



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
22.10.2008 Bulletin 2008/43

(51) Int Cl.:
E04C 5/10 (2006.01) E04C 5/12 (2006.01)

(21) Application number: **08154694.7**

(22) Date of filing: **17.04.2008**

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MT NL NO PL PT RO SE SI SK TR
Designated Extension States:
AL BA MK RS

(71) Applicant: **A-Consult Holding Group A/S**
9000 Aalborg (DK)

(72) Inventor: **Østergaard, Søren**
9000 Aalborg (DK)

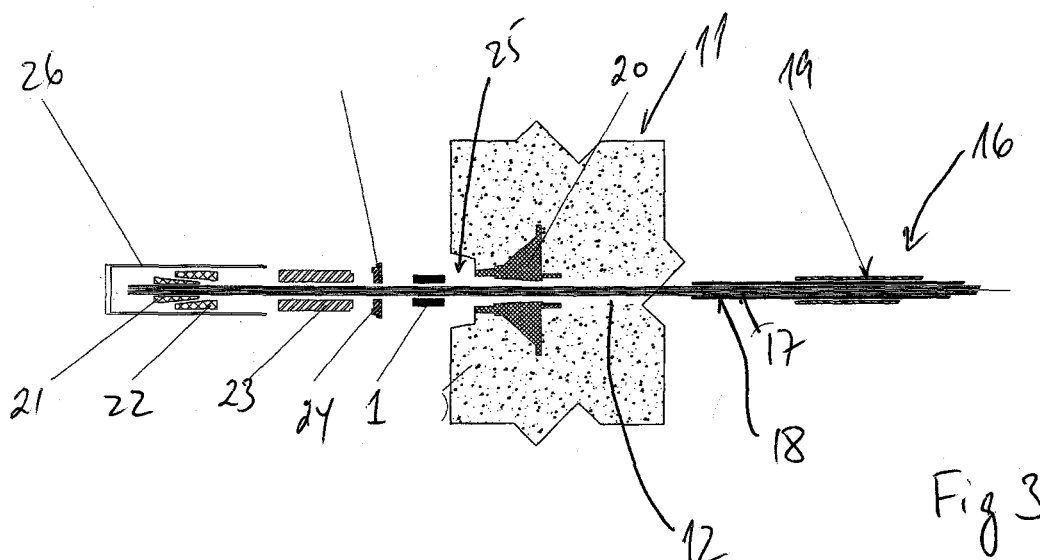
(74) Representative: **Tellefsen, Jens J.**
Patrade A/S,
Fredens Torv 3A
8000 Aarhus C (DK)

(30) Priority: **17.04.2007 DK 200700559**

(54) **Sealing device**

(57) Method of sealing a post-tensioned tendon duct (16) in a concrete structure, for example a pre-cast concrete panel (11), wherein a sealing device (1) is fitted around the tendon, where said sealing device has an annular shape with a substantially centrally placed aper-

ture (2), where the aperture (2) has a size substantially corresponding to the outside size of the tendon (16), and where the outer dimension of the sealing member (1) has a size substantially corresponding to the inner size of the duct (16), and where the sealing member (1) is suitable to be inserted partly into the duct (16).



Description

Field of the Invention

[0001] The present invention relates to a method of reliable sealing of duct-system in concrete structures as well as an annular sealing device used in such method.

Background of the Invention

[0002] Pre-stressed or stressed concrete structures are a well-known and widespread method for constructing concrete structures, where particular use is made of the compressive characteristics of the concrete material. By adding stress to the concrete in relation to the projected load to which the concrete is to be exposed, the pre-stressing or stressing of the concrete may assure that there will always be compression over the entire cross section of the concrete construction. This is particularly interesting for constructions which may be exposed to an aggressive environment in that concrete has superior compressibility characteristics whereas tension usually causes cracks in the concrete structure. These cracks may expose the reinforcement whereafter the aggressive environment might corrode the reinforcement so that the ability of the construction to withstand tension forces is diminished which may ultimately cause failure of the entire construction. It is therefore a common practice to use pre-stressed or stressed or post-tensioned concrete structures, and in the art a number of different systems exist by which to stress such concrete structures.

[0003] For stressing the concrete structures, usually cables or strings are used, which cables are arranged in special ducts going through the concrete structure in the direction where it is desirable to achieve the compression in the concrete. In some applications after the concrete structure has been stressed the ducts in which the cables are placed are injected with a mortar in order to protect the cables from corrosion. This is particularly true, when the concrete structures may be exposed to moisture or liquid in that the presence of moisture or liquid and oxygen may cause corrosive action in the cables whereby the cable may not over time be able to withstand the tension applied to the cables in order to provide compression in the concrete cross sections.

[0004] In particular, technical applications where the concrete panels are used for example in order to construct tanks, swimming-pools or other liquid containing structures, it is particularly desirable to achieve a complete and liquid-tight seal, so that no moisture or liquid may access the cables in the ducts in the concrete structure.

[0005] The injection of mortar in the cable ducts may have a number of advantages, but it may also have a number of disadvantages in that if the concrete structure as such is exposed to dynamic forces or other types of movements, for example due to thermal exposure, the

mortar in the ducts may crack and thereby give access to seeping moisture which may have a detrimental effect on the cables in the ducts.

[0006] Use of mortar for corrosive protection has also proven to be difficult from an application point of view as it is not possible to monitor that the injection ensure a proper fill of the annular space between the cable and the duct. For some types of concrete structures, where the cable is positioned off the centre of the duct use of mortar injection is not viable, as a proper fill will not be achieved. In such type of concrete structures un-bonded cables are normally used to provide protection against corrosion of the cable.

Object of the Invention

[0007] For this purpose it is an object of the present invention to provide a solution whereby the ducts become sealed without injecting mortar, but preserving the cables in the ducts in a non-corrosive environment.

Description of the Invention

[0008] The present invention addresses this by a method of sealing cable ducts in a pre-stressed or post-tensioned concrete structure, for example a pre-cast concrete panel, wherein a sealing device is fitted around the cable, where said sealing device has an annular shape with a substantially centrally placed aperture, where the aperture has a size substantially corresponding to the outside size of the cable, and where the outer dimension of the sealing member has a size substantially corresponding to the inner size of the duct, and where the sealing member is suitable to be inserted partly into the duct.

[0009] The sealing element may therefore be compared to a plug where centrally in the plug an aperture is provided. The aperture has a size substantially corresponding to the outside of the cable, but so that it has a sealing engagement with the cable. The cable will naturally have a longitudinal extent and the extent of the sealing member in the longitudinal direction must be sufficient in order to assure that there will be enough contact surface between the outside of the cable and the inside of the aperture provided in the sealing member in order to create a liquid-tight connection.

[0010] As the ducts are usually made in a number of standard sizes, the outside diameter of the sealing member may be pre-made in sizes which will fit to the limited number of duct sizes. Likewise regarding the cables. In the art a number of more or less standardized cable sizes are used, and a number of these cables are made out of a number of twisted strands, for example seven, which are covered in grease and thereafter provided with a sheeting, e.g. in the shape of a pvc-membrane, pe-membrane or the like. The contact between the inner surface of the aperture of the sealing member must therefore be suitable to create a liquid-tight contact with the outside

surface of the tension cable.

[0011] The invention furthermore provides a method of sealing a cable duct between two adjacent panels in a pre-cast concrete structure, wherein a first sealing device is arranged around the cable, where said element has an annular shape, such that the cable may sealingly fit inside the sealing device and the outside of the sealing device may partly fit inside the duct in the concrete panel, such that a part of the sealing element extends outside the duct, and when the cable is tensioned and two adjacent concrete panels are forced together due to the tension in the cable, the sealing member will abut the adjacent panel at the joint, or a similar sealing device arranged in the adjacent element, and the tension in the cable will force the concrete panels together and thereby deform the sealing devices, thereby creating a sealing of the duct.

[0012] As the cables are tensioned, the pre-cast concrete panels will be forced together and thereby abut the sealing device arranged around the cable. As the tension in the cables is further increased, the contact between the concrete panel and the sealing element will cause the sealing element to deform and thereby completely seal the duct opening simply by the compression applied by the concrete panels in response to the tensioning of the cables in the cable ducts.

[0013] In a further advantageous embodiment a second sealing member is provided, where said second sealing member has a rectangular shape and extent, substantially corresponding to the surfaces of adjacent panels to be assembled, where said second sealing member is provided with apertures corresponding and placed superposed the cable duct in the panels, and where, when the cable(s) is(are) tensioned and the two concrete panels forced together, the first sealing elements will abut the second sealing elements, and together the first and second sealing elements will create a substantially liquid-tight seal between the two concrete panels and the ducts. The first sealing member serves to seal off the ducts in which the cables are placed, and the second sealing member serves to seal between two adjacent concrete panels, so that a completely liquid-tight construction may be achieved. The second sealing member is traditionally used in order to provide a liquid-tight seal between two adjacent concrete constructions, but leaves out the sealing of the ducts in which the cables are placed so that the corrosion problems as mentioned above if only a seal, here called the second sealing member is provided. Therefore, by combining the sealing of the ducts together with the sealing of the connection between two adjacent concrete panels a completely liquid-tight seal is achieved so that the construction may be used for example by erecting a tank, swimming-pool or the like, where it is desirable to retain a liquid inside the construction.

[0014] This is elucidated in a further advantageous embodiment where the pre-cast concrete panels are part of a swimming-pool, bridge, basement construction, water retaining tank or the like.

[0015] In order to attain enough deformation when the concrete panels are forced together thereby deforming the sealing device it is desirable in a further advantageous embodiment that the sealing device projects between 3 mm and 10 mm out from the duct in the direction of the cable.

[0016] The invention is also directed to an annular sealing element as such, e.g. for use in a method as described above. This sealing device is particular in that the element has an inner and outer diameter, where the inner diameter is dimensioned such that the sealing member will sealingly fit around a cable, and the outer diameter will substantially fit inside a duct in a concrete panel.

[0017] In a further advantageous embodiment the device is made from a resistant material, such as rubber, polyurethane, PVC, PP, PE or other polymer based material.

[0018] The resistant characteristics of the materials make it possible for the sealing device to adapt to inaccuracies etc. when the tension is applied to the cables and the concrete panels are forced together so that a complete and reliable seal may be attained between the sealing device and the walls of the duct.

[0019] In a further advantageous embodiment of the invention the sealing device comprises an outer shell surrounding an inner volume, where the shell is made from a resistant material, and the inner volume is filled with a deformable fluid.

[0020] By providing a fluid or fluid-like substance inside a shell, the deformability of the seal increases so that a further security of absolute sealing properties between the cable and the duct is achieved.

[0021] In a still further advantageous embodiment of the sealing device according to the invention the sealing device is in the shape of a cone, such that the largest outer diameter of the sealing element is larger than the diameter of the duct in the concrete panel. By providing a sealing device in the shape of a cone it is straightforward to insert the narrow end of the cone in the duct and then let the tension forces force the cone further into the duct thereby creating a complete seal.

[0022] In a still further advantageous embodiment of the invention the device is C-shaped, such that the device may be pushed sideways over and fitted around the cable.

[0023] By providing a C-shaped element, i.e. an element with a slit in a longitudinal direction it is possible to place the sealing device sideways onto a cable simply by allowing the cable to pass through the slit into the central aperture.

Description of the Drawing

[0024] Below the invention will be explained with reference to the accompanying drawing wherein

fig. 1a,b,c illustrate different embodiments of the an-

- fig. 2 nular sealing element;
illustrates an exploded view of a liquid-tight seal; and
- fig. 3 and 4 illustrate an exploded view of the end of a tension cable arranged in a channel provided with a sealing element according to the invention;
- fig. 5 illustrates detail of a further sealing embodiment.

[0025] In figures 1a, 1b and 1c are illustrated three different embodiments of the annular sealing element.

[0026] Below specific examples of the invention will be explained with reference to a construction where the cables are tendons, i.e. specific members designed for being tensioned. Furthermore, the examples relates to post-tensioned constructions. Post-tensioned constructions are typically constructions which after or during assembly are fitted with tendons and thereafter tensioned. The "post" therefore refers to an action after the concrete element has been cast.

[0027] In figure 1a is illustrated a sealing device having a cylindrical shape where the sealing element 1 is provided with an aperture 2. The aperture has a size corresponding to the tendon which is supposed to be arranged inside the aperture so that between the aperture and the tendon a sealing connection will be achieved. The aperture 2 extends through the length of the element as illustrated by the phantom lines.

[0028] In figure 1b is illustrated a sealing device 1' also provided with an aperture 2', but in this embodiment of the invention the sealing device 1' has a conical shape such that a first end 4 of the sealing element is suitable to be inserted into the tendon duct in the concrete panel and the second end 5 has a size larger than the diameter of the duct such that a portion of the sealing device 1' will extend outside the tendon duct.

[0029] In figure 1c is illustrated an embodiment of the sealing device, where the device has a substantial C-shape in that a slit 3 is provided in the longitudinal direction of the sealing device 1" connecting the substantially centrally placed aperture 2" with the outside of the sealing device. The slit will enable the sealing element 1" to be mounted sideways onto a tendon and due to the engagement of the sealing device 1" with the duct in the concrete panel the slit 3 will be forced together and thereby be rendered liquid-tight.

[0030] In figures 1a and 1b the aperture in the sealing device 1, 1' are illustrated in phantom lines illustrating that the apertures 2, 2' as well as 2" extend the entire length of the sealing device 1, 1', 1".

[0031] Turning to figure 2 an exploded view of a connection between two concrete panels 10, 11 is illustrated. For the sake of clarity the tendons used to stress the structure and thereby force the concrete panels 10, 11 towards each other are not illustrated. Each panel is provided in this instance with three ducts 12 (shown in phantom lines) inside which ducts the tendon is used for

stressing the structure may be arranged. The tendons are continuous between the two concrete panels 10, 11 and the sealing elements 1 are fitted around the tendons. Furthermore, a rectangular sealing element 13 is arranged in order to create a liquid-tight seal between the end surfaces 14, 15 of the concrete panels 10, 11.

[0032] The sealing device 1 has a size such that it will partly fit inside the ducts 12, whereby another part of the sealing device 1 will project outside the panel such that as the tendons are stressed and thereby the concrete panels 10, 11 are forced together concrete panels will squeeze the sealing elements 1 thereby forcing the material of the sealing element 1 to expand and completely fill out the tendon duct 12. In this manner a complete sealing of the duct is achieved. The rectangular sealing device 13 will also be squeezed due to the action of the tendons whereby a liquid-tight seal is created between the two surfaces 14, 15.

[0033] In this manner a completely liquid-tight sealing system is provided both sealing liquid access to the tendon ducts 12 and liquid passage through the connection (joint) between the two concrete panels 10, 11.

[0034] Turning to figure 3 and 4 anchoring details including the sealing system according to the invention are illustrated. In figure 3 an exploded view of the assembly as depicted in figure 4 is illustrated. The tendon which for the sake of illustration may be a Freyssinet-type tendon 16 comprises for example un-bonded seven wire strands 17 which are twisted together. Usually the wire strands are twisted together in a grease-filled manner such that a suitable grease will fill out the small voids between the different strands in the twisted cable 17. Furthermore, the strands may be provided with a plastic seating 18 and thereafter both the strands 17 and the sheeting 18 are fitted inside a duct 19, e.g. made from PVC or other suitable material. This cable is arranged inside a duct 12 provided in a concrete panel 11. A mono-anchor plate 20 is cast into the panel in order to create the tendon's anchorage. By tensioning the tendon 16 the concrete panels 10, 11 will be exposed to compression which is the optimal way of utilizing the characteristics of concrete panels. In order to maintain this pressure and thereby the stress in the tendon the anchorage comprises a number of wedges 21, 22, a coupler 23 and a gasket/washer 24.

[0035] The sealing device 1 is arranged between the washer 24 and the cast-in anchor-block 20 in such a way that part of the sealing device 1 projects into the aperture 25. When the tendon 16 is stressed and assembled as is illustrated in figure 4 the washer 24 will force the sealing device 1 into the anchor block 20 and at the same time deform the sealing element slightly so that the sealing device will completely fill out the space between the tendon 16 and the mono-block 20 as illustrated with reference to figure 4.

[0036] Once all the wedges and couplers are engaged, the tendon stressing means (not illustrated) may be released and an end cap 26 applied in order to protect the

anchorage of the tendons in the structure. In this manner a completely liquid-tight anchorage of the tendon in the stress position is achieved and the sealing device 1 completely seals off for any liquid to gain access to the tendon duct 12 and thereby avoid corrosion in the cable 16 when the tendons are arranged in the ducts 12.

[0037] Turning to fig 5 a detail of a further embodiment according to the invention is illustrated. The two concrete elements 10, 11 to be sealingly assembled are fitted with the post-tension tendon 30. The tendon comprises a PVC sheating 31. In the duct opening on panel 10 the sheating has been trimmed to be flush with the end surface 14 of the panel 10, whereas the sheating 31 projects a distance out from the opposite end surface 15. A sealing device 1 according to the invention is fitted around the projecting sheating 31. As the tension in the tendon is increased and the two panels 10, 11 forced together, the sealing device 1 will engage the duct opening and the sheating on the opposite side, and thereby create a completely liquid-tight sealing of the ducts 12.

Claims

1. Method of sealing a post-tensioned tendon duct in a concrete structure, for example a pre-cast concrete panel, wherein a sealing device is fitted around the tendon, where said sealing device has an annular shape with a substantially centrally placed aperture, where the aperture has a size substantially corresponding to the outside size of the tendon, and where the outer dimension of the sealing member has a size substantially corresponding to the inner size of the duct, and where the sealing member is suitable to be inserted partly into the duct.
2. Method of sealing a tendon duct between two adjacent panels in a pre-cast concrete structure, wherein a first sealing element is arranged around the tendon, where said element has an annular shape, such that the tendon may sealingly fit inside the sealing element and the outside of the sealing element may partly fit inside the duct in the concrete panel, such that a part of the sealing device extends outside the element, and when the tendon is tensioned and two adjacent concrete panels are forced together due to the tension in the tendon, the sealing device will abut the adjacent panel, or a similar sealing device arranged in the adjacent panel, and the tension in the tendon will force the concrete panels together and thereby deform the sealing device, thereby creating a sealing of the duct.
3. Method of sealing according to claim 2 wherein a second sealing member is provided, where said second sealing member has a rectangular shape and extent, substantially corresponding to the surfaces of adjacent panels to be assembled, where said sec-

ond sealing member is provided with apertures corresponding and placed superposed the tendon duct in the panels, and where, when the tendon(s) is(are) tensioned and the two concrete panels forced together, the first sealing elements will abut the second sealing elements, and together the first and second sealing elements will create a substantially liquid tight seal between the two concrete panels and the ducts.

4. Method according to claim 1 or 2 where the pre-cast concrete panels are part of a swimming pool, bridge, basement construction, water retaining tank or the like.
5. Method according to claim 1 or 2, wherein the sealing device projects between 3 mm and 10 mm out from the duct in the direction of the tendon.
6. Annular sealing device for use in a method according to any of claims 1 to 5, wherein the element has an inner and an outer diameter, where the inner diameter is dimensioned such that the sealing member will sealingly fit around a tendon, and the outer diameter will substantially fit inside a duct in a concrete panel.
7. Sealing device according to claim 6 wherein the element is made from a resistant material, such as rubber, polyurethane, pvc, pp, pe or other polymer based material.
8. Sealing device according to claim 6 wherein the sealing device comprises an outer shell surrounding an inner volume, where the shell is made from a resistant material, and the inner volume is filled with a deformable fluid.
9. Sealing device according to claim 6, 7 or 8, wherein the sealing device is in the shape of a cone, such that the largest outer diameter of the sealing device is larger than the diameter of the duct in the concrete panel.
10. Sealing device according to claim 6 wherein the element is C-shaped, such that the element may be pushed sideways over and fitted around the tendon.

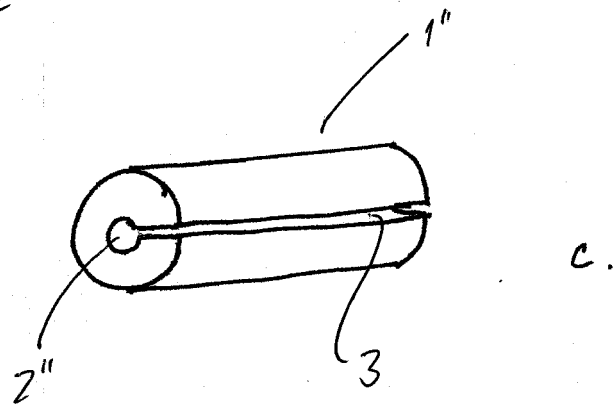
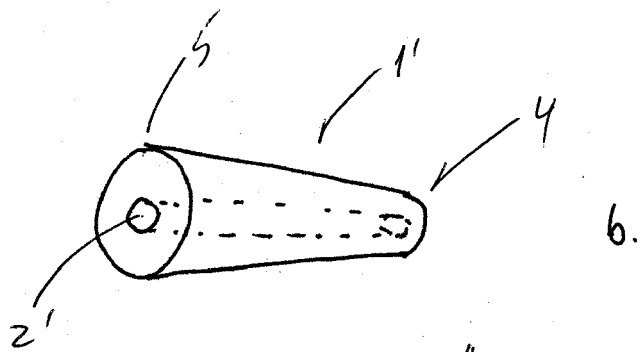
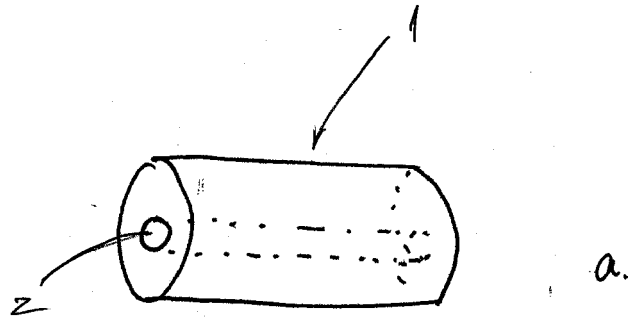
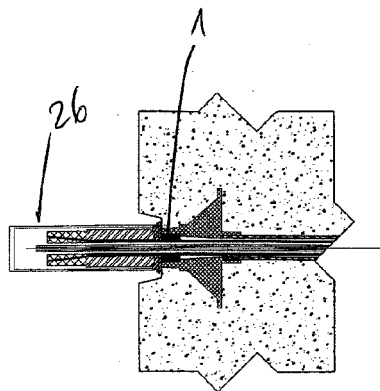
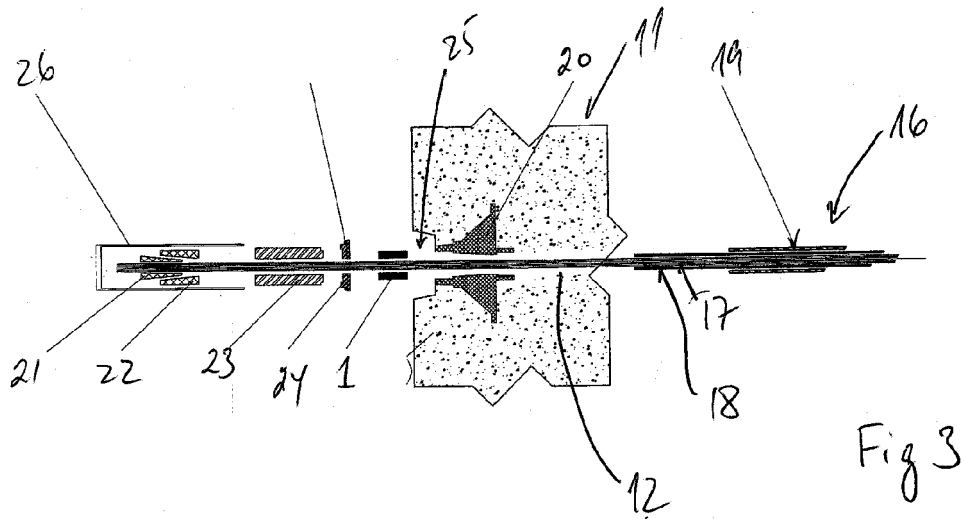
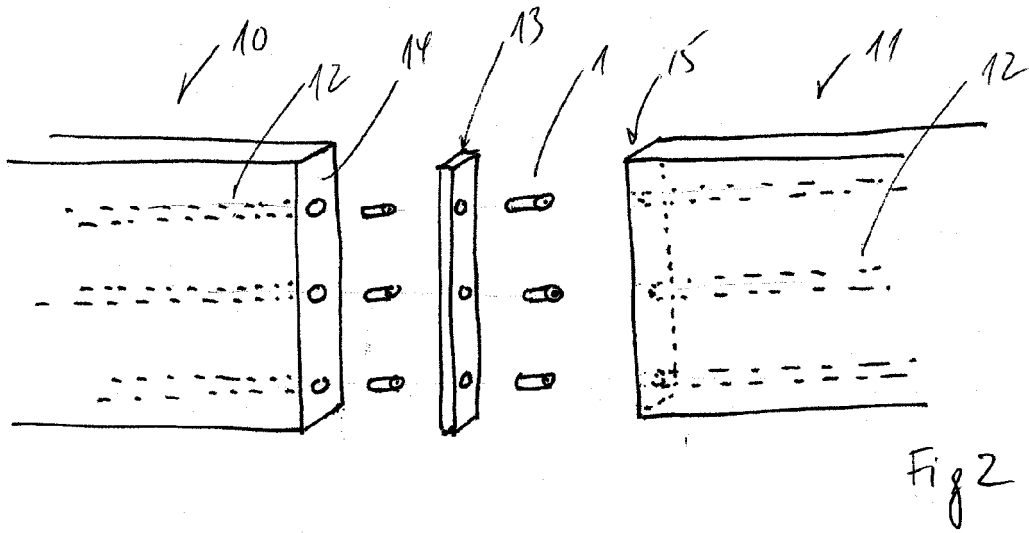


Fig. 1



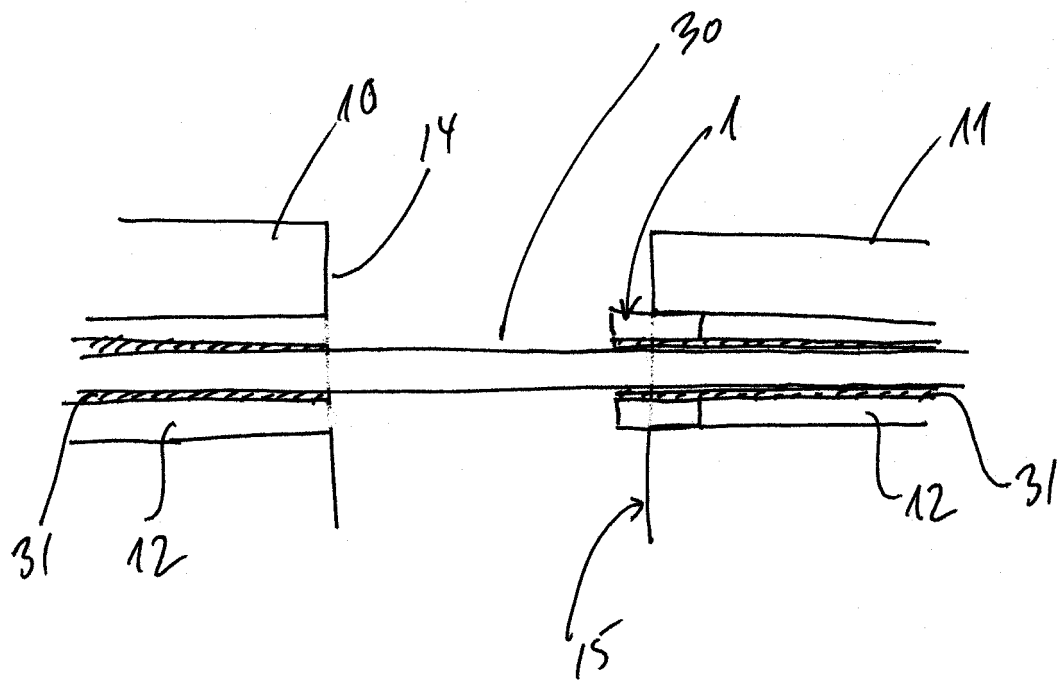


Fig. 5