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(54) **AN ARCUATE PRECAST CONCRETE SEGMENT FOR A TUNNEL LINING AND A TUNNEL LINING**

(57) An arcuate precast concrete segment (2) for a tunnel lining (1) comprises a concave side (3) and an opposite convex side (4), which extend between two pairs of opposite end faces (5-8). Each pair includes a front end face (5, 7) and a rear end face (6, 8). The segment (2) has a curved longitudinal direction and a transverse direction which extends perpendicular to the longitudinal direction. The segment (2) comprises an inter-

nal duct (9) which extends from the front end face (5, 7) to the rear end face (6, 8) of one of the pairs. At least at the front and rear end faces (5-8) of the one of the pairs the width of the duct (9) in a direction parallel to the concave side (3) and the convex side (4) is smaller than the distance between the concave side (3) and the convex side (4).

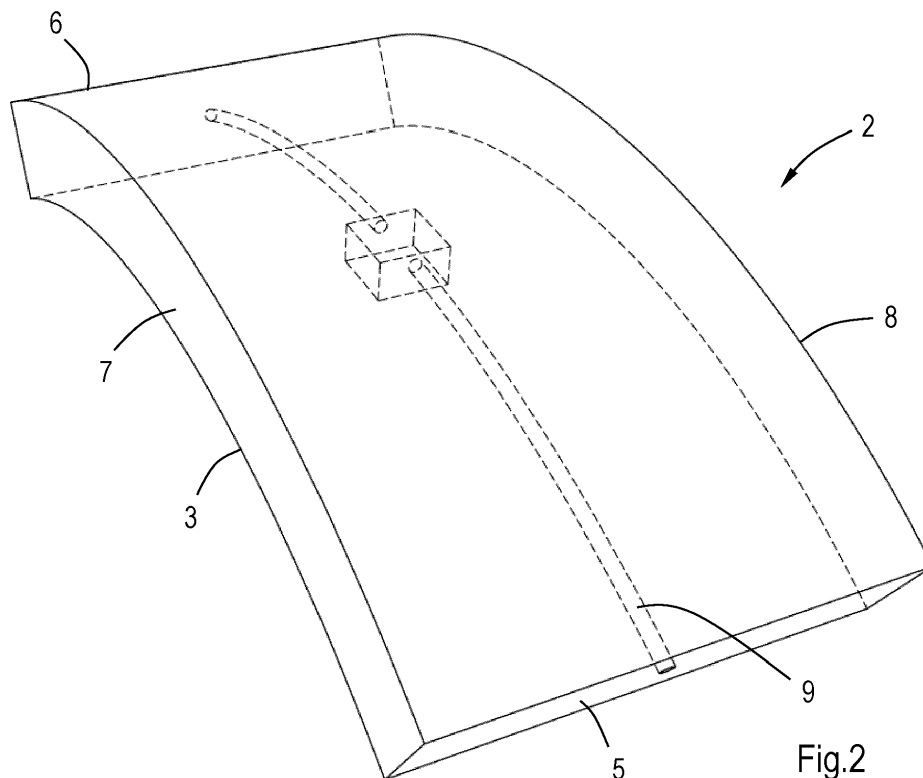


Fig.2

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Description

[0001] The present invention relates to an arcuate precast concrete segment for a tunnel lining, comprising a concave side and an opposite convex side, which extend between two pairs of opposite end faces, each pair including a front end face and a rear end face, wherein the segment has a curved longitudinal direction and a transverse direction which extends perpendicular to the longitudinal direction.

[0002] Such an arcuate precast concrete segment is known to be the state of the art. Tunnels are formed by digging a tunnelway typically of circular cross section by means of a large drilling machine or tunnel boring machine and, as work proceeds, by progressively lining the walls of the tunnelway with pre-cast concrete segments. The segments form sectors of a cylindrical ring and, ring after ring, cover the entire tunnel, hence forming a tunnel lining. The tunnel may be used for rail traffic, for example. Usually after finalizing the tunnel lining electrical wiring is installed for lighting, signals, sensors, etc. The electrical wiring is mounted to the tunnel lining. In practice the electrical wiring sometimes loosens from the tunnel lining. Typically, in the event that an overhead electrical cable in a railway tunnel comes loose and is damaged by a passing train this will lead to serious disturbances.

[0003] An object of the invention is to provide a segment which eliminates the risk of detaching cables.

[0004] This object is achieved with the arcuate precast concrete segment according to the invention, which is characterized in that the segment comprises an internal duct which extends from the front end face to the rear end face of one of the pairs, wherein at least at the front and rear end faces of the one of the pairs the width of the duct in a direction parallel to the concave side and the convex side is smaller than the distance between the concave side and the convex side.

[0005] The presence of a duct from the first end face to the second end face provides the opportunity to introduce a cable into the duct without the necessity of mounting it to the concave side of the concrete segment afterwards. Similar segments can be mounted to each other such that their respective ducts communicate with each other so as to create a common conduit through the ducts of adjacent segments. The duct may have a width at the front and the rear end faces which is smaller than 10% or 20% of the thickness of the segment. The duct may have a circular cross-section, but alternative shapes are conceivable. It is noted that the transverse direction of the segment may follow a straight line. It is also noted that creating the duct in the arcuate precast concrete segment is much easier than providing such a duct in a segment afterwards, for example by means of drilling or milling.

[0006] In a particular embodiment the duct opens to the concave side at a duct access which is located between the front end face and the rear end face of the one of the pairs. This provides the opportunity to insert a cable

into the duct from the concave side which is advantageous after the segments have been mounted to each other, for example after finalizing a tunnel lining.

[0007] The duct may be closed at the convex side at the duct access so as to facilitate guiding of a cable into the duct and to prevent the cable from entering a space adjacent to the convex side.

[0008] Preferably, the cross-section of the duct at the duct access is larger than at the remainder of the duct, since this facilitates to insert a cable into the duct and provides the opportunity to place an electrical unit like an electrical junction box at the duct access.

[0009] In a specific embodiment the front and rear end faces of the one of the pairs of end faces are located opposite to each other in the curved longitudinal direction of the segment. When a plurality of segments of this embodiment are mounted together to form a ring of a tunnel lining the individual ducts may form a common circumferential duct extending through the ring. When each segment is provided with a duct access as described hereinbefore, a plurality of duct accesses are present in the ring of the tunnel lining. This provides great flexibility to install wiring at the ring.

[0010] The distance between the duct and the concave side may decrease in a direction from the front end face of the one of the pairs to the duct access and from the rear end face of the one of the pairs to the duct access. This facilitates inserting a cable into the duct through the duct access.

[0011] In a particular embodiment the locations of the duct at the front and rear end faces of the one of the pairs as measured from the front end face or the rear end face of the other pair of opposite end faces are equal. When a plurality of segments of this embodiment are mounted together to form a ring of a tunnel lining, and the individual front end faces of the pairs of end faces of the respective segments that are located opposite to each other in the transverse direction of the segment are aligned or the individual rear end faces of the pairs of end faces of the respective segments that are located opposite to each other in the transverse direction of the segment are aligned, the individual ducts form a common circumferential duct extending through the ring.

[0012] In an alternative embodiment the front and rear end faces of the one of the pairs are located opposite to each other in the transverse direction of the segment. This means that the duct extends in transverse direction of the segment, i.e. in longitudinal direction of a tunnel lining of which the segment is part of.

[0013] The invention is also related to a tunnel lining, comprising a plurality of adjacent rings, wherein each of the rings is provided with a plurality of arcuate precast concrete segments as described hereinbefore.

[0014] In the event that the duct extends in the curved longitudinal direction of the segment, the ducts of two adjacent segments within a ring may be aligned so as to form a common duct in circumferential direction of the ring.

[0015] In the event that the duct extends in the transverse direction of the segment, the ducts of two adjacent segments of two adjacent rings may be aligned so as to form a common duct in longitudinal direction of the tunnel lining.

[0016] Wiring may be inserted through the ducts of the two adjacent segments.

[0017] The invention will hereafter be elucidated with reference to very schematic drawings showing embodiments of the invention by way of example.

Fig. 1 is a cross-sectional view of a ring of an embodiment of a tunnel lining according to the invention.

Fig. 2 is a perspective view of an embodiment of one arcuate precast concrete segment of the tunnel lining of Fig. 1 on a larger scale.

Fig. 3 is a similar view as Fig. 2, but seen from a different side.

Fig. 4 is a similar view as Fig. 2, but showing an alternative embodiment.

[0018] Fig. 1 shows a cross-section of an embodiment of a tunnel lining 1 according to the invention. The tunnel lining 1 lines walls (not shown) of a tunnelway which is drilled for example, hence forming a tunnel that can be used for rail traffic or other applications. The tunnel lining 1 is made up of a plurality of adjacent rings. Each of the rings is provided with a plurality of arcuate precast concrete segments 2. Fig. 1 shows a ring which has six segments 2, but a different number of segments 2 is conceivable.

[0019] Referring to Figs. 2 and 3 each of the segments 2 has a concave side 3 and an opposite convex side 4. The concave sides 3 of the segments 2 of the tunnel lining 1 form an inner side of the tunnel lining 1 and the convex sides 4 of the segments 2 of the tunnel lining 1 form an outer side of the tunnel lining 1. Furthermore, each segment 2 has a curved longitudinal direction and a straight transverse direction which extends perpendicular to the longitudinal direction. Usually, the length of the segment in the curved longitudinal direction is larger than its length in the transverse direction, but this may be different.

[0020] The concave side 3 and the opposite convex side 4 extend between two pairs of opposite end faces. A first pair includes a front end face 5 and a rear end face 6 which are located opposite to each other in the curved longitudinal direction of the segment 2 and a second pair includes a front end face 7 and a rear end face 8 which are located opposite to each other in the transverse direction of the segment 2. The front end face 5 and the rear end face 6 of the first pair are rectangular. Fig. 1 shows that in a mounted condition of the tunnel lining 1 the front end face 5 of the first pair of one segment 2 contacts the rear end face 6 of the first pair of an adjacent segment 2. In longitudinal direction of the tunnel lining 1 the front end face 7 of the second pair of one segment 2 contacts the rear end face 8 of the second pair of an

adjacent segment 2. The front and rear end faces 5-8 may be provided with coupling means (not shown) to couple the segments 2 to each other.

[0021] Figs. 2 and 3 show that the segment 2 is provided with an internal duct 9 which extends from the front end face 5 to the rear end face 6 of the first pair of end faces. The duct 9 is created during casting of the concrete segment 2 and is located between the concave side 3 and the convex side 4. The cross-sectional area of the duct 9 is relatively small with respect to the surfaces of the corresponding front and rear end faces 5, 6, for example smaller than 20% of the thickness of the segment 2. At least at the front and rear end faces 5, 6 the width of the duct 9 parallel to the concave side 3 and the convex side 4 is smaller than the distance between the concave side 3 and the convex side 4, i.e. the thickness of the segment 2. The duct 9 provides the opportunity to introduce a cable (not shown) into the duct 9.

[0022] Halfway between the front and rear end faces 5, 6 of the first pair of end faces the duct 9 opens to the concave side 3 at a duct access 10, which forms a cavity at the concave side 3. In the installed condition of the tunnel lining 1 as shown in Fig. 1 the duct access 10 allows to introduce a cable into the duct 9. The cross-section of the duct 9 at the duct access 10 is larger than at the remainder of the duct 9 in order to provide room for a junction box, for example. The duct 9 is closed at the convex side 4 at the duct access 10. Furthermore, Figs. 1 and 3 show that the distance between the duct 9 and the concave side 3 decreases in a direction from the front end face 5 to the duct access 10 and from the rear end face 6 to the duct access 10, but alternative routes through the segment 2 are conceivable.

[0023] The duct 9 is located at the front and rear end faces 5, 6 such that two adjacent segments within a ring of the tunnel lining 1 are aligned. This may be achieved by locating the duct 9 at the front and rear end faces 5, 6 of the first pair such that their locations as measured from the front end face 7 or the rear end face 8 of the second pair are equal. This means, that in the ring as shown in Fig. 1 the ducts 9 of all segments 2 form a common endless conduit extending in circumferential direction through the ring. After installing the tunnel lining 1 it is easy to apply electrical wiring without the step of fixing the wiring to the inner side of the tunnel lining 1. It is noted, that in the tunnel lining 1, segments 2 including the duct 9 as well as without the duct 9 may be applied. For example, the tunnel lining 1 may alternately have a number of successive rings without ducts and a ring including ducts 9 like Fig. 1. The ring including ducts 9 may be located where future electric wiring is expected, for example for signals in a railway tunnel.

[0024] Fig. 4 shows an alternative embodiment of a segment 2. In this case the duct 9 extends from the front end face 7 to the rear end face 8 of the second pair of end faces. When the ducts 9 are located in the segments 2 such and the segments 2 are located in the tunnel lining 1 such that the ducts 9 of two adjacent segments of two

adjacent rings are aligned a common conduit in longitudinal direction of the tunnel lining 1 is created.

[0025] In a further embodiment (not shown) the embodiment as shown in Figs. 2 and 3, on the one hand, and the embodiment as shown in Fig. 4, on the other hand, can be combined.

[0026] The invention is not limited to the embodiments shown in the drawings and described hereinbefore, which may be varied in different manners within the scope of the claims and their technical equivalents.

Claims

1. An arcuate precast concrete segment (2) for a tunnel lining (1), comprising a concave side (3) and an opposite convex side (4), which extend between two pairs of opposite end faces (5-8), each pair including a front end face (5, 7) and a rear end face (6, 8), wherein the segment (2) has a curved longitudinal direction and a transverse direction which extends perpendicular to the longitudinal direction, **characterized in that** the segment (2) comprises an internal duct (9) which extends from the front end face (5, 7) to the rear end face (6, 8) of one of the pairs, wherein at least at the front and rear end faces (5-8) of said one of the pairs the width of the duct (9) in a direction parallel to the concave side (3) and the convex side (4) is smaller than the distance between the concave side (3) and the convex side (4).
2. An arcuate precast concrete segment (2) according to claim 1, wherein the duct (9) opens to the concave side (3) at a duct access (10) which is located between the front end face (5, 7) and the rear end face (6, 8) of said one of the pairs.
3. An arcuate precast concrete segment (2) according to claim 2, wherein the duct (9) is closed at the convex side (4) at the duct access (10).
4. An arcuate precast concrete segment (2) according to claim 2 or 3, wherein the cross-section of the duct (9) at the duct access (10) is larger than at the remainder of the duct (9).
5. An arcuate precast concrete segment (2) according to any one of the preceding claims, wherein the front and rear end faces (5, 6) of said one of the pairs are located opposite to each other in the curved longitudinal direction of the segment (2).
6. An arcuate precast concrete segment (2) according to any one of the claims 2-4 and claim 5, wherein the distance between the duct (9) and the concave side (3) decreases in a direction from the front end face (5) of said one of the pairs to the duct access (10) and from the rear end face (6) of said one of the pairs to the duct access (10).
7. An arcuate precast concrete segment (2) according to claim 5 or 6, wherein the locations of the duct (9) at the front and rear end faces (5, 6) of said one of the pairs as measured from the front end face (7) or the rear end face (8) of the other pair of opposite end faces (7, 8) are equal.
8. An arcuate precast concrete segment (2) according to any one of the claims 1-4, wherein the front and rear end faces (7, 8) of said one of the pairs are located opposite to each other in the transverse direction of the segment (2).
9. A tunnel lining (1), comprising a plurality of adjacent rings, wherein each of the rings is provided with a plurality of arcuate precast concrete segments (2) according to any one of the preceding claims.
10. A tunnel lining (1) according to claims 5 and 9, wherein the ducts (9) of two adjacent segments within a ring are aligned.
11. A tunnel lining (1) according to claims 8 and 9, wherein the ducts (9) of two adjacent segments (2) of two adjacent rings are aligned.
12. A tunnel lining (1) according to claim 10 or 11, wherein wiring is inserted through the ducts (9) of the two adjacent segments (2).

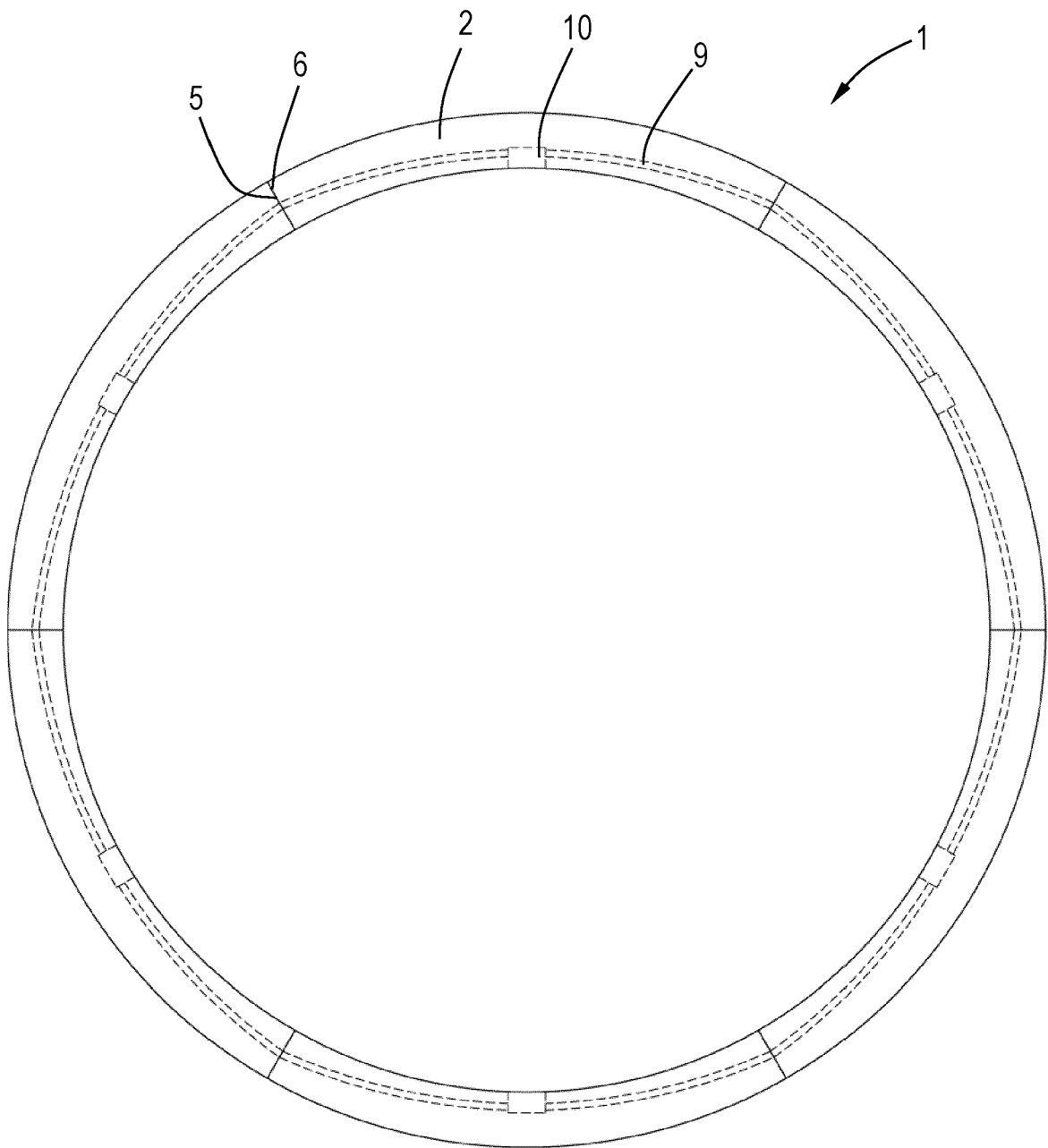
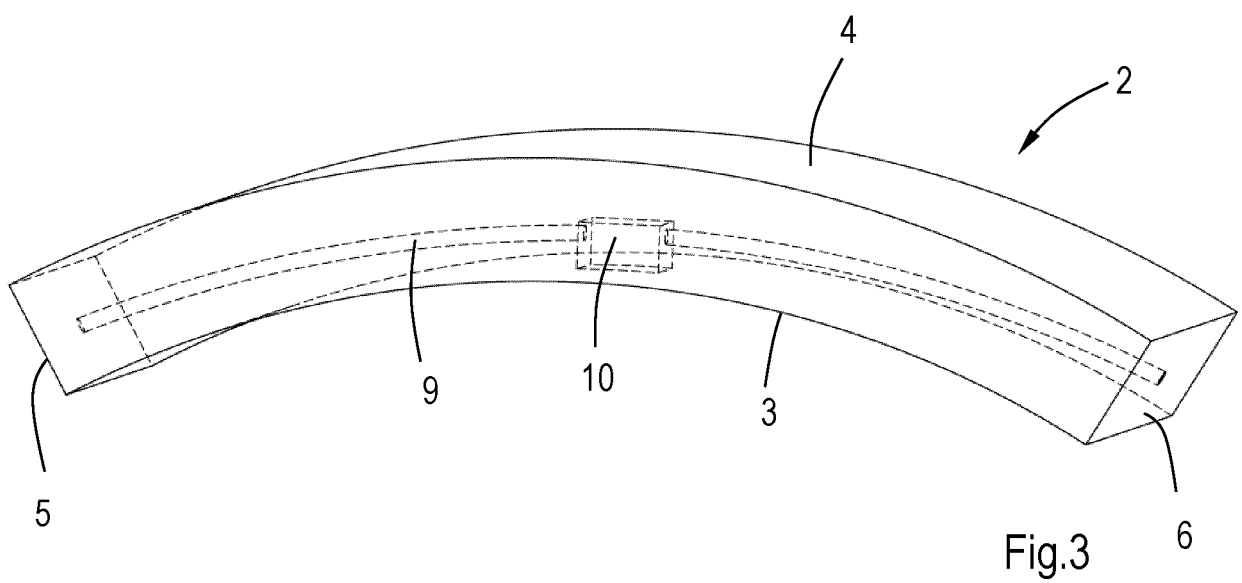
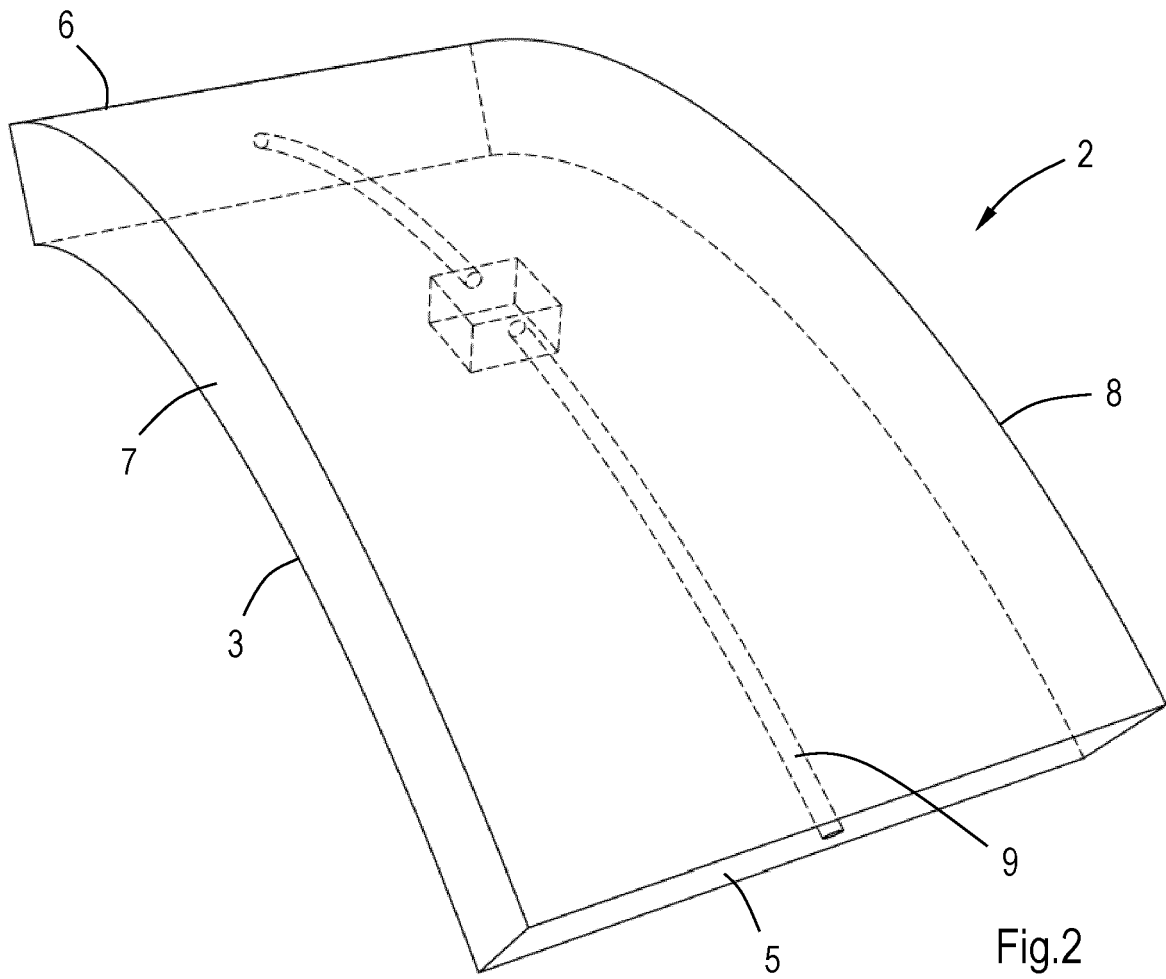


Fig.1



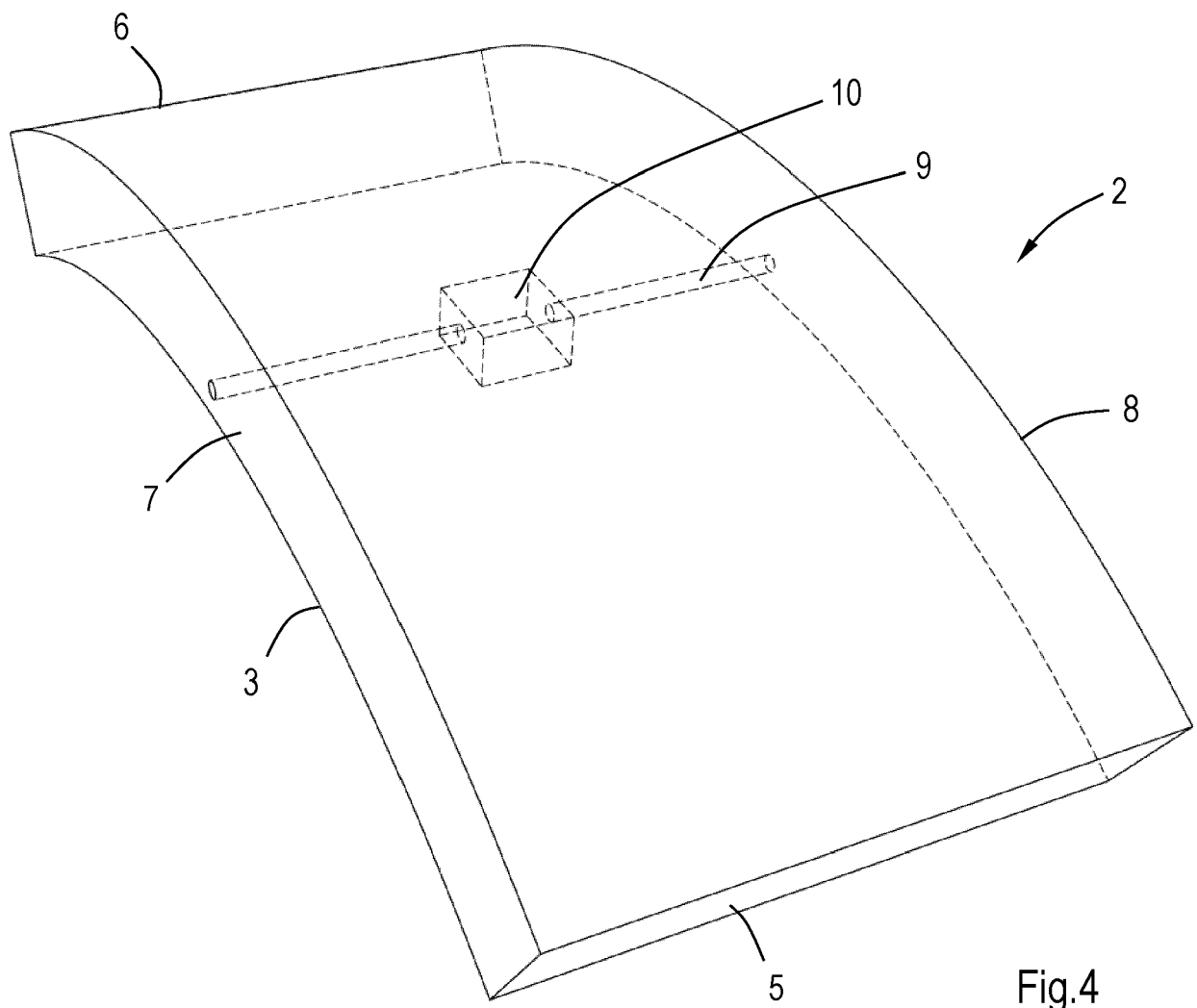


Fig.4



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The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 9 June 2020	Examiner Brassart, P
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