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(54) **Panel, particularly for providing claddings for tunnels, underpasses or the like**

(57) A panel (1), particularly for providing claddings for tunnels, underpasses or the like. The panel comprises a metal plate (2) and a fiber cement slab (3) which face

each other with one of their two larger faces and are mutually coupled by means of a layer of interposed adhesive (4).

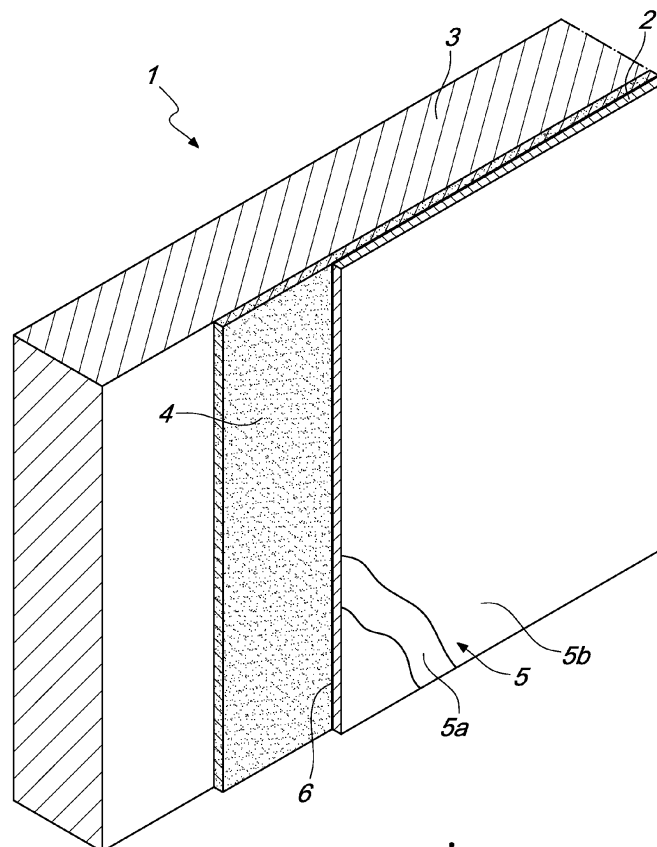


Fig. 1

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Description

[0001] The present invention relates to a panel, particularly for providing claddings for tunnels, underpasses or the like.

[0002] In recent years, increasing attention has been paid to the installation of claddings in tunnels, since a skilful implementation of such claddings makes it possible to obtain, in addition to an appreciable finish in purely aesthetic terms, considerable improvements in visibility, noise abatement and protection in the event of fire.

[0003] Currently, in order to execute claddings for tunnels panels are used which are anchored to the walls of the tunnel.

[0004] Generally these panels are made of painted aluminum or painted stainless steel, or of porcelainized steel which is optionally microperforated. In some cases, a layer of mineral fibers is applied to the face of the panel which is intended to be directed toward the wall of the tunnel so as to reduce the thermal conductivity and the acoustic transmission of the cladding.

[0005] For painted panels, the paints used for coating the exposed face of these panels are such as to ensure a high degree of reflection of light so as to enable a reduction of energy costs for lighting the tunnel.

[0006] These types of panels, although they offer fairly satisfactory performance levels in lighting engineering terms, exhibit the drawback of having an excessive deformability, which can be limited by increasing the thickness of the panel, but with the consequence of an excessive increase in weight and production costs.

[0007] Moreover, the need to allow for a possible additional layer of mineral fibers inevitably complicates the operations for laying these panels.

[0008] The aim of the present invention is to overcome the above-mentioned drawbacks, by providing a panel, particularly for providing claddings for tunnels, which has reduced deformability and the laying of which is simple and quick.

[0009] Within this aim, an object of the invention is to provide a panel that, notwithstanding the reduced deformability, can still be curved in order to be capable of following the curved walls of tunnels.

[0010] Another object of the invention is to provide a panel that is long lasting even in particularly aggressive environments.

[0011] Another object of the invention is to provide a panel that can be subjected to cutting and welding operations without problems.

[0012] Another object of the invention is to provide a panel that has a high resistance to abrasion so that it can be subjected to ordinary or extraordinary cleaning operations without wearing.

[0013] Another object of the present invention is to provide a panel that offers good resistance to fire.

[0014] This aim and these and other objects which will become more apparent hereinafter are all achieved by a panel, particularly for providing claddings for tunnels, un-

derpasses or the like, **characterized in that** it comprises a metal plate and a fiber cement slab which face each other with one of their two larger faces and are mutually coupled by means of a layer of interposed adhesive.

[0015] Further characteristics and advantages of the invention will become more apparent from the description of a preferred, but not exclusive, embodiment of the panel according to the invention, which is illustrated by way of non-limiting example in the accompanying drawings wherein:

Figure 1 is a partially cutaway perspective view of the panel according to the invention;

Figure 2 is a transverse cross-section of a tunnel with a cladding provided with panels according to the invention;

Figure 3 is an enlarged view of a detail of Figure 2;

Figure 4 is an enlarged sectional view of Figure 3 along the line IV-IV;

Figure 5 is a sectional view of Figure 4 along the line V-V with some elements removed for the sake of clarity;

Figure 6 is a sectional view, similar to Figure 4, of the set of elements that can be used to fix two panels according to the invention to the wall of a tunnel and connect them together.

[0016] With reference to the figures, the panel according to the invention, generally designated by the reference numeral 1, comprises a metal plate 2 and a fiber cement slab 3 which face each other, with one of their two larger faces, and are mutually coupled by means of a layer of interposed adhesive 4.

[0017] Conveniently, at least the exposed face of the metal plate 2, i.e. the face of the metal plate 2 that is opposite to the fiber cement slab 3, is coated by at least one layer of paint 5.

[0018] Preferably, the metal plate 2 has a thickness of substantially 0.5 mm and its exposed face is coated by two layers of paint 5a, 5b, respectively a base layer 5a and a finishing layer 5b, which constitute, overall, a layer 5 having a thickness substantially comprised between 20 and 40 microns.

[0019] The paint applied to the exposed face of the metal plate 2 is preferably of the anti-graffiti type, i.e. a paint from which it is possible to remove, without substantially damaging or wearing the paint, the paints usually used for executing graffiti.

[0020] Optionally applied to the face of the metal plate 2 which is directed toward the fiber cement slab 3 is a layer 6 of sizing paint preferably having a thickness substantially of 8 microns.

[0021] The metal plate 2 is preferably made of stainless steel, and even more preferably AISI 470Li or AISI 430 steel.

[0022] The exposed face of the metal plate 2 and the opposite face of the same plate, if painted, are painted using a paint of the polyester powder type, known in the

field of painting as "SP type painting".

[0023] The metal plate 2 can be constituted by a commercially available pre-painted stainless steel plate, such as for example the plates known commercially with the "VERNEST" brand of the ThyssenKrupp Acciai Speciali Terni company with the layer 5, made up of the base layer 5a and the finishing layer 5b, having a thickness substantially comprised between 20 and 25 microns.

[0024] The fiber cement slab 3 has a thickness of substantially 5 mm and can be constituted by a commercially available slab of fiber cement, such as for example the fiber cement slabs known commercially by the "SILBON-IT" trademark of the Società Italiana Lastre (SIL) S.p.A. company of Verolanuova (Brescia).

[0025] As an approximate guide, some of the physical/mechanical characteristics of this type of slab are given below:

- Specific weight when dry: $>1.6 \text{ kg/dm}^3$
- Maximum water absorption: 30%
- Humidity in natural state: 10-15%
- Dilution under extreme conditions of temperature and humidity from -5°C to $+100^\circ\text{C}$; from 20% to 90%: 1.5 mm/m
- Thermal conductivity: $0.35 \text{ Kcal/mh}^\circ\text{C}$
- Reaction to fire (fire resistance): Class 0
- Resistance to frost: Excellent
- Resistance to oils, acids, bases, salts: Good
- Impermeability to water (inalterability): Absolute
- Resistance to wear: Good
- Resistance to breakage by bending (ambient conditions):
- Breakage perpendicular to fibers: 250 kg/cm^2
- Breakage parallel to fibers: 180 kg/cm^2
- Resistance to compression: 400 kg/cm^2
- Resilience : 2 kg/cm/cm^2
- Modulus of elasticity E: $120,000 \text{ kg/cm}^2$

[0026] The adhesive used for bonding the metal plate 2 to the fiber cement slab 3 is preferably constituted by a polyurethane adhesive and, after hardening, it can be drilled or ground with abrasive paper and it withstands temperatures comprised between -20°C and $+100^\circ\text{C}$.

[0027] According to an embodiment of the panel according to the invention, the metal plate 2 can be constituted by an aluminum plate.

[0028] In this case, the thickness of the layer 5, made up of the two layers 5a and 5b, can have a thickness substantially comprised between 30 and 40 microns, preferably 35 microns, and the face of the metal plate 2 which is directed toward the fiber cement slab 3 can be unpainted.

[0029] According to a further embodiment of the panel according to the invention, the metal plate 2 can be constituted by a porcelainized steel plate i.e. steel coated with porcelainized enamel at least on the face which is directed opposite to the fiber cement slab 3. In this case, instead of a layer or layers of paint, vitreous and porce-

lainized enamels are applied on the metal plate 2 at a high temperature (generally higher than 500°C).

[0030] Figures 2 to 6 show, as an approximate guide, a possible method of installation of panels according to the invention during the provision of a lighting engineering cladding of a tunnel.

[0031] More specifically, a plurality of panels according to the invention can be supported by way of a supporting substructure 10 which is composed of vertical sides 13 and horizontal sides 12 which are constituted by metallic profiles.

[0032] The horizontal sides 12 are connected to the vertical sides 13 by way of brackets 27 and bolts 11 and are fork-shaped in transverse cross-section, forming seats 14 into which the lower horizontal sides and the upper horizontal sides of the panels 1 are inserted.

[0033] The vertical sides 13 are constituted by profiles, with an Omega-shaped transverse cross-section, which are fixed to the walls of the tunnel by way of inserts 15 with threaded bars 16. Each threaded bar 16 is fixed to the corresponding Omega-shaped profile 13 by way of two nuts 17, 18 and three washers 19, 20, 21. The vertical sides 13 of two contiguous panels 1 rest against the two wings of the Omega-shaped profile 13 and are locked against the Omega-shaped profile 13 by way of a joint covering 22 which is clamped against the panels 1 by way of a screw 23 which engages in a threaded hole 24 formed in the head of the threaded bar 16. Gaskets 25, 26 are interposed between the joint covering 22 and the panels 1.

[0034] The panel according to the invention, thanks to its particular structure composed of a metal plate 2, preferably pre-painted stainless steel, coupled to a fiber cement slab 3, has a lower deformability than conventional panels. However, this lower deformability does not rule out the possibility of curving the panel in order to follow the curvature of the tunnel walls, as becomes clear from the drawings.

[0035] The panel according to the invention has excellent resistance to corrosion even in particularly aggressive environments.

[0036] The preferred use of a pre-painted stainless steel plate of the "VERNEST" type ensures greater robustness and durability in that it ensures the absence of phenomena such as blistering and the delamination of edges in applications that require the cutting and welding of steel plates.

[0037] In tests to which it has been subjected, the panel according to the invention, in the preferred embodiment thereof and therefore composed of a pre-painted stainless steel plate 2 of the "VERNEST" type and of a fiber cement slab 3, has shown that it has excellent resistance to salt spray tests (2000 hours), better resistance to continuous moisture (3000 hours) and to accelerated radiation (2000 hours).

[0038] Moreover, the panel according to the invention has excellent resistance to abrasion by rubbing and resistance to cleaning cycles, as well as better suitability

for the removal of graffiti thus ensuring the maintenance of the initial thickness of the protective paint or enamel.

[0039] Finally, the panel according to the invention ensures an excellent resistance to fire, capable of meeting the standards EN 13501-1, EN 14783 DM 10/03/05 class A1.

[0040] In practice it has been found that the panel according to the invention fully achieves the set aim in that it has a reduced deformability; thanks to this characteristic, the panel according to the invention is less subject to the vibrations due to the air pressure caused by vehicles in transit through the tunnel.

[0041] Another advantage of the panel according to the invention is that of presenting an exposed surface that is continuous and uniform, entirely free from deformations and/or irregularities although being constituted by the coupling of two different materials.

[0042] Another advantage of the panel according to the invention is that it can be produced at very low cost.

[0043] The panel, thus conceived, is susceptible of numerous modifications and variations, all of which are within the scope of the appended claims. Moreover, all the details may be substituted by other, technically equivalent elements.

[0044] In practice, the materials employed, except where otherwise specified above, as well as the dimensions, may be any according to requirements and to the state of the art.

[0045] The disclosures in Italian Patent Application No. MI2012A000096 from which this application claims priority are incorporated herein by reference.

[0046] Where technical features mentioned in any claim are followed by reference signs, those reference signs have been included for the sole purpose of increasing the intelligibility of the claims and accordingly, such reference signs do not have any limiting effect on the interpretation of each element identified by way of example by such reference signs.

Claims

1. A panel (1), particularly for providing claddings for tunnels, underpasses or the like, **characterized in that** it comprises a metal plate (2) and a fiber cement slab (3) which face each other with one of their two larger faces and are mutually coupled by means of a layer of interposed adhesive (4).
2. The panel (1) according to claim 1, **characterized in that** said metal plate (2) has a thickness of substantially 0.5 mm.
3. The panel (1) according to claim 1, **characterized in that** the exposed face of said metal plate (2), i.e., the face of said metal plate (2) that is opposite to said fiber cement slab (3), is coated with at least one layer of paint or enamel (5).

4. The panel (1) according to one or more of the preceding claims, **characterized in that** the paint or enamel applied to the exposed face of said metal plate (2) is of the graffiti-resistant type.
5. The panel (1) according to one or more of the preceding claims, **characterized in that** said fiber cement slab (3) has a thickness of substantially 5 mm.
6. The panel (1) according to one or more of the preceding claims, **characterized in that** the adhesive bonding of said metal plate (2) to said fiber cement slab (3) is performed by means of a polyurethane adhesive.
7. The panel (1) according to claim 1, **characterized in that** said metal plate (2) is constituted by a porcelainized steel plate.
8. The panel (1) according to claim 1, **characterized in that** said metal plate (2) is constituted by an aluminum plate.
9. The panel (1) according to claim 1, **characterized in that** said metal plate (2) is constituted by a stainless steel plate.
10. The panel (1) according to claims 8 and 9, **characterized in that** the exposed face of said metal plate (2) is painted by means of a painting treatment of the polyester powder type (SP type painting).
11. The panel (1) according to claims 8 and 9, **characterized in that** two layers of paint (5a, 5b), respectively a base layer (5a) and a coating layer (5b), having a total thickness substantially comprised between 20 and 40 microns, are applied to the exposed face of said metal plate (2).
12. The panel (1) according to claims 7 and 9, **characterized in that** the face of said metal plate (2) which is directed toward said fiber cement slab (3) is also painted by means of a painting treatment of the polyester powder type (SP type painting) or is enamelled.
13. The panel (1) according to claim 12, **characterized in that** the layer of paint (6) applied to the face of said metal plate (2) which is directed toward said fiber cement slab (3) has a thickness of substantially 8 microns.
14. The panel (1) according to claim 9, **characterized in that** said metal plate (2) is constituted by a stainless steel plate pre-painted with polyester powder-based paints (SP type painting) at least on its face which is opposite to the face coupled to said fiber cement slab (3).

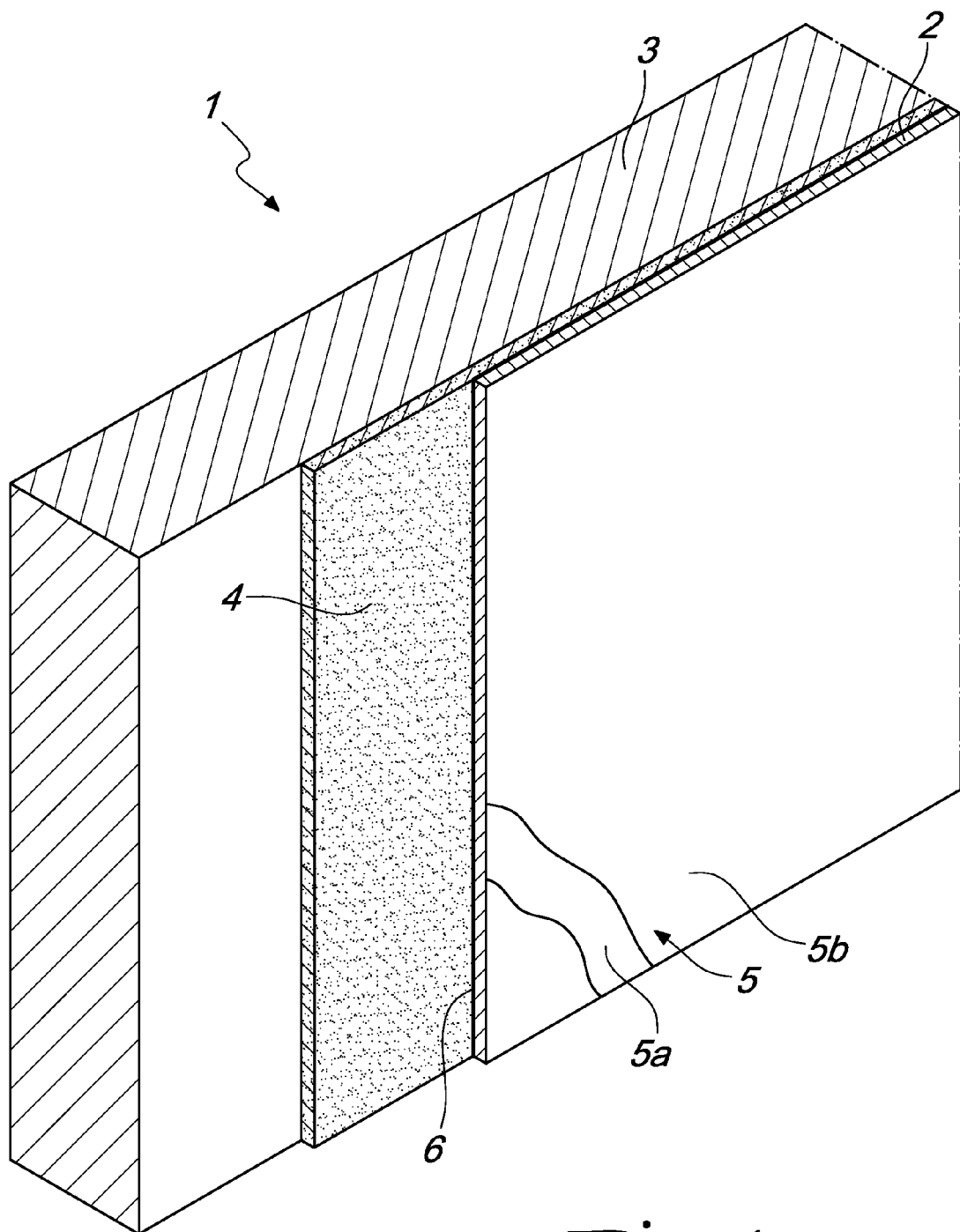


Fig. 1

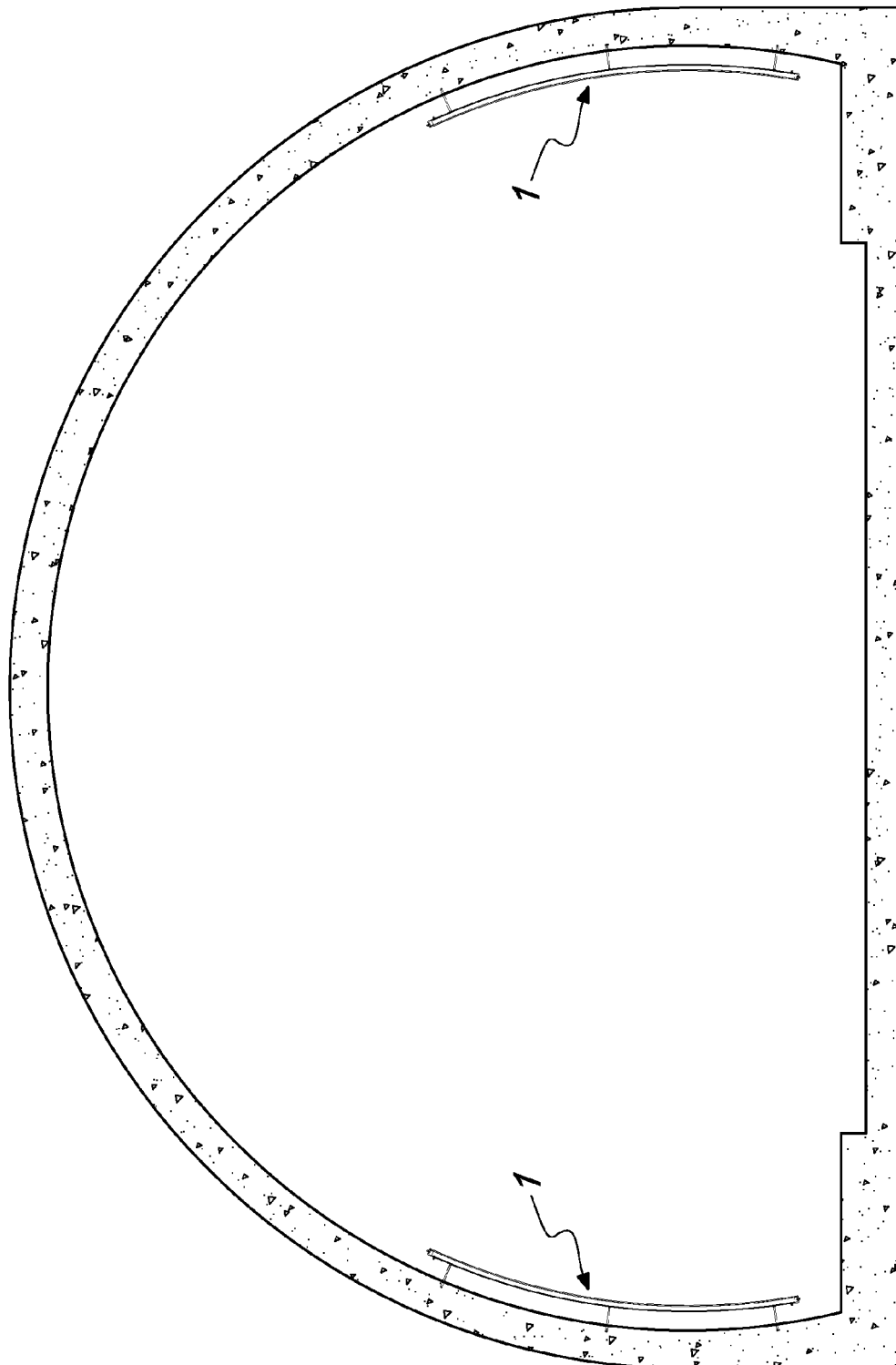
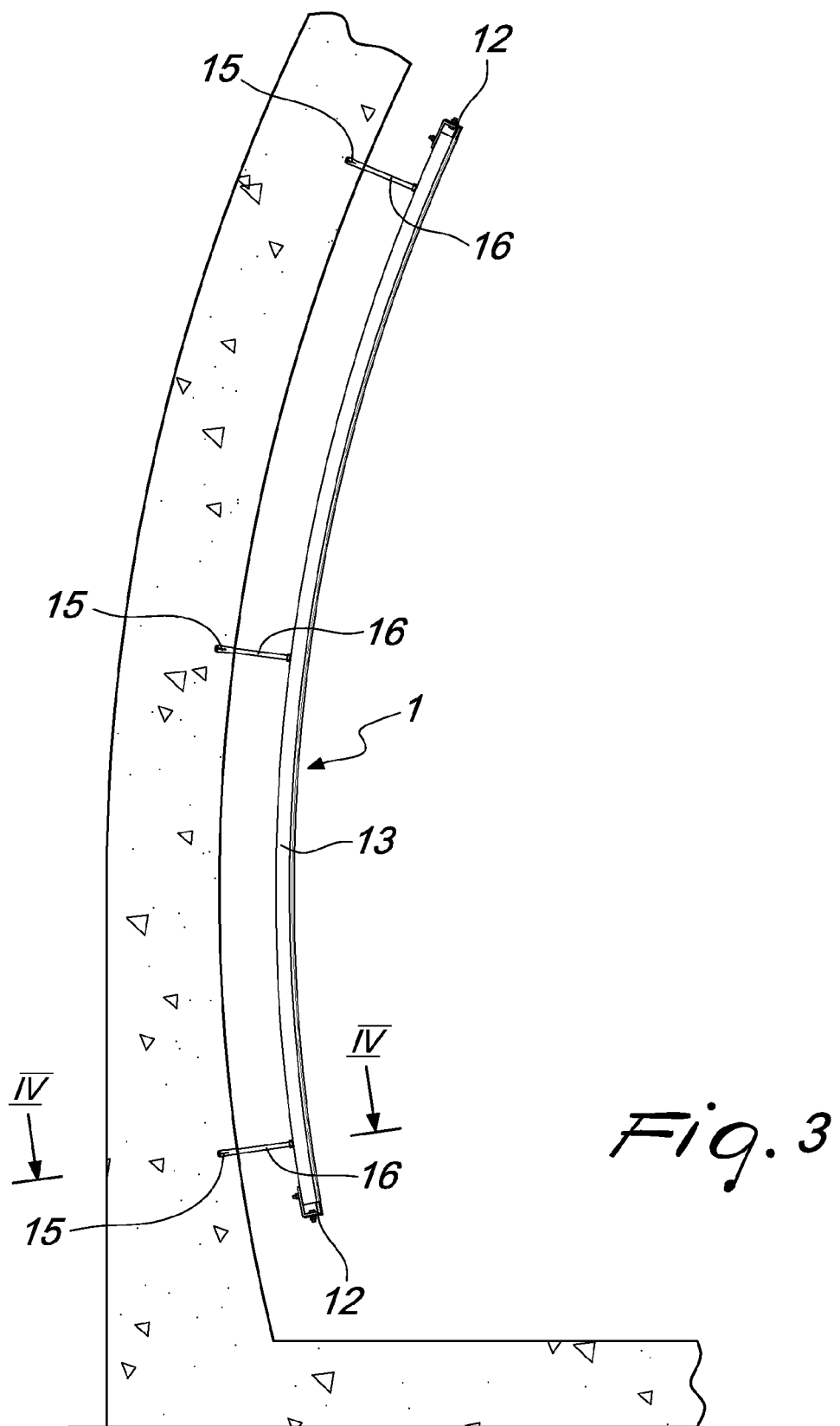
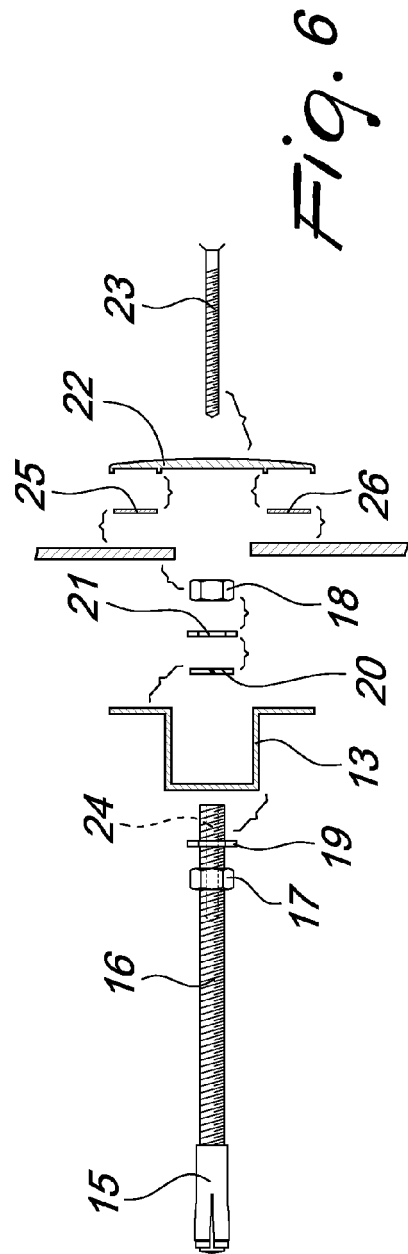
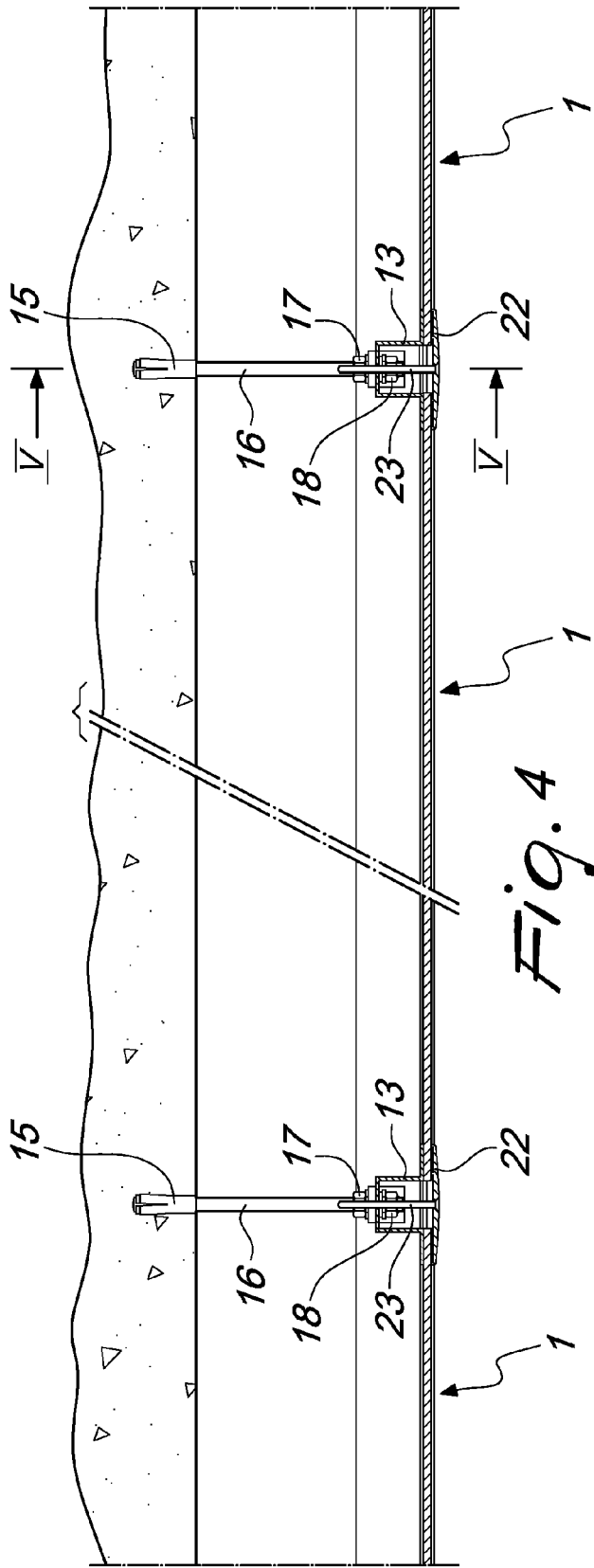
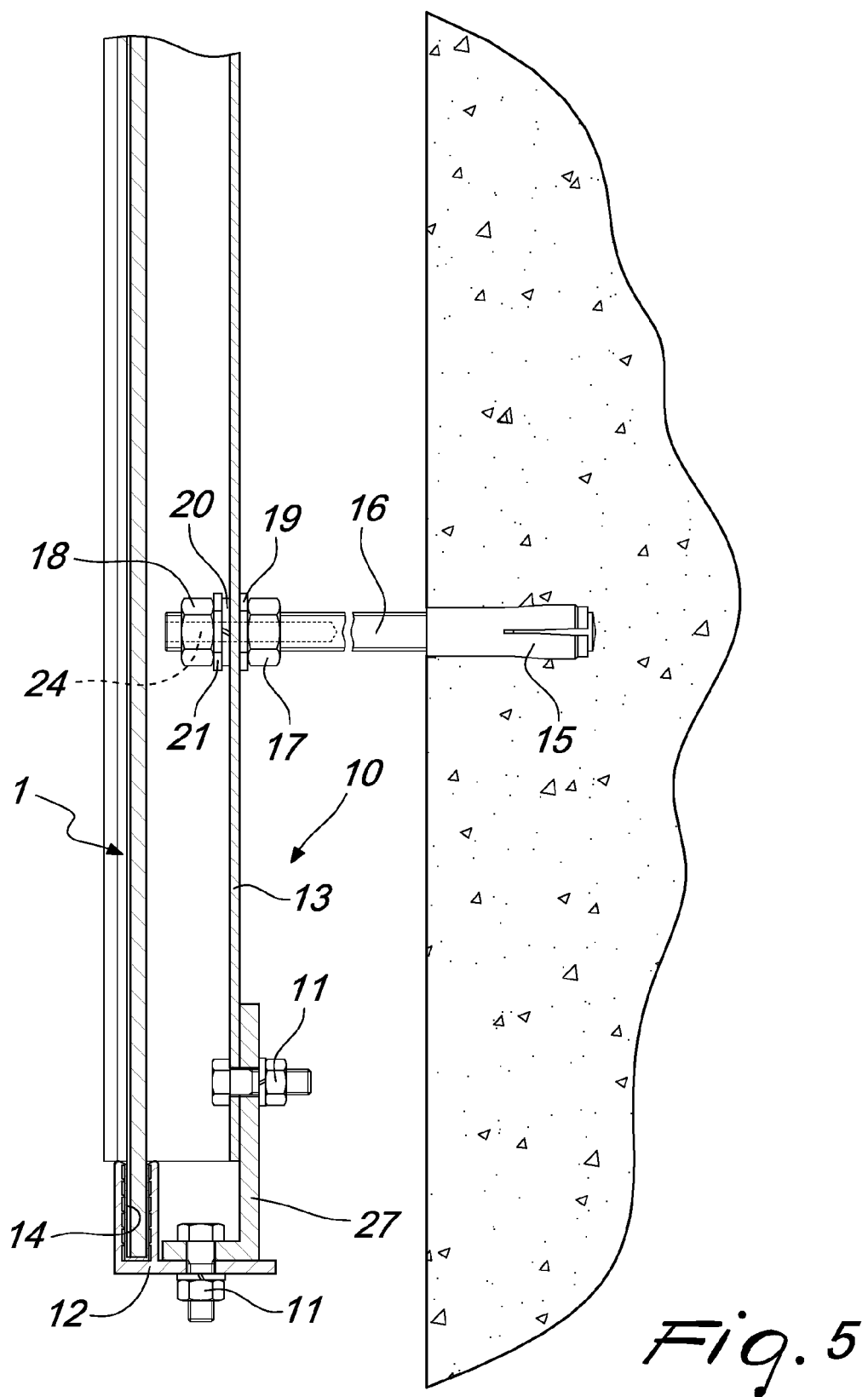


Fig. 2









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Application Number
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Place of search Munich		Date of completion of the search 8 May 2013	Examiner Manolache, Iustin
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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**ANNEX TO THE EUROPEAN SEARCH REPORT
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