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(54) **PREFABRICATED ARCH ELEMENT FOR ARCHED VAULTS**

(57) The present invention relates to a prefabricated arch element (1) for building an arched vault (11), comprising two girder elements (2) and arch-shaped masonry (3), which is laid between these girder elements (2). In addition, the present invention relates to a vault (11) which is built using such prefabricated arch elements (1), a method for producing such a prefabricated arch element (1), a method for building such a vault (11) and a device for producing such a prefabricated arch element (1).

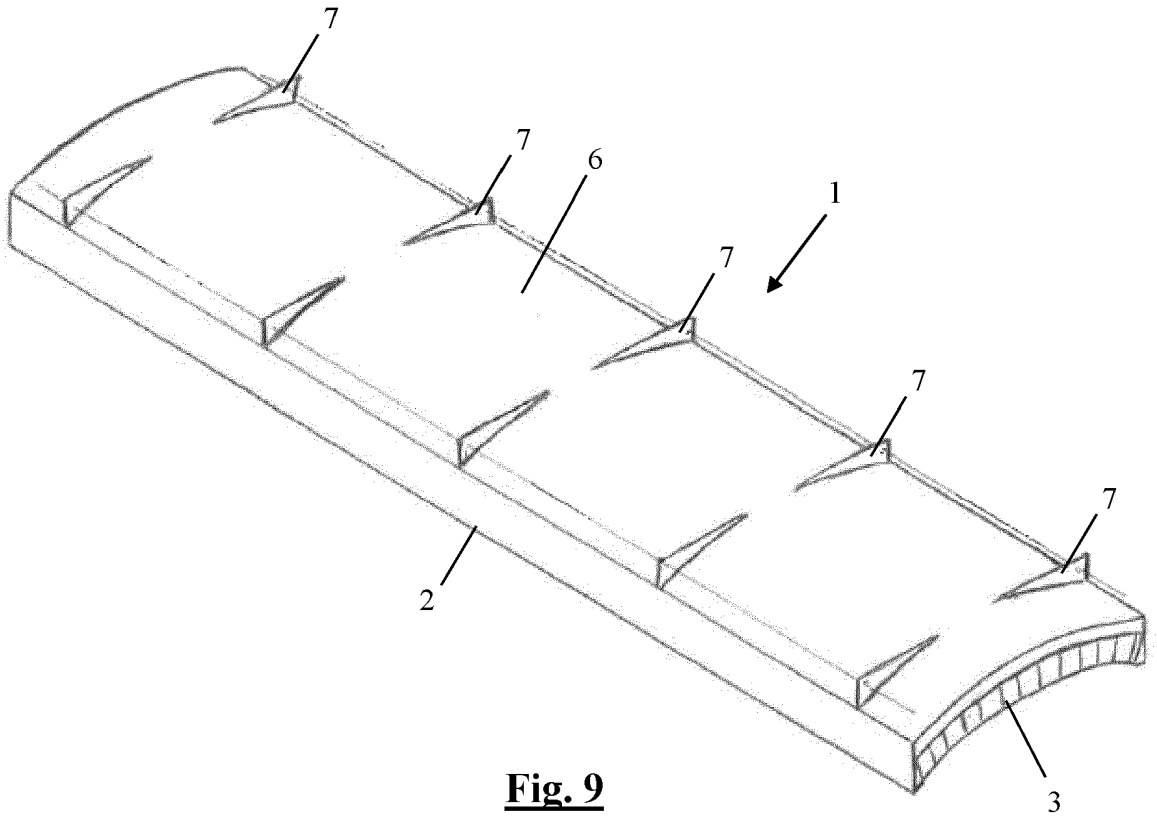

Fig. 9

EP 3 725 970 A1

Description

[0001] The present invention relates to a prefabricated arch element for building an arched vault and a method and a device for producing such a prefabricated arch element. More specifically, the method and the device are particularly suitable for producing prefabricated arch elements for building a trough vault.

[0002] In addition, the present invention relates to a vault which is built using such prefabricated arch elements and a method for building such a vault.

[0003] Vaults are constructed in all kinds of materials. In order to build brick vaults, these are built in situ in brick using a supporting structure (falsework) in order to produce a vault having the desired shape. Masonry is placed on the supporting structure and follows the shape of the supporting structure. Such masonry typically consists of blocks (e.g. bricks) between which mortar is disposed. However, it is for example for example also known to adhesively bond blocks in order to produce masonry. Once the mortar or the adhesive has dried, the supporting structure can be removed.

Building brick vaults in situ is a particularly time-consuming operation which is often undesirable on sites nowadays. In addition, in this case the bricks forming the vaults have to be laid in a position which is not very ergonomical and in an environment in which workers are exposed to weather conditions.

In order to be able to build vaults more quickly, several prefabricated systems have already been devised, in which prefabricated concrete arch elements are used to build a vault. Examples thereof are described in EP 0 947 639 A1 and MX 2013000403 A. However, such concrete arch elements do not produce the same aesthetic result as brick vaults.

[0004] It is an object of the present invention to ensure that brick vaults can be built more quickly.

[0005] This object of the invention is firstly achieved by providing a prefabricated arch element for building an arched vault which comprises two girder elements and arch-shaped masonry which is laid between these girder elements.

[0006] Such a prefabricated arch element can be produced in a workshop where workers can assume a more ergonomic position and where they are not exposed to weather conditions. In this way, it is possible to build such an arch element in brick more quickly than if this were to be done in situ.

By means of these prefabricated arch elements, it is then possible to build a vault much more quickly at the building site.

[0007] In order to be able to place such arch elements quickly, the following has been carried out:

- the girder elements are preferably virtually parallel to each other, with the masonry being arranged entirely between these girder elements.
- the girder elements preferably form edges or even sides of the arch element. By means of such girder elements, it is easier to produce a flat edge or even side to which other parts of a building can be joined for installation or extension.
- the girder elements on the convex side of the arch-shaped masonry are preferably raised with respect to this arch-shaped masonry. Thus, any additional elements of such an arch element can be arranged between these girder elements. It is then also possible to join these girder elements to external elements more easily.

[0008] The masonry of an arch element according to the present invention is preferably in the shape of a segmental arch, in which the arc segment forms at most half a circle (in order to form a barrel vault) and preferably forms a segmental arch which is smaller than half a circle (in order to form a trough vault). If desired, this masonry may, for example, also be configured as a pointed arch.

[0009] The girder elements of an arch element according to the present invention are preferably made of metal. These may be, for example, steel girders.

[0010] In addition to the girder elements and the arch-shaped masonry, a prefabricated arch element according to the present invention preferably also comprises concrete which is applied to the masonry, on the convex side of this masonry.

This concrete is then preferably configured as reinforced concrete. To this end, reinforcing steel is for example incorporated in the concrete.

If the girder elements on the convex side of the arch-shaped masonry are raised with respect to the arch-shaped masonry, this concrete is preferably arranged between these girder elements.

[0011] Furthermore, an arch element according to the present invention preferably comprises transverse reinforcing elements which are arranged on the convex side of the masonry. Such transverse reinforcing elements serve to also reinforce the masonry in a direction at right angles to the girder elements.

These transverse reinforcing elements may be made of metal, for example of steel.

These transverse reinforcing elements preferably extend entirely on this convex side. If desired, these transverse reinforcing elements may be anchored in the masonry.

In embodiments of arch elements which are provided with concrete, as described above, these transverse reinforcing elements may alternatively or additionally be anchored in this concrete. Preferably, with reinforced concrete, the reinforcement may be interwoven with these transverse reinforcing elements, for example by arranging reinforcing rods through openings in the transverse reinforcing elements.

If the girder elements on the convex side of the arch-shaped masonry are raised with respect to the arch-shaped masonry, these transverse reinforcing elements preferably extend between these girder elements and, still more preferably, these are attached to these girder

elements, for example by means of welding.

Transverse reinforcing elements of an arch element according to the present invention may take numerous forms. These may advantageously be produced from sheet metal, for example from sheet steel. These are then preferably arranged virtually parallel to each other between the girder elements.

[0012] In a particularly preferred embodiment, each girder element of an arch element according to the present invention is configured as a profiled section having a substantially L-shaped cross section, wherein the short leg of this L shape is arranged on the concave side of the arch-shaped masonry and wherein the long legs of the L shape of both girder elements are arranged virtually parallel to each other.

In this way, it is possible to allow the arch element on the short legs of the girder elements to rest on a surface, in which case forces can be transmitted in a uniform manner. By means of these short legs, it is also readily possible to finish the edge of the prefabricated arch elements in an aesthetic manner.

By means of the long legs of the girder elements, it is possible to allow the arch element to adjoin and rest against adjacent girder elements of adjacent arch elements or against an adjoining structure, in which case forces can likewise be transmitted in a uniform manner. These long legs also readily allow the arch elements to be placed accurately and to adjoin adjacent elements.

[0013] In order to facilitate transportation and handling of a prefabricated arch element according to the present invention, this arch element is preferably provided with engaging elements for a lifting tool, such as for example a hoisting crane, to engage thereon.

With arch elements which are provided with concrete, these engaging elements may for example be anchored in this concrete.

With arch elements which comprise said transverse reinforcing elements, these engaging elements may for example be processed in these transverse reinforcing elements.

[0014] The object of the present invention is in addition achieved by providing a vault comprising above-described arch elements according to the present invention.

[0015] More specifically, such a vault may, for example, be a barrel vault or a trough vault.

[0016] With a vault according to the present invention, the girder elements of arch elements arranged adjacent to each other are preferably arranged adjacent to each other.

More specifically, such a vault may comprise, for every two adjacent girder elements of adjacent arch elements, a finishing profiled section which is arranged on the concave side of the arch elements over these adjacent girder elements.

[0017] In order to be able to fit this finishing profiled section in a simple and aesthetically pleasing manner, it preferably has a substantially U-shaped cross section.

[0018] The object of the present invention is furthermore also achieved by providing a method for producing a prefabricated arch element for building an arched vault which comprises the following steps:

a. providing a first girder element;
b. laying a few layers of masonry on this first girder element;
c. tilting the first girder element with the layers of masonry arranged thereon;
d. laying a few more layers of masonry on top of the layers of masonry which have already been laid on the first girder element;
e. repeating steps c and d until a desired arch-shaped masonry construction has been achieved;
f. arranging a second girder element on top of the arch-shaped masonry construction which has been laid on the first girder element.

[0019] By means of such a method, the layers of masonry are in each case arranged on top of each other, in each case in a substantially vertical manner, and tilted, until the desired arc shape is produced. This makes it possible to lay the masonry much more quickly, than when layers of masonry are laid in a more horizontal manner.

[0020] In step a, the first girder element may in this case in addition readily be arranged on a surface which makes it possible to lay the layers of masonry thereon in an ergonomic manner. Preferably, this takes place in an indoor environment which is not affected by weather conditions, or only to a limited extent.

[0021] For step b, the bench may, if desired, be tilted at a desired inclination in order to be able to lay the first layers of masonry in a simpler manner thereon.

[0022] In steps b and d, the masonry layers are laid in such a manner that the desired arc shape is produced in the process. This can easily be achieved by using the desired arc shape as a reference in this case. This may be done, for example, by placing reference arches having the desired arc shape on either side, tying a rope between both reference arches and using this rope as reference while laying the masonry. In step c, these reference arches which are arranged on either side then have to be tilted together with the first girder element and the masonry layers laid thereon.

[0023] Step c has to be performed every time the inclination of the top surface of the top layer of masonry which is arranged on the first girder element becomes too steep to be able to lay another layer of masonry on top thereof. The first girder element and the masonry layers laid thereon are then preferably tilted until this top surface is in a virtually horizontal position or is tilted just beyond and has a slight inclination.

[0024] In steps b and f, the girder elements are attached to the masonry, for example by means of mortar or adhesive.

[0025] More specifically, a method according to the present invention may comprise the following additional

step:
g. arranging supporting elements on the concave side of the arch-shaped masonry construction in steps b to d.

[0026] By means of such supporting elements, it is possible to build such a prefabricated arch element quickly without meanwhile having to allow mortar or adhesive to set during laying of the masonry.

[0027] In this case, such supporting elements may be arranged where these are necessary or desired in order to prevent the masonry from collapsing or the desired arc shape from deviating. This is particularly desired if the masonry is not self-supporting while it is being laid until the mortar or the adhesive between the blocks is set.

[0028] Furthermore, a method according to the present invention more specifically comprises the following additional steps:

h. tilting the two girder elements with the arch-shaped masonry laid therebetween, so that the convex side of the arch-shaped masonry is directed upwards;
i. providing transverse reinforcing elements and/or reinforcement and/or concrete above the arch-shaped masonry and between the girder elements.

[0029] In order to provide transverse reinforcing elements between the girder elements, the former may in this case for example be welded to the latter and/or fitted thereto using bolts, etc.
If reinforcement is arranged between the girder elements, between which transverse reinforcing elements are also provided, this reinforcement is preferably interwoven with the transverse reinforcing elements, for example by arranging reinforcing rods of this reinforcement through openings of the transverse reinforcing elements.
In order to provide concrete between the girder elements which are placed a distance apart and comprise the arch-shaped masonry therebetween, shuttering panels are preferably attached to the ends of these girder elements and the masonry and are removed again after the concrete has set.

[0030] A method according to the present invention is particularly suitable for producing an above-described arch element according to the present invention.

[0031] If the girder elements of such an arch element are configured like an above-described L-shaped profiled section, then, in step a, the long leg of a first L-shaped profiled section is preferably arranged on a flat surface, the short leg being upright with respect to the long leg. Then, in step b, a first layer of masonry is provided on top of the long leg, against the short leg. In steps b and d, successive layers of masonry are provided on top thereof, with the short leg of the first girder element being situated on the concave side of the arc which is being formed. After the masonry has been laid, the second girder element is arranged on top of the last layer of masonry in step f, with its long leg on top of this masonry and its short leg laterally next to this masonry, on the concave side thereof.

[0032] In addition, the object of the present invention is achieved by providing a method for building a vault comprising prefabricated arch elements, which comprises the following the following steps:

a. providing several above-described prefabricated arch elements according to the present invention;
b. arranging these arch elements adjacent to each other, with girder elements of every two adjacent arch elements being arranged adjacent to each other.

[0033] If the arch elements comprise said engaging elements, these arch elements may be lifted to this end by engaging them at these engaging elements by means of, for example, a hoisting crane.

[0034] In order to finish a vault which has been built using a method according to the present invention in an aesthetic manner, a method according to the present invention may, more specifically, comprise the following additional step:
c. arranging, for every two adjacent girder elements of arch elements arranged adjacent to each other, a finishing profiled section over these adjacent girder elements on the concave side of the arch elements.

[0035] Preferably, an above-described vault according to the present invention is produced by means of a method according to the present invention.

[0036] Finally, the object of the present invention is also achieved by providing a device for producing a prefabricated arch element for building an arched vault which comprising the following elements:

- a bench with a bearing surface for arranging a first girder element thereon;
- tilting means for tilting the bench through at least 90°;
- supporting means for supporting layers of masonry arranged on the first girder element while laying them; and
- holding means for keeping two girder elements with arch-shaped masonry laid therebetween against the bearing surface during tilting thereof.

[0037] Such a device according to the present invention can advantageously be used for producing a prefabricated arch element according to an above-described method according to the present invention.

[0038] The bearing surface of the bench of a device according to the present invention is preferably arranged at a level which makes it possible to lay the required layers of masonry ergonomically on the first girder element arranged thereon. If desired, the bench may to this end be arranged so as to be vertically adjustable, so that the height can also be adjusted while the masonry is being laid.

[0039] Due to the fact that the bench of a device according to the present invention is configured to be tilta-

ble, it is possible, with a method according to the present invention for producing a prefabricated arch element, to readily tilt the first girder element with the layers of masonry arranged thereon in step c by tilting the bench on which this girder element is arranged.

[0040] As the bench can be tilted through 90°, it is possible, in the more specific embodiment of a method according to the present invention, to carry out step h in a simple manner. By means of the holding means, the girder elements with the masonry laid therebetween can easily be held against the bearing surface during tilting thereof.

[0041] The tilting means may be constructed in a large number of ways.

They may, for example, be configured so as to be manually operable. Alternatively or additionally, they may also be of a motorized and/or hydraulic design.

[0042] The supporting means may, more specifically, comprise supporting beams which are attachable to the bench on a first side of the bearing surface. If desired, additional supporting elements may be provided so as to be attachable to these supporting beams.

More specifically, the holding means may comprise holding beams which are attachable to the bench on a second side of the bearing surface, opposite to the first side. Additional accessories may be provided so as to be attachable to these holding beams in order to hold the girder elements with the masonry laid therebetween against the bearing surface. Such accessories are then preferably provided on these holding beams so as to be displaceable (slidable).

[0043] In this case, the masonry may be constructed in a zone which, in the attached position of these holding beams and these supporting beams, extends between the holding beams and the supporting beams.

[0044] In this case, said holding beams and/or said supporting beams are preferably detachably attachable to the bench.

With a method for producing a prefabricated arch element according to the present invention, the holding beams are preferably not attached to the bench during laying of masonry in steps b and d, in order to offer maximum access to the zone in which the masonry is being constructed in order to lay the layers of masonry.

During step i of a more specific such method, the supporting beams are preferably not attached to the bench in order to offer maximum access to this zone in order to provide the transverse reinforcing elements and/or the reinforcement and/or the concrete. In that case, the holding beams are preferably attached to the bench in order to support the combination of the girder elements and the masonry laid therebetween. In this case, the device, at its end which is arranged facing away from the bench, preferably comprises limbs for supporting the holding beams.

[0045] Said supporting beams and/or said holding beams may be, for example, profiled sections.

[0046] In a specific embodiment, a device according to the present invention comprises two reference beams which are attachable to the bench and two reference arches which are provided on the reference beams in order to lay the masonry in the shape of an arch between these reference arches, using these reference arches as reference. As described above, a rope may then be tied between these reference arches in order to follow the desired arc shape when laying the layers of masonry.

[0047] The present invention will now be explained in more detail by means of the following detailed description of a prefabricated arch element, a method and a device for producing such a prefabricated arch element according to the present invention and a vault and a method for building such a vault according to the present invention. The sole aim of this description is to provide illustrative examples and to indicate further advantages and features of the present invention and can therefore by no means be interpreted as a limitation of the area of application of the invention or of the patent rights defined in the claims.

[0048] In this detailed description, reference numerals are used to refer to the attached drawings, in which:

- Fig. 1 shows a part of a device according to the present invention in perspective;
- Fig. 2 shows the bench of the device from Fig. 1 with a first girder element provided thereon and a few layers of masonry provided thereon in side view;
- Fig. 3 shows the bench of the device from Fig. 1 with a first girder element and arch-shaped masonry provided thereon which is supported by supporting means of the device in side view;
- Fig. 4 shows the bench of the device from Fig. 1 with a combination of girder elements provided thereon and with arch-shaped masonry laid therebetween, which is supported by supporting means of the device and which is held against the bearing surface of the bench by holding means of the device, in side view;
- Fig. 5 shows the bench of the device from Fig. 1 with a combination of girder elements provided thereon and with arch-shaped masonry laid therebetween which is held against the bearing surface of the bench by holding means of the device, in side view, tilted through 90°, supported by limbs and comprising transverse reinforcing elements and reinforcement provided between the girder elements on the convex side of the masonry;
- Fig. 6 shows the elements from Fig. 5 in side view, wherein the holding means are detached from the combination of the girder elements and the arch-shaped masonry laid therebetween, transverse reinforcing elements and reinforcement and wherein gripper means engage with the transverse reinforcing elements in order to lift this combination;
- Fig. 7 shows the combination of the girder elements and the arch-shaped masonry laid therebetween, transverse reinforcing elements and reinforcement

from Fig. 7 separately in perspective;
- Fig. 8 shows an arch element according to the present invention in side view;
- Fig. 9 shows an arch element according to the present invention in perspective;
- Fig. 10 shows a finishing profiled section for a vault according to the present invention in perspective;
- Fig. 11 shows a vault according to the present invention in side view.

[0049] The device illustrated in the figures comprises a bench (15) which is substantially formed in this case by an I girder, with hollow box profiles arranged underneath in a transverse direction. The I girder is provided with attachment apertures (26) at regular intervals.

[0050] As can be seen in Fig. 1, axle stubs (16) which are rotatably attached to supporting blocks (17) are attached to the bench (15).
By means of a belt transmission (20), reduction (19) and rotating disc (18) with a handle, the bench (15) is rotatable.

[0051] Reference beams (21) to which reference arches (22) are attached are attached to the bench (15). Securing elements (37) for securing the reference beams (21) engage with some of said attachment apertures (26) of the bench (15). The reference beams (21) are arranged parallel to each other and spaced apart. The reference beams (21) are arranged on the sides of the bench (15), substantially vertical with respect to a bearing surface (35) of this bench (15). In this case, the reference arches (22) extend above this bearing surface (35).
A device according to the present invention may comprise several such reference arches (22) which are exchangeably attachable to the reference beams (21).
It is also possible to provide a device without such reference beams (21) and reference arches (22). Any desired profiled section can then be attached to the bench (15) as a reference beam. The reference arches (22) may then be sawn to size, for example from a wooden panel, and attached to the reference beams (21). It is also possible to produce a reference beam (21) and a respective reference arc (22) as a single piece.

[0052] With a method according to the present invention in which the illustrated device is used, an L-shaped profiled section (2) is arranged on the bearing surface (35) of the bench (15), in the zone between the reference beams (21). This L-shaped profiled section is arranged with its long leg (14) on this bearing surface (35), with its short leg (13) being erect with respect to this bearing surface (35). This profiled section (2) may be attached to the bench (15), for example by means of screw clamps. In this case, the screw clamp can easily be allowed to engage with a flange of the I girder.

[0053] Layers of masonry are laid onto this profiled section (2) by alternating layers of bricks (4) and layers of mortar (5) in a known manner, as can be seen in Fig. 2. When laying the masonry, the arc shape of the reference arches (22) is followed. To this end, it is for example possible to tie a piece of string between these reference arches (22).

[0054] In order to lay the first layers of masonry, it is advantageous to tilt the bench (15) forward first. In order to lay the next layers of masonry, it is advantageous to tilt the bench (15) slightly further backwards in each case. In each instance, several layers of masonry are preferably laid before the bench (15) is tilted backwards.

[0055] On the side of the bench (15) opposite to that on which the reference beams (21) are attached, supporting beams (23) are attached to the bench (15). To this end, threaded rods (27) are fixed in said attachment apertures (26) of the bench (15) and the supporting beams (23) are secured with nuts (28). While masonry is being laid, the layers of masonry (4, 5) which have already been laid are supported by providing supporting elements (24) between the supporting beams (23) and the masonry (4, 5). To this end, these supporting elements (24) may be attached to the supporting beams (23), for example by means of screw clamps (29).

[0056] When the desired masonry (3) has been laid, as can be seen in Fig. 3, a second L-shaped profiled section (2) is provided on top of this masonry (3). In this case, its long leg (14) is arranged on top of the masonry (3). In this case, its short leg (13) extends on the concave side of the masonry (3), as can be seen in Fig. 4. Preferably, the long legs (14) of both L-shaped profiled sections (2) in this case extend parallel to each other.

[0057] Subsequently, holding beams (25) are attached to the bench (15) by means of threaded rods (27) which engage in said attachment apertures (26) and nuts (28) on the same side of the bench (15) as the side to which the reference beams (21) are attached. Accessories (32) are attached to these holding beams (25) so as to be slidable. The accessories (32) are provided with holding elements (26) which are pressed against the long leg (14) of the second L-shaped profiled section (2). The accessories (32) are fixed with respect to the holding beams (25) by fitting a pin through an opening (30) situated underneath in the corresponding holding beam (25) and by tightening the threaded rod (32) against the holding beam (25). In this way, the combination of the L-shaped profiled sections (2) and the arch-shaped masonry (3) laid therebetween can be held against the bearing surface (35) of the bench (15) by means of these holding means (26, 31, 36).

[0058] Thereafter, limbs (33) are attached to the holding beams (25) at their end facing away from the bench (15). The bench (15) is then tilted through 90° until the position shown in Figs. 5 and 6 is reached, in which the limbs (33) rest on a surface.

[0059] The supporting beams (23) and supporting elements (24) are released.

[0060] Plate-shaped, U-shaped transverse reinforcing elements (7) are arranged between the L-shaped profiled sections (2), on the convex side of the masonry (3), substantially parallel to each other and spaced apart from each other. These transverse reinforcing elements (7)

are welded to these profiled sections (2). Reinforcement (8) is also arranged on the convex side of the masonry (3) between the L-shaped profiled sections. This reinforcement (8) is interwoven with the transverse reinforcing elements (7) by arranging the reinforcing rods thereof through openings (9) in these transverse reinforcing elements (7).

[0061] Subsequently, the accessories (31) are displaced with respect to holding beams (25) and moved away from the second L-shaped profiled section (2) in the process.

[0062] The transverse reinforcing elements (7) are provided with openings (10) which may themselves act as engaging element or in which brackets may be arranged as additional engaging elements on which hooks (34) of a lifting tool can engage.

By engaging thereon with a lifting tool, it is then possible to lift the combination of the L-shaped profiled sections (2) with the masonry (3) laid therebetween , transverse reinforcing elements (7) and reinforcement (8) from the holding beams (25). This combination is represented separately in perspective in Fig. 7.

[0063] Thereafter, shuttering panels are fitted at the ends of the L-shaped profiled sections (2) and the masonry in order to pour concrete (6) at the convex side of the masonry (3) between the L-shaped profiled sections (2). In this case, a layer of concrete of approximately 5 cm is preferably provided.

[0064] After the concrete (6) has set, the shuttering panels can be removed again, resulting in a prefabricated arch element (1) as illustrated in Figs. 8 and 9.

[0065] By means of such arch elements (1), it is possible to build a vault (11) as illustrated in Fig. 11. To this end, the arch elements (1) are lifted and arranged adjacent to each other, with the long legs of L-shaped profiled sections (2) adjacent to each other. For every two adjacent L-shaped profiled sections (2) of arch elements (1) arranged adjacent to each other, a U-shaped painted finishing profiled section (12) is arranged over the short legs of both L-shaped profiled sections (2).

Claims

1. Prefabricated arch element (1) for building an arched vault (11), **characterized in that** this arch element (1) comprises two girder elements (2) and arch-shaped masonry (3) which is laid between these girder elements (2).

2. Prefabricated arch element (1) according to Claim 1, **characterized in that** this arch element (1) comprises transverse reinforcing elements (7) which are at least partly arranged on the convex side of the masonry (3).

3. Prefabricated arch element (1) according to one of the preceding claims, **characterized in that** each girder element (2) is configured as a profiled section with a substantially L-shaped cross section, wherein the short leg (13) of this L shape is arranged on the concave side of the masonry (3) and wherein the long legs (14) of the L shape of both girder elements (2) are arranged virtually parallel to each other.

4. Vault (11) comprising prefabricated arch elements (1), **characterized in that** the arch elements (1) are configured as arch elements (1) according to one of the preceding claims.

5. Vault (11) according to Claim 4, **characterized in that** the girder elements (2) of arch elements (1) arranged adjacent to each other are arranged adjacent to each other.

6. Vault (11) according to Claim 5, **characterized in that** this vault (11) comprises a finishing profiled section (12) for every two adjacent girder elements (2) of arch elements (1) arranged adjacent to each other, which is arranged over these adjacent girder elements (2) on the concave side of the arch elements (1).

7. Method for producing a prefabricated arch element (1) for building an arched vault (11), **characterized in that** this method comprises the following steps:

   a. providing a first girder element (2);
   b. laying a few layers of masonry (4, 5) on this first girder element (2);
   c. tilting the first girder element (2) with the layers of masonry (4, 5) arranged thereon;
   d. laying a few more layers of masonry on top of the layers of masonry (4, 5) which have already been laid on the first girder element (2);
   e. repeating steps c and d until a desired arch-shaped masonry construction (3) has been achieved;
   f. arranging a second girder element (2) on top of the masonry construction (3) which has been laid on the first girder element (2).

8. Method according to Claim 7, **characterized in that** this method comprises the following additional step:
   g. arranging supporting elements (23, 24) on the concave side of the arch-shaped masonry construction (3) in steps b to d.

9. Method according to Claim 7 or 8, **characterized in that** this method comprises the following additional steps:

   h. tilting the two girder elements (2) with the masonry (3) laid therebetween, so that the convex side of the arch-shaped masonry (3) is directed upwards;

i. providing transverse reinforcing elements (7) and/or reinforcement (8) and/or concrete (6) above the masonry (3) and between the girder elements (2).

10. Method according to one of Claims 7 to 9, **characterized in that** a prefabricated arch element (1) according to one of Claims 1 to 5 is manufactured thereby.

11. Method for building a vault (11) with prefabricated arch elements (1), **characterized in that** this method comprises the following steps:

a. providing several prefabricated arch elements (1) according to one of Claims 1 to 3;
b. arranging these arch elements (1) adjacent to each other, with girder elements (2) of every two adjacent arch elements (1) being arranged adjacent to each other.

12. Method according to Claim 11, **characterized in that** this method comprises the following additional step:
c. arranging, for every two adjacent girder elements (2) of arch elements (1) arranged adjacent to each other, a finishing profiled section (12) over these adjacent girder elements (2) on the concave side of the arch elements (1).

13. Device for producing a prefabricated arch element (1) for building an arched vault (11), **characterized in that** this device comprises the following elements:

a. a bench (15) with a bearing surface (35) for arranging a first girder element (2) thereon;
b. tilting means (16, 18, 19 , 20) for tilting the bench (15) through at least 90°;
c. supporting means (23, 24) for supporting layers of masonry (4, 5) arranged on the first girder element (2) while laying them; and
d. holding means (25, 31) for keeping two girder elements (2) with arch-shaped masonry (3) laid therebetween against the bearing surface (35) during tilting thereof.

14. Device according to Claim 13, **characterized in that** the supporting means (23, 24) comprise supporting beams (23) which are attachable to the bench (15) on a first side of the bearing surface (35), and **in that** the holding means (25, 31) comprise holding beams (25) which are attachable to the bench (15) on a second side of the bearing surface (35), opposite the first side.

15. Device according to Claim 13 or 14, **characterized in that** the device comprises two reference beams (21) which are attachable to the bench (15) and two reference arches (22) which are provided on the reference beams (21) for laying arch-shaped masonry (3)between these reference arches (22), using these reference arches (22) as reference.

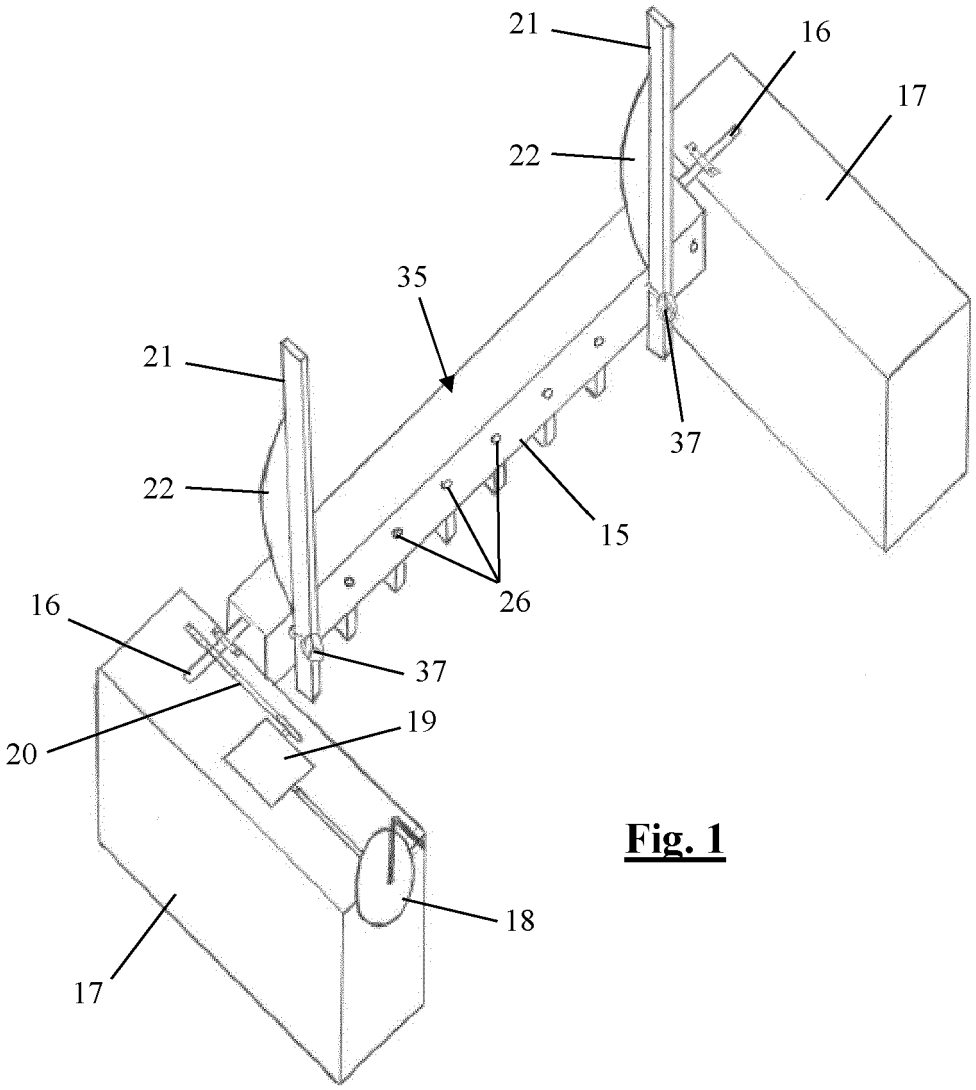

Fig. 1

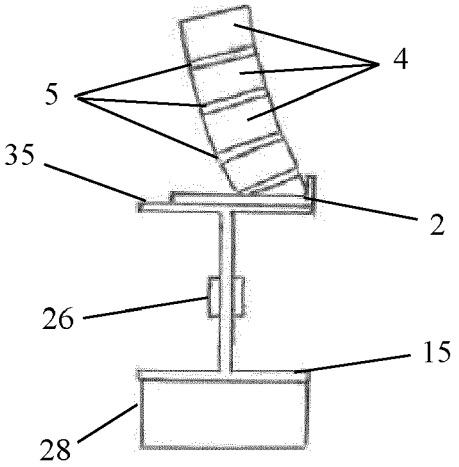

Fig. 2

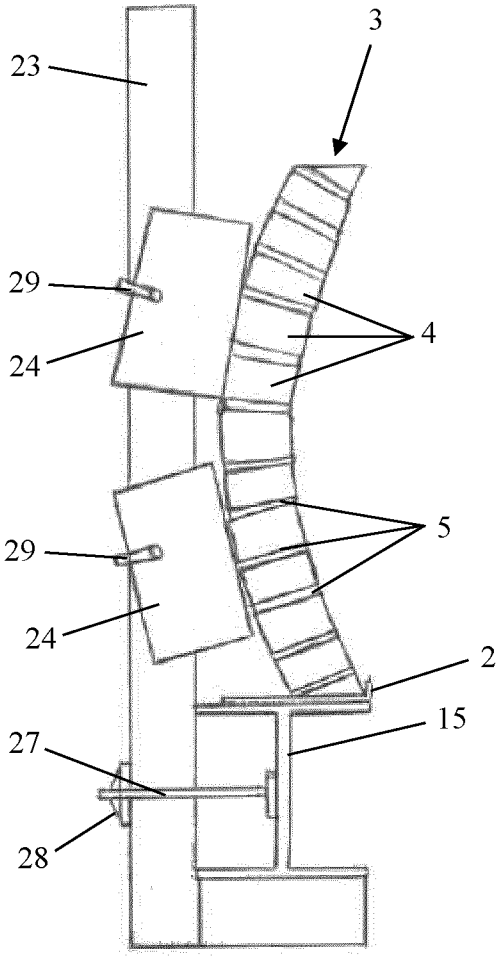
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Fig. 3

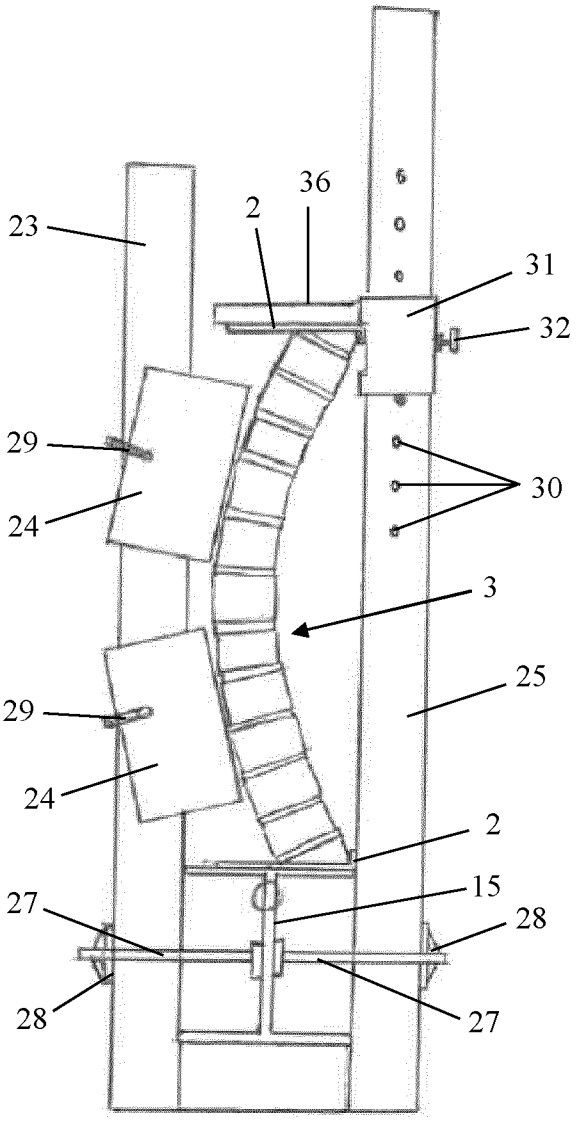
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Fig. 4

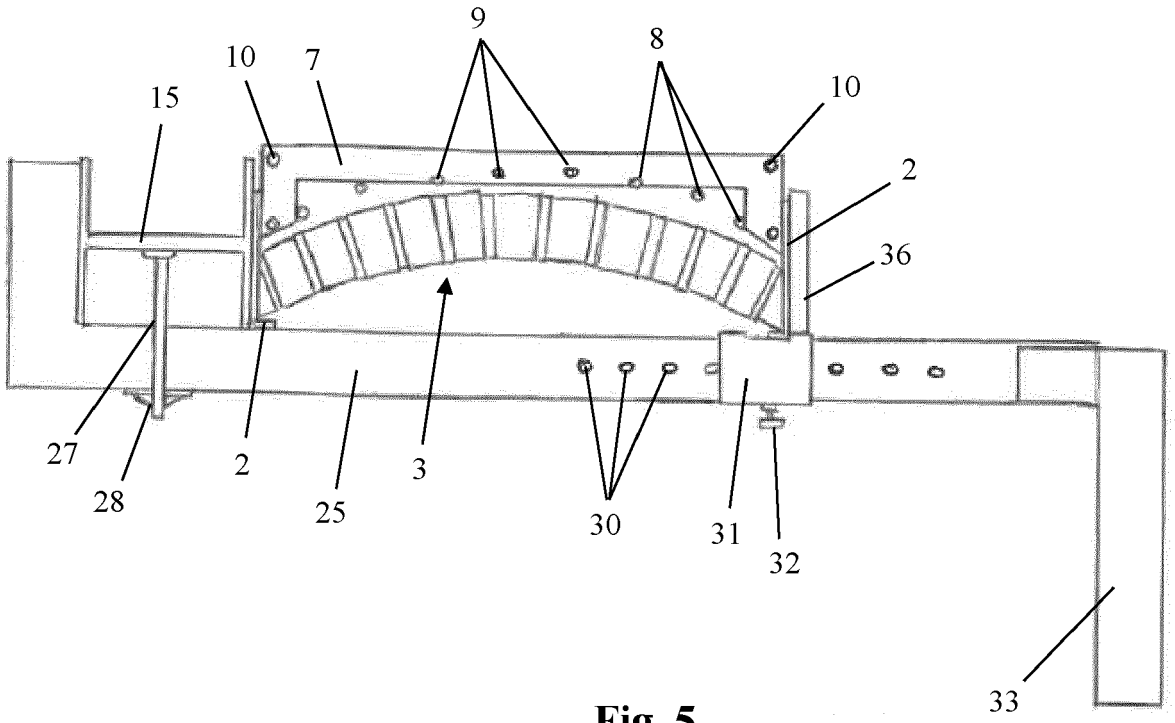
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Fig. 5

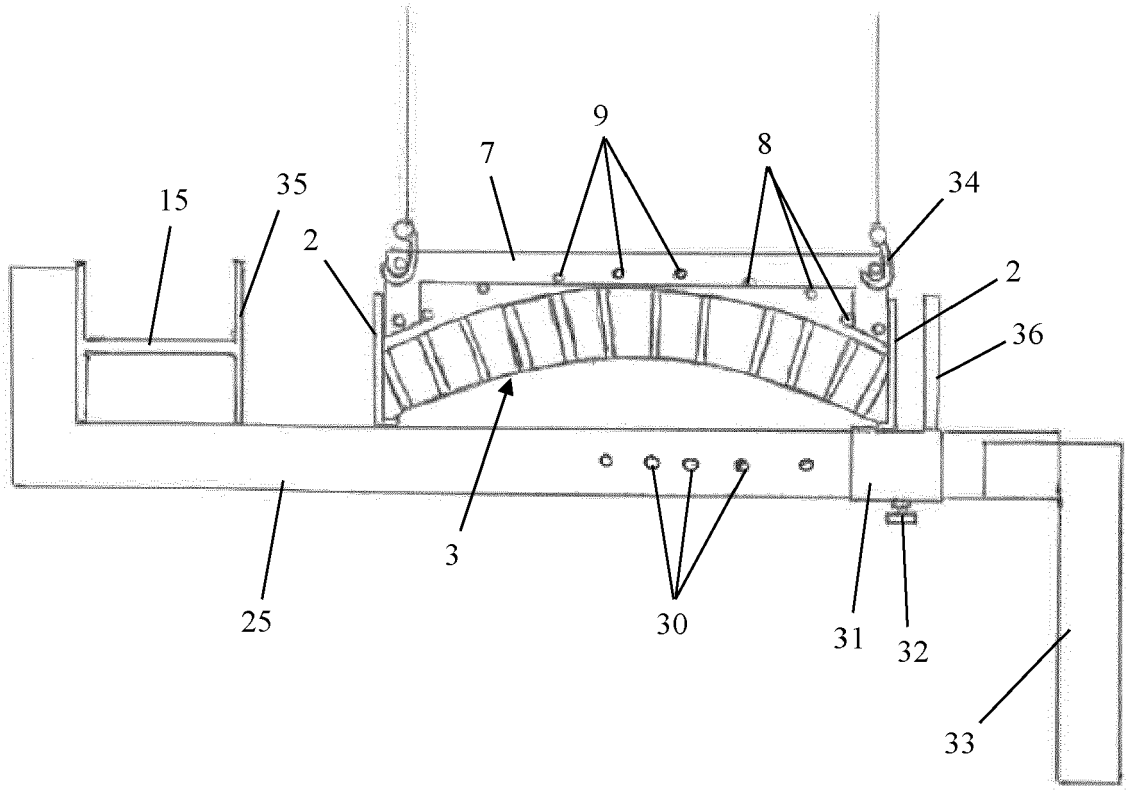
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Fig. 6

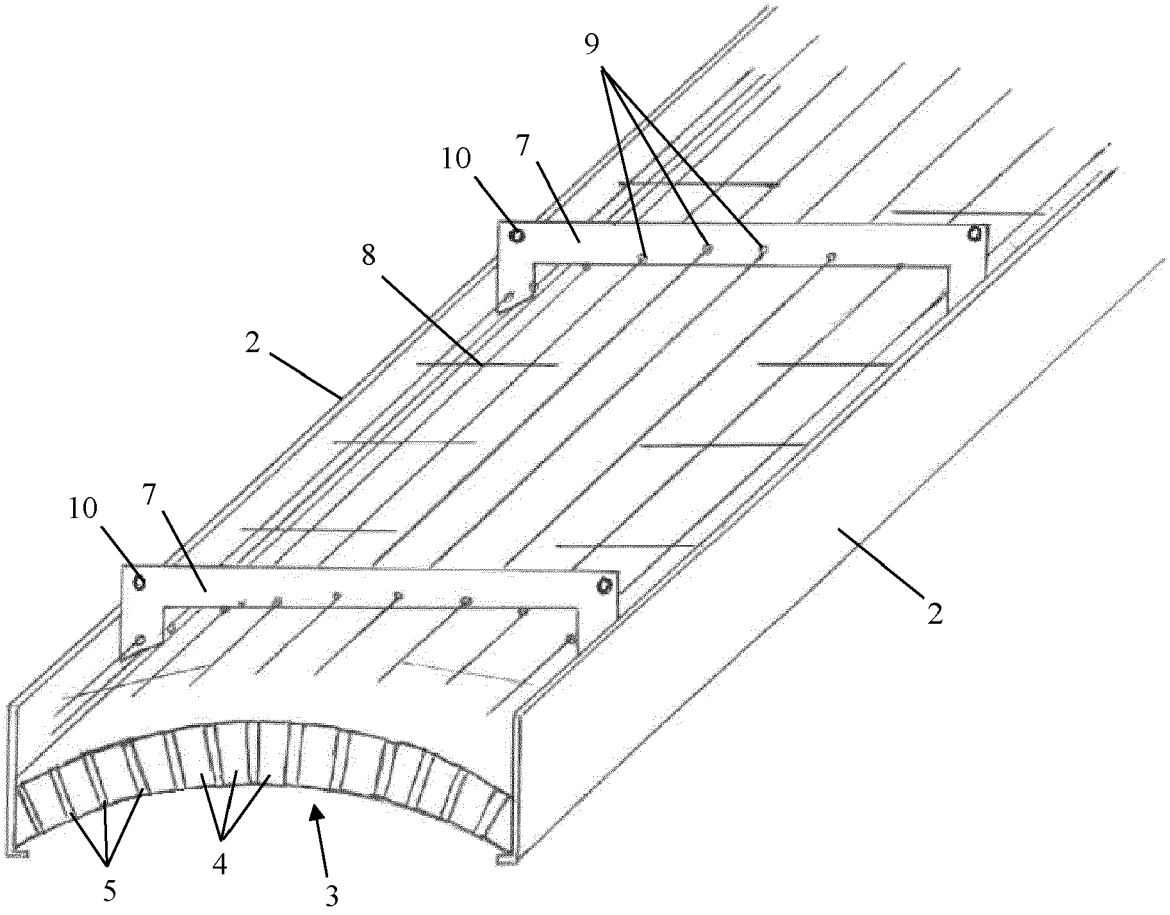

Fig. 7

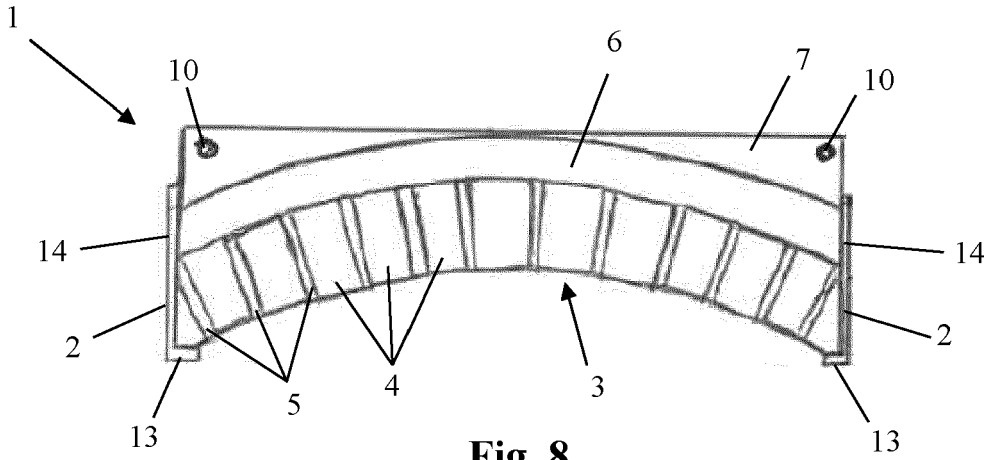

Fig. 8

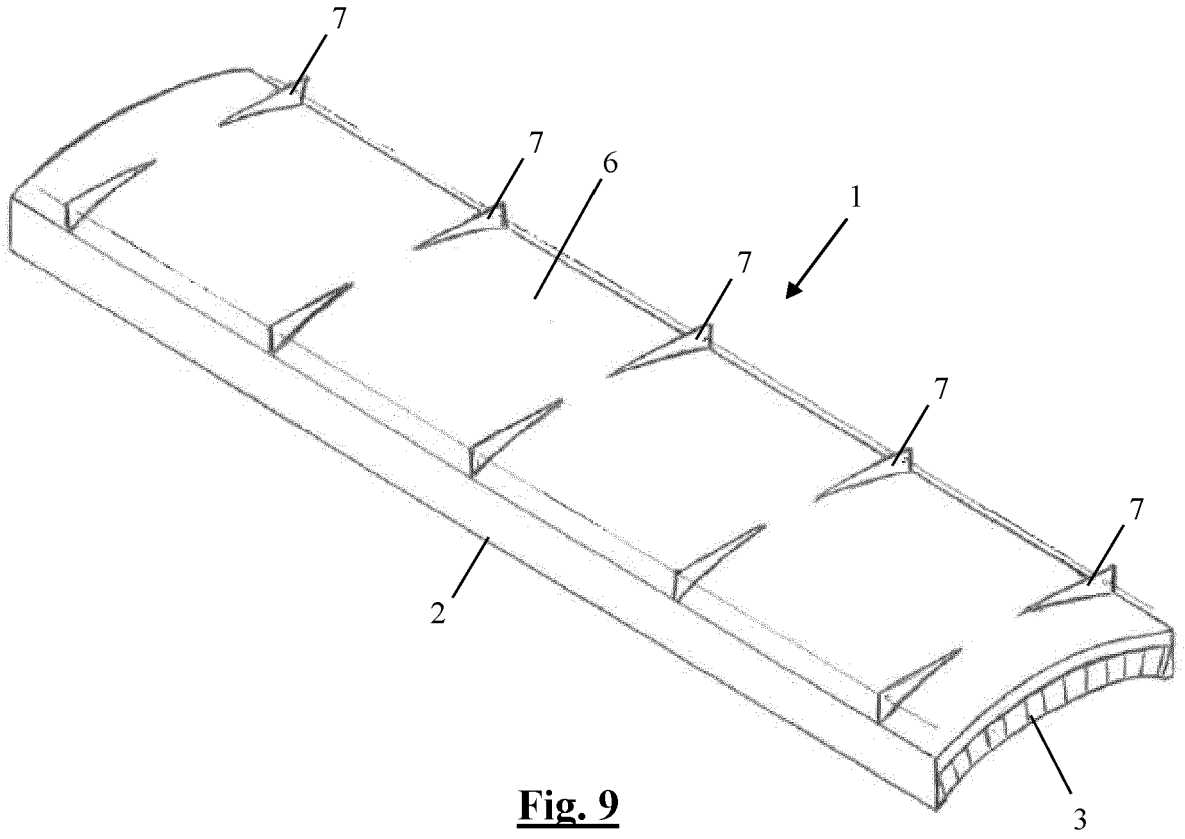

Fig. 9

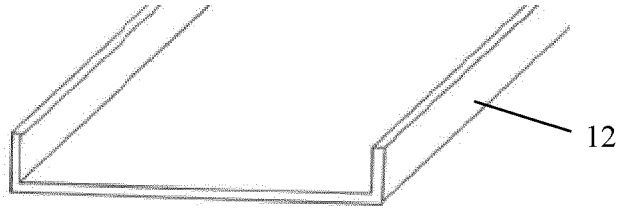

Fig. 10

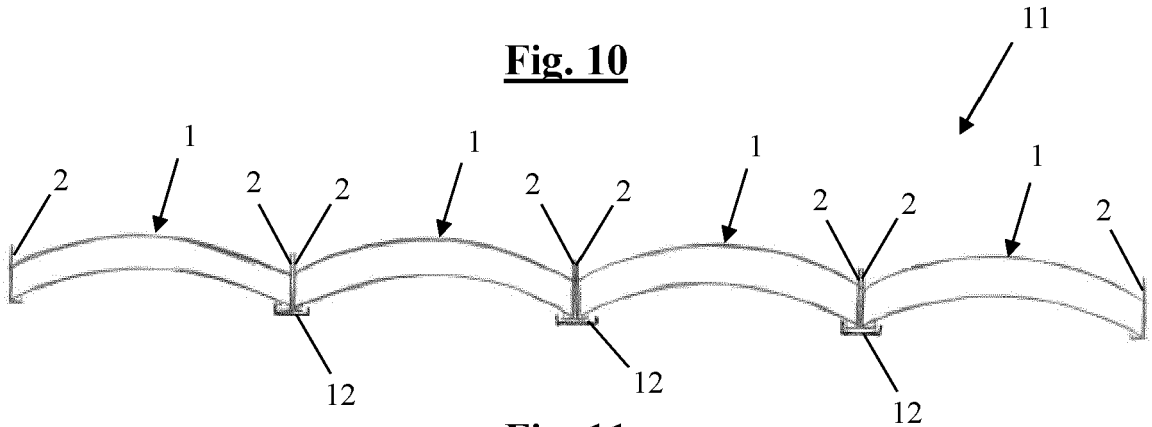

Fig. 11

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EUROPEAN SEARCH REPORT

Application Number
EP 20 16 9225

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	25 August 2020	Righetti, Roberto

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REFERENCES CITED IN THE DESCRIPTION

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