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

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
28 March 2019 (28.03.2019)

WIPO | PCT

(10) International Publication Number
WO 2019/059776 A1

(51) International Patent Classification:
E21D 11/00 (2006.01) *E04C 2/26* (2006.01)
E21D 11/38 (2006.01) *C03C 11/00* (2006.01)
E04B 1/343 (2006.01)

(21) International Application Number:
PCT/NO2018/050227

(22) International Filing Date:
10 September 2018 (10.09.2018)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
20171522 22 September 2017 (22.09.2017) NO

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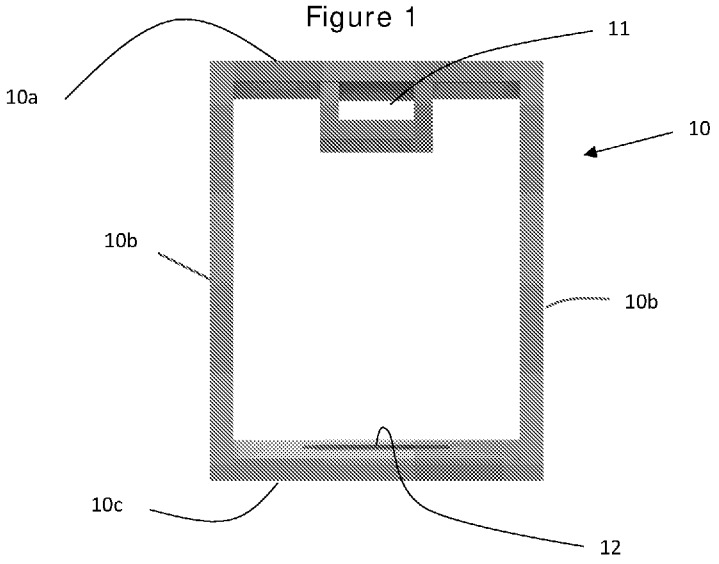
(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report (Art. 21(3))*

(54) Title: TUNNEL PROFILE ELEMENT MADE OF FOAM GLASS PANELS

Figure 1



(57) Abstract: The present invention disclose a tunnel profile element (10, 20A, 20) comprising a lightweight body constituted by foam glass panels sprayed with unbroken polyurea layer providing a fire resistant coating, and which is providing increased mechanical integrity of the tunnel profile element (10, 20A, 20).

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TUNNEL PROFILE ELEMENT MADE OF FOAM GLASS PANELS

FIELD OF THE INVENTION

The present invention is related to a tunnel profile element comprising sidewalls, roof and floor elements of foam glass panels that are assembled and sprayed with an unbroken layer of polyurea covering all visible outside surfaces of the tunnel profile element.

BACKGROUND OF THE INVENTION

Road and railway tunnels are usually expensive to make and security issues related to possible fires and accidents inside tunnels are well known challenges in prior art. Conventional methods of building tunnels usually comprises drill and blast methods providing the necessary and intended tunnel profile at correct dimensions. It is also common to adapt and assemble concrete wall elements, thermal isolation, fire protections, electric wires, communication lines, traffic lights, electric lightning, water drainage etc. corresponding to the tunnel profile.

In recent years, it is common to provide images of the raw rock tunnel walls by scanning the rock faces of the drilled and blasted tunnel with a moving laser thereby identifying locations on the walls suitable for drilling bolts holding concrete wall elements being assembled afterwards. The information from computerized images captured via the laser scanning can be used to direct and position drilling equipment moving inside the tunnel while drilling. Then the mounting of the concrete elements is much easier and faster after the bolts have been attached to the rock walls.

The weight of concrete is high and the ability to handle heavy weight objects inside a limit space like a tunnel limits the practical size of concrete wall elements of tunnels.

Further, tunnels need to be equipped with additional infrastructure elements like escape-route tunnels, emergency communication systems, warning systems, airing channels that can ventilate smoke from fires etc., and that can ventilate exhaust from cars etc. Supplying fresh air from the outside of the tunnel is also necessary. It is also necessary that any additional infrastructure element is fire and water and frost protected.

Prior art tunnel designs includes many parts providing solutions to respective technical problems. Concrete walls may provide protection against parts of rocks that may loosen from the tunnel rock faces and fall down onto the traffic lanes or railway tracks, for example. Protection against ice formation and frost control is necessary since water freezing to ice increases in volume as known in prior art. The forces induced on the surroundings from freezing water, for example water left in cracks in the rock face of the tunnel, can be large in magnitude and can result in breaking stones free from the rock wall of the tunnel. Further, frost may make for example the roads in the tunnel very slippery. When concrete wall elements are assembled, it may be left voids between the concrete element surfaces facing the rock surface of the tunnel. Water may assemble in these voids, and if the ice formation protection is insufficient, the water in the voids may cause structural damage to the concrete walls of the tunnel.

US 200700138857 A1 disclose a vehicle with a milling arrangement on the top side of the machine. The milling arrangement includes a milling device for grinding an upper tunnel wall surface like tunnel ceilings of traffic tunnels. Such a vehicle with the milling arrangement is suitable for treating tunnel walls such that a desired limited surface roughness and removal of carbon black is achieved. This assures that a lining, which is applied to the tunnel ceiling and wall surface, is sufficiently attached to the surfaces.

US 8662796 B2 disclose a method for lining tunnel walls or ceilings with protective nets or the like, web-shaped protective net material is unwound from a reel and is fastened to the tunnel walls or ceiling by tie bolts. The reel is rotatable arranged. The rotation of the reel about a shaft is controlled in order to unwind the protective net material, the shaft being mechanically moved in steps along the tunnel walls or ceiling together with the reel. The stretching and mechanically fastening of the protective net is preferably executed when unwound in each step.

US 3561223 A disclose a tunnel making machine adapted not only to tunnels through the earth, but also to concurrently form a concrete wall in the tunnel. Forms for the concrete wall are erected by the machine at the head end thereof and are removed by the machine at the tail end thereof. The forms remain in place only long enough for the concrete to harden and are constantly reused, those from the tail end being transferred to the head end in a continuous process of form reuse. Removal of the

forms at the tail end of the machine leaves the tunnel complete rearward of the machine with a smooth concrete wall or bore.

WO 2004/024645 A3 disclose a method of producing a foamed glass composite panel, wherein the glass and a 0.1-20.0% by weight of at least one non-sulfur based foaming agent, mixing it together, and heating the mixture to a temperature sufficient to foam it. Then cooling the foamed mixture forming at least one foamed glass substrate. During or after the cooling step, material is bonded or attached to at least one side of the foamed glass substrate forming a composite panel.

CN 101638990 B disclose a fireproof thermal-insulation layer of a tunnel and a construction method thereof. The fireproof thermal-insulation layer comprises a polyurethane thermal-insulation layer connected with two linings of the tunnel and an external fireproof layer, wherein the fireproof layer is constituted by pressing one or two kinds of medium-alkali glass fiber cloth and non-woven fabric, which are taken as basal materials, and waterproof and fireproof components.

The cost of making for example safe road and/or railway tunnels are high and therefore there is a need of improved tunnel designs providing cheaper tunnels that preferably are simpler to build, faster to build and which requires less maintenance and improved lifetime. It is also a need of facilitating simple and cheap installation of additional infrastructure elements in tunnels.

OBJECT OF THE INVENTION

It is a further object of the present invention to provide an alternative to the prior art.

In particular, it may be seen as an object of the present invention to provide a lightweight tunnel profile element facilitating lining of tunnel profiles as well as installation of respective tunnel infrastructure elements.

SUMMARY OF THE INVENTION

Thus, the above described object and several other objects are intended to be obtained in a first aspect of the invention by providing a tunnel wall element

constituted by a lightweight element having thermal insulating properties coated with a fireproof coating increasing the mechanical integrity of the lightweight element.

An aspect of the present invention is to provide a tunnel profile element adaptable to respective aperture dimensions of raw tunnels, wherein the tunnel profile element comprises foam glass panels,

wherein at least a tunnel floor element, at least respective sidewall elements and at least a roof element of foam glass panels are hold together by a sprayed unbroken surface layer of polyurea on at least all visible outside surfaces of an assembled tunnel profile element.

Another aspect of the present invention is to provide a method of assembling a tunnel profile element comprising steps of:

- defining a shape and dimension of the tunnel profile element,
- arranging a support frame with the shape and dimension of the defined tunnel profile element,
- holding respective adapted foam glass panels in the support frame; and
- spraying an unbroken layer of polyurea on at least all visible outside surfaces of the foam glass panels supported by the supporting frame.

Respective aspects of the present invention may each be combined with any of the other aspects. These and other aspects of the invention will be apparent from and elucidated with reference to the embodiments described hereinafter.

DESCRIPTION OF THE FIGURES

The tunnel wall element and the method of building tunnel walls with the tunnel wall elements according to the present invention will now be described in more detail with reference to the accompanying figures. The accompanying figures illustrates an example of embodiment of the present invention and is not to be construed as being limiting to other possible embodiments falling within the scope of the attached claim set.

Figure 1 illustrates an example of a tunnel profile element according to the present invention.

Figure 2 illustrates another example of a tunnel profile element according to the present invention.

Figure 3 illustrates another example of a tunnel profile element according to the present invention.

Figure 4 illustrates another example of a tunnel profile element according to the present invention.

Figure 5 illustrates another example of a tunnel profile element according to the present invention.

Figure 6a – 6b illustrates an example of assembling tunnel profile elements according to the present invention.

DETAILED DESCRIPTION OF AN EMBODIMENT

Although the present invention is described in connection with specified embodiments, it should not be construed as being in any way limited to the presented examples. The scope of the present invention is set out by the accompanying claim set. In the context of the claims, the terms "comprising" or "comprises" do not exclude other possible elements or steps. The mentioning of references such as "a" or "an" etc. should not be construed as excluding a plurality. The use of reference signs in the claims with respect to elements indicated in the figures shall also not be construed as limiting the scope of the invention. Furthermore, individual features mentioned in different claims, may possibly be advantageously combined, and the mentioning of these features in different claims does not exclude that a combination of features is not possible and advantageous.

A first aspect of the present invention is to combine water, fire and frost prevention features in a lightweight tunnel profile element constituted by assembled foam glass panels sprayed with a layer of unbroken polyurea.

Figure 1 illustrates an example of a rectangular shaped tunnel profile elements 10 according to the present invention.

Av profile element is made with a periphery dimension adapted to the aperture of a raw tunnel profile of a location of the tunnel wherein the profile element is intended to be used. The length of a tunnel profile element according to the present invention

is in principle arbitrary, but is usually manufactured with a set of different lengths for a specific tunnel. When lining a raw tunnel with tunnel profile elements according to the present invention, a plurality of tunnel profile elements are inserted into the tunnel opening from one end of the tunnel, one element after the other. The tunnel profile elements are attached together thereby covering the complete periphery and length of the raw tunnel surface including the raw tunnel roof, the raw walls of the tunnel as well as the bottom or floor of the raw tunnel. If the tunnel is straight, longer tunnel profile elements may be made with a same length. If there are curves in the tunnel, smaller length of the tunnel profile elements makes the lining smother along the curved tunnel section. It is also within the scope of the present invention that for example the width of a tunnel profile element at the side of the profile element facing inwards to the interior of the tunnel can be larger or smaller than the width of the profile element facing towards the raw tunnel side surfaces. In this manner, the elements can be adapted and assembled according to any type of curved tunnel surfaces.

The roof element of the tunnel profile element illustrated in Figure 1 is arranged with an additional infrastructure element 11 being for example an element constituting an airing channel. At the bottom or floor of the tunnel profile element 10 there is an opening 12 adapted to receive fluids, for example surface water, wherein the opening 12 is in fluid communication with a drainage pipe arranged below the bottom of the tunnel profile element 10. The opening 12 may not be present in all tunnel profile elements according to the present invention.

Figure 2 illustrates another example of embodiment comprising further additional infrastructure elements 13, 14. The additional infrastructure elements 13, 14 may be used as additional airing channels, for example supplying fresh air into the tunnel from the outside of the tunnel. In such a case, additional openings will be arranged on a side surface of the airing channels 13 and 14 as well as the airing channel 11 discussed above. However, these additional infrastructure elements may be used to support other items like power cables, communication lines etc.

Figure 3 illustrates another example of embodiment of the present invention wherein an escape-route tunnel element 15 is arranged on an adjacent sidewall element 10b of a tunnel profile element (10). The roof 16 of the escape-route element 15 is inclined downwards relative to the adjacent sidewall element 10b. Water inside rocks of the tunnel can then flow over the inclined roof 16 and down on the side of the

escape-route element 15 and be collected by arranged channels at the bottom of the raw tunnel.

Figure 5 illustrates another example of embodiment of the present invention, wherein the roof element 10a of the tunnel profile element is curved, and wherein an airing channel 11 is arranged on an outside surface of the roof element 10a. The figure 5 illustrates an example, wherein an escape-route tunnel element is arranged on both sides of the tunnel profile element 10. In addition, an additional channel 17 is arranged on top of the left most escape-route element 15. For example, an emergency communication line may be arranged inside the channel 17.

Further examples of additional infra structure elements that can be added to a tunnel profile element 10 according to the present invention, can be fire proof and water tight cabinets. Inside such cabinets it is possible to store for example fire extinguishers, an emergency telephone etc. The cabinet is made out of polyurea sprayed foam glass panels, including an adapted cabinet door.

Figure 6a, Figure 6b and Figure 6c illustrates some principles that is used when joining a first tunnel profile element 20 to another tunnel profile element 20a.

The illustration is only a part of a full tunnel profile element, for example a sidewall of tunnel profile element. The illustrated sidewall is a rectangular object with a certain thickness. The illustration is not intended to illustrate an actual tunnel profile element, but only the principle of how to join tunnel profile elements.

With reference to Figure 6a and Figure 6b, when spraying polyurea on an tunnel profile element 10 according to the present invention, a patch 19, 19a of polyurea is made extending outwardly from an edge of a surface 18 of the tunnel profile element 10, and which is flush with the surface 18. When joining a first tunnel profile element 20 with a second tunnel profile element 20a, the second tunnel profile element is joined to the first tunnel profile element 20 by applying polyurea 21 on an outside surface of the patch 19 facing towards the inner side of the tunnel. Then the second tunnel profile element 20a is positioned onto the surface of the patch having polyurea. The second tunnel profile element 20a is pushed towards and joined with the first tunnel profile element 20. Polyurea may also be applied over the joint between the first and second tunnel profile element 20, 20a on the surface facing towards the interior of the tunnel. A completely water and fireproof joint is then established.

An alternative of using a polyurea sprayed foam glass panel in the floor element 10c of a tunnel profile element 10, as illustrated for example in Figure 1, is to install tunnel profile elements without floor elements 10c. Afterwards it is possible to distribute smashed foam glass panels (granulated foam glass) for example on the raw tunnel bottom and add a layer of asphalt on top of the smashed foam glass. The smashed foam glass provides the necessary frost insulation of the floor element 10c.

It is also possible to add reinforcement rods inside foam glass panels used in a floor element 10c of a tunnel profile element 10. The rods may be of steel or be made from a composite material.

Lightning is also part of an infrastructure of a tunnel. According to an aspect of the present invention, LED lights may be integrated into surfaces of the polyurea sprayed foam glass panels according to the present invention. Power and control signals can be conveyed to respective LED lights via added channels 11, 13, 14 etc. illustrated in Figure 1 and Figure 2.

Besides providing light inside the tunnel, LED lights can also contribute to the safety of driving inside a tunnel. For example, when a profile of a tunnel is rectangular, refer for example Figure 1, the tunnel may be experienced by drivers of cars to be somehow narrow. If LED lights is arranged to make the illusion of a star filled sky, the visual impression of the tunnel changes dramatically. In long tunnels, drivers may experience the tunnel as extremely monotone, which may affect their awareness. It is possible to arrange sections of LED lights with different colors, intensity, and it is possible to change colors automatically within time periods, or by external control signals an known in prior art.

The weight of a typical tunnel profile element 10 according to the present invention is about 30Kg/m^2. The thickness of the sides of the tunnel profile is typically about 10cm of foam glass panels with an additional thickness of polyurea of 0,5cm. However, the thickness can be increased if the frost conditions are severe in a tunnel. Therefore, a thickness of 25cm is also possible. The weight will increase accordingly.

Assembling of a tunnel profile element according to the present invention can be done by holding respective foam glass panels in a support structure or frame that is adapted or adaptable to specific dimensions of a tunnel profile element 10. Then a polyurea can be sprayed onto all surfaces of the tunnel profile element. A main

aspect of the design is that it is not necessary to glue together respective panels forming the tunnel profile element before applying the polyurea. The polyurea itself holds the tunnel profile element together. It is also possible to add further foam glass panels or glass plates supported by the support frame, wherein the added plates or panels constitute for example channels as discussed above. Added plates or panels can be sprayed with polyurea at the same time as the other foam glass panels of the tunnel profile element, or after the other panels are cured. An example of a method of assembling a tunnel profile element is disclosed below.

The supporting frame can be made out of plywood panels, or steel plates, or by composite materials etc.

In some examples of embodiment of the present invention, the support frame is constituting an integral part of a finished tunnel profile element according to the present invention. Then it is preferable to use a support frame made of steel plates or composite materials.

In other examples of embodiment of the present invention, the support frame is supporting respective foam glass panels temporary and will not constitute an integral part of a finished tunnel profile element according to the present invention. For example, when spraying polyurea onto assembled foam glass panels, surface areas of the foam glass panels close up to the supporting frame is left unsprayed until the support frame is taken away from the assembly. The rest of the tunnel profile element is then sprayed with polyurea finishing the tunnel profile element with an unbroken polyurea layer. In this case, it is preferable that the support frame is made out of for example plywood plates. The continued spraying of polyurea may continue after the first applied polyurea is cured. Then the cured polyurea is holding the foam glass panels together during the continued spraying.

According to an example of embodiment of the present invention, a tunnel profile element 10 adaptable to respective aperture dimensions of raw tunnels comprises foam glass panels,

wherein at least a tunnel floor element 10c, at least respective sidewall elements 10b and at least a roof element 10a of foam glass panels are hold together by a sprayed unbroken surface layer of polyurea on at least all visible outside surfaces of the assembled tunnel profile element 10.

Further, additional polyurea sprayed foam glass panels may constitute at least one airing channel element 11 arranged adjacent to the roof element 10a of the tunnel profile element 10.

Further, additional polyurea sprayed foam glass panels may constitute at least one escape-route tunnel element 15 arranged adjacent to at least one of the sidewalls 10b of the tunnel profile element 10.

Further, a roof element 16 of the escape-route tunnel element 15 may be inclined downwards relative to the adjacent sidewall element 10b of the tunnel profile element 10.

Further, the escape-route tunnel element 15 may comprise additional service channel elements 11, 13, 14, 17 constituted by additional polyurea sprayed foam glass panels.

Further, additional polyurea sprayed foam glass panels may constitute at least one channel element arranged adjacent to the floor element 10c and/or the respective sidewall elements 10b and/or the roof element 10a of the tunnel profile element 10.

Further, additional polyurea sprayed foam glass panels may constitute at least one cabinet, including a hinged door element of the cabinet, arranged adjacent to a sidewall element of the tunnel profile element.

Further, a plurality of assembled smaller polyurea sprayed foam glass panels may constitute a curved roof surface.

Further, the profile shape of the tunnel profile element may be rectangular.

Further, the weight of a tunnel profile element is about 30 kg/m^2.

Further, a thickness of respective foam glass panels is typically about 10 cm.

Further, the foam glass panels may be constituted by a plurality of sandwiched thinner foam glass plates,

wherein a joint between a first thinner foam glass plate adjacent to a second thinner foam glass plate is covered by a third thinner foam glass plate located above or below the first and second thinner foam glass plate joints,
wherein the sprayed unbroken polyurea layer is applied on the outer surfaces of the respective sandwiched foam glass plates, thereby forming a panel.

Further, a floor element 10c may arranged with a fluid drainage opening 12 being in fluid communication with a drainage pipe arranged below the floor element 10c of the tunnel profile element 10.

Further, granulated recirculated glass may constitute respective foam glass panels.

Further, additional support elements resting on the floor of the raw tunnel is supporting the floor element 10c of the tunnel profile element 10.

Further, additional reinforcements rods may be included in the foam glass panels of the floor elements.

Further, a layer of smashed foam glass covered by asphalt may constitute the floor element 10c of the tunnel profile element 10.

Further, LED lights may be arranged in respective sidewall elements 10b and/or roof elements 10a of a tunnel profile element according to the present invention..

Further, the LED lights in the roof element 10a may be configured as a star filled sky.

Further, the LED lights may be configured to change color on a regular basis, or in accordance with an externally submitted command.

According to an example of embodiment of the present invention, a method of assembling a tunnel profile element according to the present invention comprises steps of:

- defining a shape and dimension of the tunnel profile element (10),
- arranging a support frame with the shape and dimension of the defined tunnel profile element,

- holding respective adapted foam glass panels in the support frame; and
- spraying an unbroken layer of polyurea on at least all visible outside surfaces of the foam glass panels supported by the support frame.

Further, the support frame may be sprayed with polyurea thereby integrating the support frame in a finished tunnel profile element.

Further, the sprayed polyurea layer may be partly covering the supported foam glass panel surfaces close up to, but not covering the support frame, and after the partly sprayed polyurea layer is cured, the supporting frame is removed followed by a step of spraying the rest of all visible outside surfaces of the foam glass panels with polyurea.

Further, an unbroken layer of polyurea may be constituted by spraying a first part of a polyurea layer followed by spraying a second part of the polyurea layer overlapping at least partly the first polyurea layer.

Further, additional foam glass panels arranged in the support frame may constitute further units of a finished tunnel profile 10 according to the present innvetion.

Further, the additional foam glass panels may sprayed with polyurea at the same time as the other outside surfaces of the other foam glass panels of the tunnel profile element is sprayed.

Further, the additional foam glass panels are sprayed after the other outside surfaces of the tunnel profile element is sprayed and cured.

Further, the sprayed polyurea layer may extend outside at least an edge of a surface, and flush with said surface, constituting an outwardly protruding patch 19 of the tunnel profile element.
The method of claim 1, wherein the support frame is sprayed with polyurea thereby integrating the support frame in a finished tunnel profile element.

Further, the sprayed polyurea layer may partly be covering the supported foam glass panel surfaces close up to, but not covering the support frame,

after the partly sprayed polyurea layer is cured, the supporting frame may be removed followed by a step of spraying the rest of all visible outside surfaces of the foam glass panels with polyurea.

Further, additional foam glass panels may be sprayed with polyurea at the same time as other outside surfaces of other foam glass panels of the tunnel profile element is sprayed.

Further, additional foam glass panels may be sprayed after other outside surfaces of the tunnel profile element is sprayed and cured.

Further, a sprayed polyurea layer may extend outside at least an edge of a surface of the tunnel profile element, and flush with said surface, constituting an outwardly protruding patch of the tunnel profile element.

Further, an unbroken layer of polyurea may be constituted by spraying a first part of a polyurea layer followed by spraying a second part of the polyurea layer overlapping at least partly the first part of the polyurea layer.

Claims:

1. A tunnel profile element (10) adaptable to respective aperture dimensions of raw tunnels, wherein the tunnel profile element (10) comprises foam glass panels,

wherein at least a tunnel floor element (10c), at least respective sidewall elements (10b) and at least a roof element (10a) of foam glass panels are hold together by a sprayed unbroken surface layer of polyurea on at least all visible surfaces of an assembled tunnel profile element (10).

2. The tunnel profile element of claim 1, wherein additional polyurea sprayed foam glass panels constitute at least one airing channel element (11) arranged adjacent to the roof element (10a) of the tunnel profile element (10).

3. The tunnel profile element of claim 1, wherein additional polyurea sprayed foam glass panels constitute at least one escape-route tunnel element (15) arranged adjacent to at least one of the sidewalls (10b) of the tunnel profile element (10).

4. The tunnel profile element of claim 3, wherein a roof element (16) of the escape-route tunnel element (15) is inclined downwards relative to the adjacent sidewall element (10b) of the tunnel profile element (10).

5. The tunnel profile element of claim 3, wherein the escape-route tunnel element (15) comprises additional service channel elements (17) constituted by additional polyurea sprayed foam glass panels.

6. The tunnel profile element of claim 1, wherein additional polyurea sprayed foam glass panels constitute at least one channel element (11, 13, 14, 17) arranged adjacent to the floor element (10c) and/or the respective sidewall

elements (10b) and/or the roof element (10a) of the tunnel profile element (10).

7. The tunnel profile element of claim 1, wherein additional polyurea sprayed foam glass panels constitute at least one cabinet, including a hinged door element of the cabinet, arranged adjacent to a sidewall element of the tunnel profile element (10).

8. The tunnel profile element of claim 1, wherein a plurality of assembled smaller polyurea sprayed foam glass panels constitute a curved roof surface.

9. The tunnel profile element of claim 1, wherein the profile shape of the tunnel profile element (10) is rectangular.

10. The tunnel profile element of claim 1, wherein the weight of a tunnel profile element is about 30 kg/m^2.

11. The tunnel profile element of claim 1, wherein a thickness of respective foam glass panels typically is about 10 cm.

12. The tunnel profile element of claim 1, wherein the foam glass panels are constituted by a plurality of sandwiched thinner foam glass plates, wherein a joint between a first thinner foam glass plate adjacent to a second thinner foam glass plate is covered by a third thinner foam glass plate located above or below the first and second thinner foam glass plates,

wherein the sprayed unbroken polyurea layer is applied on the outer surfaces of the respective sandwiched foam glass plates thereby constituting the foam glass panel.

13. The tunnel profile element of claim 1, wherein a floor element is arranged with a fluid drainage opening (12) being in fluid communication with a drainage pipe arranged below the floor element (10c) of the tunnel profile element.

14. The tunnel profile element of claim 1, wherein additional support elements resting on the floor of the raw tunnel is supporting the floor element of the tunnel profile element.

15. The tunnel profile element of claim 1, wherein additional reinforcement rods are included in the foam glass elements of the floor elements (10c).

16. The tunnel profile element of claim 1, wherein a layer of smashed foam glass covered by asphalt constitute the floor element (10c).

17. The tunnel profile element of claim 1, wherein LED lights are arranged in respective sidewall elements (10b) and/or roof elements (10a).

18. The tunnel profile element of claim 18, wherein the LED lights in the roof element (10a) is configured as a star filled sky.

19. The tunnel profile element of claim 17-18, wherein the LED lights are configured to change color on a regular basis, or in accordance with an externally submitted command.

20. A method of assembling a tunnel profile element of any claim 1-19, comprising steps of:

- defining a shape and dimension of the tunnel profile element (10),
- arranging a support frame with the shape and dimension of the defined tunnel profile element,
- holding respective adapted foam glass panels in the support frame; and
- spraying an unbroken layer of polyurea on at least all visible outside surfaces of the foam glass panels supported by the supporting frame.

21. The method of claim 1, wherein the support frame is sprayed with polyurea thereby integrating the support frame in a finished tunnel profile element.

22. The method of claim 1, wherein the sprayed polyurea layer is partly covering the supported foam glass panel surfaces close up to, but not covering the support frame,

after the partly sprayed polyurea layer is cured, the supporting frame is removed followed by a step of spraying the rest of all visible outside surfaces of the foam glass panels with polyurea.

23. The method of claim 20, wherein additional foam glass panels arranged in the support frame constitute further units of a finished tunnel profile.

24. The method of claim 23, wherein the additional foam glass panels are sprayed with polyurea at the same time as the other outside surfaces of the other foam glass panels of the tunnel profile element is sprayed.

25. The method of claim 24, wherein the additional foam glass panels is sprayed after the other outside surfaces of the tunnel profile element is sprayed and cured.

26. The method of claim 20, wherein the sprayed polyurea layer extends outside at least an edge of a surface of the tunnel profile element, and flush with said surface, constituting an outwardly protruding patch 19 of the tunnel profile element.

27. The method of claim 20, wherein an unbroken layer of polyurea is constituted by spraying a first part of the polyurea layer followed by spraying a second part of the polyurea layer overlapping at least partly the first sprayed part of the polyurea layer.

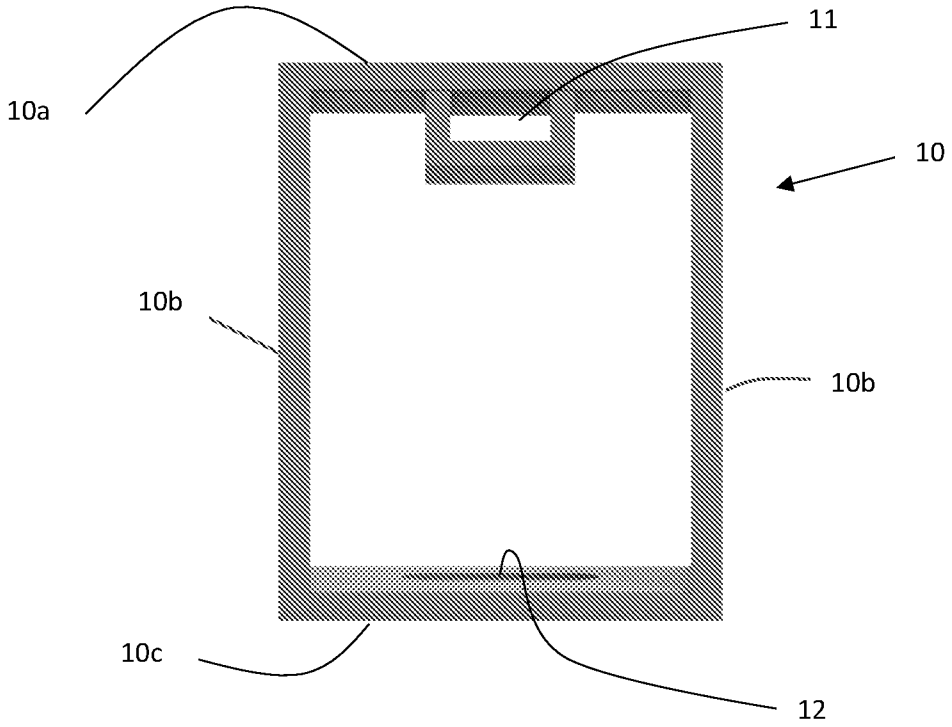

Figure 1

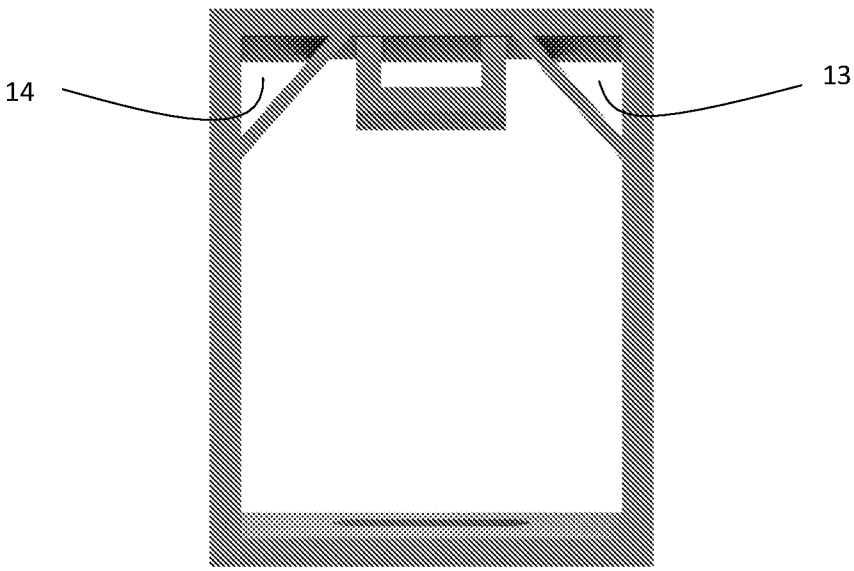

Figure 2

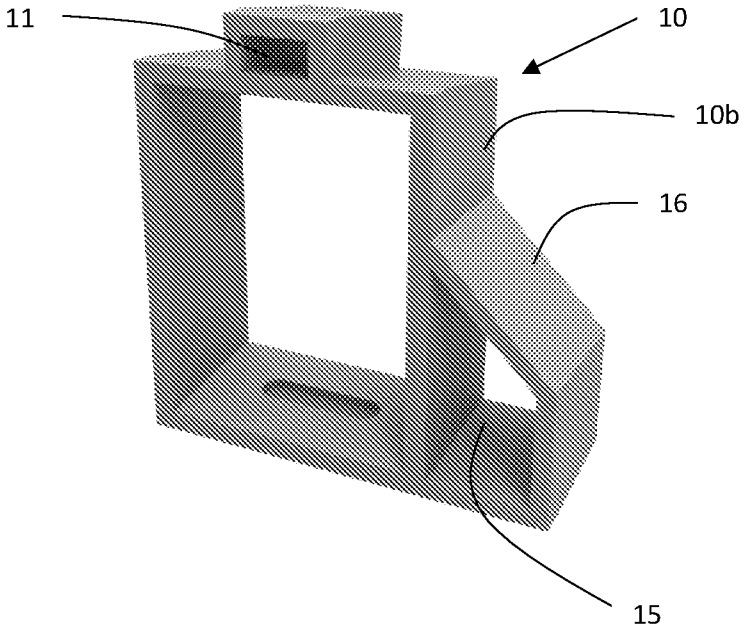

Figure 3

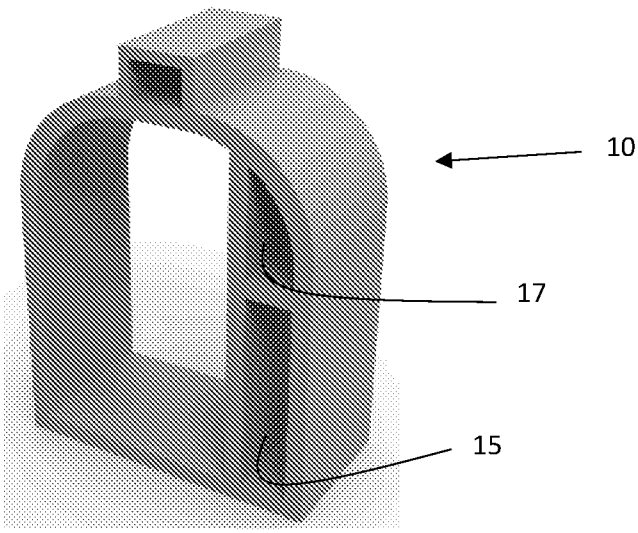

Figure 4

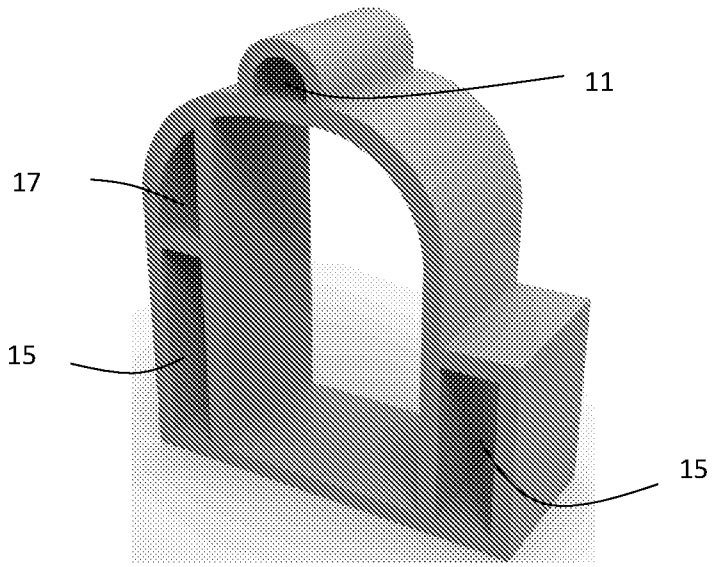

Figure 5

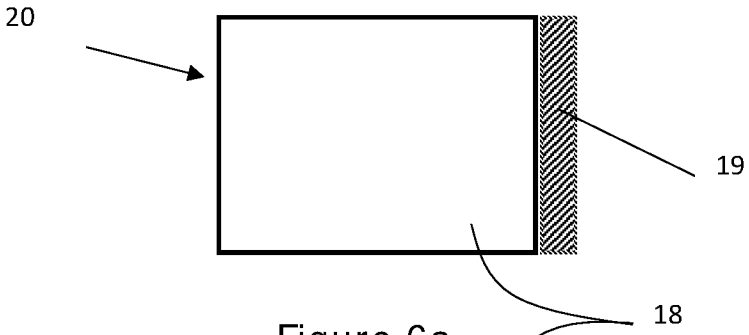

Figure 6a

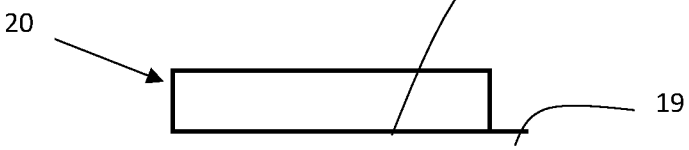

Figure 6b

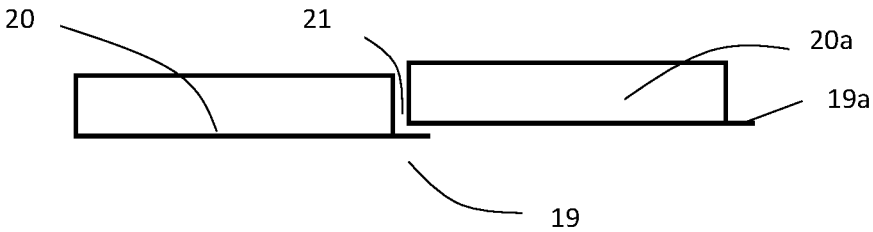

Figure 6c

INTERNATIONAL SEARCH REPORT

International application No
PCT/NO2018/050227

A. CLASSIFICATION OF SUBJECT MATTER
INV. E21D11/00 E21D11/38 E04B1/343 E04C2/26 C03C11/00
ADD.

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)
E21D C03C E04B E04C

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 practicable, 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.
A	US 4 940 360 A (WEHOLT RAYMOND L [US]) 10 July 1990 (1990-07-10) column 2, lines 35-64 column 3, lines 6-11	1-27
A	WO 2004/024645 A2 (EARTHSTONE INTERNAT LLC [US]) 25 March 2004 (2004-03-25) cited in the application page 3, line 30 - page 4, line 7	1-27
A	US 2013/051918 A1 (RAYNER TERRENCE JOHN [CA] ET AL) 28 February 2013 (2013-02-28) paragraph [0011]	1-27
A,P	WO 2017/171558 A1 (TPD AS [NO]) 5 October 2017 (2017-10-05) page 9, lines 6-22	1-27

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
28 November 2018	06/12/2018

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, Fax: (+31-70) 340-3016	Garrido Garcia, M

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INTERNATIONAL SEARCH REPORT

International application No
PCT/NO2018/050227

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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A	EP 1 350 922 A1 (LYONNAISE D ETANCHEITE PAR GEO [FR]) 8 October 2003 (2003-10-08) paragraphs [0017], [0021], [0024], [0029], [0030] -----	1-27

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INTERNATIONAL SEARCH REPORT

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