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(54) **Sealing assembly for tunnel segments**

(57) An edge seal assembly (10) comprising a first member (11) having intrados (12) and extrados (13) side surfaces and a first edge (15) between the side surfaces (12, 13), and a second member (18) having intrados (19) and extrados (20) side surfaces and a second edge (21) between the side surfaces (19, 20), each of the first and second edges (15, 21) in use facing one another and at least one of the edges having a recess (24), and there being a gasket (25) receivable between the first and second edges (15, 21) and being receivable in part, in the recess (24) characterised in that the thickness of the gasket (25) decreases from a thicker region which is positioned more closely adjacent the intrados (12, 19) or extrados (13, 20) side surfaces, to a thinner region (27) which is positioned more closely adjacent to the extrados (13, 20) or intrados (12, 19) side surfaces respectively.

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Description

[0001] This invention relates to an edge seal assembly and more particularly but not exclusively to such an assembly for a tunnel lining or pipeline which is made up of members arranged edge to edge, which edge joint requires sealing against the ingress or egress of fluid, usually liquid.

[0002] It will be appreciated that in a typical tunnel lining application, an extrados side surface of the lining may be subjected to substantial fluid pressure and the joints between adjacent tunnel lining members must be able to prevent the ingress of such fluid.

[0003] It is common practice to provide sealing material between the edges of adjacent members, such as a rubber or similar gasket. As the members are urged together the gasket is subjected to compression forces in the direction in which the members are brought together and thus an edge seal is effected.

[0004] However in use the gasket is subjected to fluid pressure in a transverse direction and sometimes fluid can leak past the gasket.

[0005] In GB-A-2197917 there is disclosed a gasket for an edge seal assembly which is of constant thickness but has a first part which is received in a recess of one member, and a second part which is received in a recess of the second member, each of the first and second parts decreasing in width in a direction extending into the recess.

[0006] According to one aspect of the invention we provide an edge seal assembly including a first member having intrados and extrados side surfaces and a first edge between the side surfaces, and a second member having intrados and extrados side surfaces and a second edge between the side surfaces, each of the first and second edges in use facing one another and at least one of the edges having a recess, and there being a gasket receivable between the first and second edges and being receivable in part in the recess characterised in that the thickness of the gasket decreases from a thicker region which is positioned more closely adjacent the intrados or extrados side surfaces, to a thinner region which is positioned more closely adjacent the extrados or intrados side surfaces respectively.

[0007] Thus by providing the gasket in such configuration improved sealing against the ingress or egress of fluid can be achieved.

[0008] Where the intrados or extrados side surfaces of the assembly are adapted to be exposed in use to a greater fluid pressure than the extrados or intrados side surfaces respectively, the gasket may be arranged such that the thickness of the gasket decreases from a side more closely adjacent to the intrados or extrados side surfaces which are in use exposed to the greater fluid pressure.

[0009] Alternatively where each of the intrados and extrados side surfaces are adapted to be exposed in use to fluid pressure, the first and second members

being operative to maintain the fluids separate, the gasket may thus include a first part the thickness of which decreases from a thicker region which is positioned more closely adjacent to the intrados side surfaces to the thinner region, and a second part the thickness of which decreases from a thicker region which is positioned more closely adjacent the extrados side surfaces such that the gasket has a reduced thickness in a region between the thicker regions.

[0010] In each case the effect of the fluid pressure from the extrados or intrados surface is to urge the thicker region or regions of the gasket away from the surface or respective surface thereof.

[0011] Preferably the recess in the edge of the first or second member decreases in depth from a side more closely adjacent to intrados and/or extrados side surface which is in use exposed to fluid pressure. Thus the thicker region or regions of the gasket is/are urged into a decreasing smaller recess volume by the fluid, to aid sealing.

[0012] Generally, the recess in the edge of the first and/or second member may be configured generally to correspond to the cross-sectional profile of the gasket.

[0013] Preferably the gasket includes in the main, a length of an elastic material such as rubber although if desired in addition to the elastic material of the gasket, hydrophillic sealing material may be provided between the edges of the first and second members, again to aid sealing.

[0014] In one example the hydrophillic material is separate from the gasket but preferably is attached to the gasket or integral with the gasket. For example where the gasket is an extrusion, the hydrophillic material may be co-extruded with the gasket.

[0015] In each case if necessary, the recess in the edge of the first and/or second member may be particularly configured so as to accommodate the hydrophillic material therein.

[0016] To aid deformation of the gasket particularly as compressive forces are applied as the first and second members are positioned adjacent one another, the gasket may have at least one internal chamber.

[0017] In one embodiment, in cross-section, the gasket may include a first major surface which extends generally parallel to the edges of the first and second members, a second major surface which is inclined to the edges of the first and second members, and side faces between the first and second major surfaces. To further aid sealing the side face of the gasket towards the intrados or extrados side surfaces from where the thickness of the gasket decreases, may include a pair of inclined face parts which may meet on a line towards the adjacent side surfaces with at least one of the face parts inclined away from the line.

[0018] The line where the pair of face parts meet may be located within the recess of the edge of the first or second member.

[0019] In each case, the gasket may be of a symmet-

rical or non-symmetrical cross-sectional configuration.

[0020] If desired, the gasket may include an integral anchor means which includes a formation which in use, extends inwardly of the respective member away from the recess. Thus where the first and/or second member is made of a settable material such as concrete, the formation may be embedded in the first or second member before the settable material sets. Thus a gasket may integrally be provided with the first and/or second member.

[0021] To assist anchoring, the formation may include a plurality of laterally existing tangs.

[0022] In a preferred edge seal assembly, each of the first and second edges of the first and second members has a recess and a gasket, so that as the first and second members are brought together the two gaskets engage each other to provide a seal between the two edges.

[0023] Each of the first and second members may be generally rectangular in side view, having two pairs of opposed edges between the intrados and extrados side surfaces. Preferably a recess is provided in all four edges of at least one of the members, each recess receiving a gasket.

[0024] According to a second aspect of the present invention we provide a tunnel lining or pipeline including an edge seal assembly according to the first aspect of the invention.

[0025] According to a third aspect of the invention we provide a gasket for an edge seal assembly according to the first aspect of the invention.

[0026] The invention will now be described with reference to the accompanying drawings in which:-

FIGURE 1 is a diagrammatic exploded perspective view of an edge seal assembly in accordance with the invention.

FIGURE 2 is a plan view of part of the assembly of Figure 1

FIGURE 3 is an enlarged cross-sectional view through a gasket for use in the assembly of Figure 1 and

FIGURE 4 is a view similar to Figure 2, but showing an alternative configuration.

FIGURE 5 is a view similar to Figure 3 but of a modification.

[0027] Referring to Figure 1, an edge seal assembly 10 includes a first member 11 which has intrados 12 and extrados 13 side surfaces, and a first edge 15 between the side surfaces, and a second member 18 having an intrados 19 and extrados 20 side surfaces and a second edge 21 between the side surfaces 19 and 20, the first and second edges 15 and 21 facing one another in use.

[0028] The first and second members 11 and 18 are in this example, tunnel lining members. In this example, the tunnel extends generally in the direction of arrow A

such that the members 11 and 18 each have a curvature extending away from their respective edges 15 and 21, the edges 15 and 21 being generally planar and linear.

[0029] The edges 15 and 21 of each of the first and second members 11, 18 each includes a recess 24 which is adapted to receive a gasket 25 such that as the first 11 and second 18 members are brought together the gaskets 25 which project from the respective recesses 24, engage to form a seal between the adjacent edges 15 and 21. It will be appreciated that a substantial compressive force may be applied to the gaskets 25 so that they provide a seal.

[0030] In a typical tunnel lining application, where the inside of the tunnel is intended to be dry, the tunnel lining members 11 and 18 form a barrier to fluid from the extrados side surfaces 13 and 20 entering the tunnel, and the edge seal between the first and second members 11 and 18 thus needs to be substantially fluid tight. The fluid pressure to which the extrados side surfaces 13 and 20 exposed, can be substantial.

[0031] Referring now also to Figure 2 it can be seen that for each member 11, 18 the recess 24 and the gasket 25 is of a non-symmetrical but generally corresponding configuration and the gaskets 25 are oppositely handed. The general thickness of each gasket 25 decreases from a thicker region 26 to a thinner region 27, the thicker regions 26 being located more closely to the extrados side surfaces 13 and 20 than the intrados side surfaces 12 and 19 of the first and second members 11 and 18.

[0032] The recesses 24 in the edges 15, 21 of the first and second members 11, 18 are correspondingly configured, decreasing in depth from a deeper region 28 to a shallower region 29. Thus as fluid exerts pressure on the extrados side surfaces 13 and 20 of the members 11 and 12 and on the gaskets 25, the thicker regions 26 of the gaskets 25 will be urged sideways in their respective recesses 24 towards the lower volume shallower recess regions 29. Thus increasing fluid pressure merely improves the sealing effectiveness of the gaskets 25.

[0033] Referring now also to Figure 3, it can be seen that each gasket 25 includes a generally elongate length of preferably elastic material, having, in this example three, internal chambers 30 which aid deformation of the gasket 25 particularly as compressive forces are exerted (in the directions of the arrows B and C in Figure 2), as the first and second members 11 and 12 are brought together, as well as in response to fluid pressure at the extrados side surfaces 13 and 20.

[0034] The gaskets 25 each have a first major surface 32 which extends generally parallel to the side edges 15 and 21 of the first and second members 11 and 18, and which engage when the members 11, 18 are brought together edge to edge. Further, each gasket 25 has a second major surface 33 which is inclined to the side edges 15 and 21 of the first and second members 11 and 18, and to the first major surface 32, and each gas-

ket 25 includes side faces 34 and 35 between the first and second major surfaces 32 and 33. Each of the side faces 34 and 35 has a pair of inclined face parts 36 and 37, and 38 and 39. The side faces 36 and 37 and 38 and 39 meet on a line 40 and the face parts 36 and 37 and 38,39 incline away from the line 40. It can be seen from Figure 2 that the line 40 is located within the recesses 24 of the edges 15 and 21 of the first and second members 11,18. It has been found that such an arrangement further enhances the sealing effect achieved by the gaskets 25 in response to fluid pressure exerted on the extrados side surfaces 13 and 20 and on the gaskets 25.

[0035] Further to aid sealing as the first and second members 11 and 12 are brought together, the second major surfaces 33 of the gaskets 25 include a pair of recesses 43.

[0036] If desired, in addition to the rubber gasket 25, alternative sealing material may be provided between the edges 15 and 21 of the members 11 and 12. In figure 3 it can be seen that the gasket 25 is co-extruded with such additional material 45 and 46, the material 45, 46 being hydrophillic material which swells when subjected to liquid, particularly water. Thus the hydrophillic material 45 and 46 is integral with the remainder of the generally elastic rubber gasket 25, although hydrophillic material 45, 46 could be provided separately in addition to the gasket 25 in an alternative arrangement. Preferably the recesses 24 in the edges 15,21 of the first and second members 11, 18 are configured in any event, to accommodate such hydrophillic material 45 and 46 where provided, and where necessary.

[0037] Various modifications may be made within departing from the scope of the invention.

[0038] For example, if desired only the edge 21 of the second member 12 may have a recess 24 to receive a gasket 25, such that the first major surface 32 may simply engage a plain edge 15 of the member 11, or the edge 15 of member 11 may have a recess but no gasket, to receive the first major surface 32 of a gasket 25 in a recess 24 of the edge 21 of the member 18.

[0039] The assemblies 10 so far described are particularly suitable to an application where there is fluid pressure on only the extrados 13, 20 side surfaces of the members 11 and 12, and the object is to prevent such fluid entering the inside of a tunnel. In another application, such as a pipeline, fluid pressure may be exerted on the intrados side surfaces 12 and 19 of the members 11 and 18, the object being to prevent such fluid escaping from the pipeline to the extrados side surfaces 13 and 20. In that event it would be appreciated that the recess 24 or recesses 24 and gasket or gaskets 25 would need to be of an opposite configuration such that the thicker region or regions 26 of the gasket or gaskets 25 would need to be accommodated closer to the intrados side surfaces 12 and 19 than the thinner region 27 which would be located closer to the extrados side surfaces 13 and 20.

[0040] If desired, the gaskets 25, instead of each having a major surface 32 which is generally parallel to the edges 15 and 21 of the members 11 and 12, may have corresponding oppositely inclined major surfaces 32, relative to the edges 15,21, or where only one gasket 25 is provided e.g. in a recess 24 in the edge 15 of the first member 11, a recess of corresponding configuration would need to be provided in the edge 21 of the second member 12 to receive the gasket 25

[0041] In yet another application, the first and second members 11 and 18 may serve to separate fluids on the extrados 13 and 20 side surfaces and the intrados 12 and 19 side surfaces of the members 11 and 18.

[0042] Thus fluid pressure may be exerted in both opposite directions on the gasket or gaskets 25 generally normal to the directions of arrows B and C shown in Figure 2 and Figure 4.

[0043] Referring now to Figure 4, an alternative form of edge seal assembly for such application is illustrated. Again, the general thicknesses each of a pair of gaskets 25 decreases from a thicker region 26 closer adjacent to the extrados 13 and 20 side surfaces towards a thinner region 27 located closer adjacent to the intrados 12 and 19 side surfaces, but the thicknesses of the gaskets 25 then again increase towards a further thicker region 26' which is closer adjacent to the intrados side surfaces 12 and 19 compared to the thinner region 27 which is now located closer to the extrados side surfaces 13 and 20. Thus the thinner regions 27 each provide a waist in the respective gasket 25. Recesses 24 and 24' are provided in each of the edges 15 and 21 of the first and second members 11 and 12 to accommodate the gaskets 25. Again it can be seen that side faces of the gaskets 25 between first 32 and second 33 major surfaces, each includes a pair of inclined face parts 34, 34a which meet at a line 40, 40' and the face parts extend away from the lines 40, 40'.

[0044] When exposed to fluid pressure on the extrados surfaces 13 and 20, the thicker region 26 of the gasket 25 shown in Figure 4, is urged towards the lower volume thinner regions of the recess 24, and when subjected to fluid pressure on the intrados side surfaces 12 and 19, the thicker region 26' is urged towards the thinner lower volume region 27 so that sealing is improved whether the fluid pressure is applied to the extrados 13, 20 and/or intrados 12 and 19 side surfaces.

[0045] Again the gaskets 25 shown in Figure 4 could include or be attached to or be integral with elements of another sealing material such as hydrophillic material located between the edges 15 and 21 of the first and second members 11 and 18.

[0046] It will be appreciated that the actual configuration of the gasket or gaskets 25 and corresponding recess or recesses 24 may be changed to suit different applications although in each case, there will be a thicker gasket region closer adjacent to one of the side surfaces which may be subjected to a fluid pressure greater than the pressure at an opposite side surface of

the assembly.

[0047] Referring to figure 5, an arrangement similar to figure 3 but modified, is shown. In this arrangement, the gaskets 25 each includes an integral anchor means including a formation A which extends away from the recess 24 into the body of the respective member 11, 18, and each formation A has a plurality of tangs T. The members 11, 18 are made in a settable material such as concrete, and the gaskets 25 are arranged in the mould during casting of the concrete to form the members 11, 18, such that the formations A become embedded in the concrete as the concrete sets. Thus the gaskets 25 are attached to the members 11, 18 so that in forming the assembly 10, positioning of the gaskets 25 relative to the recesses 24, is not required. The gaskets 25 will be received already in the recesses 24 as the first 11 and second 18 members are brought together edge 15 to edge 21.

[0048] At the left hand side of the figure, the formation A of the gasket 25 for member 11 has a pair of relatively inclined features F1 and F2, each of which terminates in a generally round tang T.

[0049] At the right hand side of the figure, the formation A of the gasket 25 for member 18 is of a conical configuration, with laterally outwardly extending Tangs T along the cone axis.

[0050] Other formation A configurations may be provided as required.

[0051] In another arrangement, a gasket 25 may be attached to one of the members 11, 18 only which has a recess 24 during casting of member 11, 18 in concrete, in a mould. Of course other configurations of anchor means may be used in conjunction with hydrophillic materials such as is described with reference to figure 2.

[0052] Preferably each of the first 11 and second 18 members is generally rectangular in side view, i.e. from either intrados 12/19 or extrados 13/20 surfaces, having two pairs of edges 15, 21, and 15', 21' (seen in figure 1). As described above, edges 15, 21 are generally linear, whereas edges 15', 21' will be curved, following the curve of the intrados 12, 19 and extrados 13, 20 surfaces. Gaskets 25 as described above may be provided in recesses 24 in all four edges of the members 11, 18 to provide edge seals not only between edges 15, 21 which extend axially of the tunnel lining or pipeline, but circumferentially too.

[0053] The features disclosed in the foregoing description, or the following claims, or the accompanying drawings, expressed in their specific forms or in terms of a means for performing the disclosed function, or a method or process for attaining the disclosed result, as appropriate, may, separately, or in any combination of such features, be utilised for realising the invention in diverse forms thereof.

Claims

1. An edge seal assembly (10) including a first member (11) having intrados (12) and extrados (13) side surfaces and a first edge (15) between the side surfaces (12, 13), and a second member (18) having intrados (19) and extrados (20) side surfaces and a second edge (21) between the side surfaces (19, 20), each of the first and second edges (15, 21) in use facing one another and at least one of the edges (15, 21) having a recess (24), and there being a gasket (25) receivable between the first and second edges (15, 21) and being receivable in part, in the recess (24) characterised in that the thickness of the gasket (25) decreases from a thicker region which is positioned more closely adjacent the intrados (12, 19) or extrados (13, 20) side surfaces, to a thinner region (27) which is positioned more closely adjacent the extrados (13, 20) or intrados (12, 19) side surfaces respectively.
2. An assembly according to claim 1 characterised in that the intrados (12, 19) or extrados (13, 20) side surfaces of the assembly (10) are adapted to be exposed in use to a greater fluid pressure than the extrados (13, 20) or intrados (12, 19) side surfaces respectively, the thickness of the gasket (25) decreasing from the thicker region which is positioned more closely adjacent the intrados (12, 19) or extrados (13, 20) side surfaces which are in use exposed to the greater fluid pressure.
3. An assembly according to claim 1 characterised in that each of the intrados (12, 19) and extrados (13, 20) side surfaces are adapted to be exposed in use to fluid pressure, the first and second members (11, 18) being operative to maintain the fluids separate, the gasket (25) including a first part the thickness of which decreases from a thicker region (26') which is positioned more closely adjacent the intrados (12, 19) side surfaces, to the thinner region (27), and a second part the thickness of which decreases from a thicker region (26) which is positioned more closely adjacent the extrados (13, 20) side surfaces such that the gasket (25) has a reduced thickness in a region (27) between the thicker regions (26', 26).
4. An assembly according to claim 2 or claim 3 characterised in that the recess (24) in the edge (15, 21) of the first and/or second member (11, 18) decreases in depth from a side more closely adjacent to intrados (13, 20) and/or extrados (13, 20) side surface which is in use exposed to fluid pressure.
5. An assembly according to claim 4 characterised in that the recess (24) in the edge (15, 21) of the first

and/or second member (11,18) is configured generally to correspond to the cross-sectional profile of the gasket (25).

6. An assembly according to any one of the preceding claims characterised in that the gasket (25) includes in the main, a length of an elastic material such as rubber. 5
7. An assembly according to claim 6 characterised in that in addition to the elastic material of the gasket (25), hydrophilic sealing material (45,46) is provided between the edges (15,21) of the first and second members (11,18). 10
8. An assembly according to any one of the preceding claims characterised in that the gasket (25) has at least one internal chamber (30). 15
9. An assembly according to any one of the preceding claims characterised in that in cross-section the gasket (25) includes a first major surface (32) which extends generally parallel to the edges (15,21) of the first and second members (11,18), a second major surface (33) which is inclined to the edges (15,21) of the first and second members (11,18), and side faces (34,35) between the first and second major surfaces (32,33). 20 25
10. An assembly according to claim 9 characterised in that the side face (34,35) of the gasket (25) towards the intrados (12,19) or extrados (13,20) side surfaces from where the thickness of the gasket decreases, includes a pair of inclined face parts (36,37; 38,39) and the pair of face parts (36,37; 38,39) meet either on a line (40) towards the adjacent side surfaces (12,29; 13,20) and at least one of the face parts (36,37; 38,39) is inclined away from the line (40), or a line (40) is located within the recess (24) of the edge (15,21) of the first or second member (12,19). 30 35 40
11. An assembly according to any one of the preceding claims characterised in that the gasket (25) is of a symmetrical or non-symmetrical cross-sectional configuration. 45
12. An assembly according to any one of the preceding claims characterised in that the gasket (25) includes an integral anchor means which includes a formation (A) which in use, extends inwardly of the respective member away from the recess (24) and is embedded in one of the first (11) and second members (18). 50
13. An assembly according to claim 12 characterised in that the formation (A) includes a plurality of tangs (T) which assist in anchoring the gasket (25) in the 55

first and/or second member (11,18).

14. an assembly according to any one of the preceding claims characterised in that each of the first and second edges (15,21) of the first and second members (11,18) has a recess (24) and a gasket (25), so that as the first and second members (11,18) are brought together, the two gaskets (25) engage each other to provide a seal between the two edges (15,21).
15. An assembly according to any one of the preceding claims characterised in that each of the first and second members (11,18) is generally rectangular in side view, having two pairs (15,21; 15',21') of opposite edges, and a recess (24) is provided in all four edges (15,21; 15',21') of at least one of the members 11,18), each recess (24) receiving a gasket (25).
16. A tunnel lining or pipeline including an edge seal assembly according to any one of the preceding claims.

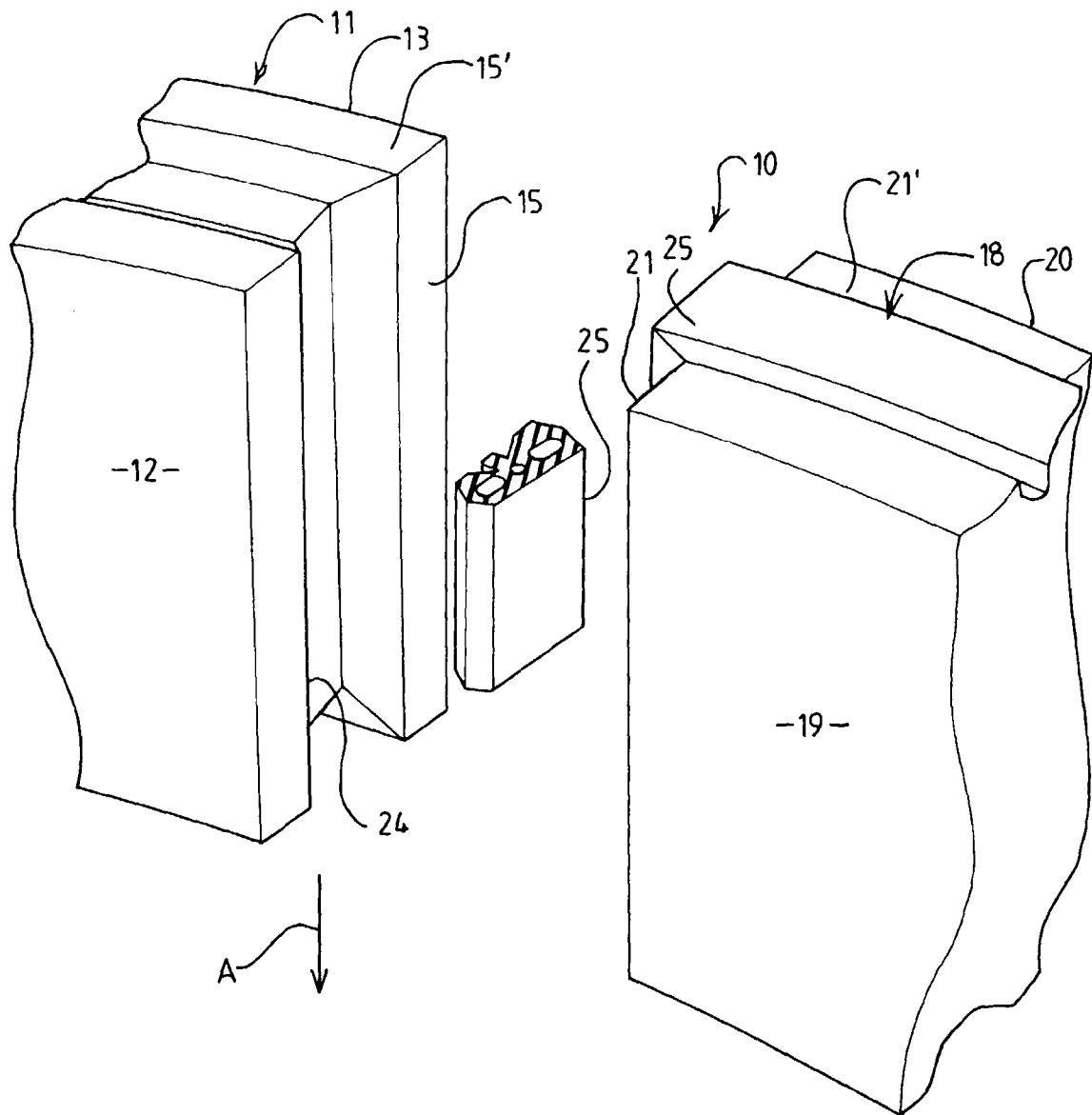


FIG 1

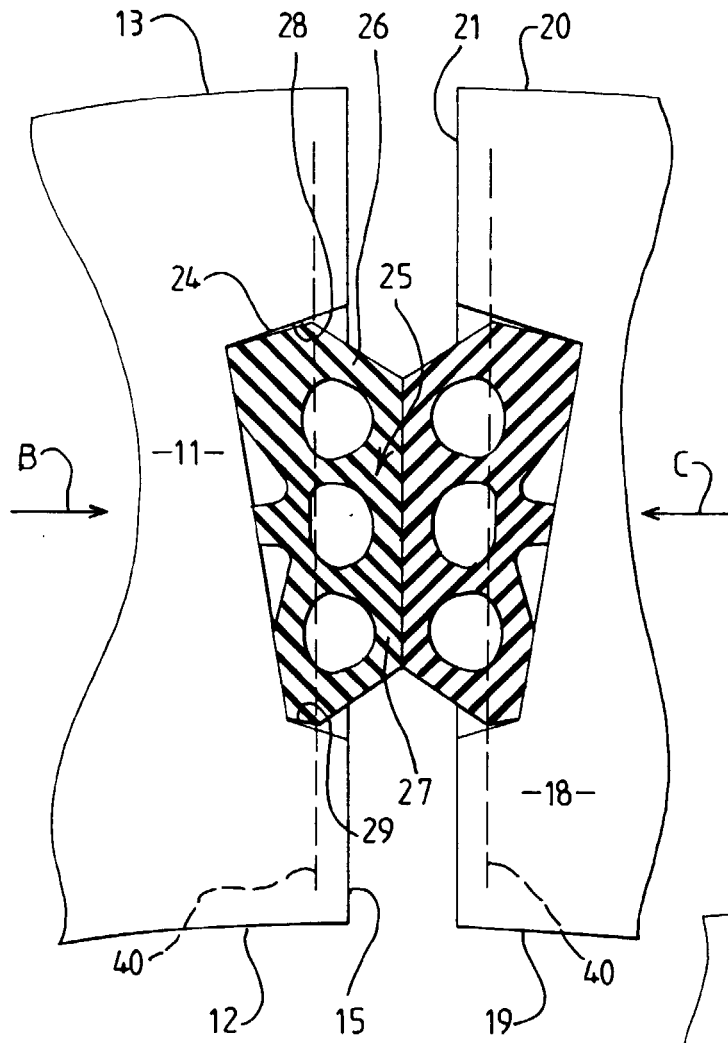


FIG 2

FIG 3

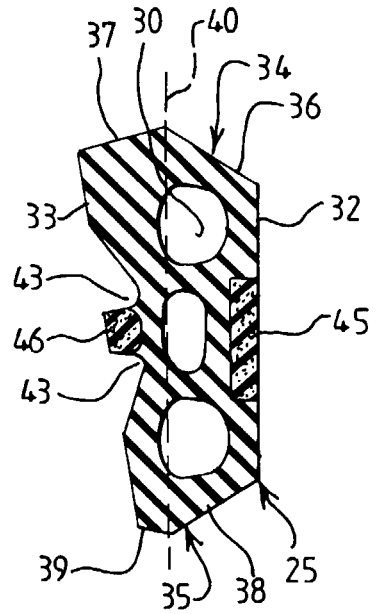
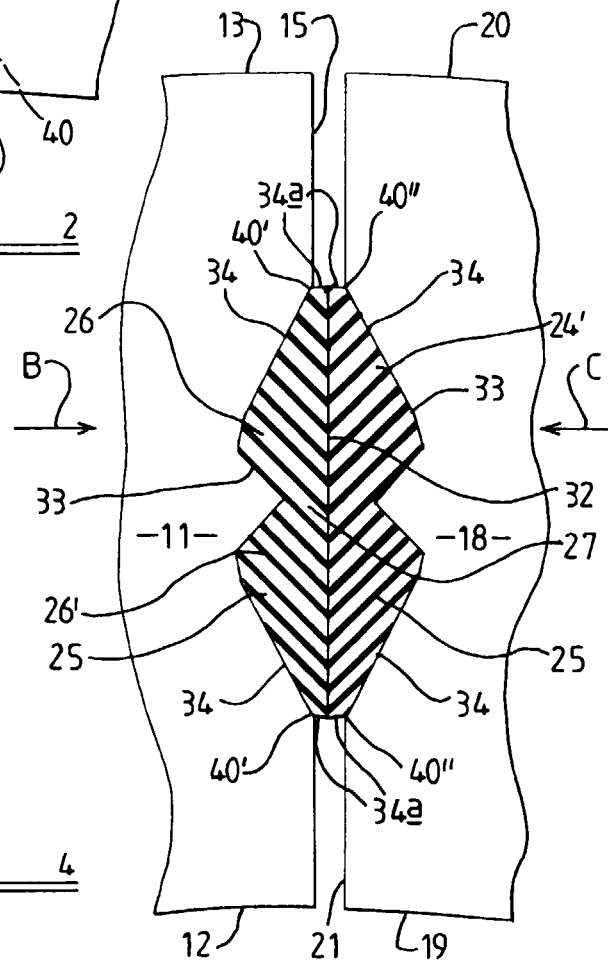


FIG 4



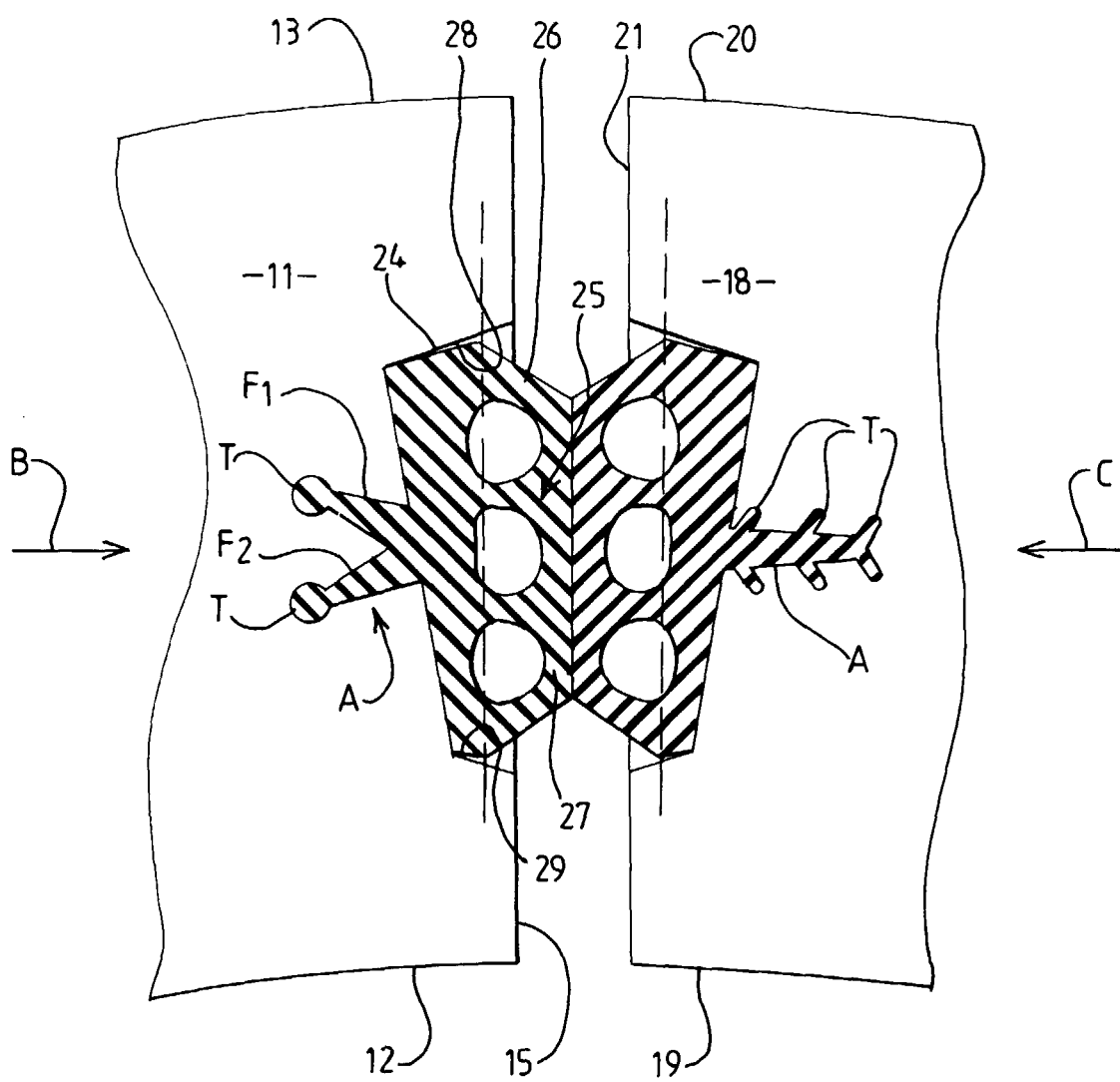


FIG 5



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EUROPEAN SEARCH REPORT

Application Number
EP 99 11 6570

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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 4 October 1999	Examiner Fonseca Fernandez, H
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

EPO FORM 1503 03.82 (P04C01)



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EUROPEAN SEARCH REPORT

Application Number
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**ANNEX TO THE EUROPEAN SEARCH REPORT
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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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