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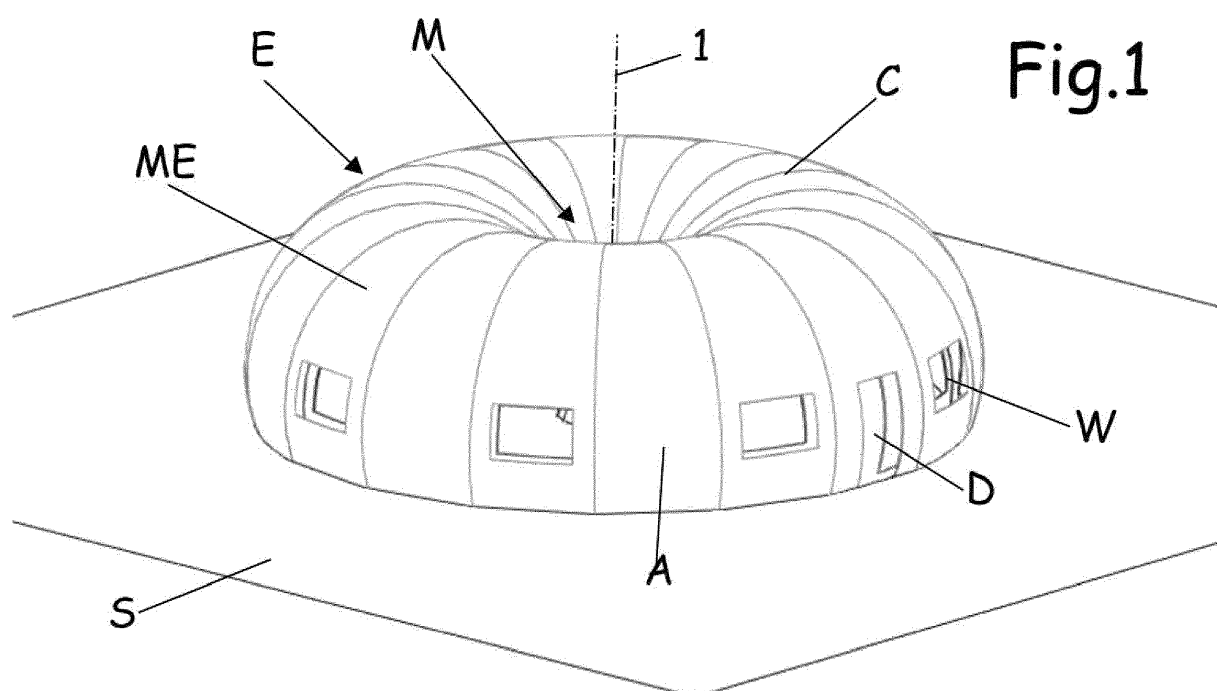
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(54) **A METHOD FOR THE THERMAL AND ACOUSTIC ACTIVE TYPE INSULATION OF BUILDINGS AND BUILDING MADE BY THIS METHOD**

(57) A method of active thermal and acoustic insulation for buildings, characterised by two layers, one encompassed by the other, never in contact, self-enclosed and entirely enveloping the entire inhabited space, made up of all outer and inner walls, and the floors and roofs of the building. The space between the two layers generates a single hermetically sealed volume. The volume can also be internally divided using ducts-including on several levels-acting as flow conveyors. The objective is

to collect, through the layers, all the different temperatures present both inside and outside the building, causing a convective motion of the fluid or fluids present within the volume between the two layers, seeking the optimum thermal equilibrium. This method also allows the achievement of a degree of vacuum in the entire volume described above or in one of the layers of channels it may be divided into, to recover energy and to counteract seismic waves.



Description

[0001] A method for the thermal and acoustic active type insulation of buildings and building made by this method.

[0002] This invention aims to provide a method of active and dynamic thermal and acoustic insulation for buildings, as well as buildings manufactured using this method. The current thermal insulation technique for buildings is typically passive, in that it calls for the insertion of thermal and acoustic insulation materials, with pre-defined dimensional and physical characteristics, into the floor level and the side and upper surfaces of the building envelope, to reduce heat loss to the surroundings as much as possible, while simultaneously preventing heat, cold and noise from entering the rooms of the buildings. This invention introduces a thermal and acoustic insulation system for large or small-scale buildings, characterised by two suitably spaced enveloping layers, never in contact with one another.

[0003] These layers can be parallel (for buildings with flat walls), "offset" using a numeric parameter (in the case of regular and/or irregular curved walls), or in a variable free-form, whether mobile or with either increased or decreased separation, including point-to-point modification between the two layers (ME, MI), or a modification of the positioning of a one layer in relation to the other. In each of these situations they contain a single, hermetically sealed, volume. The two layers and the single volume they encompass constitute the entire wall system, made up of all the building's perimeter and interior walls (roof, floor and foundations), and delimit the entire living space for all possible purposes; whether thick or thin walls, whether inside the house to divide the various rooms or used as partitions for outdoor spaces.

[0004] The volume enclosed by all the walls creates a unique, undivided geometric continuity for each building or complex of buildings, if placed in contact with each other. The two layers can be produced in different materials of differing thicknesses, and different materials of differing thicknesses can be used in the same layer. Naturally, suitable materials offer their own advantages, chosen according to weather conditions, the specific characteristics of the building or the material type. For example, to allow for the production of one or both layers, in their entirety or in sections, in a transparent material that encourages the greenhouse effect, thereby increasing the temperature of the fluid within the enclosed volume. The enclosed volume, which encompasses a fluid (air, gas, etc.), can be fully open (i.e. undivided) or divided into the most appropriate manner. These divisions can be longitudinal, creating "subdivisions", or horizontal, creating "layers", using bulkheads or ducts of various materials, fixed or movable in both directions, changing the position or the geometry, and thus the shape and the volume, acting as structural flow conveyors, creating channels, whether integral with the layer (as a grouped band of channels) or totally autonomous in the materials

of the layer, hermetic or otherwise in terms of the volume (VO).

[0005] These channels can be placed horizontally, vertically, radially, or diagonally relative to the building, with the option of a different layout for each level, in varied dimensions, mobile and variable in number, both per subdivision and per level. The aforementioned ducts can also intersect according to various formats; their path is not obliged to remain on the same level, but has the possibility to jump between them, with alternations dictated by the project requirements and opportunities.

[0006] The process described above has the aim of collecting, through the layers, all the different temperatures present in each point of the entire building, bringing them together through a convective motion, either natural or encouraged by fans, of the fluid present in the single volume, possibly divided by flow conveyors into multiple subdivisions or levels.

[0007] The temperature differences in the various points of the two layers can be generated in many ways. For example, the sun acts on the outer layer, while internal walls can be affected by independent heating systems or the presence of people.

[0008] The system may include one or more containers of water or other fluid placed inside the building, preferably in contact with the walls, so as to act as heat absorption and release devices, collecting heat from the walls and releasing it during the cooler hours.

[0009] Naturally, in seeking the optimum thermal equilibrium, in which the entire system of this invention must best fulfil its thermal insulation function, careful planning will be crucial, including in light of future experimental data, which may also propose new models of buildings, rethinking the concept of inhabited space. Of course, this process can be constructively applied in its fixed form, relying only on natural action, perhaps with the option to use inexpensive materials, thereby yielding lower results. However, if the design is accurate and/or includes the use of motorised systems to put everything in motion, managed by computers, software and sensors, and using more appropriate materials, it is likely to yield more interesting results. The process can also be applied during renovations of existing buildings.

[0010] Unlike in new constructions, where the entire wall system is involved in the process, in existing buildings it will be put into place on a partial scale, generating equivalent results through careful planning.

[0011] The windows and doors to the building can be constructed normally, creating a small discontinuity but not preventing the convective movement of the fluid, or special doors and windows can be created, positioned carefully within the design, consisting of a double layer, mirroring the construction of the entire wall system.

[0012] Naturally, the layers of the windows will be made of a transparent material, such as glass or plastic. Between the walls of the ducts placed in contact with each other-particularly for those placed on different levels and in specific positions, i.e. where there is narrowing-

nozzles and/or valves will be placed, mobile or driven by natural pressure, with the aim of bringing together the fluid in one channel with the fluid in another channel.

[0013] Fluid migration may also take place in both directions. The speed difference generated by the convective motion inside the channels should cause the Venturi effect, naturally creating at least a partial vacuum (e.g. in the channels positioned on the level bordering the interior of the building), ensuring that the entire process will better perform its thermal insulation function for the implementation of the objective expressed above.

[0014] Vacuums offer the best thermal and acoustic insulation, and if particular conditions do not result in a successful Venturi effect, the use of mechanical means of suction is an option—such as pumps or even a household vacuum cleaner—acting on a single channel or all at the same time, having connected them in series. Having a single volume of fluid enveloping the entire building allows for a vacuum to be created very easily, either naturally through the channel system or through simple mechanical action applied to the entire volume or an equally effective channel level. In certain cases of specific extreme weather conditions, such as building positions in which the wind is very strong, with a continuous and constant intensity, a dedicated channel level can be installed, alongside the other channel levels described above, directly in contact with the outside, with nozzles/valves, mobile or driven by natural pressure, in the walls of the channels bordering the external surface affected by the wind. In this case a Venturi effect can be generated on the level of the channels placed on the outside of the building, as set out above, with the aid of the wind speed, creating a depression and then a suction of air to the outside, generating a vacuum in the channels placed on the outside level. Through the use of spacers for energy dissipation—spring, viscous or hysteretic—placed between the two layers (ME, MI), the oscillatory seismic action present in the outer layer (ME), transmitted through the ground, is reported to the layer (MI) in a dampened form, making the method appropriate for use in seismic areas.

[0015] Alternatively or additionally, the two layers may be spaced through the use of magnetic forces, to keep the inner layer stable, levitating within the outer layer.

[0016] Furthermore, the method can develop applications in the production of electrical energy, for example, by exploiting the convective motion of air (Fig. 16) through micro turbines (TU), thereby generating electrical energy.

[0017] In the above description the systems referred to as "mobile" are always activated and regulated through a computerised system with the help of specific software, regulated by various detection sensors placed in appropriate positions.

[0018] Earlier documents (US 4 006 856 and US 4 244 519) lay out the creation of buildings that are able to harness solar energy to heat or cool the interior rooms, with the same construction of channels in the roof, in the outer side walls and the floor, connected together in series to

form a closed loop—at least in terms of a cross-section of the building—and

with the means for solar rays to produce heat located in the top channel in the roof, while in the lower channel under the floor there is a heat storage centre, usually in the form of a bed of rocks. Valves, thermostats and fans are provided to obtain from the circuit, by the aforementioned method, the desired heating or cooling effects of the building's interior volume. They therefore refer to the heating systems of buildings, and not their thermal (and acoustic) insulation. Naturally, in terms of heating systems rather than thermal insulation, the role of thermal insulation is fulfilled by a system of passive, not active, insulating materials or technologies. As stated in the introduction, this invention offers a system of thermal and acoustic insulation for buildings that can be defined as active and dynamic, proposing the construction of the building with at least two layers, an outer layer and an inner layer.

[0019] The outer layer, according to a cross-section of the building, can be formed by a plurality of adjacent annular channels, placed on the most suitable vertical surfaces.

[0020] The annular channels have a lower section, measuring, for example, about $1/2 - 1/4$ of the perimeter of each annular channel, located below ground level so as to be sheltered from the weather and to be subject to the effects of the temperature of the soil itself i.e. geothermal energy.

[0021] The annular channels also feature an exposed section, affected by the sun and the atmospheric temperature changes in terms of day and night and summer and winter.

[0022] The annular channels of the outer layer are filled with a gaseous fluid (e.g. air, etc.) that, because of the temperature difference between the upper exposed section and the lower, not exposed section of the annular channels, is subjected to a convective motion, the speed and direction of which varies during day and night-time hours. The channels of the outer layer are made with one or more materials with good conductive properties and/or thermal permeability, such as aluminium, so that the fluid circulating is better subjected to the aforementioned temperature differences. Below the outer layer is at least one inner layer, also formed by multiple closed annular channels, in which air undergoes dynamic rarefaction to a greater or lesser extent, exploiting the circulation of the fluid in the outer layer, from which circulation suction can be derived, either through means similar to those of the Venturi effect or through the suction of small electric pumps, fed by the production and accumulation of electrical energy activated by the circulation of the fluid in the rings of the outer layer and/or from other possible renewable energy sources, including wind power, solar cells and the Seebeck effect, or through the application of a Stirling engine, generators in air or water channels, and/or others. Further characteristics of this invention and the advantages that can be derived are laid out more

clearly in the following description of some preferred uses, purely as an example, in the figures of the attached 8 tables of illustrations, in which:

- Fig. 1 illustrates a toroidal-shaped building in perspective, with the invention;
- Fig. 2 illustrates a partially sectioned version of the building from Figure 1 in perspective on a vertical plane;
- Fig. 3 illustrates a partially sectioned version of the building from Figure 1 in perspective on a vertical plane, showing a section of the channels within the volume (VO) according to the subdivisions and levels;
- Fig. 4 illustrates a sectioned version of the building from Figure 1 in perspective on a vertical plane, containing the axis of revolution of the primary circular structure that forms the same toroidal building, showing a section of the channels within the volume (VO) according to the levels;
- Fig. 5 is a top plan view of the building shown in the previous figures;
- Fig. 6 illustrates a cross-section of two consecutive segments of the toroidal structure, as in section IV-IV of figure 5;
- Fig. 7 illustrates a segment of the building seen from the interior part of the living space as indicated by the arrow (K) in Figure 4;
- Fig. 8, 9 and 10 illustrate a longitudinal section of the two layers that make up the building and the various possibilities in terms of the channels in each layer to implement the dynamic insulation of the building, according to the invention;
- Fig. 11 illustrates the application of the invention in a building with traditional architecture, shown here from a slightly raised perspective and partly cross-sectioned;
- Fig. 12 illustrates longitudinal sections of two channels according to the divisions (C) of Figures 1, 2, 3 and 4, two full consecutive segments of the toroidal structure;
- Fig. 13 illustrates the cross-sections of the two layers (ME, MI) placed in parallel to each other;
- Fig. 14 illustrates a cross-section of two portions of consecutive segments of the toroidal structure, as in section IV-IV of Figure 5;
- Fig. 15 illustrates a longitudinal section of two channels, according to the divisions (C) of Figures 1, 2, 3 and 4, two full consecutive segments of the toroidal structure;
- Fig. 16 illustrates a cross-section of two portions of consecutive segments of the toroidal structure, as in section IV-IV of figure 5;

[0023] In Figures 1 to 4 a toroidal-shaped building (E) is illustrated, formed by the revolution about vertical axis (1), of a circular or polygonal figure (2), placed on an ideal vertical plane which contains said axis (1), which is in

turn outside of the circle or polygon (2). From the detail of Figure 4 it can be noted that the toroidal building is formed by a plurality of annular structures (A), of which plan views show a circular crown shape with wedge-shaped segments, with the widest portion (B) defining the outer diameter of the building and the narrowest portion (B') defining the inner diameter of the toroidal building (E), as the various sectors or segments (A) are reciprocally fixed in consecutive and adjacent areas (C) (see below). From Figures 1 and 2 it appears that the toroidal building (E) is submerged in the ground (S) for about a third of the circumference of the circular generator (2), labelled E', and that within the building (E) there is a floor (P) placed at a level equal to or preferably slightly higher than the floor level of the external ground (S). From Figures 3, 4 and 6 it can be noted that each segment (A) comprises at least one external annular channel (3) and at least one internal annular channel (4), reciprocally superimposed, and of which the external annular channel (3) is in contact with the atmosphere and is made wholly or at least partly facing outwards, with suitable materials for the collection and transmission of thermal solar energy to the inner walls of the same channel (3). The same applies to the internal channel (4), made at least in part with materials with good thermal insulating qualities, particularly the part facing the internal volume of the building (E).

[0024] In the external channels (3), for example in the areas (C) in which the segments (A) are reciprocally connected, and in the only part of the segments (A) which is exposed to the atmosphere, additional channels can be reciprocally positioned adjacent to and/or within the aforementioned channels, made up, for example, of bundles of tubes which can circulate the liquid, connected in series and/or in parallel.

[0025] Specifically, these bundles of tubes can be placed on the inner wall of the inner layer and/or on the outer wall of the outer layer, in order to create more convective movement.

[0026] In the connection areas between the various channels (3 and 4) adjacent to each other, materials and techniques capable of ensuring watertight connections will be used, to avoid the formation of thermal bridges between the inner volume of the building (E) and the atmosphere, in the event that construction was carried out through the adjacent installation of pre-assembled channels. For this purpose, the internal channels (4) may be staggered in relation to the external channels (3), rather than perfectly centred, as in the example in Figure 4, so that a channel (4) touches two consecutive sections of each pair of adjacent external channels (3) in equal parts. In the external (3) and internal channels (4) air may be present, without excluding the use of specific gases or other fluids as indicated below. The building (E), made in the manner described, will be provided with input and output doors (D) and windows (W) to allow for air renewal and for daylight to enter the building; these doors and windows (Fig. 1) may be affected by the channels (3 and

4), or the latter may be located outside and on the perimeter of the doors and windows (D and W). When the building is exposed to the action of the sun, the large temperature difference between the part of the external channels (3) that is exposed to the sun and the part of the channels (3) that is buried is such that a convective motion is automatically triggered, generating internal air circulation, for example in the direction indicated by the arrows (F1) in Figure 2. To effect the upward movement of the upper air heated in the part of the building exposed to the sun, the air at lower temperatures is reclaimed by the buried sections of the external channels (3) and rises toward the exposed, warmer sections of the same channels (3), creating an initial reduction of the heat towards the internal space of the building (E). Viewed in the direction indicated by the arrow (K) in Figure 4, the channels (3 and 4) of each segment (A) of the building (E), have an hourglass-shaped bottleneck (X), as shown in Figure 7, which causes the flow of air that circulates by convection in the channels (3) to increase speed and decrease pressure, so much so a small opening (6) between the channels (3 and 4) is created in this area (X); the external channel (3), for the Venturi effect, tends to draw air from the internal channel (4), emptying it, as indicated by the arrows (F2) in Figure 8, significantly improving the thermal insulation qualities of the coating formed by the internal channels (4). The vacuum creates the best conditions for both thermal and acoustic insulation. In Figure 8 the aforementioned opening between the channels (3 and 4) in said bottleneck (X) is labelled as 6, and 106 indicates a unidirectional valve that intercepts said opening (6), and which is activated by an servocontrol (7) through which the valve (106) can be brought from the closed position to the open position and vice versa. The servocontrol (7) is connected to an interface (8) governed by a microprocessor (9), which receives information related to the outside temperature and the temperature inside the building (E) from at least two thermometers (10 and 11), and which is connected to at least one anemometer (12) that detects the direction and intensity of the air flow in at least one external channel (3), and which is preferably also connected to at least one vacuum switch (13) which detects the degree of depression in at least one internal channel (4). The invention also offers the constructive possibility illustrated schematically in Figure 10, according to which the internal channels (4) are not in communication with the external ones as in the previous hypothesis, but are connected together by means of a manifold (14), involving at least a small electric pump (15) which sucks air from the same channels (4) and discharges it to the outside atmosphere through the duct (16) and a check valve (17). The processor (9) will be paired with software that, in relation to the internal and external temperature variations of the building and/or other parameters, will automatically activate the opening and closing of the aforementioned unidirectional valves (106, 106') or automatically activate or deactivate the aforementioned electric pump for the vac-

uum (15) or to enable or disable the hydraulic pump for the forced circulation of hot liquid in the radiant tubes (5) of the external channels (3), to ensure building automation with the best thermal and acoustic efficiency that can be attained through the various means available. The same software can also be used to control the automatic and temporary opening of the windows (W) to ensure the necessary ventilation of the building's interior volume, while respecting the optimum thermal and acoustic performance of the entire system. The invention also offers the application of the principle of active and dynamic insulation, first demonstrated for a toroidal-shaped building, for diverse architectural styles-including traditional-such as that shown in Figure 9, where the part of the building exposed to the atmosphere is labelled E", while the part of the building submerged in the ground (S) is labelled E''' . The building (E'') is in this case formed by two parallel rows of adjacent annular structures (2', 2'') in the form of an isosceles trapezium, with the larger bases positioned at the inside and at the ridge of the double sloping roof (H1 and H2). In this case the annular structures (2', 2'') are formed by external channels (3) and internal channels (4), as in the solution demonstrated with reference to the preceding figures. For this type of structure, the external channels 3 can be equipped with bottlenecks transversally or in the direction of the depth, to create the aforementioned Venturi effect for the removal of air from the internal channels (4), or it may be advantageous to apply the solution described with reference to Figure 8 to the same end, which does not require the presence of such bottlenecks. It is therefore understood that the invention offers numerous variants and modifications in terms of construction, without abandoning the principle of the invention, as described and illustrated, and as claimed below. In the claims, the references given in brackets are purely indicative, and do not limit the scope of protection of the claims.

Claims

1. A method for the thermal and acoustic active type insulation of buildings, **characterized by** the fact that the whole occupied space of the building is enveloped by two mantles contained the one into the other, closed in themselves and never in contact between theirs, in which the space comprised between said mantles is constituting a unique volume hermetically insulated.
2. The method according to claim 1, **characterized by** the fact that the volume comprised between said two mantles can be subdivided at its interior by means of canalizations also on several levels having the function of flow conveyers.
3. The method according to any one of the preceding claims, in which the volume comprised between said

mantles is filled with air or with a gaseous fluid which picks up through contact with said mantles all the temperature differences which are present both at the outside and to the inside of the building, thus causing a convective motion of the fluid present at the inside of said volume, to search for the better thermal equilibrium.

4. The method according to any one of the preceding claims 1 to 3, in which in the volume comprised between said two mantles a certain degree of depression or of void is preferably formed.
5. A building thermally and acoustically actively insulated according to the method of claims 1 to 4, **characterized by** the fact that all the external outer walls of the building as well as all the internal party walls of the building, as well also the floor, ceiling, roof and the foundations of the building are formed by two mantels (ME, MI) made from suitable materials, closed in themselves and never in contact containing between their distance a volume (VO) unique and hermetically closed, inside of which are circulating by convective motion rarefied gaseous fluids (F1), the said volume (VO) being canalized also at more levels (3, 4) and subdivision.
6. The building according to claim 5, in which at least the channels of the external mantle (3) of the building are provided with transversal throttled section, or the throttled portions (X) that said external channels (3) forms with their section in correspondence of the central wall (M) of the building and in said throttled zones are formed openings (6) provided with valve means (106, 106') for connecting said external channels (3) with internal channels (4) and for exploiting the suction effect which is formed in the external channels (3) in correspondence of the said throttled portion (X), by means of which it is possible to suck air from the internal channels (4) and by consequence it is possible to void them, thus improving their features of thermal and acoustic insulation.
7. The building according to claim 6, wherein said valves (106, 106') for opening and closing the bores (6) of communication between the external channels (3) and the internal channels (4) in correspondence of the said throttled portion (X), are of the kind of the clapet valves and are operated by a servo control (7) connected to an interface (8) controller by a micro processor (9) and by the thermometers (10, 11) receiving the information relating to the external and internal temperature of the building (E) and which is connected to an anemometer (12) detecting the direction and the intensity of the air flow in the at least one internal channel (4), the said microprocessor (9) being provided with an output unit (20) for feeding, through a suitable interface, of at least one pump for

the forced circulation of the hot liquid between said accumulator (T) and the external Exchange elements (5, Z).

8. A building (E") according to anyone of claims 5 to 7, **characterized by** the fact that it is formed by two parallel rows of tubular structures (2', 2'") disposed side by side having the shape of a isosceles trapezoid with the main basis disposed inside and in correspondence of the roof which, for example has two sloping sides (H1, H2) the said annular structures (2', 2'") being formed by the overlapping of external channels (3) and internal channels (4) in which the void is formed by sucking means (6, 106, 6', 106') operating by Venturi effect or through small electro pumps (15).
9. The building according to one or more of the preceding claims 5 to 8, **characterized by** the fact that it comprises in association with the said processor (9), a software which in function of the variations in the internal and external temperature of the building (E', E") and or of the other parameters, control automatically the opening and closing steps of the said clapet valves (106, 106') or to automatically activate or deactivate the said electro pump of the void (15) or to activate or deactivate the said hydraulic pump and/or the means for the circulation of the hot liquid on the radiant pipes (5) of the external channels (3), in order to assure that the building may function automatically with the best thermal and acoustic efficiency which can be obtained by the predisposed means.
10. The building according to one or more of the preceding claims 5 to 9, **characterized by** the fact that it comprises an increase or a decrease of the distance between the two mantles (ME, MI) in selected points or in specific parts or a modification of the positioning of a mantle with respect to the other (Fig. 12) through the use of electric actuators (AL) to better adapt the method to the variation of the temperatures.
11. The building according to one or more of the preceding claims 5 to 10, **characterized by** comprising a change in the trim both in the subdivision and in the level of the channels (Fig. 13) which are in the volume (VO) confined between the two mantles (ME, MI) through the rotation with respect to an axis (1') of light constructive elements (CR) the two mantles (ME, MI) being hold by distance pieces (DI) the said rotational action being obtained through the use of electric actuators (AR) in order to adapt better the method to the variation of the temperature.
12. The building according to one or more of preceding claims 5 to 11, **characterized by** the fact that it comprises (Fig. 14) a level of dedicated channels (3') in contact with the mantle (ME) positioned toward the

exterior, in which on said mantle (ME) are mounted clapet valves (VC) which under the action of the wind (VE) permits the exit of air (AA) from the volume (3'), by producing more or less rarefaction of the air in the volume (3') thanks to the action of the wind producing by Venturi effect a depression. 5

13. The building according to anyone of the preceding claims, **characterized by** the fact that the two mantles (ME, MI) are structurally acting like two shells (Fig. 15) positioned the one inside of the other, in which the oscillatory seismic action present in the mantle (ME) transmitted by the ground is transmitted to the mantle (MI) in a damped form through the use of energy dissipation spacers like a spring or viscous or hysteretics (DE). 10 15

14. The building according to anyone of the preceding claims, **characterized by** the fact that the convective movement of the air (Fig. 16) feeds micro turbines (TU) which are apt to the generation of electric power, which are mounted inside said channels and are also disposed in correspondence of the throttled portions (X) by exploiting the increase of speed of the fluid during the circulation inside of the channels. 20 25

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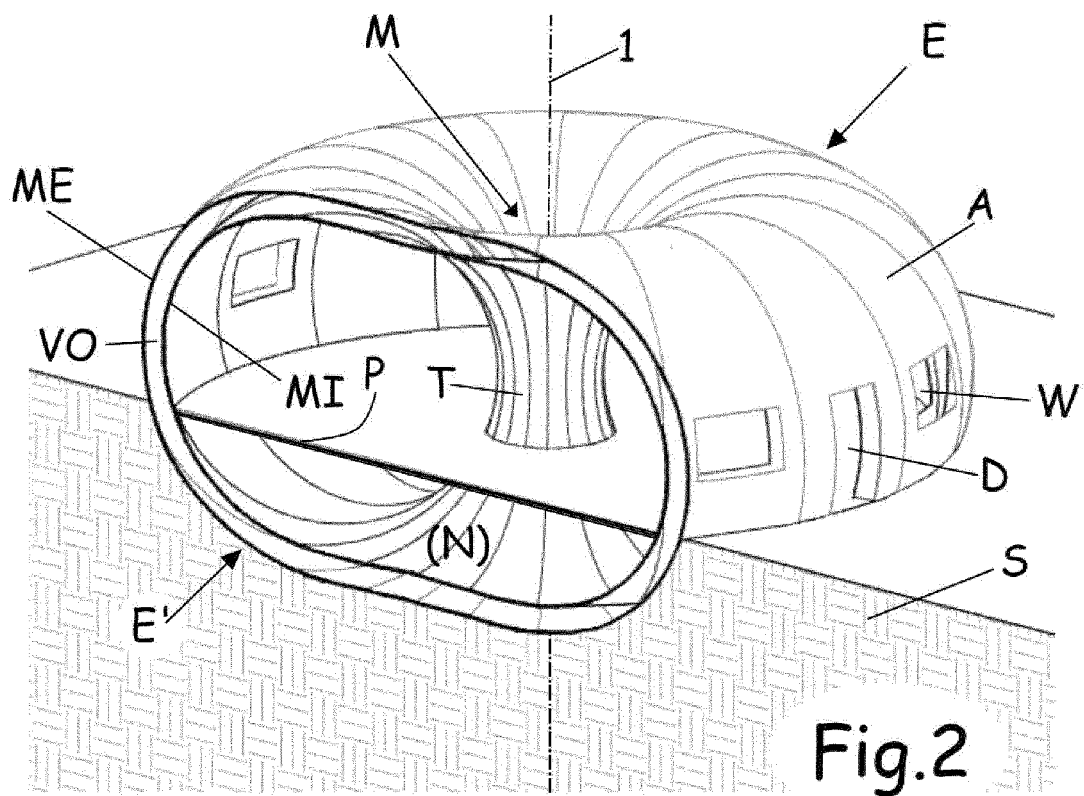
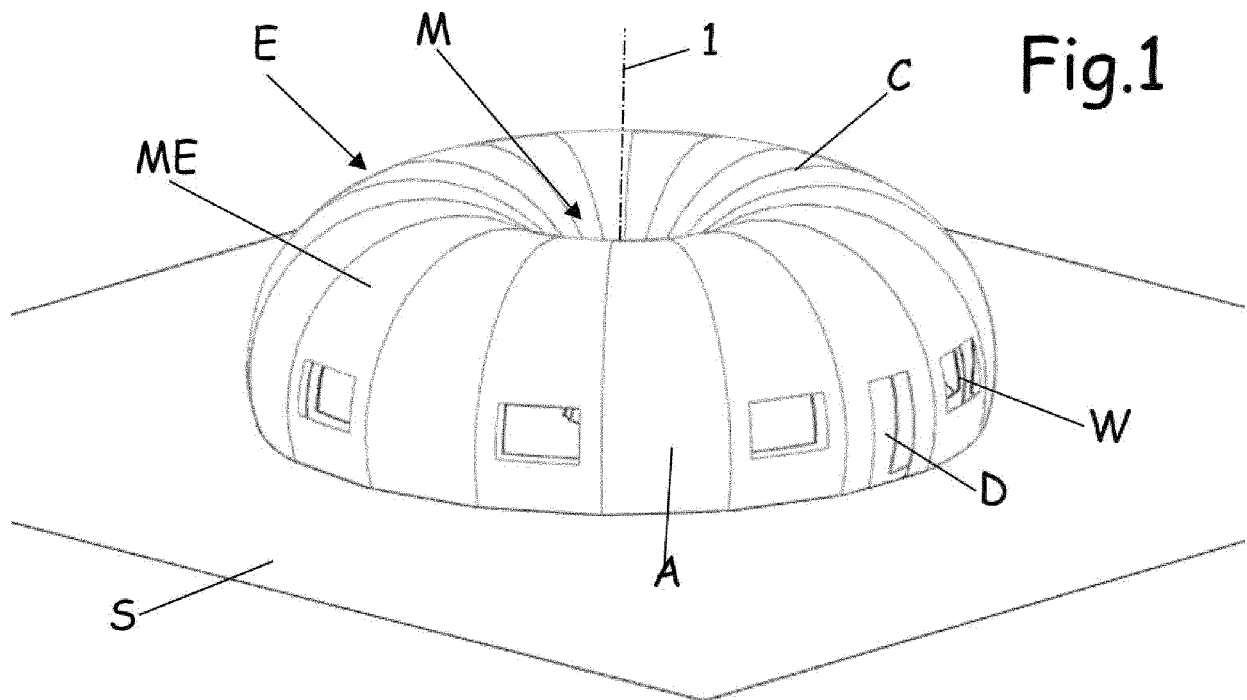
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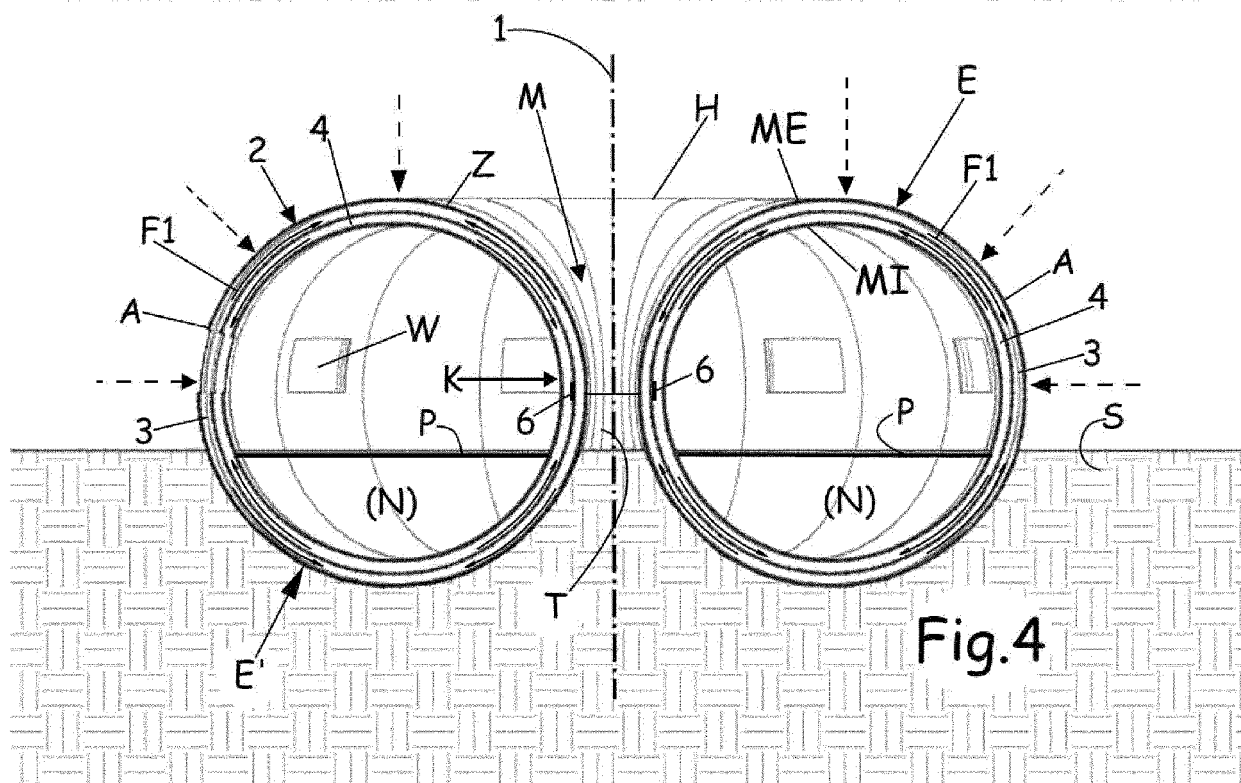
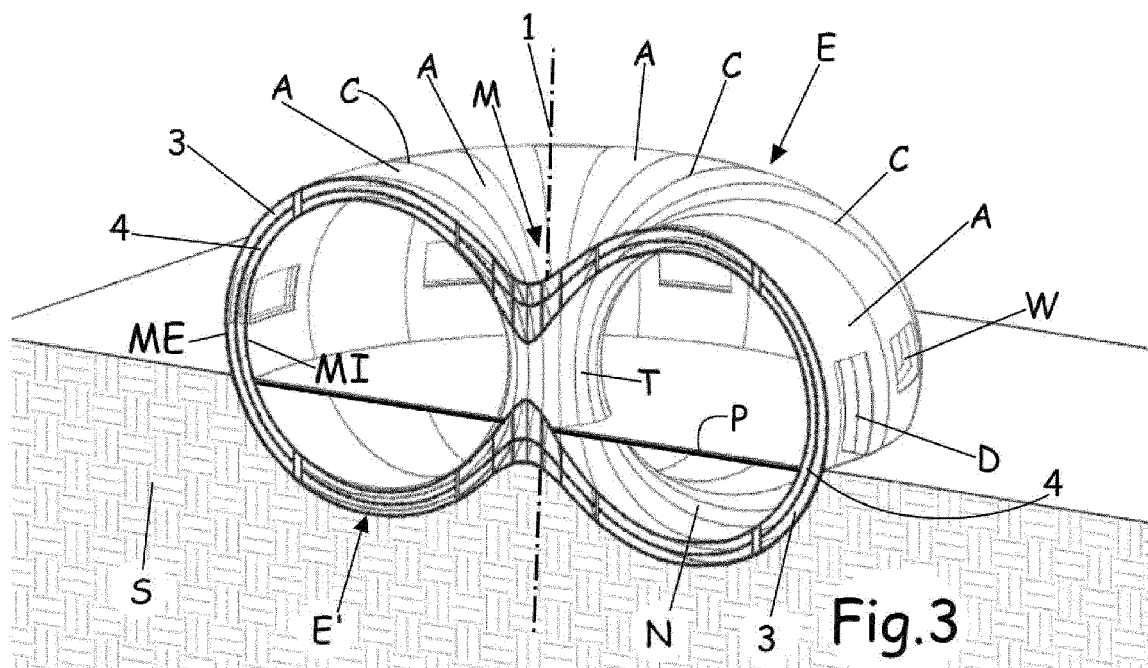
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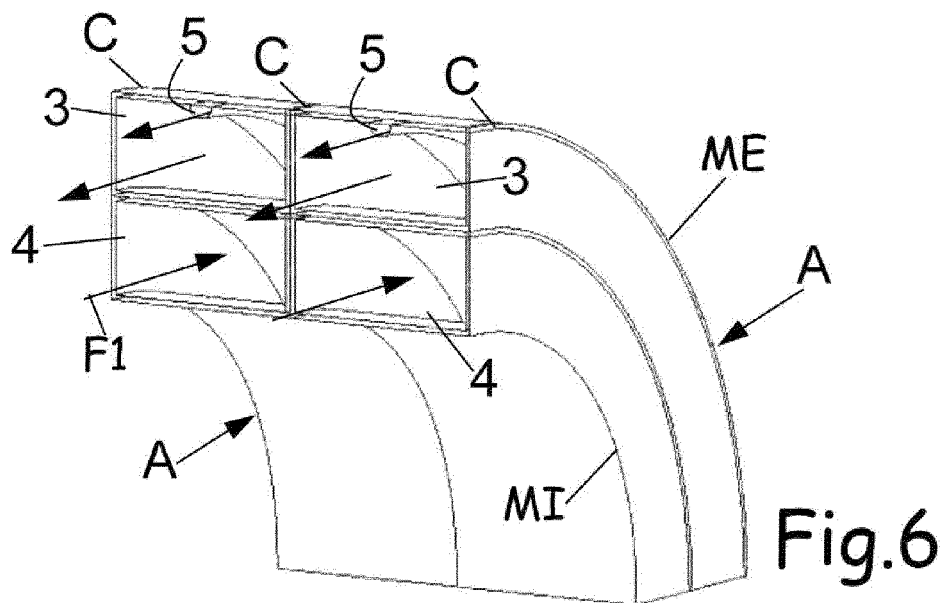
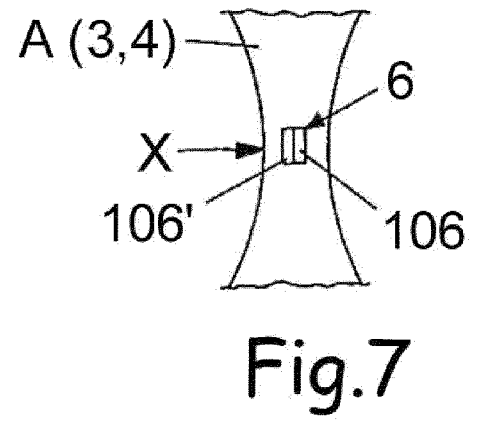
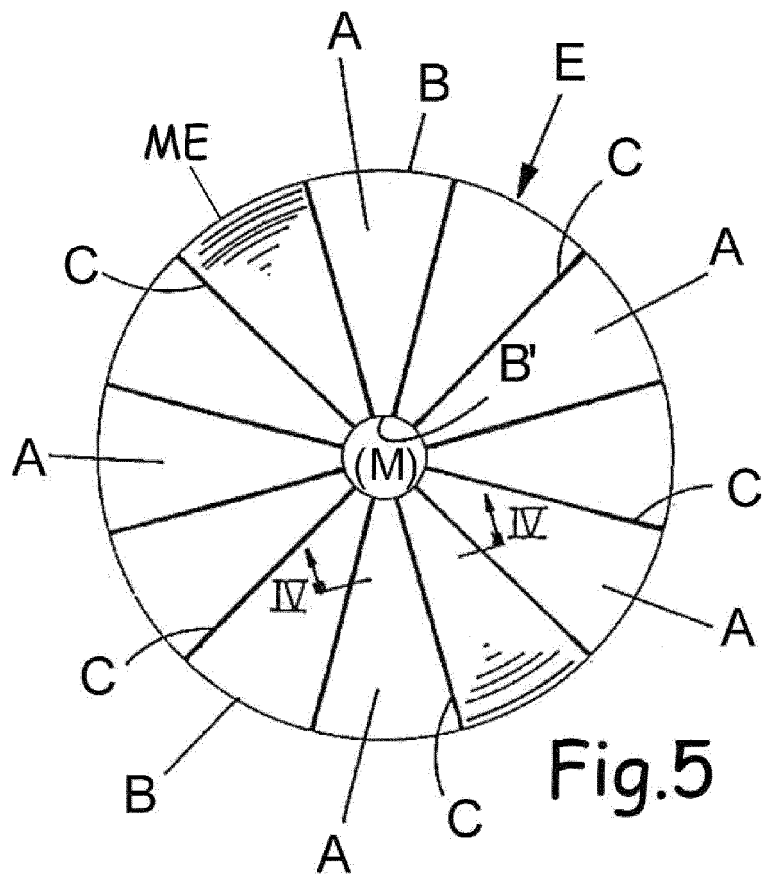
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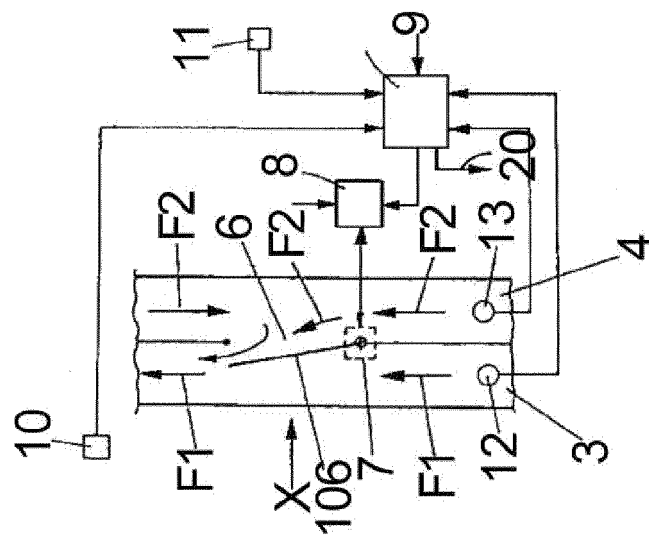


Fig. 8

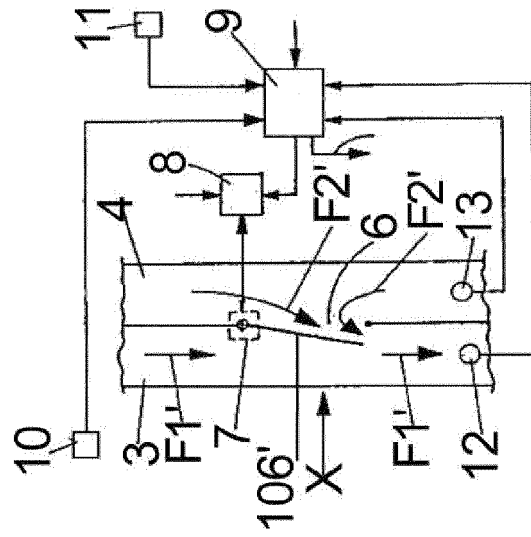


Fig. 9

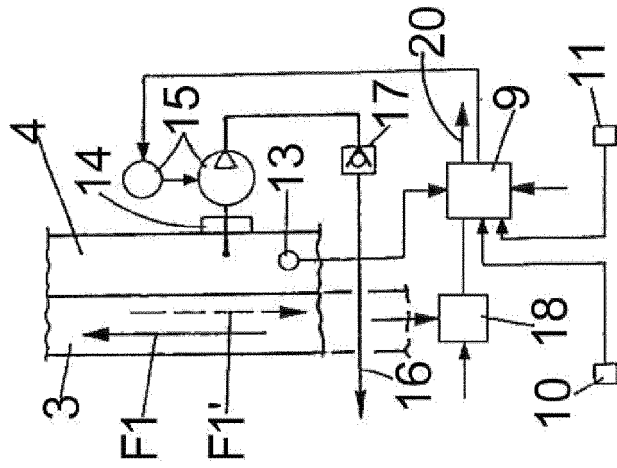


Fig. 10

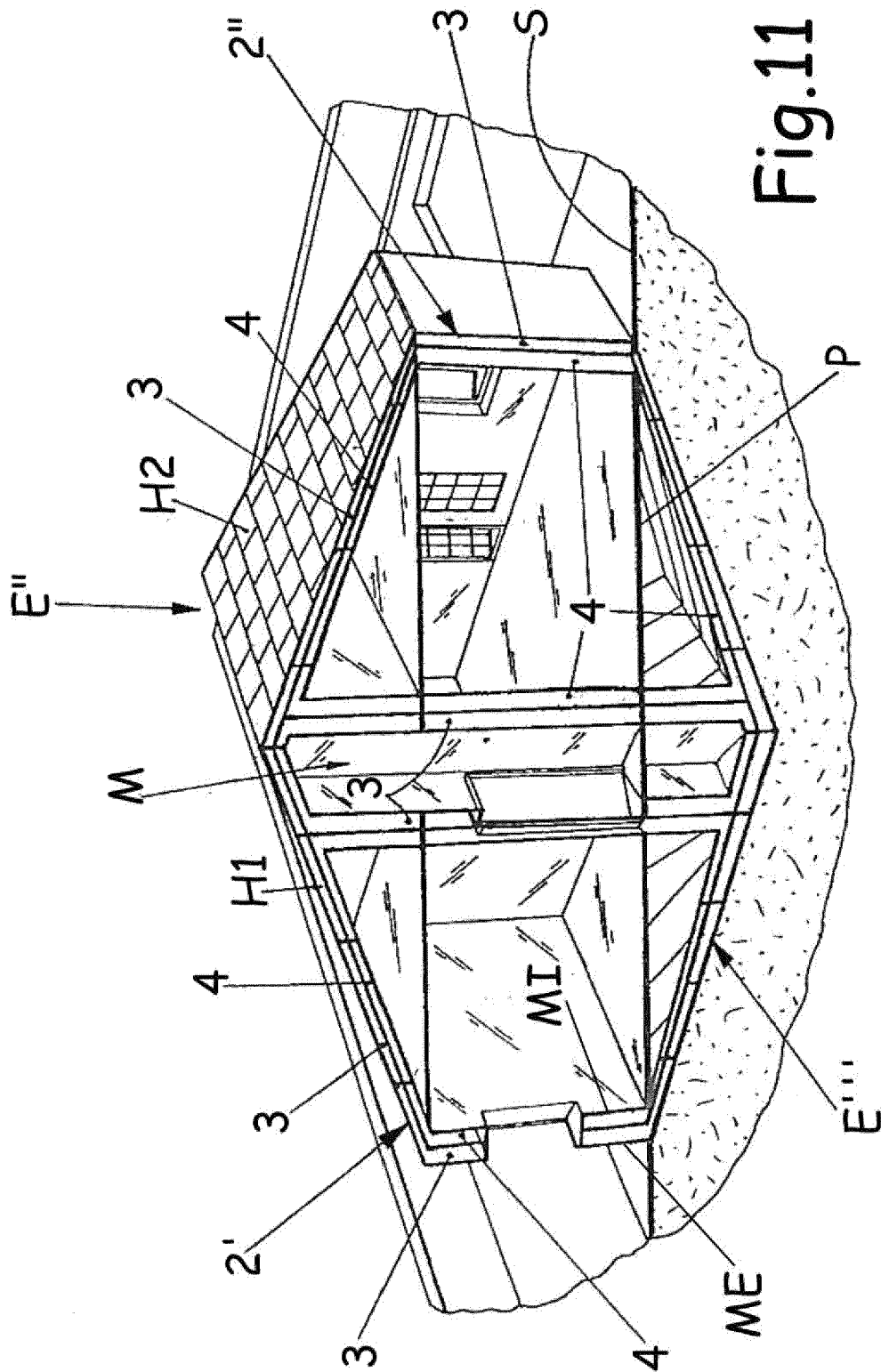


Fig.11

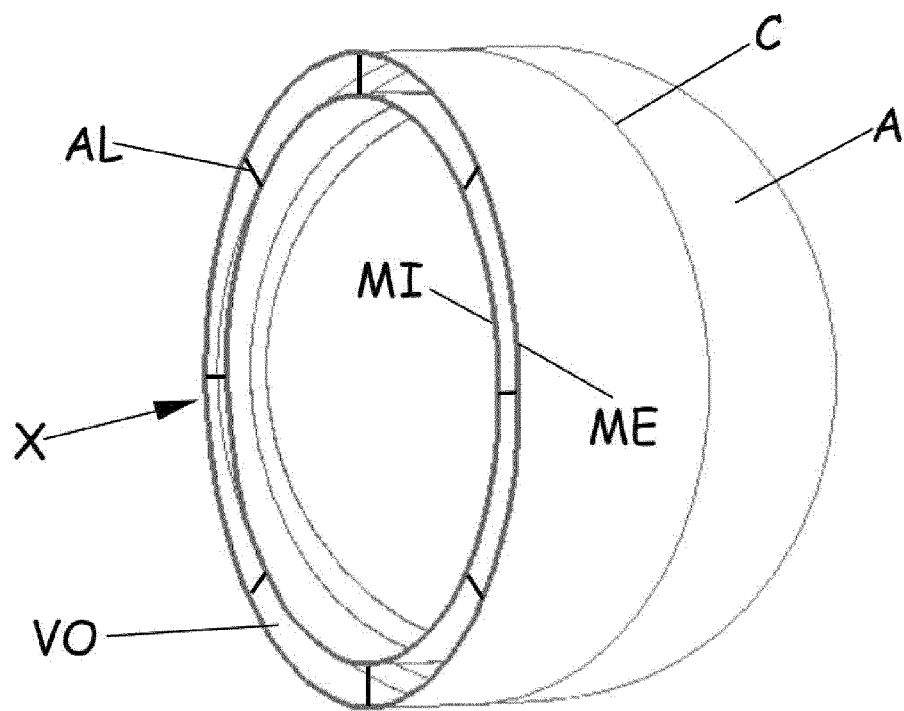


Fig.12

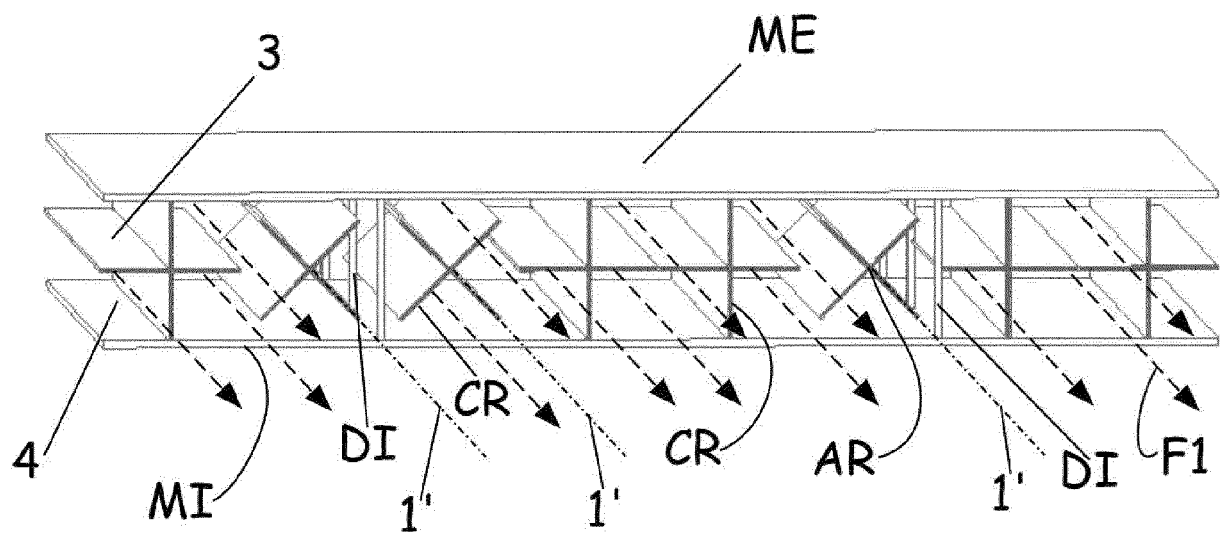


Fig.13

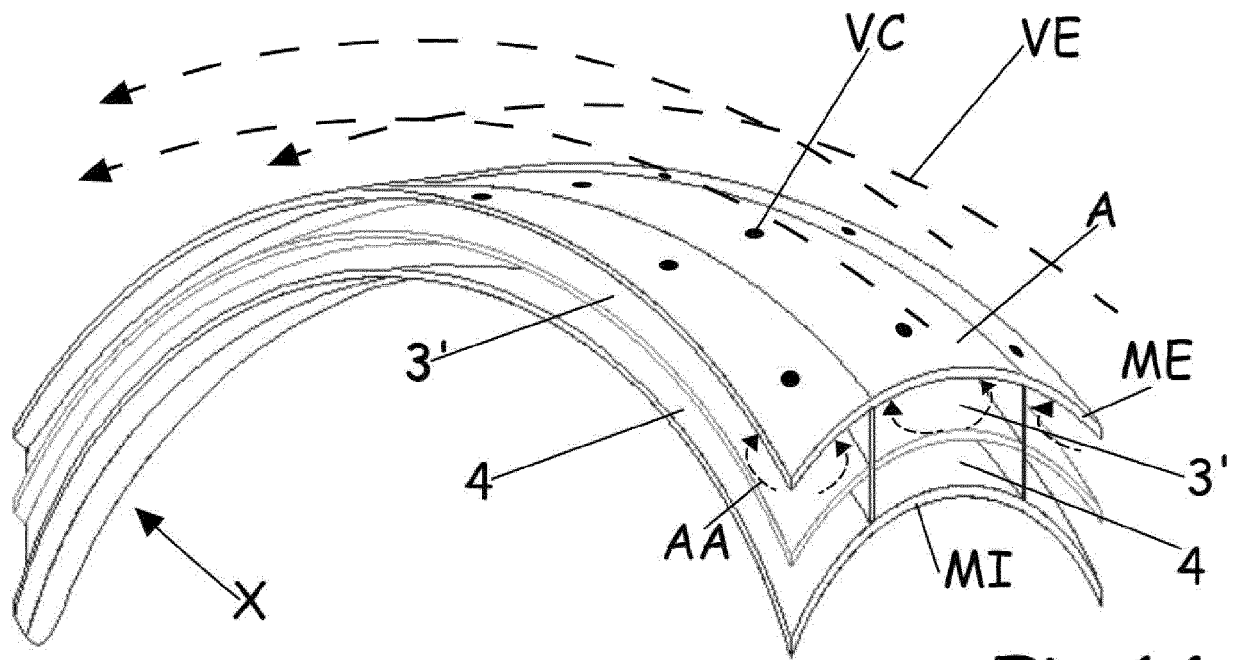


Fig.14

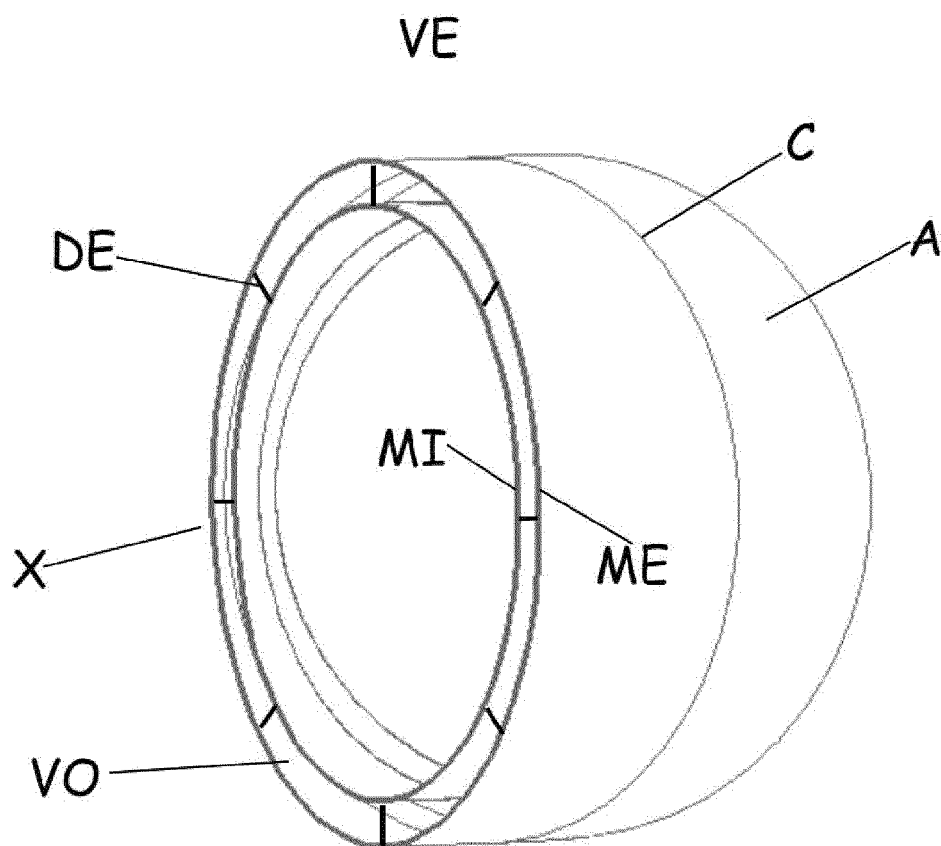
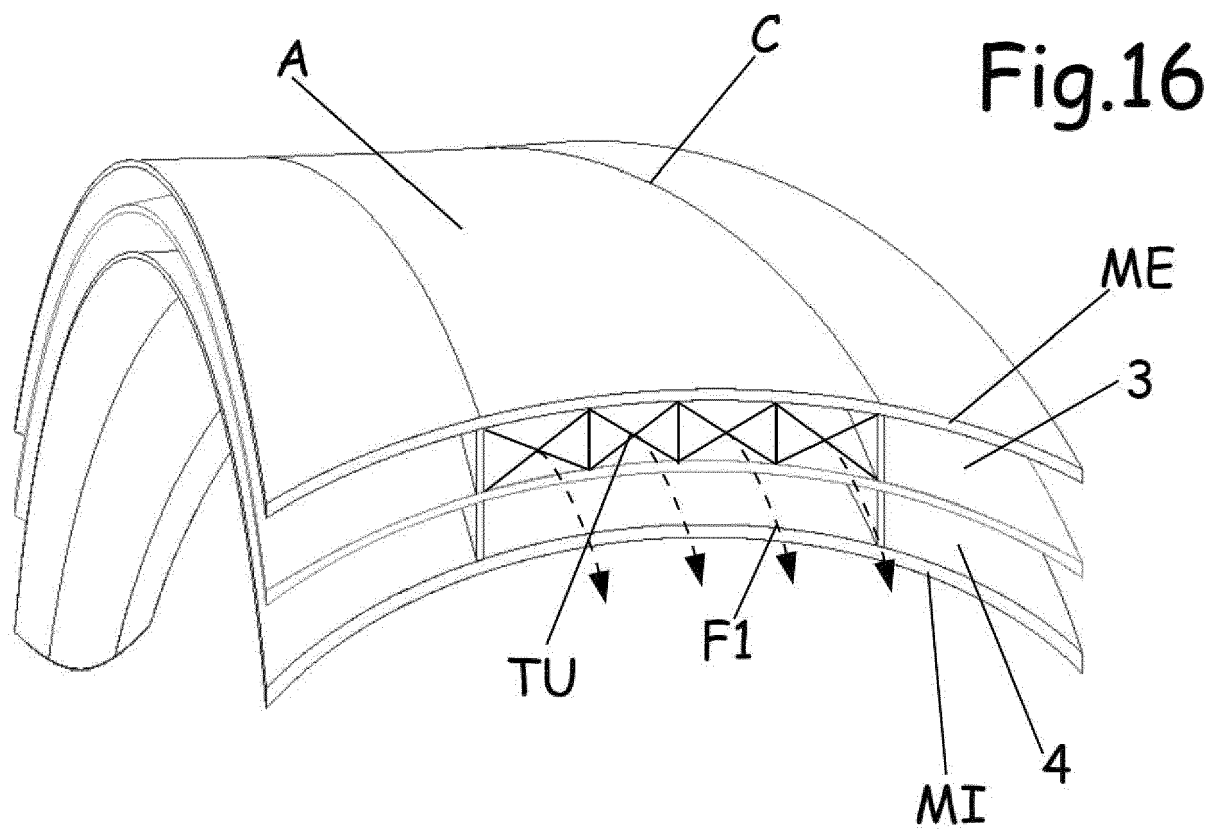


Fig.15





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Place of search The Hague		Date of completion of the search 30 June 2017	Examiner Delzor, François
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