



EUROPEAN PATENT SPECIFICATION

Date of publication of patent specification :
06.11.91 Bulletin 91/45

Int. Cl.⁵ : **E02D 5/60**

Application number : **87901546.9**

Date of filing : **20.02.87**

International application number :
PCT/GB87/00127

International publication number :
WO 87/05066 27.08.87 Gazette 87/19

IMPROVEMENTS RELATING TO THE PROTECTION OF PILES.

Priority : **20.02.86 GB 8604285**

Date of publication of application :
21.12.88 Bulletin 88/51

Publication of the grant of the patent :
06.11.91 Bulletin 91/45

Designated Contracting States :
BE FR GB IT NL SE

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FR-A- 2 337 792
US-A- 3 939 665

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EP 0 295 254 B1

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Description

This invention relates to the protection of piles or risers, such as those of oil rigs, piers or jetties. For convenience, the specification will simply refer to piles.

These are usually massive steel tubing, or concrete or wooden members. Although they may initially be painted or otherwise coated, they inevitably become subject to corrosion or bacterial attack in the hostile environment of sea water. This is particularly so over the splash zone, where the pile is alternately wetted and dried.

It is comparatively easy to apply a protective sheathing to such a structural member before it is placed in the sea, for the job can be done in comfortable and dry conditions. However, it is not always desirable to put such sheathing on beforehand, as it may easily be damaged in transit to the site. Also, of course, there are thousands of existing piles already in place, corroding away and needing attention.

There have been various proposals for sheathing such piles in situ. The difficulties are formidable, starting with the need in most cases to clean the pile of virtually every trace of marine growth and corrosion. The favoured approach then has been to construct a jacket around the pile leaving an annular space, sealed around the bottom so that it can be emptied of water. Then a filler material is poured in; for example concrete is suggested in GB-A-1,352,226. Other proposals have been for an inert bonding material as in GB-A-1,546,710 and GB-A2,108,566. Such a jacket has to be tailor-made for the particular size of pile, and it also has to be in two parts at least so that it can be assembled around the pile. There also have to be spacers to keep the jacket uniformly distanced around the pile, adding to the complexity and cost.

Another drawback is that once such sheathing has been fitted it is permanent unless completely destroyed. There can be no absolute guarantee that corrosion will be kept at bay by any of these systems, and it is desirable from time to time to make a visual inspection. Existing sheathing systems of this sort make this extremely difficult and expensive, and there is the temptation to assume all is well underneath.

In GB-A-1,503,464 and FR-A-2 337 192 (Liddell), there is a flexible sheet which wraps around a pile. The same technique is also described in GB 1,557,077, also of Liddell. The edges which meet are provided with "pole pieces" of semi-circular cross section whose flat sides are put together and then rolled by a tool applied at one end. While this can draw the wrapping tight, it cannot do so over the entire surface area of the pile. There is inevitably a gap where one edge portion of the wrapping leaves the pile to wind around the combined pole pieces. That gap must, of course, then be closed at the ends. It follows that, the pole pieces cannot extend over the whole length of

the wrapping, but must leave end portions to be closed tightly, against the pile when the roll has been completed. Part of Liddell's answer to this is the extra step of wrapping the pile with accurately spaced sealing bands at the top and bottom of the main sheet.

Another drawback with Liddell is that by rotating from one end, long slim pole pieces are bound to twist, and there will be uneven tension in the wrapping. It will tend to be tighter at the top than at the bottom.

Nevertheless, a flexible wrapping drawn tight around the pile is a simpler system and one that should give many advantages once the problems of Liddell are resolved, which the present invention aims to do. Furthermore it should allow fairly easy replacement, or even re-use after removal for inspection. It would also be advantageous to have a wrapping that could sustain minor damage and keep its sealing properties for a reasonable length of time there-after, without deterioration. Any protective system should also advantageously be resistant to marine growth and, particularly for steel piles, protect against electrolytic action.

According to one aspect of the present invention there is provided a pile wrapping comprising a flexible sheet with substantially rigid members along substantially the entire length of the opposed edges which are adjacent when the wrapping is positioned around a pile, the members affording means by which the wrapping can be tightened around the pile, characterised in that said members are in the form of outwardly extending flanges to provide counter-abutments for the application of a tool by which the members can be closed together to impose hoop stresses on the wrapping, and in that said flanges have apertures at intervals along their length to accept fastening elements securable while the hoops stresses are maintained.

The sheet will have a certain elasticity, but the hoop stresses applied can be made sufficient to prevent the sheet being sucked clean off the pile by wave action. They can also be evenly spread over the length of the wrapping.

The sheet preferably comprises an outer skin of water impermeable flexible material, such as reinforced plastics sheet, and an inner layer of liquid permeable material such as felted or porous plastics material bonded to the skin and impregnated with a water resistant sealant. The outer skin may have a thickness of the order of 3 mm, and a suitable material is that used for the skirts of hovercraft. The thickness of the inner layer may be of the order of 6 mm, or at least sufficient to accommodate to variations in surface profile of that order of magnitude.

The wrapping is intended to go once around the pile, which is normally cylindrical. To help complete the seal at the contiguous edges the inner layer may have an extension beyond one of the opposed edges to tuck under the opposite one.

The sealant impregnated in the inner layer may

have other properties beyond just being water resistant. It may incorporate corrosion inhibiting and anti-fouling components. Preferably, it will be in the form of a thixotropic gel and not form a permanent bond to a pile surface. Also the fastening means will generally be releasable, so that the wrapping can be easily removed for inspection, and later re-used.

The inner layer and sealant will generally be covered by a removable backing sheet on manufacture, which will be discarded before positioning around the pile.

The wrapping sheet may also be adapted to form an element of a cathodic protection system, being a carrier for sacrificial anode material, or providing a jacket with a high dielectric constant, for example. It could also carry anti-fouling material externally.

To assist in fitting this wrapping, the sheet may be outwardly provided with handles so that divers can manoeuvre it into position. Also, it will be advantageous to have temporary strap fasteners for holding the wrapping around a pile during an initial phase while at least some of the fastening elements are secured. Conveniently, there will also be gauge marks on the outside of the sheet to provide an indication of the hoop stresses imposed. The fastening elements will usually be bolts.

According to another aspect of the present invention there is provided a method of protecting a pile comprising wrapping a sheet as outlined above around the pile, drawing said opposed edges together by at least one said tool to create hoop tensions that are resistant to wave suction forces, securing said fastening elements while the hoop stresses are maintained, and removing said tool or tools.

With the sealant version, this tensioning causes the sealant to exude into any surface irregularities. The pile will normally be cleaned first, but it need not be done so with the meticulousness of some previous systems. Any vestigial marine growths or other imperfections will be firmly encapsulated and rendered impotent due to lack of oxygen and/or reaction to corrosion or anti-fouling inhibitors.

For a fastening operation, tools may be engaged through some of the apertures to draw the opposite edges together. Bolts are then engaged through others of said apertures in a first securing operation, the tools are removed, and replaced by bolts in a second securing operation.

The wrapping will usually be positioned at least partially under water and during the initial stages it will conveniently be supported by buoyancy bags as it is positioned by divers around the pile.

It is not practical to sheath a complete pile with a single such sheet. Where this is desired, a series of sheets will be wrapped around the pile, butted together and sealing means applied around the butt joints.

For a better understanding of the invention, one

embodiment will now be described, by way of example, with reference to the accompanying drawing, in which:

Figure 1 is a perspective view of a wrapping sheet in preparation for installing around a pile,

Figure 2 is a perspective view of the sheet in a first stage of installation,

Figure 3 is a cross-section of the pile with the sheet secured around it,

Figure 4 is a diagrammatic elevation of the cooperating edges of the wrapping sheet, and

Figure 5 is a diagram of hydraulic closure apparatus.

The sheet is of composite construction having an outer skin 1 of material such as nylon reinforced Neoprene, 3mm thick, similar to hovercraft skirt material. Bonded to the rear side of this is an inner layer 2 of polypropylene felt, 6mm thick and impregnated with a polymeric thixotropic water-displacing gel sealant, formulated to act as a host for corrosion inhibitors and/or anti-foulants. It will be effective over a wide temperature range, say -40°C to 150°C. On manufacture this felt is protected by a peel-off backing sheet 3, which remains during transport and handling and is only removed by the divers as they fit the wrapping around the pile. Handles 4 to assist that fitting operation are bonded or otherwise attached to the outer face of the skin 1, as are straps 5 and fasteners 6 for temporary use as described below. The skin 1 also has permanent datum marks 7 for checking the stability of the wrapping.

Sealing members 8 in the form of substantially rigid flanges extend along the edges of the sheet that are to meet when it has been wrapped around a pile. They will project radially outwardly and each has a series of apertures 9 which register when the wrapping is in place. The inner layer 2 is extended beyond one of the flanges 8 to form a flap 10 which will tuck under the opposite inner edge portion of the layer 2 and form an overlap, thus ensuring a good seal. If it is known that the wrapping will be used singly, the flanges 8 may extend the full length of their respective edges, but if several are to be used in series along a pile, the flanges 8 will be short of each end, by 75mm or thereabouts, for reasons explained below. Figures 1 and 2 show a hybrid, with the flanges 8 short at the top end only.

For installation, the sheet is folded concertina fashion as shown in Figure 1. It may be loosely held thus by ropes or straps. It is then supported by variable buoyancy bags and floated to the pile to be wrapped. Divers release and unfold it, wrapping it around the pile, which will have been locally cleaned as mentioned above. Once roughly in place, it can be loosely secured by the straps 5 and fasteners 6 as shown in Figure 2, and usually one at the top, one at the bottom and one at the middle will suffice. The wrapping can then be adjusted longitudinally of the

pile 11.

Once precisely in position, power means are applied to the members 8 to draw the wrapping tight. In the preferred system, hydraulic rams 12 as shown in Figure 5 are used, attached to a diver operated handpump 13 via flexible hoses 14. These have swivel connections 15 at their ends to the rams 12 and to the T-pieces 16 or manifolds at the pump 13. Although only two rams are shown, for wrappings of any length it will be preferred to use three, applied to the top, bottom and middle of the members 8 adjacent the straps 5. The ram rods 17 are inserted through the registering bolt apertures 9 and quick-lock nuts are fitted to their ends. The rams are then briefly actuated to apply a light tension to the wrapping.

Further rams operable by a second pump are then applied to other registering bolt apertures 9, preferably alternate ones, leaving half the apertures free. The temporary straps 5 can then be loosened or removed. One of the divers operates the first hand hydraulic pump to contract the rams at top and bottom and middle, and the second pump is operated to obtain even closure of the seal. Once the wrapping has been checked that it is free from wrinkles and correctly aligned, non-metallic bolts 18 are inserted into the vacant apertures, and nuts 19 are fitted and done up finger tight. The hydraulic pumps are then operated again to achieve full face to face closure of the sealing members 8. The nuts are tightened and the rams are removed.

This exposes the other half set of alternate apertures, into which bolts 18 are then fitted and secured by nuts 19. Tightening of these is completed, preferably using an air-operated "nut spinner", and then nylon locking rings are installed on each bolt. During these tightening operations, the impregnated sealant will be exuded into any surface irregularities and between the members 8 to complete the encasement and protection of the wrapped zone.

Finally, the datum marks 7 are used to measure and note the extension achieved, and this will be compared against a table, and recorded for future reference and checks.

Where a greater length of pile is to be wrapped, two or more such sheets are applied and butt jointed together, using ones where the members 8 do not extend right to the ends. There might be an overlap of the inner layers in the manner of the flap 10. Over this joint there will be placed a band or "cummerbund", which is simply a foreshortened version of the wrapping described with similar flanges by which it is stretched tight and secured in the manner of the main wrappings. It may not need such a substantial inner layer and its flanges will preferably be offset circumferentially from those of the main wrappings to ensure a good seal. Generally, the flanges 8 of the main wrappings will be arranged to be downstream in relation to the most powerful tidal stream or current expected

and the offset of any cummerbund will preferably be 10° - 30°.

Such a wrapping can be removed by reversing this procedure. Unless its removal is occasioned by damage it will normally be possible to replace it.

Minor punctures of the outer skin 1 will self seal as radial hoop stresses in the material will cause the permanently soft sealant impregnated in the inner layer to exude and fill a punctured cavity. However, even major cuts and tears will remain stable, the tension placed on the material during installation being less than that which causes tears to propagate. But, even though it will not be totally immune to damage, such a wrapping will provide additional impact resistance being, in effect, a cushion around the pile.

In general, a particular material for the outer skin 1 has not yet been settled and different ones may be suitable for different applications. Polyester reinforced polychloroprene is one further example being considered. Likewise there may be suitable materials for the inner layer 2 other than the polypropylene referred to above, and rather than felt the material may be homogeneous but porous.

It is envisaged that future applications for or modifications of the system will include the loading of polychloroprene rubber (forming the outer or only skin) with conductive particles of the type used in the construction of sacrificial anodes. An alternative approach is to make the wrapping, as a single or multi-skin jacket, of materials that will give it a very high dielectric constant; this alone should be an efficacious cathodic protection device. Both forms will provide a flexible anode assembly or a shield by which cathodic protection effects could be directed into suspected vulnerable areas of subsea structures.

A further application is to use the system as a carrier for anti-foulant materials, preventing marine growth build up and consequent increase in current drag forces on subsea platform legs, risers and caissons. This could be achieved by providing an additional outer skin, conveniently a foamed polymer matrix for the anti-foulant material, such as copper particles. If used solely for this purpose the inner sealant layer could be dispensed with. It will be understood however, that a single wrapping could combine any of these functions.

Claims

1. A pile wrapping comprising a flexible sheet (1,2) with substantially rigid members (8) along substantially the entire length of the opposed edges which are adjacent when the wrapping is positioned around a pile (11), the members (8) affording means by which the wrapping can be tightened around the pile (11), characterised in that said members (8) are in the form of outwardly extending flanges to provide

counter-abutments for the application of a tool (12) by which the members can be closed together to impose hoop stresses on the wrapping, and in that said flanges (8) have apertures (9) at intervals along their length to accept fastening elements (18) securable while the hoop stresses are maintained.

2. A wrapping as claimed in Claim 1, characterised in that the sheet comprises an outer skin (1) of water impermeable flexible material, such as reinforced plastics sheet, and an inner layer (2) of liquid permeable material such as felted or porous plastics material bonded to the skin (1) and impregnated with a water resistant sealant.

3. A wrapping as claimed in Claim 2, characterised in that the inner layer (2) has an extension (10) beyond one said opposed edge to tuck under the other opposed edge portion when the wrapping is positioned around a pile (11).

4. A wrapping as claimed in Claim 2 or 3, characterised in that the impregnated sealant has corrosion inhibiting and/or anti-foulant properties, and is a thixotropic gel.

5. A wrapping as claimed in Claim 2,3 or 4, characterised in that the impregnated sealant does not form a permanent bond to a pile surface, and wherein the fastening means (18) are releasable.

6. A wrapping as claimed in any one of Claims 2 to 5, characterised in that the inner layer (2) and sealant are covered by a removable backing sheet (3) discarded before positioning around a pile.

7. A wrapping as claimed in any preceding claim, characterised in that the sheet (1,2) is adapted to form an element of a cathodic protection system, being a carrier for sacrificial anode material or providing a jacket with a high dielectric constant.

8. A wrapping as claimed in any preceding claim, characterised in that the sheet (1,2) is outwardly provided with handles (4) for assisting manoeuvring the wrapping into position, and with temporary strap fastening means (5,6) for holding the wrapping loosely in position around a pile while at least some of the fastening elements (8) are secured.

9. A wrapping as claimed in any preceding claim, characterised in that the sheet (1,2) is outwardly provided with gauge marks (7) to provide an indication of the hoop stresses imposed.

10. A wrapping as claimed in any preceding claim, characterised in that the fastening elements are bolts (18).

11. A method of protecting a pile comprising wrapping a sheet (1,2) according to any preceding claim around the pile (11), drawing said opposed edges together by at least one said tool (12) to create hoop tensions that are resistant to wave suction forces, securing said fastening elements (18) while the hoop stresses are maintained, and removing said tool or tools.

12. A method as claimed in Claim 11, character-

ised in that said tools (12) are engaged through some of said apertures (9) to draw the opposite edges together, whereafter bolts (18) are engaged through others of said apertures (9) in a first securing operation, and wherein the tools (12) are removed and replaced by bolts (18) in a second securing operation.

Patentansprüche

1. Pfahlumhüllung mit einer flexiblen Platte (1,2) und daran weitgehend entlang der gesamten Länge der sich gegenüberliegenden Ränder angeordneten, im wesentlichen starren Gliedern (8), wobei die Ränder bei um einen Pfahl (11) angeordneter Umhüllung aneinandergrenzen und die Glieder (8) eine Einrichtung zum Festziehen der Umhüllung um den Pfahl (11) aufweise, **dadurch gekennzeichnet**, daß die Glieder (8) in Form von sich nach außen erstreckenden Flanschen zur Bildung von Wiederlagern zur Anwendung eines Werkzeugs (12) ausgebildet sind, durch das die Glieder zur Beaufschlagung der Umhüllung mit Umfangsspannungen schließbar sind, und daß die Flansche (8) entlang ihrer Länge in Abständen den Öffnungen (9) zur Aufnahme von Befestigungselementen (18) aufweisen, die während der Beaufschlagung mit Umfangsspannungen befestigbar sind.

2. Umhüllung nach Anspruch 1, dadurch gekennzeichnet, daß die Platte eine Außenhaut (1) aus wasserundurchlässigem flexiblen Material, wie beispielsweise eine verstärkte Kunststoffplatte, und eine Innenschicht (2) aus flüssigkeitsdurchlässigem Material, wie filziges oder poröses Kunststoffmaterial, aufweist, das an die Haut (1) gebunden und mit einem wasserbeständigen Dichtungsmittel imprägniert ist.

3. Umhüllung nach Anspruch 2, dadurch gekennzeichnet, daß die Innenschicht (2) eine Verlängerung (10) bis über einen der gegenüberliegenden Ränder aufweist, um unter den anderen Randabschnitt zu gleiten, wenn die Umhüllung um einen Pfahl (11) angeordnet ist.

4. Umhüllung nach Anspruch 2 oder 3, dadurch gekennzeichnet, daß das imprägnierte Dichtungsmittel korrosions- und/oder fäulnishemmende Eigenschaften aufweist und ein thixotropisches Gel ist.

5. Umhüllung nach einem der Ansprüche 2 - 4, dadurch gekennzeichnet, daß das imprägnierte Dichtungsmittel nicht eine dauernde Bindung an der Pfahloberfläche bildet und daß die Befestigungsglieder (18) lösbar sind.

6. Umhüllung nach einem der Ansprüche 2 - 5, dadurch gekennzeichnet, daß die Innenschicht (2) und das Dichtungsmittel von einer lösbaren Trägerplatte (3) bedeckt sind, die vor der Anordnung um den Pfahl abnehmbar ist.

7. Umhüllung nach einem der Ansprüche 1 - 6, dadurch gekennzeichnet, daß die Platte (1,2) zur Bil-

dung eines Elements eines Kathodenschutzsystems ausgebildet ist, derart, daß sie ein Träger für ein Opferanodenmaterial ist oder einen Mantel mit einer hohen Dielektrizitätskonstante bildet.

8. Umhüllung nach einem der Ansprüche 1 - 7, dadurch gekennzeichnet, daß die Platte (1, 2) außen- 5 seitig Handgriffe (4) zur leichteren Handhabung der Umhüllung bei deren Positionierung aufweist und eine vorübergehend einsetzbare Gurtbefestigungseinrichtung (5, 6) besitzt, um die Umhüllung während der Festlegung wenigstens einiger der Befestigungselement (8) locker in Position um der Pfahl herum zu halten.

9. Umhüllung nach einem der Ansprüche 1 - 8, dadurch gekennzeichnet, daß die Platte (1, 2) außen- 10 seitig Maßstriche (7) zur Anzeige der beaufschlagten Umfangsspannungen aufweist.

10. Umhüllung nach einem der Ansprüche 1 - 9, dadurch gekennzeichnet, daß die Befestigungselemente Bolzen (18) sind.

11. Verfahren zum Schutz eines Pfahls durch Umhüllen des Pfahls (11) mit einer Platte (1, 2) gemäß einem der Ansprüche 1 -10, Zusammenziehen der sich gegenüberliegenden Ränder mittels wenigstens eines Werkzeugs (12) zur Erzeugung von Umfangs- 15 spannungen, die Wellensaugkräften widerstehen, Festlegen der Befestigungselemente (18), während die Umfangsspannungen aufrechterhalten werden, und Entfernen des Werkzeugs oder der Werkzeuge.

12. Verfahren nach Anspruch 11, dadurch gekennzeichnet, daß die Werkzeuge (12) durch einige der Öffnungen (9) in Eingriff stehen und die gegenüberliegenden Ränder zusammenziehen, woraufhin die Bolzen (18) durch andere der Öffnungen (9) in einem ersten Festlegungsarbeitsgang in Eingriff gebracht werden, und daß die Werkzeuge (12) entfernt und durch Bolzen (18) in einem zweiten Festlegungsarbeitsgang ersetzt werden.

Revendications

1. Enveloppe pour pieu comprenant une feuille souple (1, 2) munie d'éléments sensiblement rigides (8) sur sensiblement toute la longueur des bords opposés qui sont adjacents lorsque l'enveloppe est placée autour d'un pieu (11), les éléments (8) formant des moyens par lesquels l'enveloppe peut être serrée autour du pieu (11), caractérisée en ce que lesdits éléments (8) sont sous forme de rebords qui s'étendent vers l'extérieur pour former des contrebutées pour l'application d'un outil (12) par lequel les éléments peuvent être fermés ensemble pour imposer des contraintes périphériques sur l'enveloppe, et en ce que lesdits rebords (8) comportent des ouvertures (9) à des intervalles suivant leur longueur pour recevoir des éléments de fixation (18) qui peuvent être fixés tandis que les contraintes périphériques sont

maintenues.

2. Enveloppe selon la revendication 1, caractérisée en ce que la feuille comprend une peau externe (1) de matériau souple imperméable à l'eau, telle qu'une feuille de matière plastique renforcée, et une couche interne (2) de matériau perméable aux liquides tel qu'une matière plastique feutrée ou poreuse, liée à la peau (1) et imprégnée d'un matériau d'étanchéité résistant à l'eau.

3. Enveloppe selon la revendication 2, caractérisée en ce que la couche interne (2) comporte un prolongement (10) au-delà de l'un desdits bords opposés pour pénétrer sous l'autre partie formant bord opposé lorsque l'enveloppe est placée autour d'un pieu (11).

4. Enveloppe selon la revendication 2 ou 3, caractérisée en ce que le matériau d'étanchéité imprégné a des propriétés inhibant la corrosion et/ou anti-salissure, et est un gel thixotrope.

5. Enveloppe selon la revendication 2, 3 ou 4, caractérisée en ce que le matériau d'étanchéité imprégné ne forme pas une liaison permanente avec la surface d'un pieu, et dans laquelle les éléments de fixation (18) sont amovibles.

6. Enveloppe selon l'une quelconque des revendications 2 à 5, caractérisée en ce que la couche interne (2) et le matériau d'étanchéité sont recouverts par une feuille dorsale (3) amovible rejetée avant le positionnement autour d'un pieu.

7. Enveloppe selon l'une quelconque des revendications précédentes, caractérisée en ce que la feuille (1, 2) est adaptée pour former un élément d'un système de protection cathodique, en constituant un support pour un matériau d'anode réactive ou en formant une chemise à constante diélectrique élevée.

8. Enveloppe selon l'une quelconque des revendications précédentes, caractérisée en ce que la feuille (1, 2) est munie à l'extérieur de poignées (4) pour favoriser le positionnement de l'enveloppe, et de moyens de fixation à bandes temporaires (5, 6) pour maintenir de manière lâche l'enveloppe en position autour d'un pieu tandis qu'au moins certains des éléments de fixation (8) sont fixés.

9. Enveloppe selon l'une quelconque des revendications précédentes, caractérisée en ce que la feuille (1, 2) est munie à l'extérieur de marques d'éta- 45 lonnage (7) pour donner une indication des contraintes périphériques imposées.

10. Enveloppe selon l'une quelconque des revendications précédentes, caractérisée en ce que les éléments de fixation sont des boulons (18).

11. Procédé de protection d'un pieu, comprenant le positionnement d'une feuille (1, 2) selon l'une quelconque des revendications précédentes autour du pieu (11), le rapprochement par traction desdits bords opposés par ledit ou lesdits outils (12) pour créer des tensions périphériques qui sont résistantes aux forces d'aspiration des vagues, la fixation desdits éléments de fixation (18) tandis que les contraintes

périphériques sont maintenues, et le retrait dudit outil ou desdits outils.

12. Procédé selon la revendication 11, caracté-
risé en ce que lesdits outils (12) sont engagés dans
certaines desdites ouvertures (9) pour tirer ensemble 5
les bords opposés, après quoi des boulons (18) sont
introduits dans d'autres ouvertures parmi lesdites
ouvertures (9) dans une première opération de fixa-
tion, et dans lequel les outils (12) sont retirés et rem-
placés par des boulons (18) dans une seconde 10
opération de fixation.

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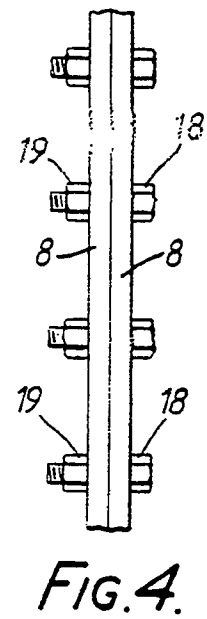
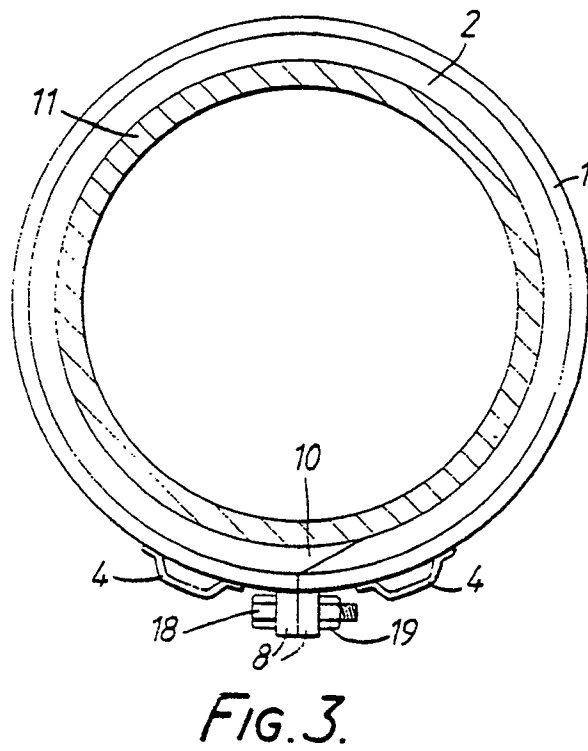
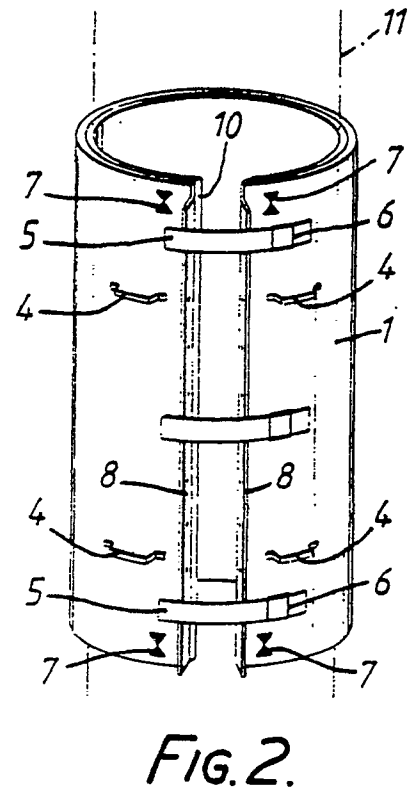
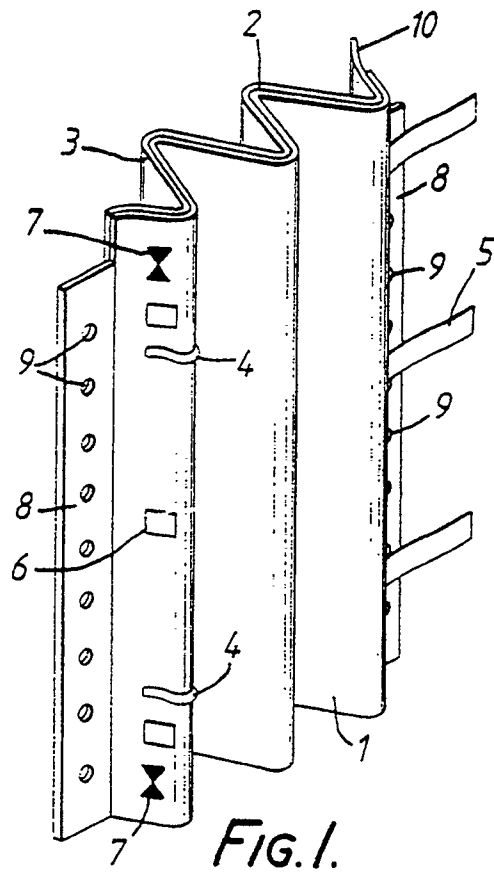
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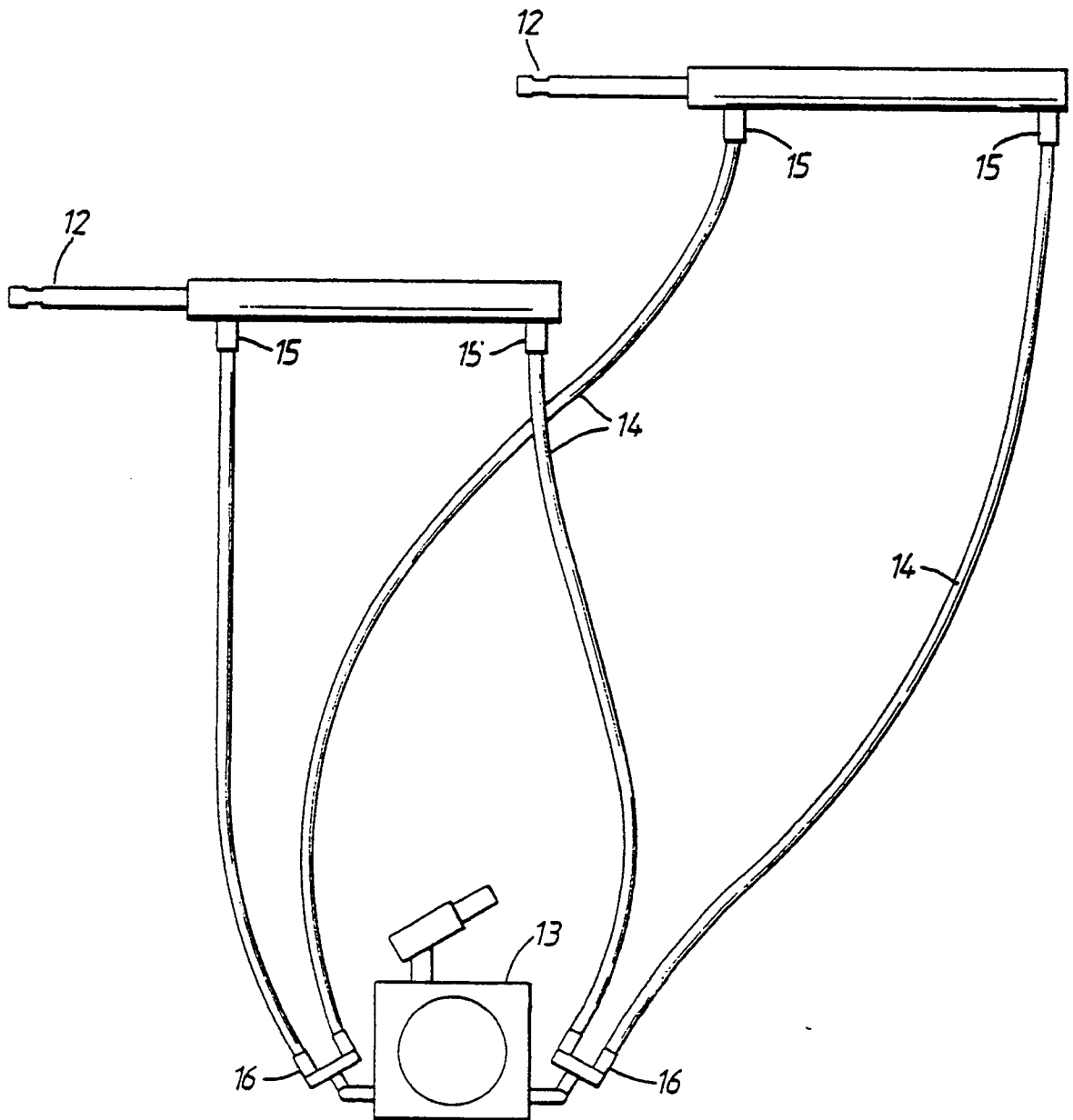


FIG. 5.