first circular carriage is mounted and a second end on which a second circular carriage is mounted, said first and second carriages being diagonally opposed to each other, said spherical envelope comprising an internal face on which there is mounted at least one rail that extends over an entire periphery of this internal face, each of said circular carriages being placed on said rail or rails so as to be able to run thereon.

24. Device according to claim 22, characterised in that said seat or seats are mounted so as to rotate about a shaft that extends substantially parallel to a bottom part of a backrest of said seat or seats,

said shaft comprising a first and second end, said ends being fixed to a first circular frame provided with rollers, said spherical envelope comprising an internal face on which there is mounted at least one rail that extends over an entire periphery of this internal face, said first circular frame being placed on said rail or rails so as to be able to run thereon.

25. Device according to claim 22, characterised in that said seat or seats are mounted on a shaft that extends substantially parallel to a bottom part of a backrest of said seat or seats, said shaft comprising a first and second end, said ends being fixed rotatably to a first circular frame, said first circular frame being connected to a second circular frame by means of two shaft ends being disposed perpendicular to said shaft so that a first and second circular frames can pivot with respect to each other, said second circular frame being connected to a third circular frame by means of two further shaft ends being disposed perpendicular to said shaft end so that said second and third circular frame can pivot with respect to each other, said third circular frame being fixed to said spherical envelope.

26. Device according to claim 22, characterised in that said seat or seats are mounted on a shaft that extends substantially parallel to a bottom part of a backrest of said seat or seats, said shaft comprising a first and second end, said ends being fixed rotatably to a first circular frame, said first circular frame being connected to a second circular frame by means of two shaft ends disposed perpendicular to said shaft so that said first and second circular frames can pivot with respect to each other, said second circular frame being provided with rollers disposed on its external periphery, said spherical envelope comprising an internal face on which there is mounted at least one rail that extends over the entire periphery of an internal face, said second circular frame being placed on said rail or rails so as to be able to run thereon.

27. Device according to claim 22, characterised in that said seat or seats are mounted on a structure whose circumference is provided with a first set of rollers, said rollers engaging on a first circular frame, said first circular frame being connected to a second circular frame by means of two shaft ends so that said first and second circular frames can pivot with respect to each other, said second circular frame being equipped with a second set or rollers disposed on its external periphery, said spherical envelope comprising an internal face on which there is mounted at least one rail that extends over an entire periphery of this internal face, said second set of rollers being placed on said rail or rails so as to be able to run thereon.

28. Device according to claim 22, characterised in that said seat or seats are mounted on a structure whose circumference is provided with a first set of rollers, said rollers engaging on a first circular frame, said first circular frame being connected to a second circular frame by means of two shaft ends so that said first and second circular frames can pivot with respect to each other, said spherical envelope comprising an internal face equipped with a second set of rollers on which said second frame is placed so as to be able to run thereon.

29. Device according to claim 22, characterised in that said seat or seats are mounted on a circular structure that is placed on a set of rollers mounted on a first circular frame, said first circular frame being connected to a second circular frame by means of two shaft ends so that said first and second circular frames can pivot with respect to each other, said second circular frame being equipped with a second set of rollers disposed on its external periphery, said spherical envelope comprising an internal face on which there is mounted at least one rail that extends over an entire periphery of this internal face, said second set of rollers being placed on said rail or rails so as to be able to run thereon.

30. Device according to one of claims 23 to 29, characterised in that said rail or rails provided on the internal surface of a spherical envelope are mounted on said ring.

31. Device according to one of claims 1 to 30, characterised in that said seat or seats are provided with a wire-netting envelope mounted retractably.

32. Device according to claim 14, characterised in that said pivoting means comprise a set of hinges having a double-parallelogram mechanism provided with runners connecting said ring to said two hemispheres, so that an angle between one of said hemispheres and said ring remains substantially identical to that between said other hemisphere and said ring when said hemispheres pivot with respect to said ring.

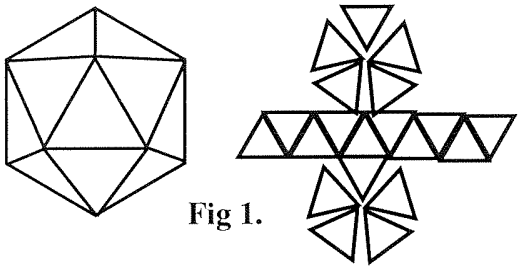


Fig 1.

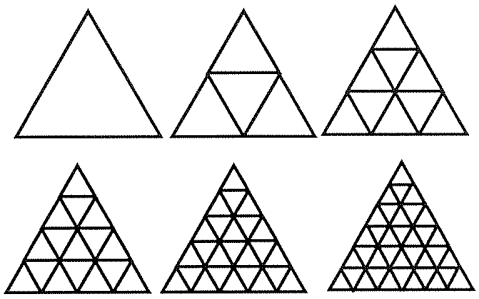


Fig 2.

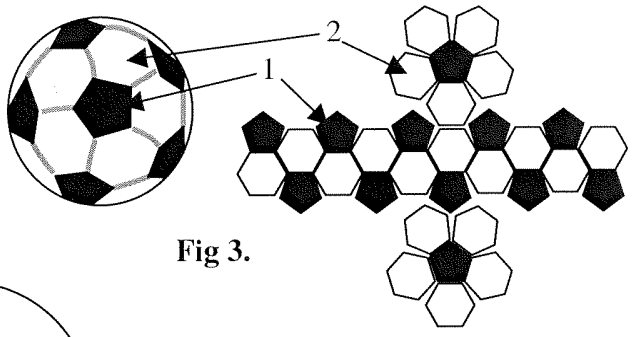


Fig 3.

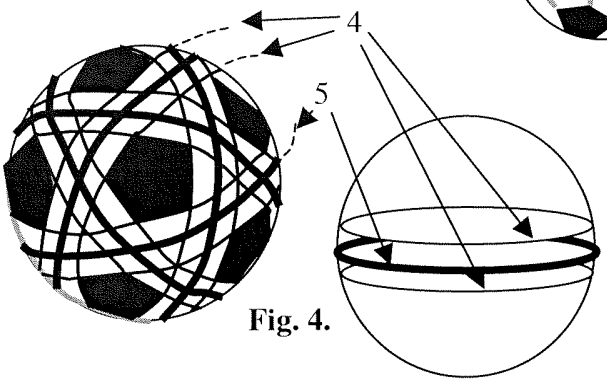


Fig. 4.

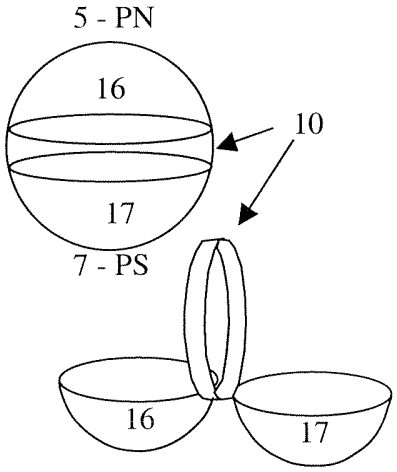


Fig.6.

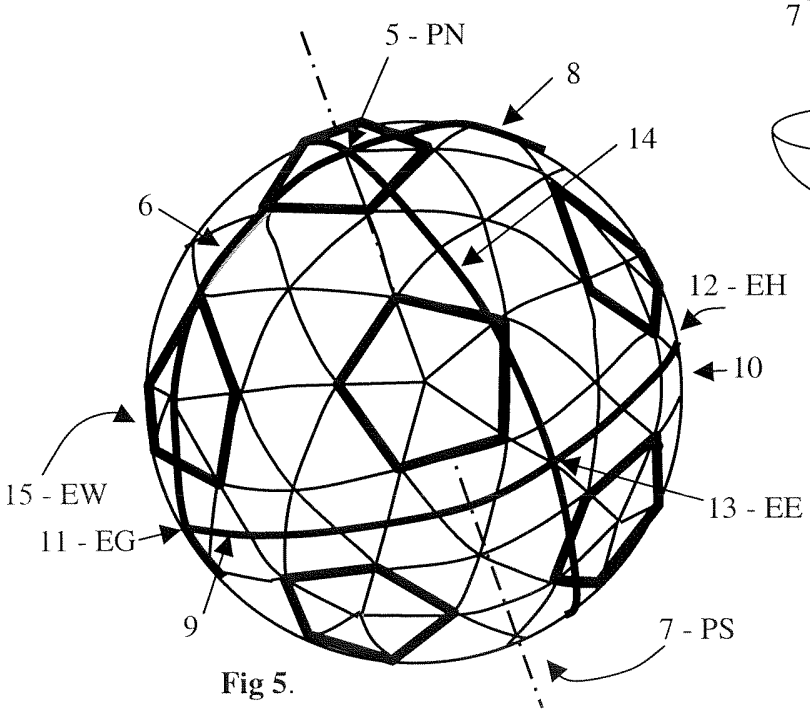


Fig 5.

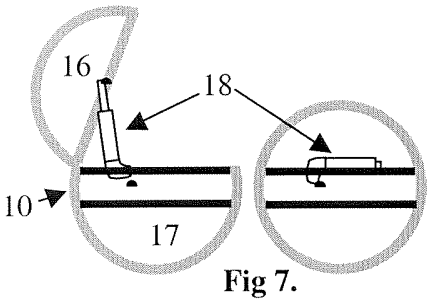


Fig 7.

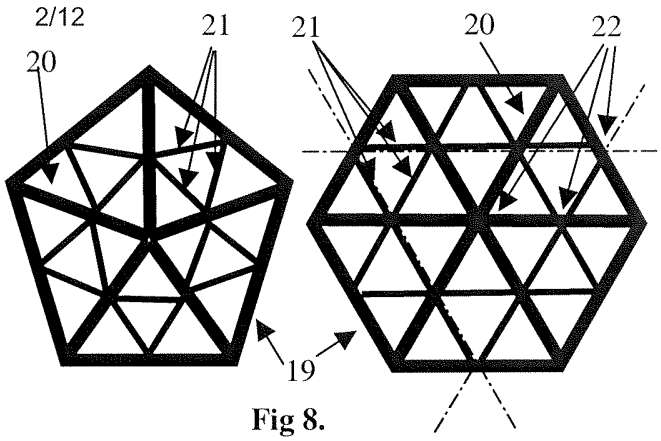


Fig 8.

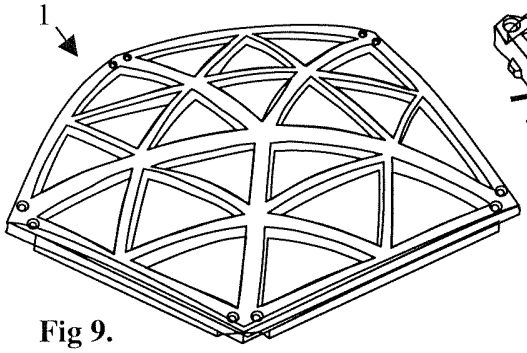


Fig 9.

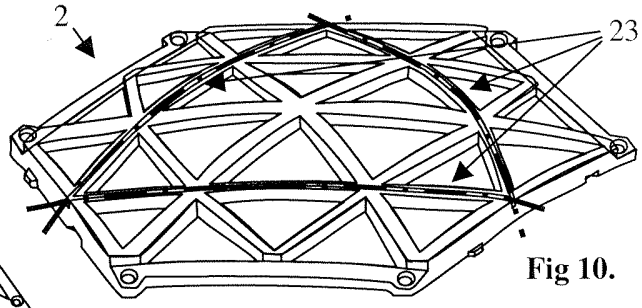


Fig 10.

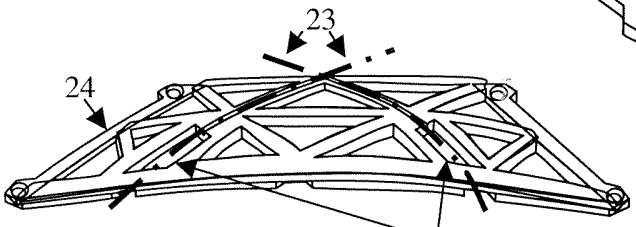


Fig 11.

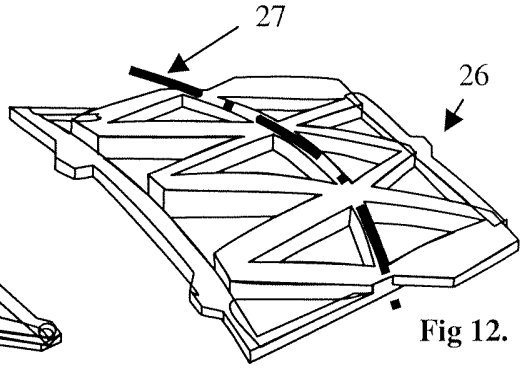


Fig 12.

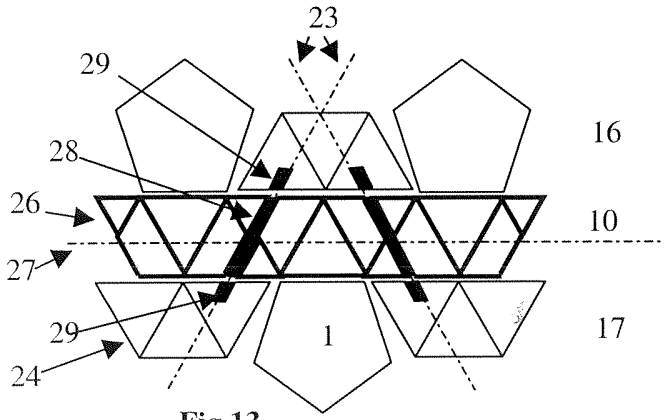


Fig 13.

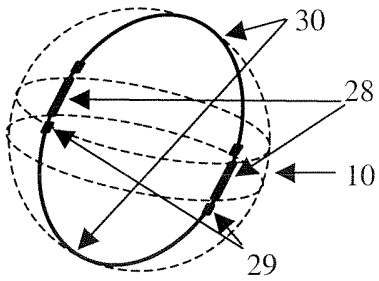


Fig 14.

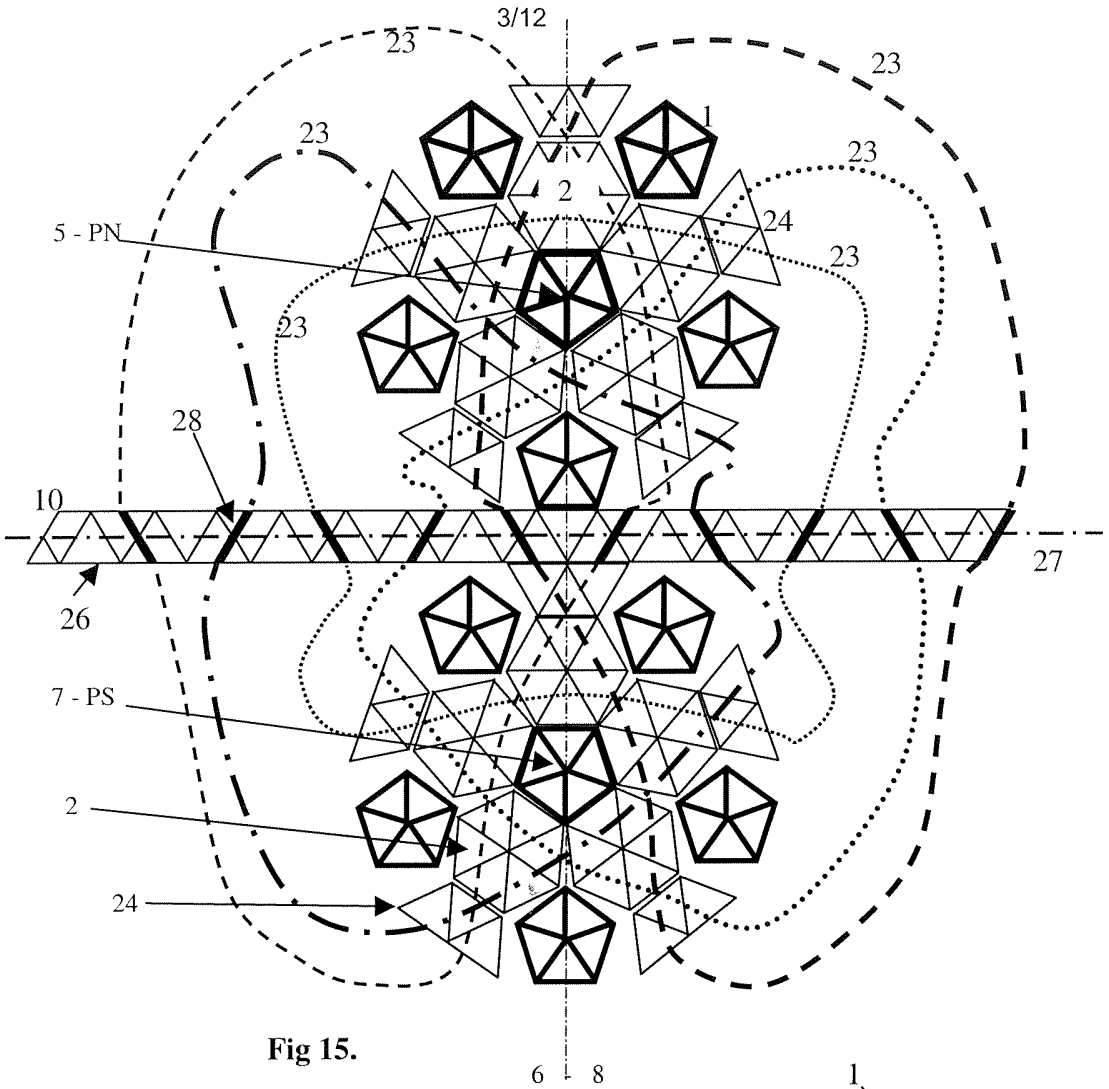


Fig 15.

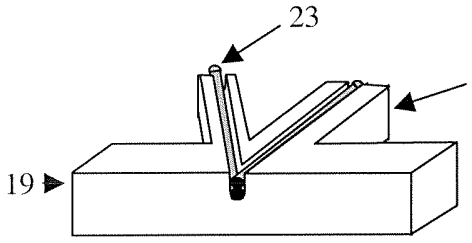


Fig 16.

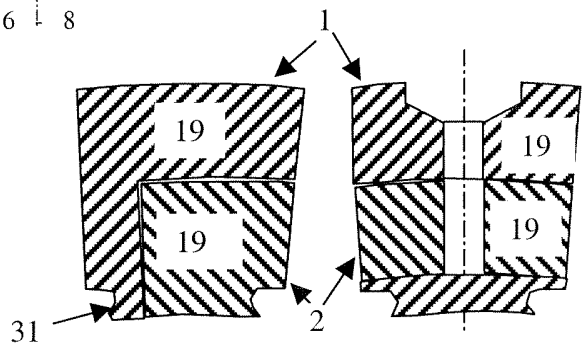
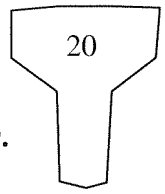


Fig 17.



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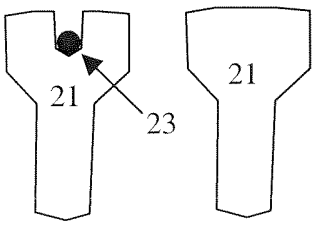
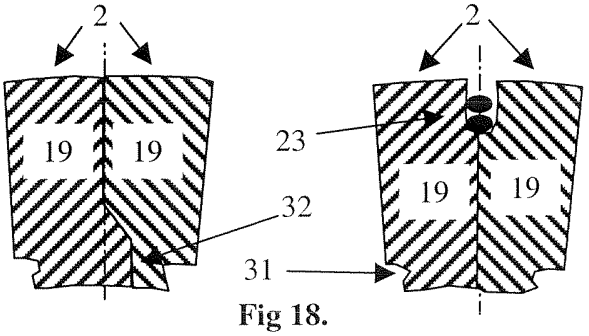


Fig 20.



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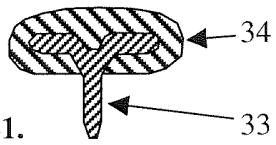


Fig 21.

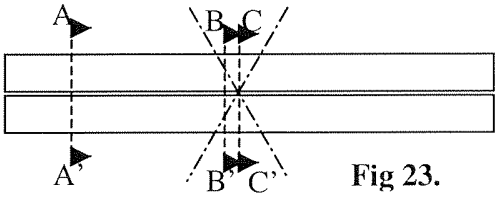


Fig 23.

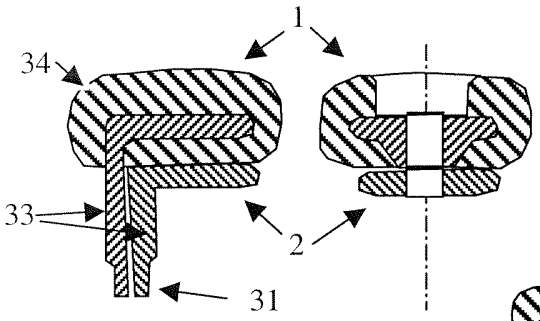


Fig 22.

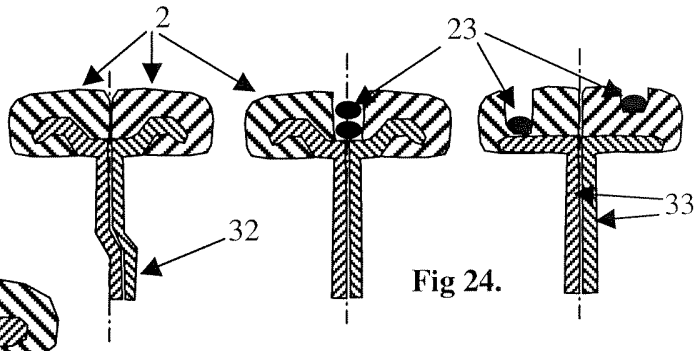


Fig 24.

AA' CC' BB'

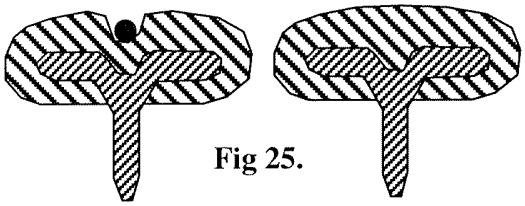
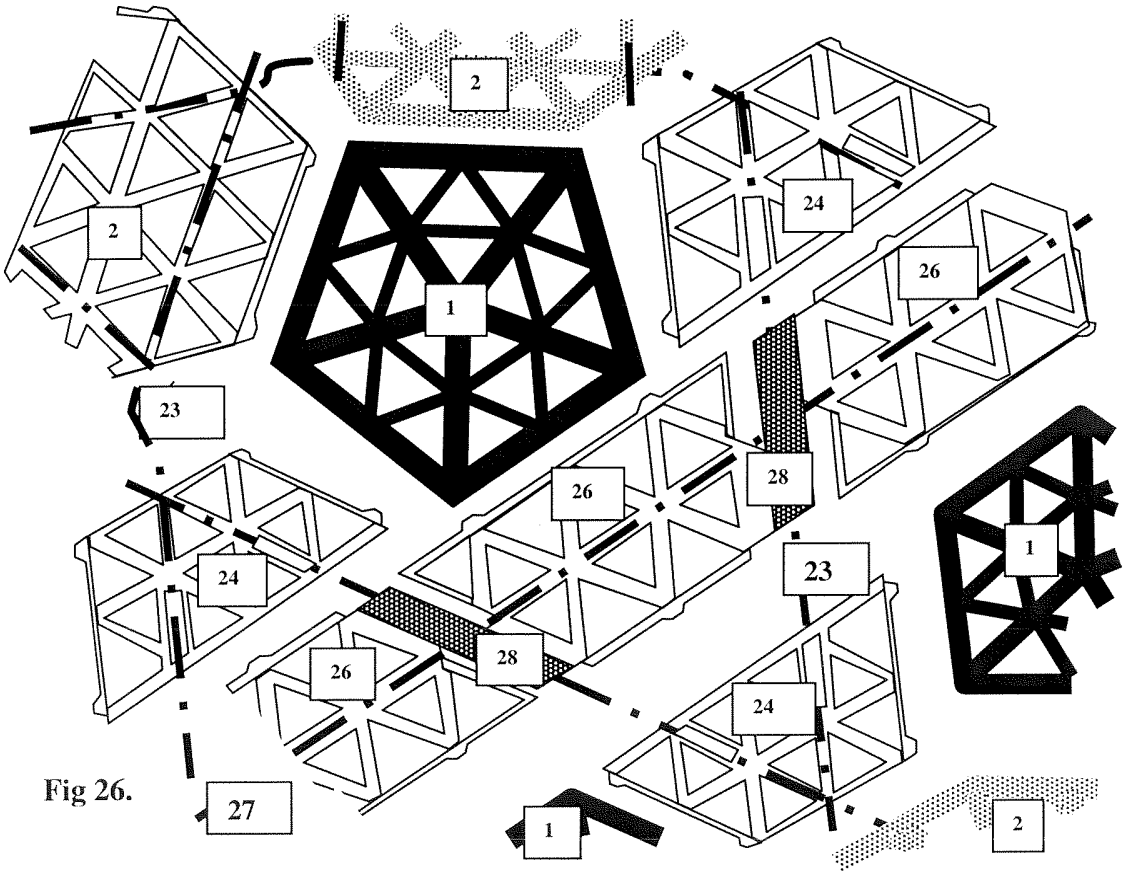


Fig 25.



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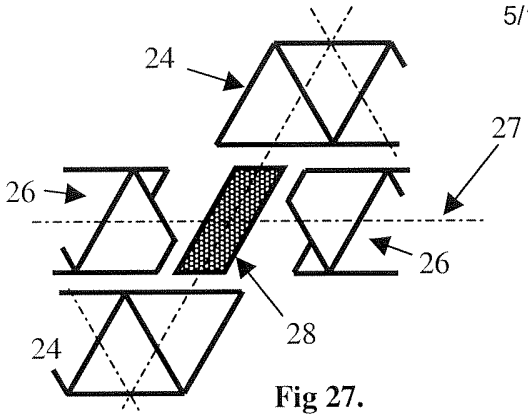

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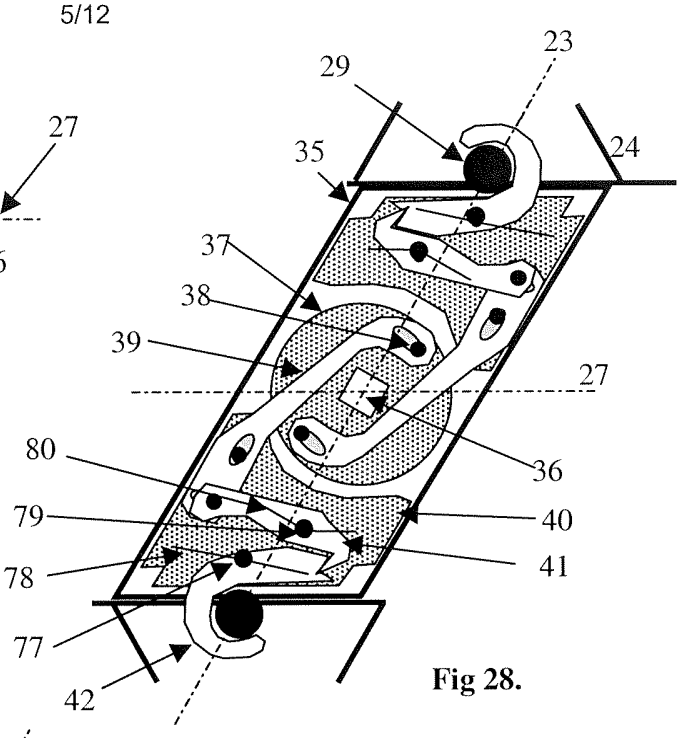

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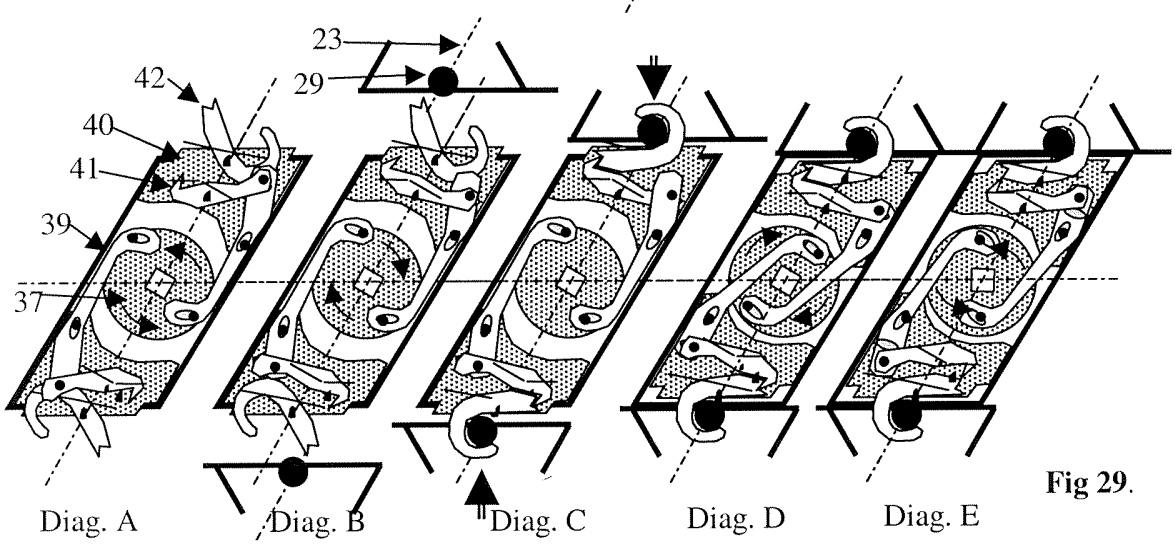


Fig 29.

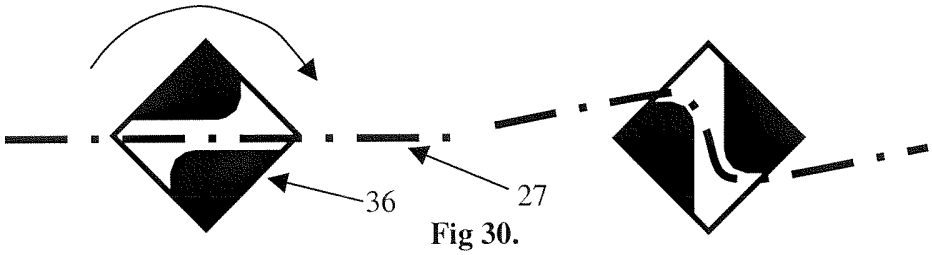


Fig 30.

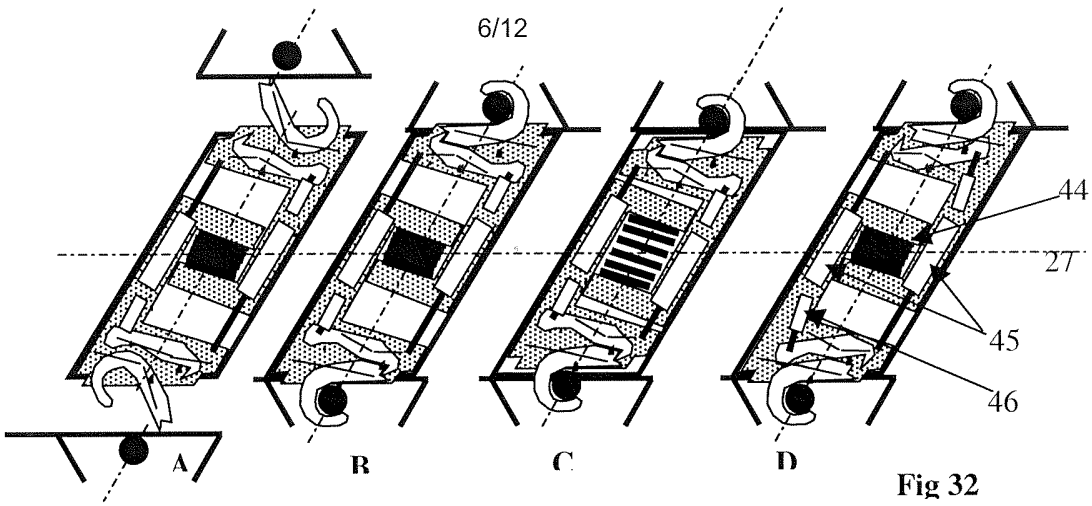
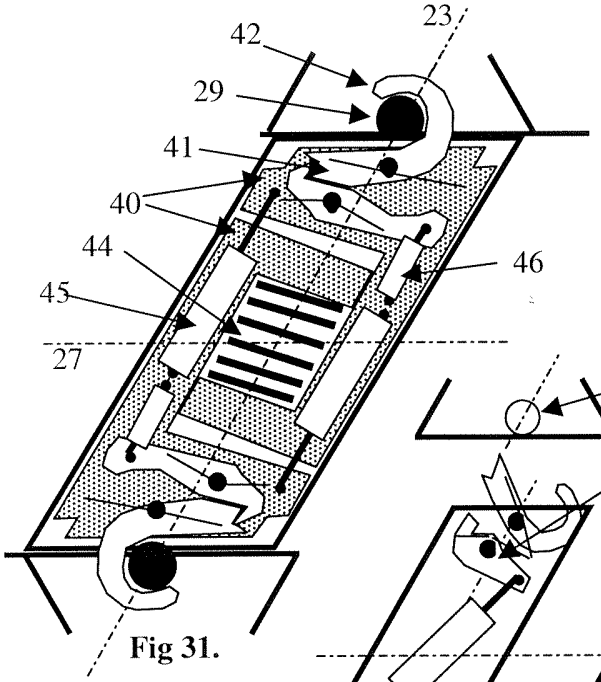


Fig 32



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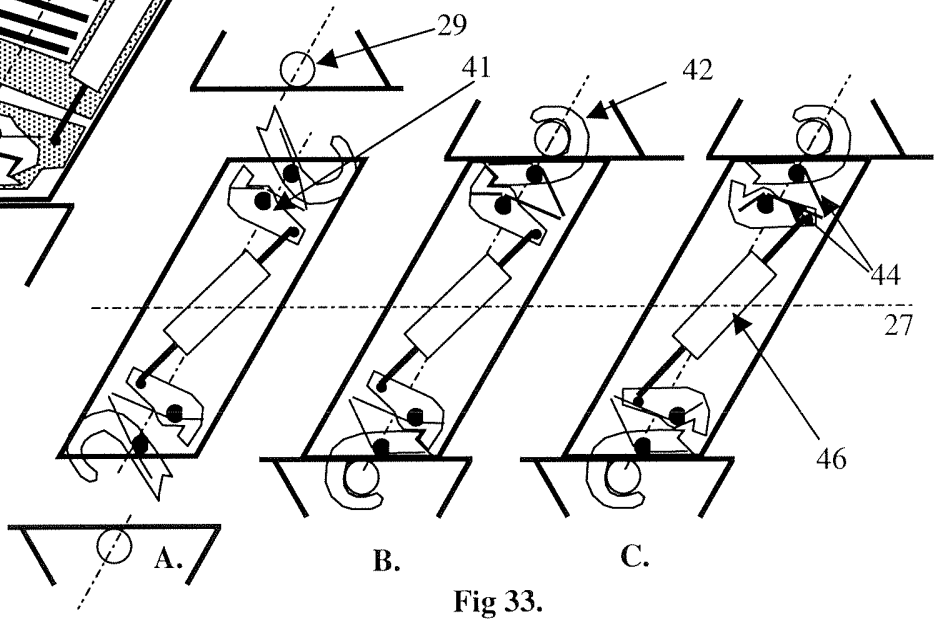


Fig 33.

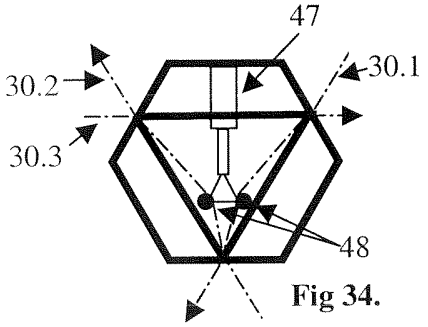


Fig 34.

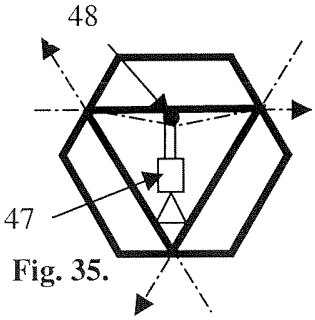
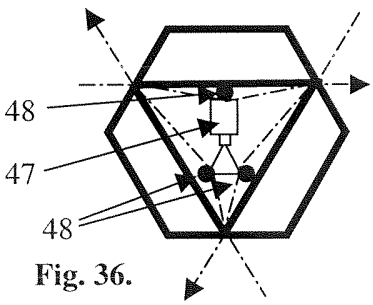


Fig. 35.



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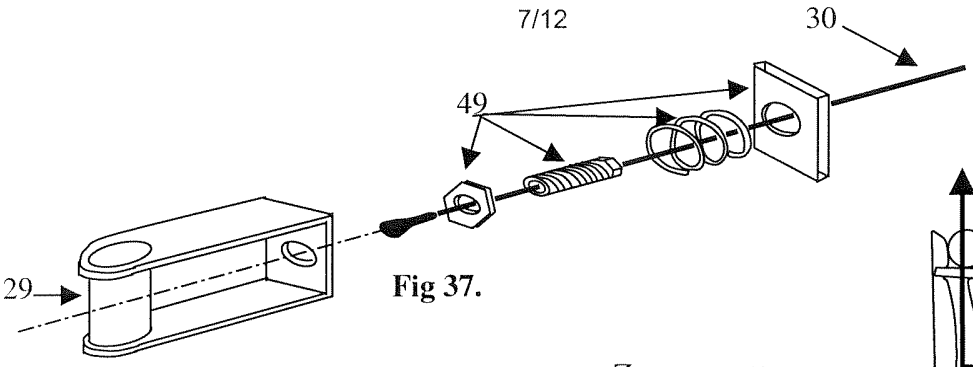

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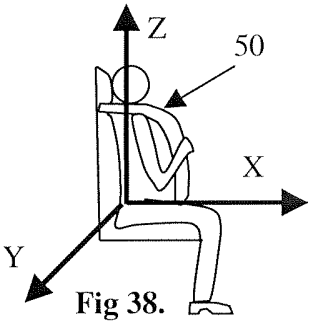

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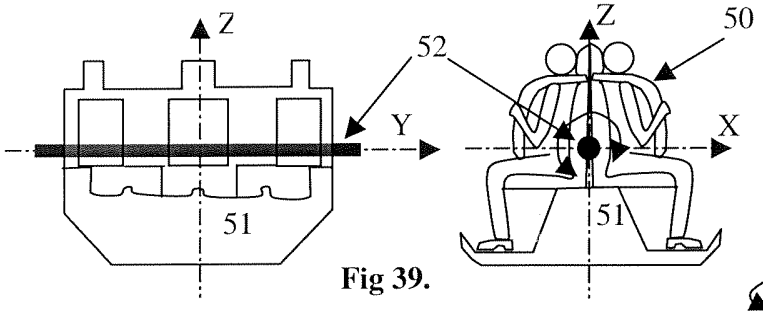

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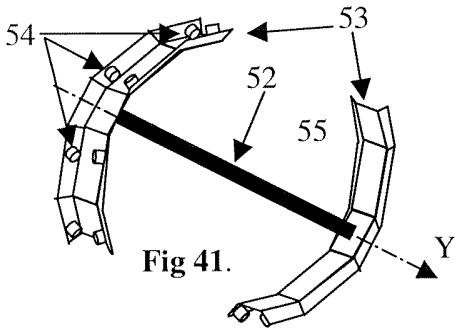

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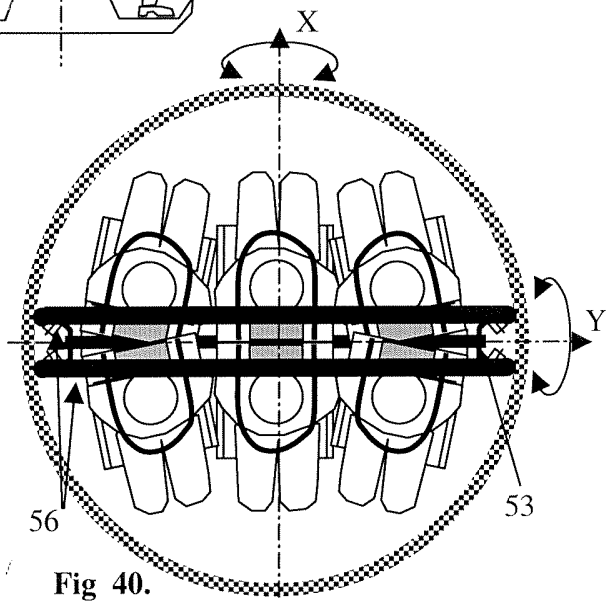

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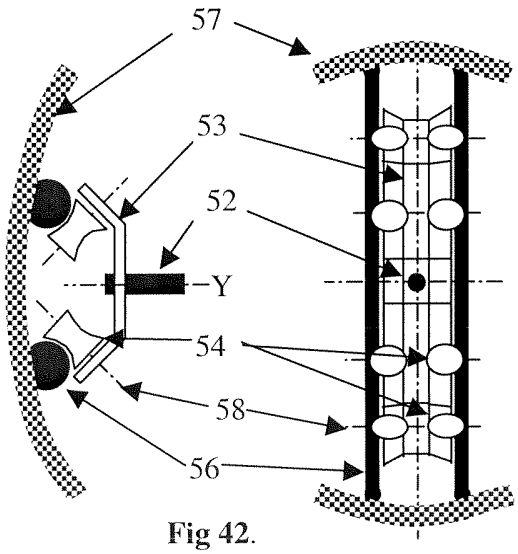

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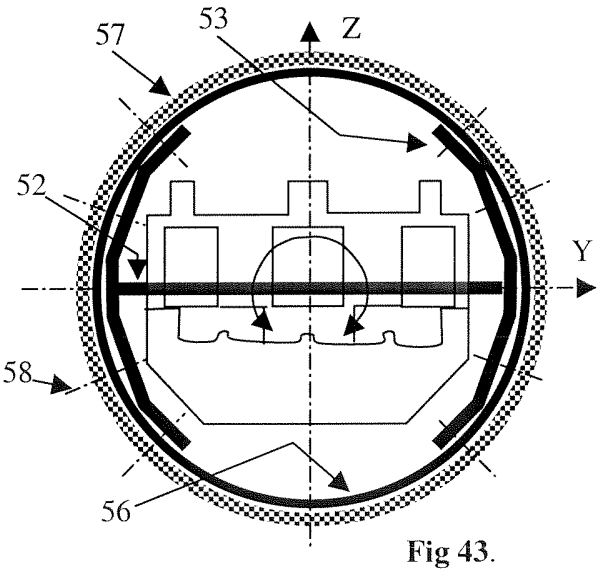

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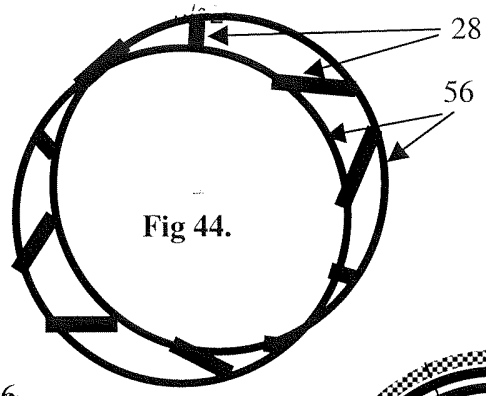

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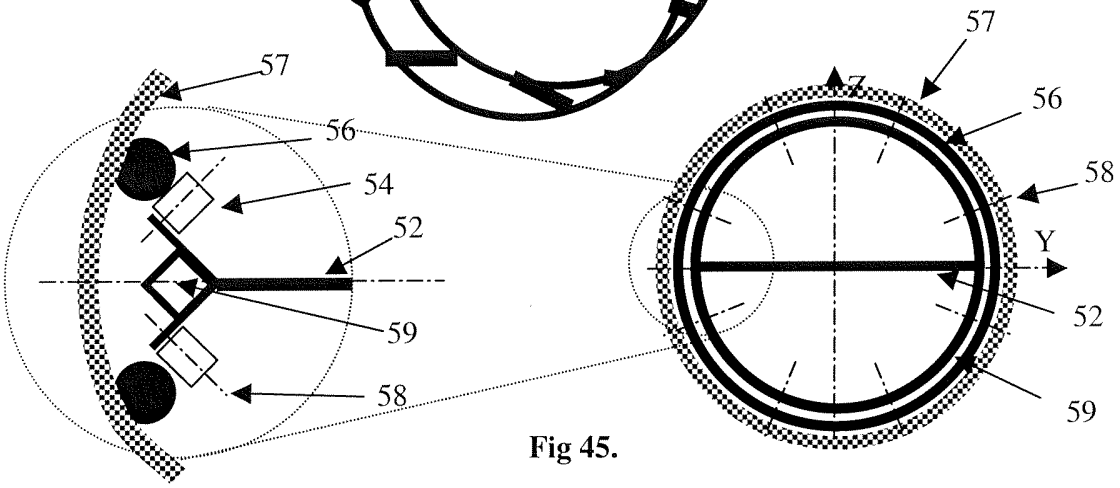

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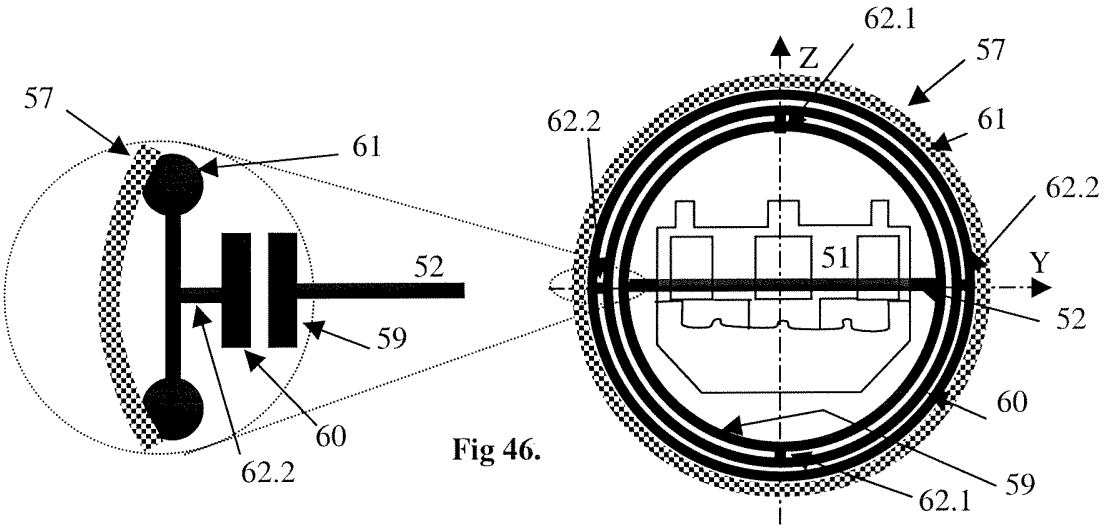

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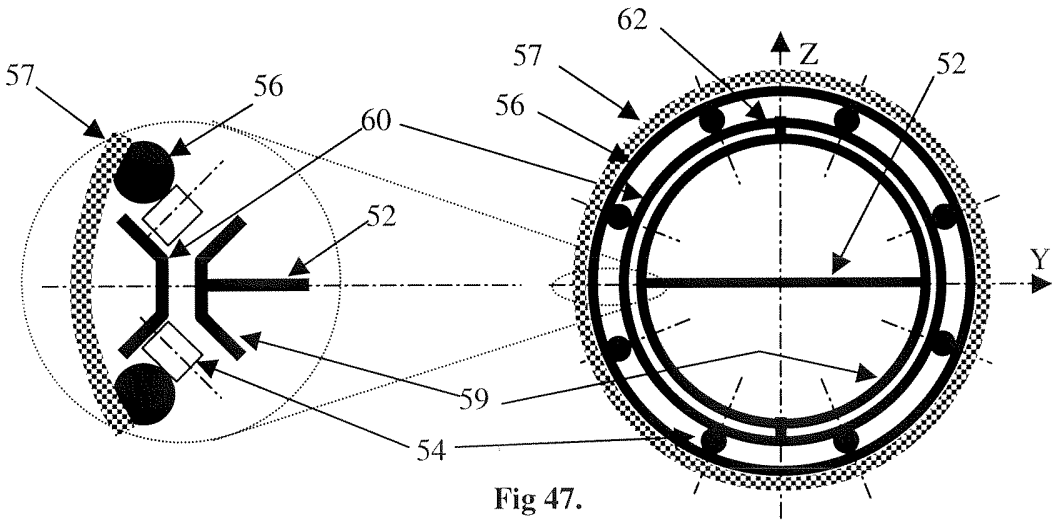

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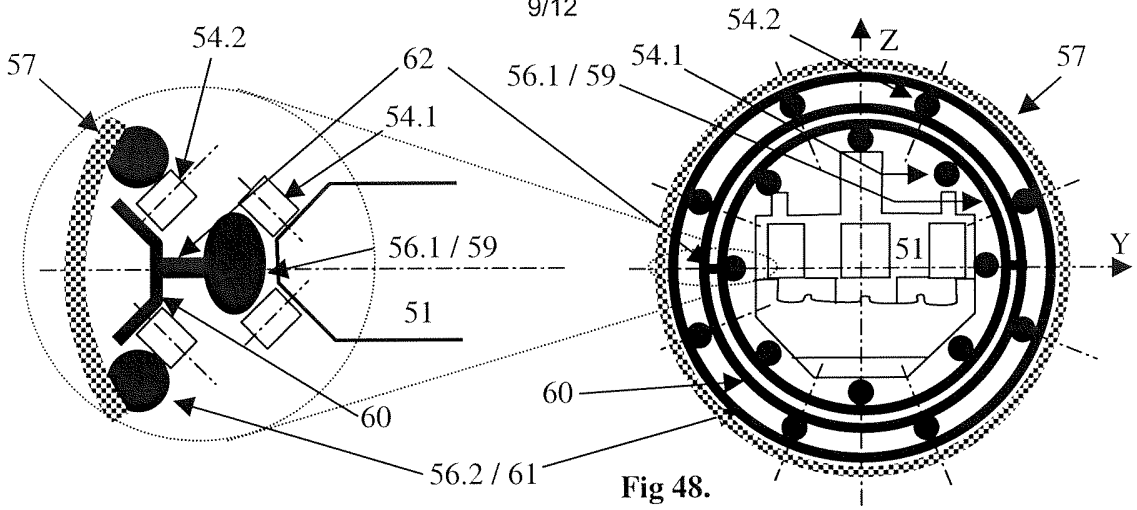

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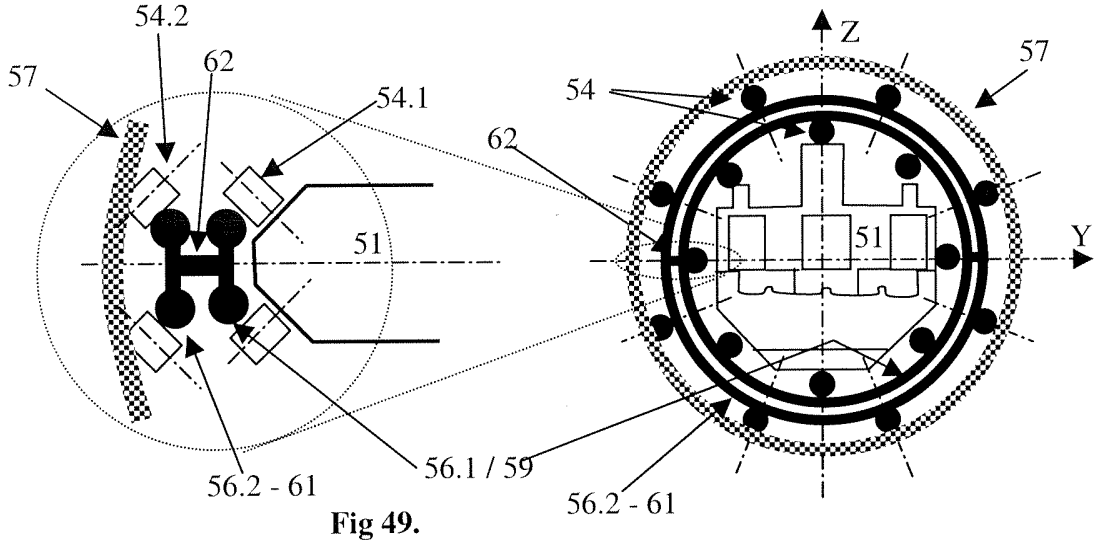

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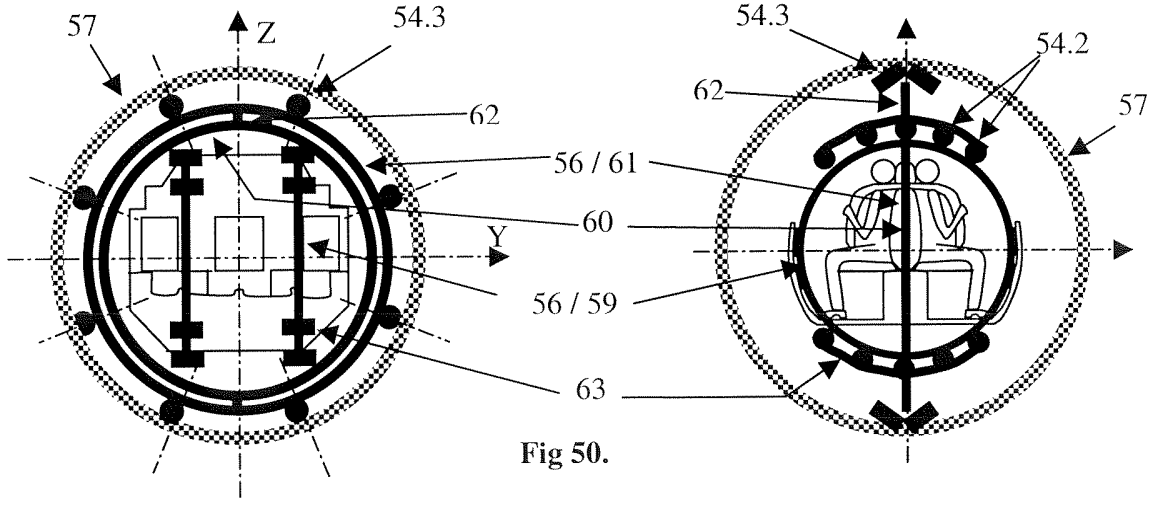

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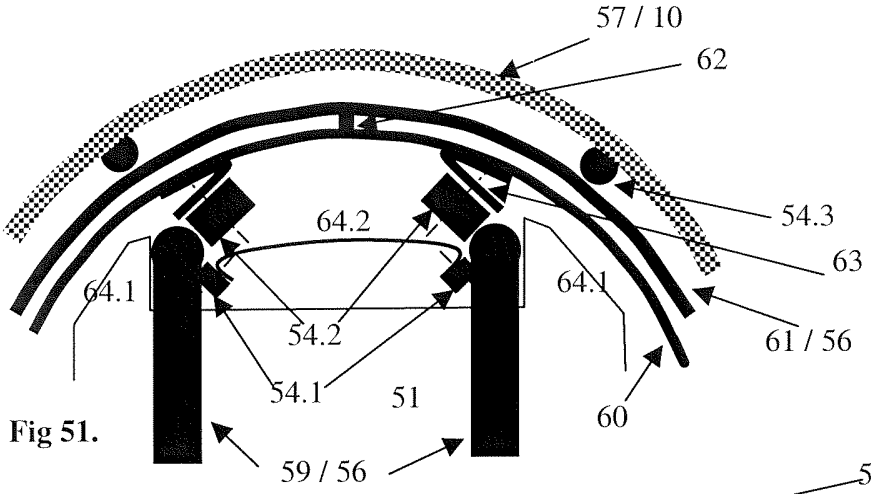

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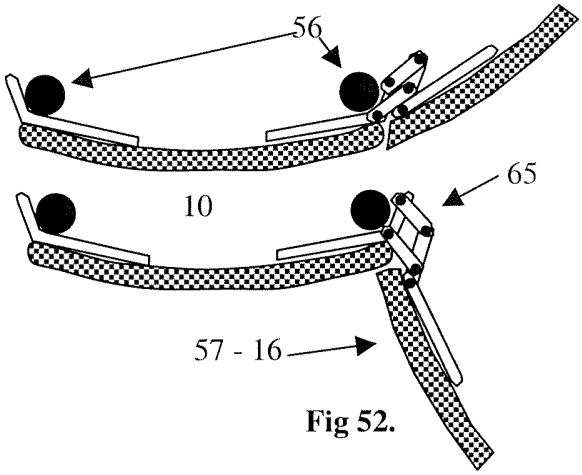

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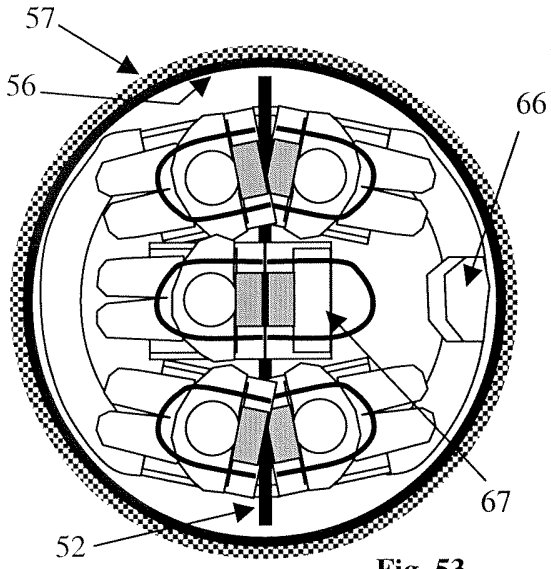

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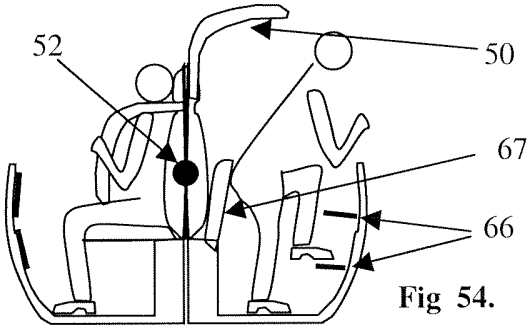

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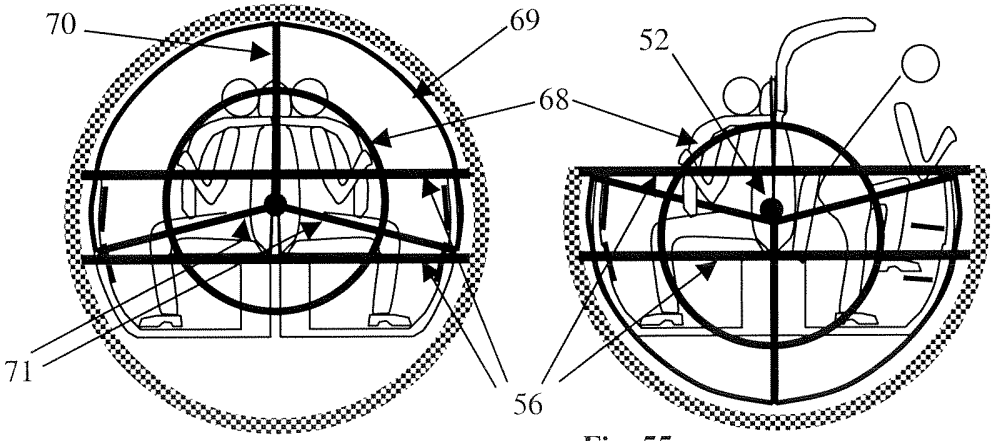

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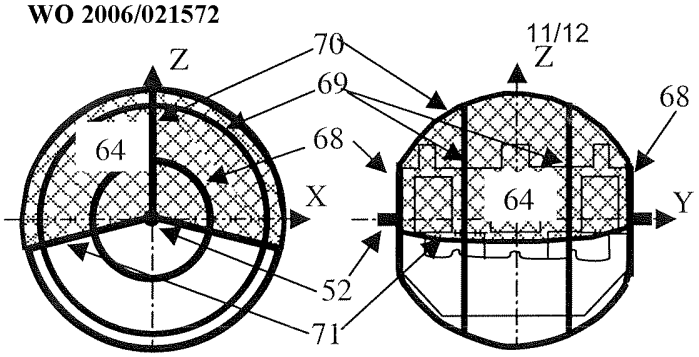

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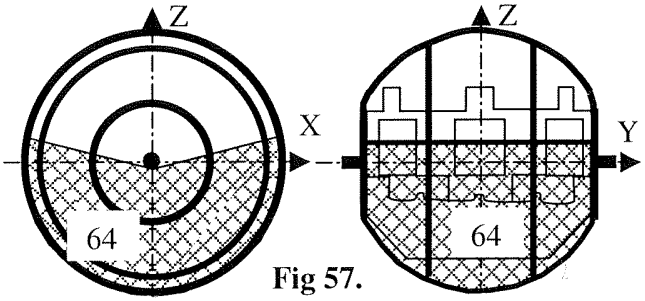

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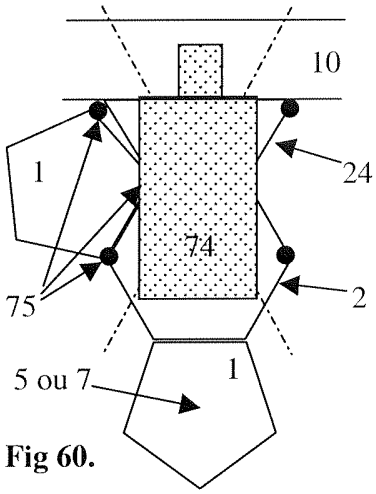

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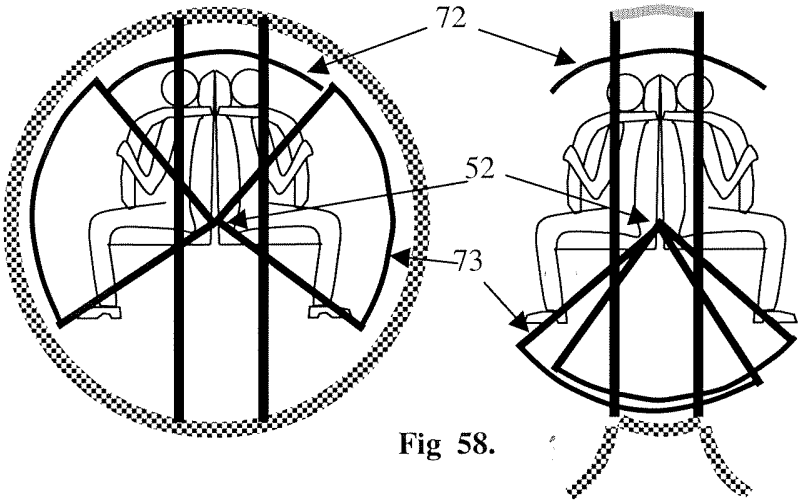

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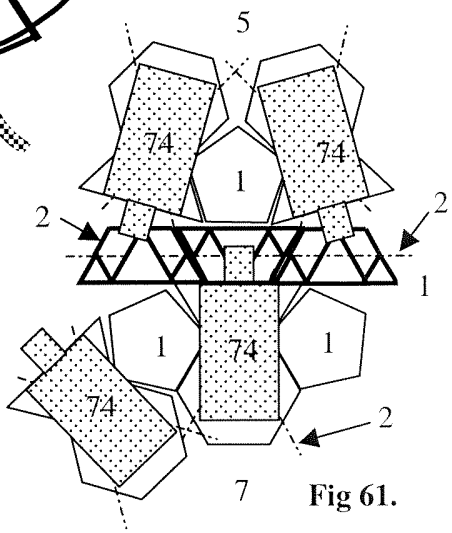

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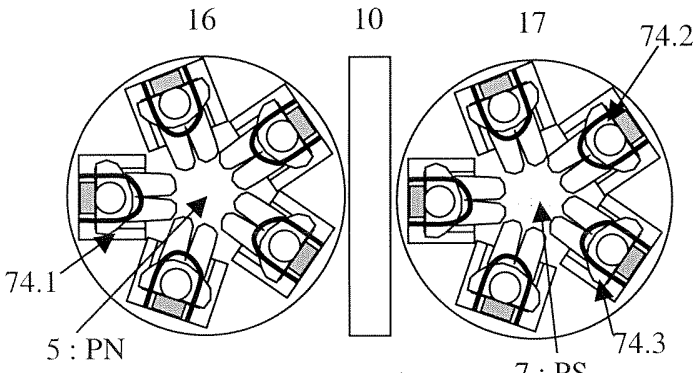

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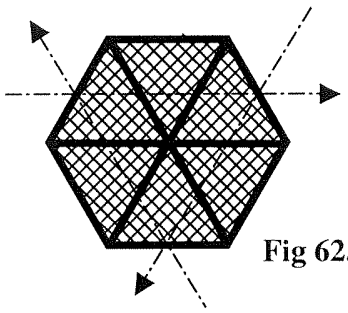

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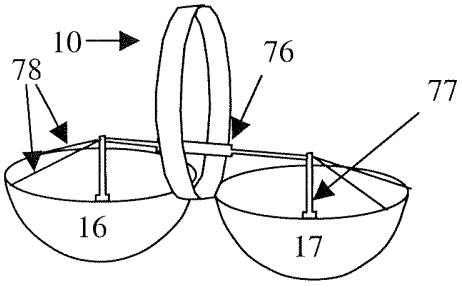

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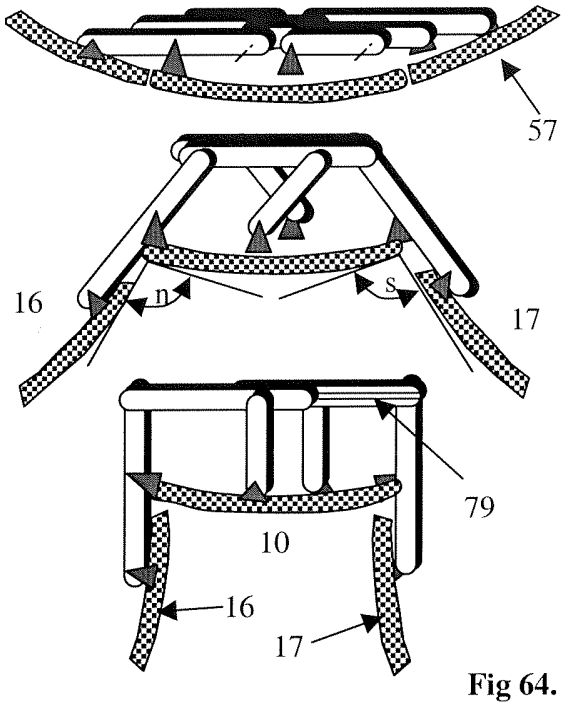

Fig 64.

INTERNATIONAL SEARCH REPORT

International Application No
PCT/EP2005/054170

A. CLASSIFICATION OF SUBJECT MATTER
A63G29/00

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)
A63G B62D A63B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X A	EP 0 159 052 A (ENTREPRISES ROBERT DELBRASSINNE) 23 October 1985 (1985-10-23) page 5, line 17 - page 9, line 19; figures 1-4,11,14 page 14, line 30 - page 15, line 17 page 17, line 22 - line 29	1-5,22, 27-30 5,18, 23-26
A	FR 2 493 167 A (EBERSOLT GILLES) 7 May 1982 (1982-05-07) the whole document	1,2,7,8, 11
A	US 4 501 434 A (DUPUIS ET AL) 26 February 1985 (1985-02-26) abstract; figure 2	2,22, 27-29
A	US 6 098 549 A (MARES ET AL) 8 August 2000 (2000-08-08) abstract; figures	22-26

☐ *Further documents are listed in the continuation of box C.*

☒ *Patent family members are listed in annex.*

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"A" document defining the general state of the art which is not considered to be of particular relevance

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"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"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

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Date of the actual completion of the international search	Date of mailing of the international search report
24 January 2006	03/02/2006

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Bagarry, D

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/EP2005/054170

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 0159052 A	23-10-1985	NONE	
FR 2493167 A	07-05-1982	NONE	
US 4501434 A	26-02-1985	NONE	
US 6098549 A	08-08-2000	NONE	