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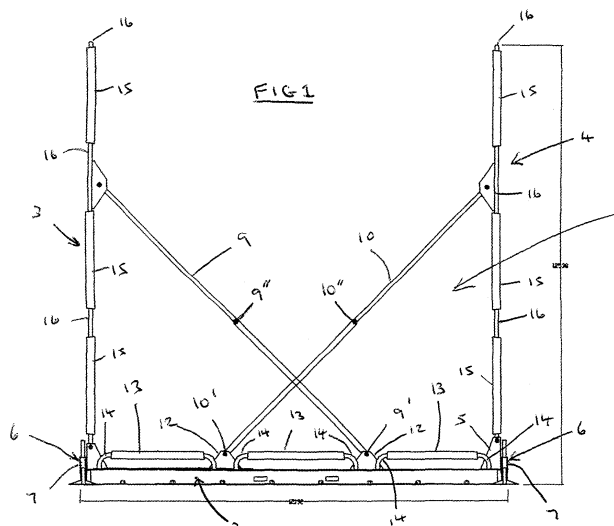
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(54) **Corrosion inhibiting anode assemblies for use with underwater structures**

(57) A corrosion inhibiting anode assembly (1) for use with an underwater structure comprises a generally planar main frame (2) for lying on the bed of a body of water, a plurality of spaced-apart elongate anode bars (13) fixedly secured by respective stand-off supports (14) to the main frame (2) and extending in one or more planes that are generally parallel to that of the main frame (2), and at least one wing frame (3, 4, 20, 21, 22, 23) pivotally attached to the main frame (2). The wing frame (3, 4, 20 - 23) comprises a plurality of spaced-apart elongate an-

ode bars (13), and is capable of being pivoted from a folded condition to an extended condition in which the anode bars (13) of the wing frame (3, 4, 20 - 23) are generally more remote from those of the main frame (2) than in said folded condition, Wing frame supports (9, 10) are connected to the wing frame (3, 4, 20 - 23) and arranged to support the wing frame (3, 4, 20 - 23) in said extended condition.

A plurality of wing frame assemblies may be provided.



Description

[0001] The present invention relates to corrosion inhibiting anode assemblies, particularly, but not exclusively, to anode assemblies suitable for use with off-shore structures associated with oil and/or gas production, such as oil and gas platforms.

[0002] The invention relates to both sacrificial anode assemblies and to impressed current anode assemblies.

[0003] There is a requirement to extend the planned life of some offshore structures. Such offshore structures would generally have been provided with permanently attached sacrificial anodes when first installed, and the dimensions of the anodes would have been chosen in relation to the planned life of the extraction site. It has now become economic to keep some offshore structures operational beyond their planned life.

[0004] Additional anodes need to be attached to such structures to prolong their lives. The use of a diving bell to enable additional or replacement anodes to be attached to a deeply submerged structure is very expensive. A common form of anode assembly is of generally cow-horn shape to provide a stand-off for an elongate anode bar. The horns can be produced from round-bar steel or tubular steel, and constitute stand-off supports for the anode bar. Alternatively, the stand-off supports may be in the form of an L-shaped bracket.

[0005] However, such anode assemblies need to be attached by the free-ends of the horns to the structure to be protected.

[0006] It is also known to provide a sacrificial anode assembly, and an impressed current anode assembly, in the form of a rigid stool-shaped framework in which the legs of the stool each comprise a bar of a sacrificial metal. The spacing-apart of the legs of the stool helps to reduce material anode interference. Such a free-standing assembly can be positioned on the bed of the sea.

[0007] A problem with such a stool is that it will have a limited surface area of the anodes, and accordingly increasing the surface area results in a very large assembly that is difficult to transport and manoeuvre to its submerged location.

[0008] According to one aspect of the invention a corrosion inhibiting anode assembly for use with an underwater structure comprises a generally planar main frame for lying on the bed of a body of water, a plurality of spaced-apart elongate anode bars fixedly secured by respective stand-off supports to the main frame and extending in one or more planes that are generally parallel to that of the main frame, and at least one wing frame pivotally attached to the main frame, the wing frame comprising a plurality of spaced-apart elongate anode bars, and being capable of being pivoted from a folded condition to an extended condition in which the anode bars of the wing frame are generally more remote from those of the main frame than in said folded condition, and wing frame supports connected to the wing frame and arranged to support the wing frame in said extended con-

dition.

[0009] The stand-off supports may be straight, curve through 90° or be in the shape of a right-angle.

[0010] In one preferred arrangement the main frame is of oblong-rectangular shape in plan, and first and second wing frames are pivotally attached to opposite ends of the main frame, the wing frames being dimensioned such that in said folded condition, the wing frames lie substantially within the plan area of the main frame.

[0011] Preferably the widths of the wing frames are narrower than the transverse spacing of the anode bars carried by the longitudinal main frame members to enable the folded wing frames to lie between the anode bars of the main frame as viewed in plan, thereby to help facilitate a relatively compact assembly for transportation.

[0012] The wing frame supports of said first preferred arrangement are preferably arranged to support the extended wing frames substantially perpendicular to the plane of the main frame, ie, substantially vertical when the main frame is resting on a horizontal bed.

[0013] The wing frame supports are preferably then in the form of respective struts extending at an acute angle from a pivot point on the main frame to a pivot point on the respective frame, the struts having a hinge connection at their midpoints to enable the strut to be folded when the wing is in the folded condition.

[0014] The struts are preferably provided with latches associated with the hinges that engage to lock the strut permanently when the wing frame reaches its fully extended condition.

[0015] In a second preferred arrangement the main frame is of oblong-rectangular outline in plan and at least one wing frame is pivotally connected thereto about an axis extending along one margin of the main frame, the wing frame in said extended condition extending outwardly from the main frame and generally in a plane parallel to or coincident with the plane of the main frame.

[0016] The wing frame supports may simply comprise feet which engage with the bed when the wing frame is in the extended condition, and the feet may be provided on short support legs extending downwardly from the outer end of the wing frame.

[0017] In the second preferred arrangement a plurality of such wing frame assemblies are preferably provided, which open out from the respective margins of the main frame.

[0018] The wing frames preferably each comprise upper and lower elongate anode bars spaced apart vertically, as seen with the wing frame in an extended condition, and the anode bars of the wing frames are so positioned on the wing frames as to be received between anode assemblies that are directly supported on the main frame, when the wing frame is positioned in said folded condition.

[0019] A particularly compact assembly, when the wing frames are in their folded conditions, is facilitated by arranging that the horizontal dimension of the wing frame, going from the pivotal axis of the wing to the tip

of the wing, is substantially equal to the maximum height, relative to the base of the main frame, of the anodes on the main frame.

[0020] One or more elongate components of the assembly may be formed as a telescopic hydraulic unit that can be extended when the assembly has been immersed in water, preferably as the assembly nears or reaches its deployed position on the bed of the sea or body of water.

[0021] The hydraulic unit/s are preferably provided with latches that hold the extended hydraulic unit, once charged, in a substantially extended condition.

[0022] A pre-charged hydraulic accumulator is preferably mounted on one of the frames, preferably on the main frame, and is connected to the hydraulic unit/s.

[0023] An actuation valve is provided between the accumulator and the hydraulic unit/s, the valve being arranged to be opened when it is desired to extend the hydraulic unit/s.

[0024] The actuation valve is preferably a normally closed probe-operated valve, the probe being positioned to be operated by contact with the sea bed/bed of water when the main frame is deposited onto the bed.

[0025] In order to minimise the risk of the hydraulic unit/s being charged prematurely, by wave action on the probe, it is preferred to provide a normally closed water-pressure operated valve in series with the probe-operated valve, the water pressure operated valve being configured to open when the assembly reaches a predetermined depth of water, thereby reconnecting the supply from the hydraulic accumulator to enable charging of the hydraulic units when the probe-operated valve is opened.

[0026] Unfolding of the folded shipped assembly can be assisted by the provision of one or more floats attached to a part or parts of the wing frames that move upwardly on unfolding of the wing frame/s.

[0027] Some embodiments of the invention will now be described, by way of example only, with reference to the accompanying drawings in which:

Figure 1 is a side elevation of a first sacrificial anode assembly in accordance with the invention, and shown with the wing frames in an extended condition;

Figure 2 is a an end elevation of the assembly of Figure 1, and showing outriggers in an extended condition;

Figure 3 is a plan view of the assembly of Figure 1 but showing the wing frames in a folded condition;

Figure 4 is an end view of the folded assembly of Figure 3, and with the outriggers contracted;

Figure 5 is a side elevation of the base frame of the assembly of Figure 1;

Figure 6 is a plan view of the base frame of the

assembly of Figure 1;

Figures 7 and 8 are end views looking from the right and left respectively in Figure 5;

Figure 9 is a plan view of a second sacrificial anode assembly in accordance with the invention and shown with the four wing frames in an extended condition;

Figure 10 is an end view of the assembly deployed as in Figure 9;

Figure 11 is a longitudinal vertical cross-section of the deployed second assembly taken on the line 11-11 of Figure 9;

Figure 12 is an end view of the assembly of Figure 9 showing the wing frames in a folded condition as shipped;

Figure 13 is a longitudinal cross-section on the line 13-13 of Figure 12 of the folded assembly as shipped;

Figures 14 to 18 are views of a third assembly in accordance with the invention and which is similar to the embodiment of Figures 9 to 12 but in which the anodes are more widely spaced-apart in the vertical direction when deployed as in Figures 15 and 16, the views of Figures 14 to 18 corresponding respectively to the views of Figures 9 to 13; and

Figure 19 is a schematic hydraulic circuit diagram.

[0028] Referring to Figures 1 and 2 these show a first configuration of a sacrificial anode assembly 1 in the form of an oblong-rectangular main frame 2 in the form of a skid to which is pivotally attached a pair of wing frames 3, 4. The main frame is conveniently a commercially available steel freight flat, of dimensions 12192mm x 2438mm in this example, but other skid dimensions are possible.

[0029] Hinge brackets welded to the skid provide pivotal attachment points of the wing frames 3, 4 at opposite ends of the main frame 2.

[0030] Telescopic hydraulic extendable outriggers 6 are shown in Figure 2 extending horizontally from outrigger housings 7 welded to the opposite ends of the skid. The outriggers carry feet 8 at their outer ends to engage the seabed. The outriggers are powered by a hydraulic accumulator tank, not shown, mounted on the skid, and triggered by a ground engageable trigger mounted on the skid. A pressure sensitive safety valve prevents charging of the outriggers until the pressure corresponds to a predetermined depth of immersion. An arming mechanism, in the form of a manual valve, enables the accumulator to be connected to the hydraulic circuit just prior to immersion of the assembly.

[0031] The telescopic tubes of each outrigger 6 are provided with respective drop catches, not shown, arranged to lock the tubes of the respective outrigger one to another in the extended condition of the outriggers.

[0032] The wing frames, when displayed in use of the assembly 1, are supported by respective struts 9, 10 which are each pivotally connected at their lower ends at 10', 9' respectively to brackets 12 welded to the main frame 2, and are pivoted at their mid-points 9", 10". Tubular latches, not shown, slide under gravity down over the mid-point pivots, once the struts have straightened, to hold the struts 9, 10 straight.

[0033] Elongate anode bars 13 of known polygonal transverse cross-section, seen best in Figures 7 and 8, are attached in known manner by curved stand-off supports 14 to the opposite upper margins of the main frame 2. Such anode bars 13 and supports 14 are often termed of 'cow-horn' type, and the anode bars are conveniently cast onto a continuous cow-horn shape of length of steel round bar.

[0034] The wing frames 3, 4 each comprise straight lengths of round alloy bars 15 interconnected by steel round bar lengths 16. This configuration of alloy bars 15 keeps the bars spaced-apart from one another, and also spaced from the bars 13 on the main frame 2.

[0035] As shown in Figures 3 and 4, the wing frames are initially in a folded condition in which they lie within the plan area of the main frame and substantially parallel thereto so as to provide a compact assembly for transportation and lowering to the seabed. The wing frames 3, 4 are preferably provided with buoyancy means, not shown, to urge them towards their upright position. The frame assembly is provided with leads 50 electrically connected to the pivoted ends of the wing frames 3, 4 at 51 and carrying a roving contact 52 for attachment in use to the structure being protected.

[0036] Figures 9 to 13 show a second assembly configuration in which four wing frames 20, 21, 22, 23 are pivotally attached to the respective sides of the main frame 2. The main frame 2 can be a commercially available freight flat as in the embodiment of Figures 1 to 8. In the Figures 9 to 13 construction of the main frame 2 is provided with an array of cow-horn shaped anode units arranged in three groups 25, 26, 27 of longitudinally extending anodes, and in addition there are four transversely extending bars 28, 29, 30, 31.

[0037] As shown in Figures 10 and 11 the bars in each group 25, 26, 27 have stand-off supports of two different heights, so that alternate elongate bars in each group are higher and lower than one another, in order to help space the alloy bars apart.

[0038] The wing frames 20, 21, 22, 23 each comprise a series of elongate alloy bars connected as a rectangular cage by steel rods 30. As shown in Figures 10 and 11, the alloy bars are in two horizontal layers. For example, in Figure 10 bar 35 is positioned above bar 30, and in the same vertical plane.

[0039] The wing frames in their extended, deployed

condition shown are supported by legs 36 which stand on the seabed, and the anode bars 30, 35, 37 for example, of the wing frames lie in planes parallel to the plane of the main frame.

[0040] As shown in Figures 12 and 13, the wing frames are permitted to be put in a folded condition for shipping, and to enable easy lowering of the assembly to the seabed.

[0041] In order to enable the larger wing frames 20, 22 to be pivoted through 90° to the folded condition, the positioning of the groups of bars 25, 26, 27 and that of bars 28, 29, 30 and 31, is chosen to define un-obscured strip-like areas on top of the main frame 40, 41, 42 and 43 to accommodate anodes on the wing frames 20, 22.

[0042] In the construction of Figures 14 to 18 the stand-off arm supports of the alternate anode bars 45 attached to the main frame are taller when deployed than the corresponding stand-offs in Figures 10, 11 in order to space the anodes 46 more from one another in the vertical direction. Similarly the upper 48 and lower 47 bars of the wing frames are spaced apart more in the vertical direction when deployed.

[0043] The stand-off arm supports 45 mounted on the skid 2, and those stand-off arm supports 60 mounted on the wing frames, are telescopic hydraulic units with respective latches to hold them in the extended raised, deployed condition, shown in Figures 15 and 16.

[0044] The unfolding of the assembly of Figures 14 to 18, and the extending of the hydraulic units of supports 45 and 60, is preferably accomplished using a hydraulic accumulator tank, not shown, in Figures 14 to 18, provided on the skid 2. Figure 19 schematically shows the hydraulic circuit. Activation of the hydraulic units 45, 60 is by operation of a probe 61 mounted on the skid 2 and arranged to be operated by contact with the sea bed, when the assembly is lowered to the sea bed. In order to avoid premature actuation of the hydraulic units by wave action on the probe during immersion of the assembly, a pressure sensor 62 is preferably provided, responsive to the water pressure to initiate charging of the hydraulic units, until a predetermined depth of the assembly has been reached sufficient to enable the hydraulic accumulators 63.

[0045] The embodiments of Figures 1 to 19 have been designed primarily for use as sacrificial anode assemblies, but modifications of those embodiments may instead be used as impressed current anode assemblies, the individual anodes of the anode assemblies being fed with electrical current from a suitable supply on the structure, as is usual. The modifications required are to electrically isolate the anodes from the main frame 2 by the incorporation of suitable insulators in their mountings, such as by the use of tubular plastics anode supports.

[0046] The choice of alloys for the anode is dependent on the prevailing water composition. Aluminium alloy is usually employed in sea water.

Claims

1. A corrosion inhibiting anode assembly (1) for use with an underwater structure comprises a generally planar main frame (2) for lying on the bed of a body of water, a plurality of spaced-apart elongate anode bars (13) fixedly secured by respective stand-off supports (14) to the main frame and extending in one or more planes that are generally parallel to that of the main frame (2), and at least one wing frame (3, 4, 20, 21, 22, 23) pivotally attached to the main frame (2), the wing frame (3, 4) comprising a plurality of spaced-apart elongate anode bars (13), and being capable of being pivoted from a folded condition to an extended condition in which the anode bars (13) of the wing frame (3, 4, 20 - 23) are generally more remote from those of the main frame (1) than in said folded condition, and wing frame supports (9, 10) connected to the wing frame (3, 4, 20 - 23) and arranged to support the wing frame (3, 4, 20 - 23) in said extended condition.
2. The anode assembly of claim 1 wherein the main frame (2) is of oblong-rectangular shape in plan, and first and second wing frames (3, 4) are pivotally attached to opposite ends of the main frame (2), the wing frames (3, 4) being dimensioned such that in said folded condition, the wing frames (3, 4) lie substantially within the plan area of the main frame (2).
3. The anode assembly of claim 2 wherein the widths of the wing frames (3, 4) are narrower than the transverse spacing of the anode bars (13) carried by the longitudinal main frame members to enable the folded wing frames (3, 4) to lie between the anode bars (13) of the main frame (2) as viewed in plan, thereby to help facilitate a relatively compact assembly for transportation.
4. The anode assembly of claim 2 or claim 3 wherein the wing frame supports (9, 10) are arranged to support the extended wing frames (3, 4) substantially perpendicular to the plane of the main frame (2), namely, substantially vertical when the main frame (2) is resting on a horizontal bed.
5. The anode assembly of claim 4 wherein the wing frame supports (9, 10) are in the form of respective struts extending at an acute angle from a pivot point on the main frame (2) to a pivot point on the respective frame (3, 4), the struts (9, 10) having a hinge connection at their midpoints to enable the strut (9, 10) to be folded when the wing frame (3, 4) is in the folded condition.
6. The anode assembly of claim 5 wherein the struts (9, 10) are provided with latches associated with the hinges that engage to lock the strut (9, 10) permanently when the wing frame (3, 4) reaches its fully extended condition.
7. The anode assembly of claim 1 wherein the main frame (2) is of oblong-rectangular outline in plan and at least one wing frame (20, 21, 22, 23) is pivotally connected thereto about an axis extending along one margin of the main frame (2), the wing frame (20 - 23) in said extended condition extending outwardly from the main frame (2) and generally in a plane parallel to or coincident with the plane of the main frame (2).
8. The anode assembly of claim 7 wherein the wing frame supports (9, 10) comprise feet which engage with the bed when the wing frame (20 - 23) is in the extended condition, and the feet may be provided on short support legs extending downwardly from the outer end of the wing frame (20 - 23).
9. The anode assembly of claim 7 or claim 8 wherein a plurality of such wing frame assemblies are preferably provided, which open out from the respective margins of the main frame (2).
10. The anode assembly of any one of the preceding claims wherein the wing frames (20 - 23) preferably each comprise upper and lower elongate anode bars spaced apart vertically, as seen with the wing frame (20 - 23) in an extended condition, and the anode bars of the wing frames (20 - 23) are so positioned on the wing frames (20 - 23) as to be received between anode assemblies (1) that are directly supported on the main frame (2), when the wing frame (20 - 23) is positioned in said folded condition.
11. The anode assembly of any one of the preceding claims wherein the horizontal dimension of the wing frame (20 - 23), going from the pivotal axis of the wing to the tip of the wing, is substantially equal to the maximum height, relative to the base of the main frame (2), of the anodes on the main frame.
12. The anode assembly of any one of the preceding claims wherein one or more elongate components of the assembly are formed as a telescopic hydraulic unit (45, 60) that can be extended when the assembly has been immersed in water, preferably as the assembly nears or reaches its deployed position on the bed of the sea or body of water.
13. The anode assembly of claim 12 wherein the hydraulic unit/s (45, 60) are provided with latches that hold the extended hydraulic unit (45, 60), once charged, in a substantially extended condition.
14. The anode assembly of claim 12 or claim 13 wherein a pre-charged hydraulic accumulator (63) is mount-

ed on one of the frames, preferably on the main frame, and is connected to the hydraulic unit/s (45, 60).

15. The anode assembly of claim 14 wherein an actuation valve is provided between the accumulator (63) and the hydraulic unit/s (45, 60), the valve being arranged to be opened when it is desired to extend the hydraulic unit/s (45, 60). 5
- 10
16. The anode assembly of claim 15 wherein the actuation valve is a normally closed probe-operated valve, the probe being positioned to be operated by contact with the sea bed/bed of water when the main frame is deposited onto the bed. 15
17. The anode assembly of claim 16 wherein a normally closed water-pressure operated valve is provided in series with the probe-operated valve, the water pressure operated valve being configured to open when the assembly reaches a predetermined depth of water, thereby reconnecting the supply from the hydraulic accumulator (63) to enable charging of the hydraulic units (45, 60) when the probe-operated valve is opened. 20 25
18. The anode assembly of any one of the preceding claims comprising one or more floats attached to a part or parts of the wing frames that move upwardly on unfolding of the wing frame/s. 30

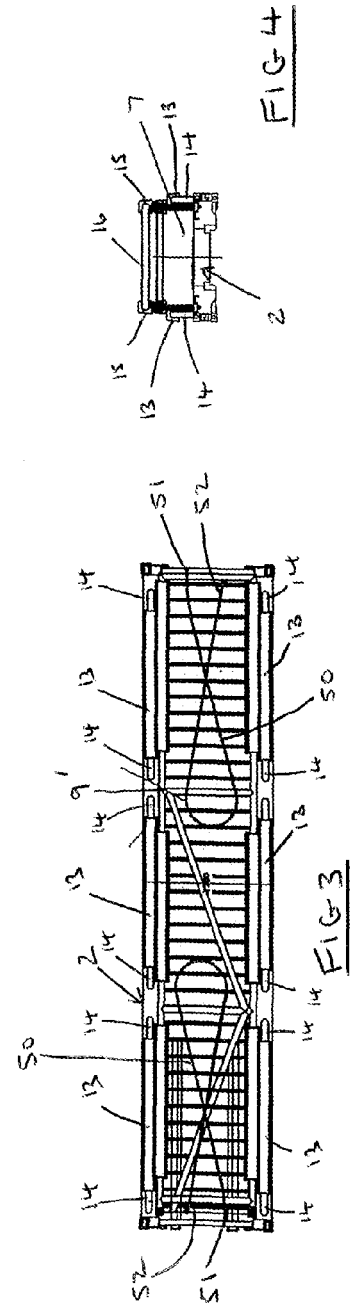
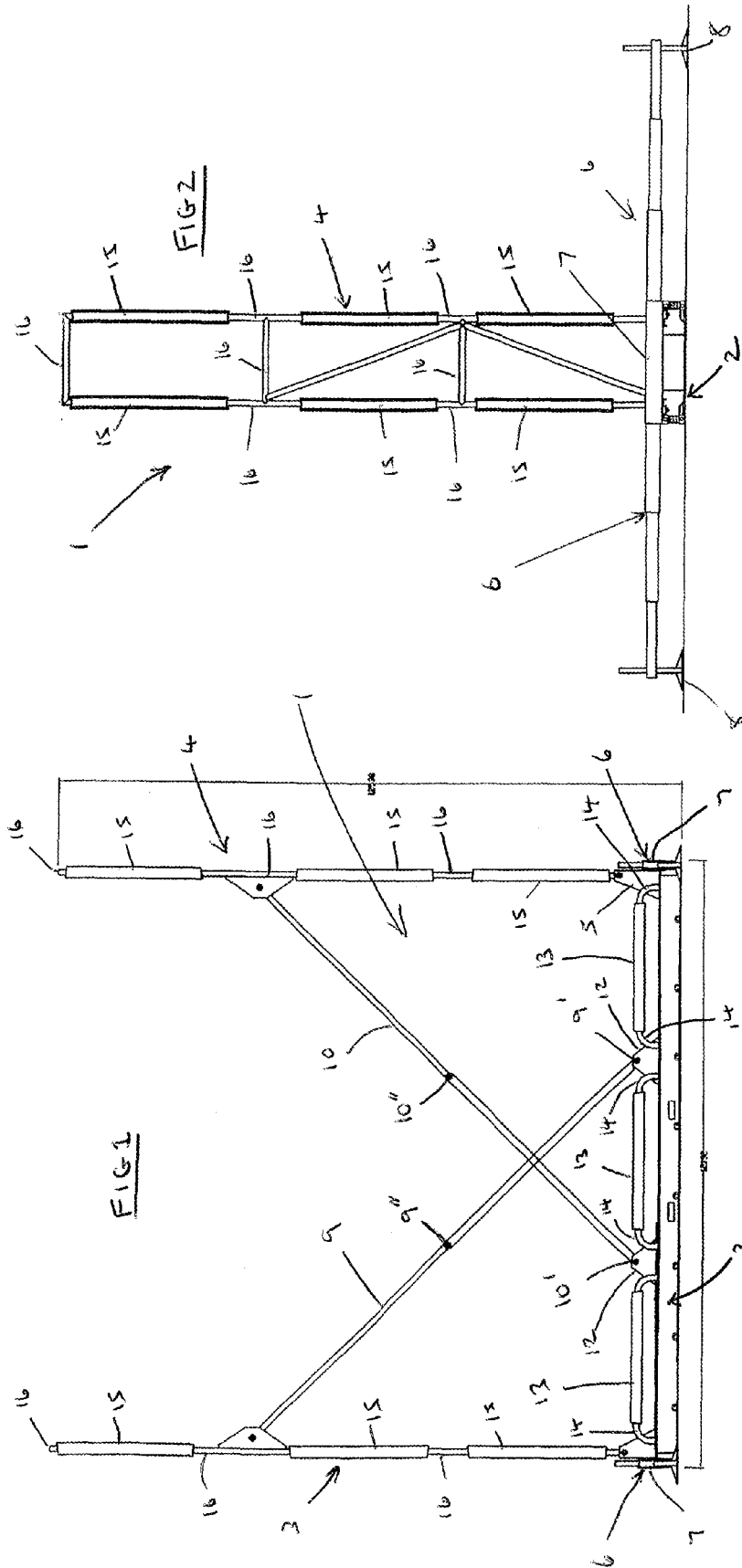
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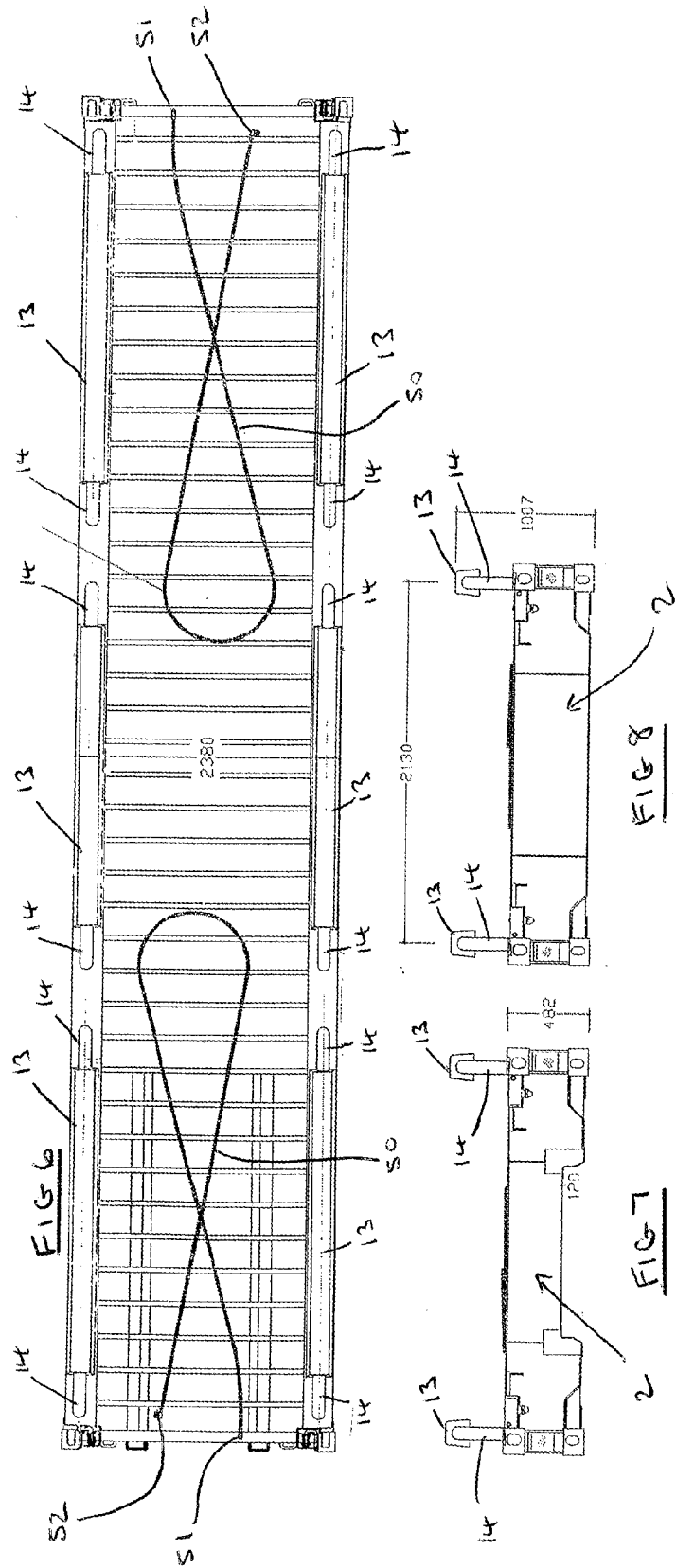
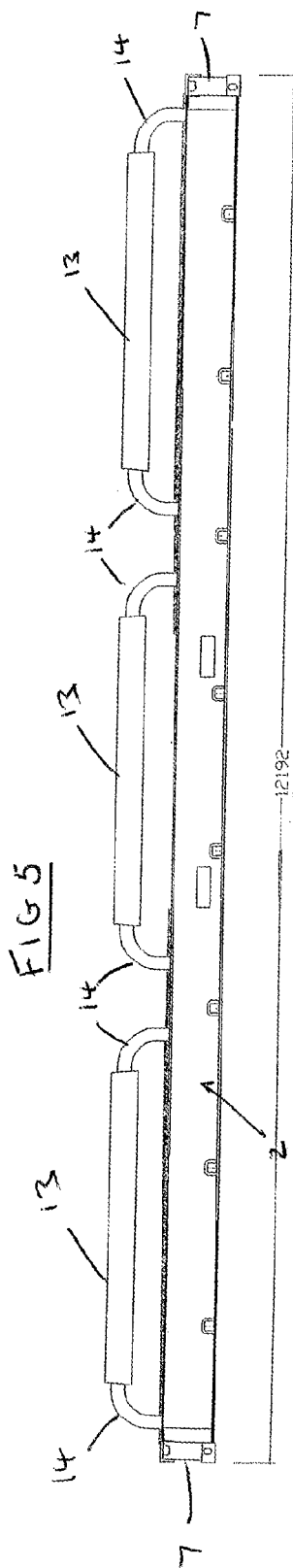
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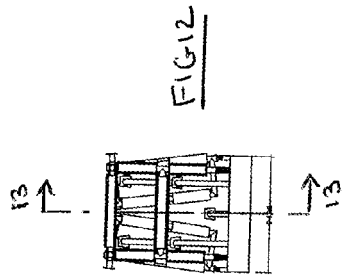


FIG 12

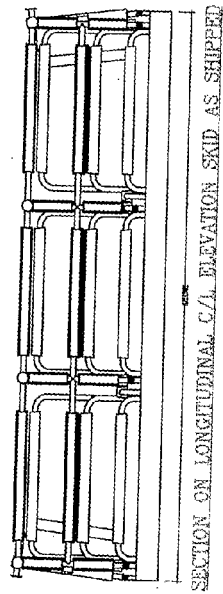


FIG 13

SECTION ON LONGITUDINAL C/A. ELEVATION SKID AS SHIPPED

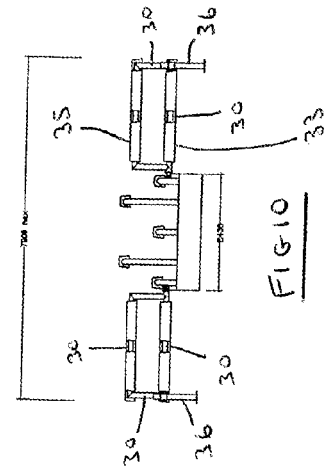


FIG 10

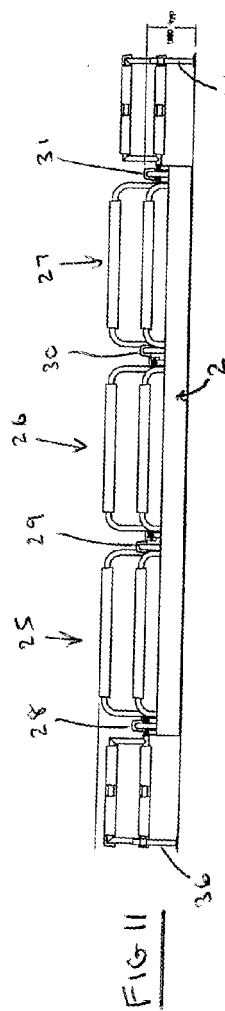


FIG 11

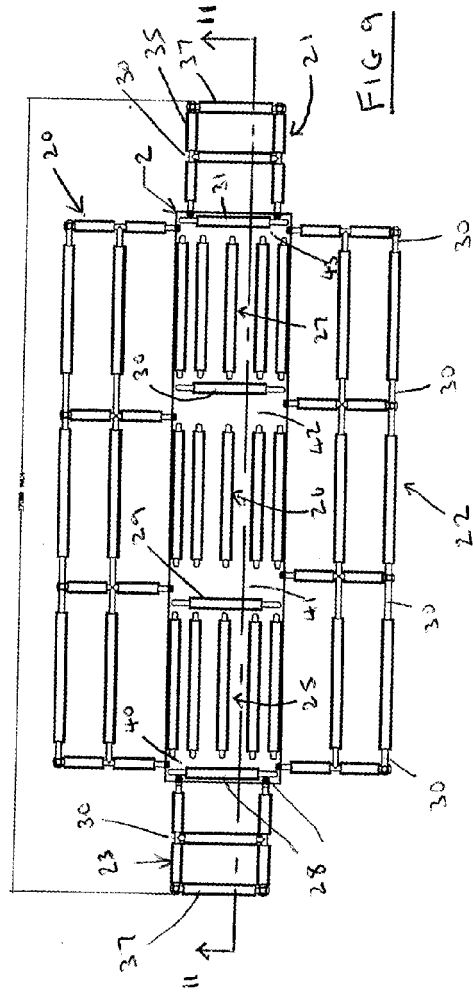


FIG 9

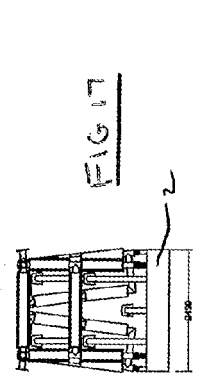


FIG 17

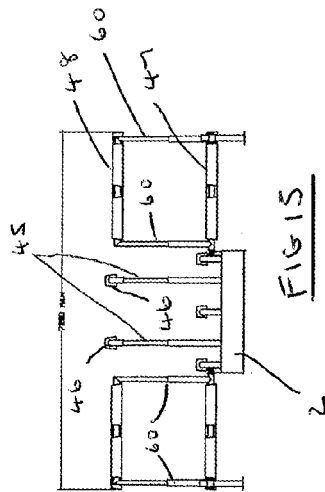


FIG 15

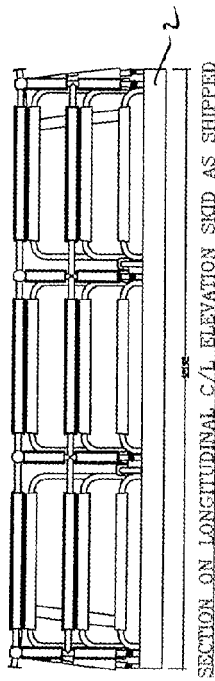


FIG 18

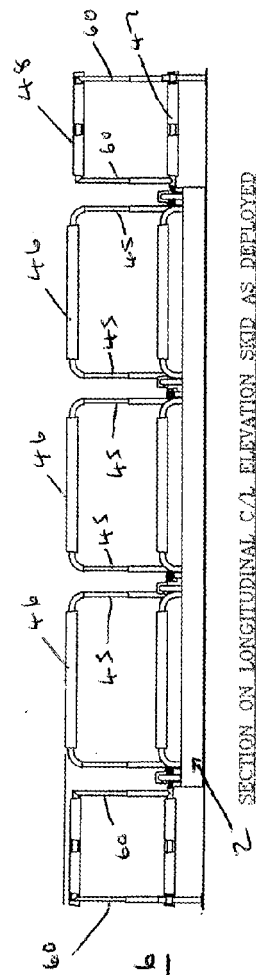


FIG 16

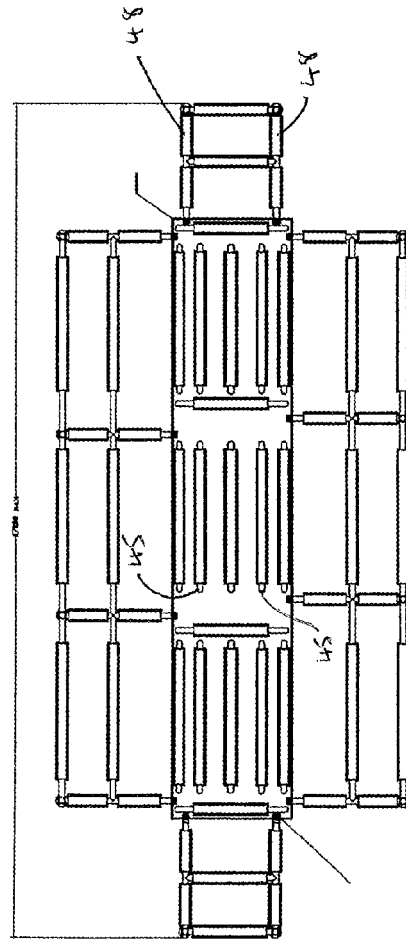


FIG 14

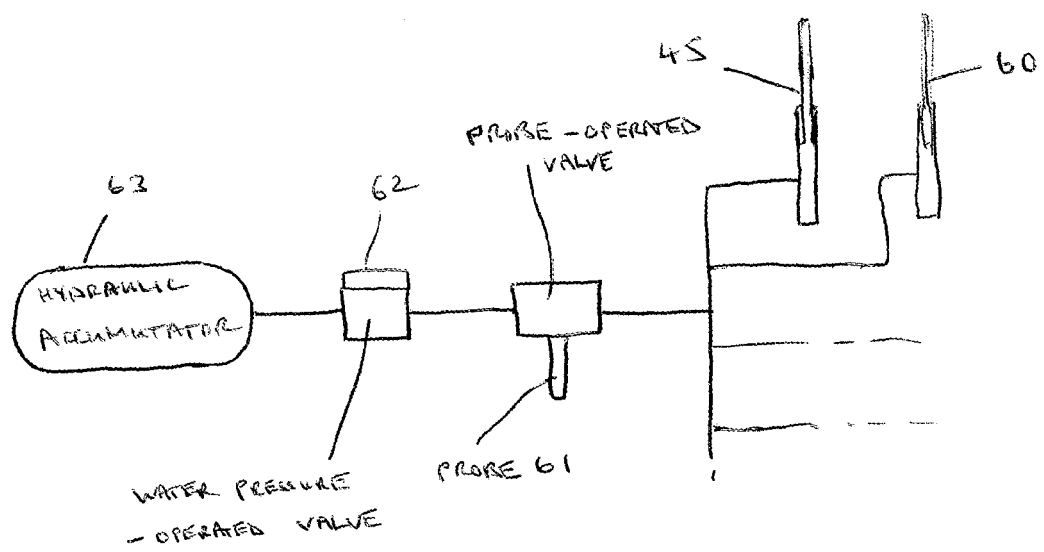


FIG 19



EUROPEAN SEARCH REPORT

Application Number
EP 10 15 9836

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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			TECHNICAL FIELDS SEARCHED (IPC)
			E02B C23F
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 31 August 2010	Examiner Geisenhofer, Michael
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EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 10 15 9836

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31-08-2010

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