

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
25 January 2007 (25.01.2007)

PCT

(10) International Publication Number
WO 2007/010179 A1

(51) International Patent Classification:
E21B 47/01 (2006.01)

(21) International Application Number:
PCT/GB2006/002336

(22) International Filing Date: 26 June 2006 (26.06.2006)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
0514550.3 15 July 2005 (15.07.2005) GB

(71) Applicant (for all designated States except US): **VETCO GRAY CONTROLS LIMITED** [GB/GB]; 2 High Street, Nailsea, Bristol BS48 1BS (GB).

(72) Inventor; and

(75) Inventor/Applicant (for US only): **WEBSTER, David** [GB/GB]; Prospect Cottage, Welsh Newton Common, Monmouth NP25 5RT (GB).

(74) Agent: **NEWSTEAD, Michael, John**; Page Hargrave, Southgate, Whitefriars, Lewins Mead, Bristol BS1 2NT (GB).

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LV, LY, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

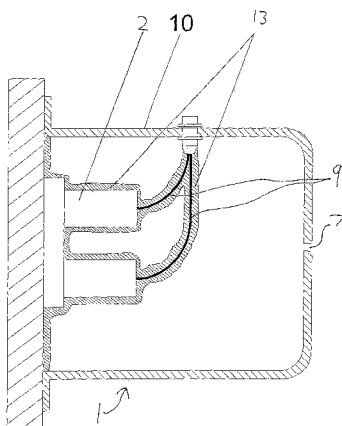
(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

- with international search report
- with amended claims

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: UNDERWATER MODULE



(57) Abstract: A module for underwater installation comprises a component and a waterproof covering applied to the component, to protect the component from the water in use.

WO 2007/010179 A1

Underwater Module

This invention relates to a module for underwater installation and a method for protecting components for underwater use.

Background

Underwater installations, such as subsea hydrocarbon wells, may require reliable functioning of various components in a harsh environment, for example on the seabed subject to high ambient pressures and potentially damaging sea-water. Patent application GB0428001.2 describes a mini pod for use at such an installation which contains, as a minimum, electrically operated Directional Control Valves (DCVs) to provide hydraulic operation of hydraulic devices at a remote location, powered from a local hydraulic source. Such a mini pod is illustrated in Fig. 1 in sectioned view. Conventionally, such a mini pod houses the hydraulic components in a container which is typically filled with a contaminant-free dielectric fluid such as specified in British Standard 1148. The pressure of this fluid is equalised to the ambient water pressure by a flexible diaphragm interface between the fluid and the sea water. A mini pod 1 comprises hydraulic components such as directional control valves 2 which are housed within a housing 10. A cavity 3 surrounding the hydraulic components 1 is filled with dielectric fluid via a port 4. The pressure in the cavity is equalised by the sea water pressure in a cavity 6 via a diaphragm 5. The cavity 6 is vented to the sea at a vent 7. Particular attention has to be made to ensure a good seal at an interface connector 8, which may carry both electrical power and communications signals and hydraulic power. These may be carried from connector 8 to components 1 via lines 9. Likewise, the seal 11 between the pod casing and a base plate 12 has to be very reliable. Since the water pressure at the sea bed, where such modules are deployed, can be as high as 300 bar, the pressure equalisation system avoids the need for a heavy, rugged mini pod housing. However, the manufacture of a housing with its high reliability sealing and its pressure equalising system is expensive. It is an aim of the

- 2 -

present invention to avoid this substantial expense by dispensing with the need of the housing sealing and its pressure equalising system.

5 In accordance with a first aspect of the invention there is provided a module for underwater installation, comprising a component and a waterproof covering applied to the component, to protect the component from the water in use.

The covering is preferably coated onto the component. The covering may comprise a silicone-based material.

10

Advantageously, the module may comprise a plurality of components.

The module may comprise a hydraulic and / or electrical component.

15 Preferably, the module comprises a line connected to the component. The line may be covered with the waterproof covering.

20 Advantageously, the module comprises a housing which contains the component, the housing having means for allowing fluid communication between the interior and exterior of said housing.

In accordance with a second aspect of the present invention, there is provided a subsea installation comprising a such module.

25 In accordance with a third aspect of the present invention, there is provided a method of protecting a component for underwater use, comprising the step of providing a waterproof covering for the component.

The covering may preferable comprise a conformal coating.

30

The covered component may be contained within a housing.

- 3 -

The invention will now be described, by way of example, with reference to the accompanying drawings, in which:-

Figure 1 shows a known module for subsea use in sectional view; and

5 Figure 2 shows, in sectional view, a module suitable for underwater use in accordance with the present invention.

As far as possible, the numbering scheme used in Fig. 1 is maintained in Fig. 2. Fig. 2 shows a module 1, which in this embodiment is shown as a mini pod suitable for subsea
10 installation. The module 1 comprises hydraulic elements 2 such as directional control valves, which are contained within a housing 10. Also provided within the housing 10 are lines 9 for carrying hydraulic and / or electrical signals. In this embodiment, both the hydraulic elements 2 and lines 9 are coated with a waterproof conformal coat 13. Several
15 coats of the conformal coating i.e. layers, may be necessary to ensure elimination of pin holes and suchlike imperfections that may result from a single coating. The provision of this conformal coating removes the need for a pressure equalisation system as shown in Fig. 1, as sea water for example is able to enter the module 1 through gap 7, so that the internal module pressure is substantially equal to the external pressure. The conformal coating provides protection for the components and lines from the potentially damaging
20 sea water. The coating also helps to protect the components from damaging pressures.

It is important that the components are coated with a conformal coating that is inert both to the components themselves and the sea water. Silicone-based coatings, such as those manufactured by Dow Corning for example, are considered likely to be suitable. Such
25 coatings are resiliently flexible, which have an advantage that they may withstand differential expansions caused by temperature and / or pressure changes. However, in certain environments it may be preferable to use other materials, which may for example be rigid or soft. Whilst it is acknowledged that the use of conformal coatings to protect components is common practice in various fields of engineering, the technique has not
30 been applied to sub sea well extraction system modules. Use of the technique simplifies the assembly of such modules and provides both electrical insulation resistance and

- 4 -

pressure compensation. It should be noted that the technique can be applied to any sub sea units which are not, in themselves, sensitive to high pressures. Currently the technique is not suitable for electronic assemblies since in general the components are unable to withstand pressures of more than 20.7 bar. Such assemblies are traditionally housed in nitrogen in a high pressure resistant housing. However, in the future, digital electronic design may well eliminate pressure sensitive components such as capacitors thus enabling the technique to be applied to electronic modules as well. Hydraulic assemblies are currently particularly suitable for this invention since the components are generally resistant to the high pressures involved.

The cost of manufacture of a mini pod housing, without seals, a pressure equalising diaphragm, dielectric fluid and its filling port, is much reduced as a result of this invention. Furthermore, the costs involved in the fluid filling process are eliminated and the testing is much simplified. The reliability is much improved, since there are no conventional seals or diaphragms to fail.

Although the invention has been described with reference to one particular embodiment, many variations are possible within the scope of the claims, which would be apparent to those skilled in the art. For example, although the module shown comprises an outer housing, this is not strictly required, providing that the conformal coating is strong enough to provide protection against prevailing water currents, and that any connections, such as connector 8, are provided elsewhere in the apparatus, for example at baseplate 12.

Although a silicone-based conformal coating may be used, any covering which provides adequate protection for components in the installation environment may be used. It should be noted of course that the "harshness" of the environment will depend on various factors, including water depth of installation, strength of current, whether the installation is located in fresh or salt water etc.

- 5 -

CLAIMS

1. A module for underwater installation, comprising a component and a waterproof covering applied to the component, to protect the component from the water in use.
- 5 2. A module according to Claim 1, wherein the covering is coated onto the component.
3. A module according to Claim 2, wherein the covering comprises a silicone-based material.
- 10 4. A module according to any preceding claim, comprising a plurality of components.
- 15 5. A module according to any preceding claim, comprising a hydraulic and / or electrical component.
6. A module according to any preceding claim, comprising a line connected to the component.
- 20 7. A module according to Claim 6, wherein the line is covered with the waterproof covering.
8. A module according to any preceding claim, comprising a housing which contains the component, the housing having means for allowing fluid communication between the interior and exterior of said housing.
- 25 9. A subsea installation comprising a module according to any preceding claim.
- 30 10. A method of protecting a component for underwater use, comprising the step of providing a waterproof covering for the component.

- 6 -

11. A method according to Claim 10, wherein the covering comprises a conformal coating.

5 12. A method according to either of Claims 10 and 11, comprising the step of containing the covered component within a housing.

13. A module substantially as herein described with reference to Fig. 2.

10 14. A method as herein described with reference to Fig. 2.

AMENDED CLAIMS
received by the International Bureau on 04 December 2006
(04.12.06)

CLAIMS

1. A module for underwater installation, comprising a component and a waterproof covering applied to the component, to protect the component from the water in use, the module further comprising a housing which contains the component, the housing having means for allowing fluid communication between the interior and exterior of said housing. .
2. A module according to Claim 1, wherein the covering is coated onto the component.
3. A module according to Claim 2, wherein the covering comprises a silicone-based material.
4. A module according to any preceding claim, comprising a plurality of such components.
5. A module according to any preceding claim, wherein the or each component is a hydraulic and/or electrical component.
6. A module according to any preceding claim, comprising a line connected to the or each component.
7. A module according to Claim 6, wherein the line is covered with the waterproof covering.
8. A subsea installation comprising a module according to any preceding claim.
9. A method of protecting a component for underwater use, comprising the step of providing a waterproof covering for the component and containing the covered

component within a housing, the housing having means for allowing fluid communication between the interior and the exterior of the housing.

10. A method according to Claim 9, wherein the covering comprises a conformal
5 coating.

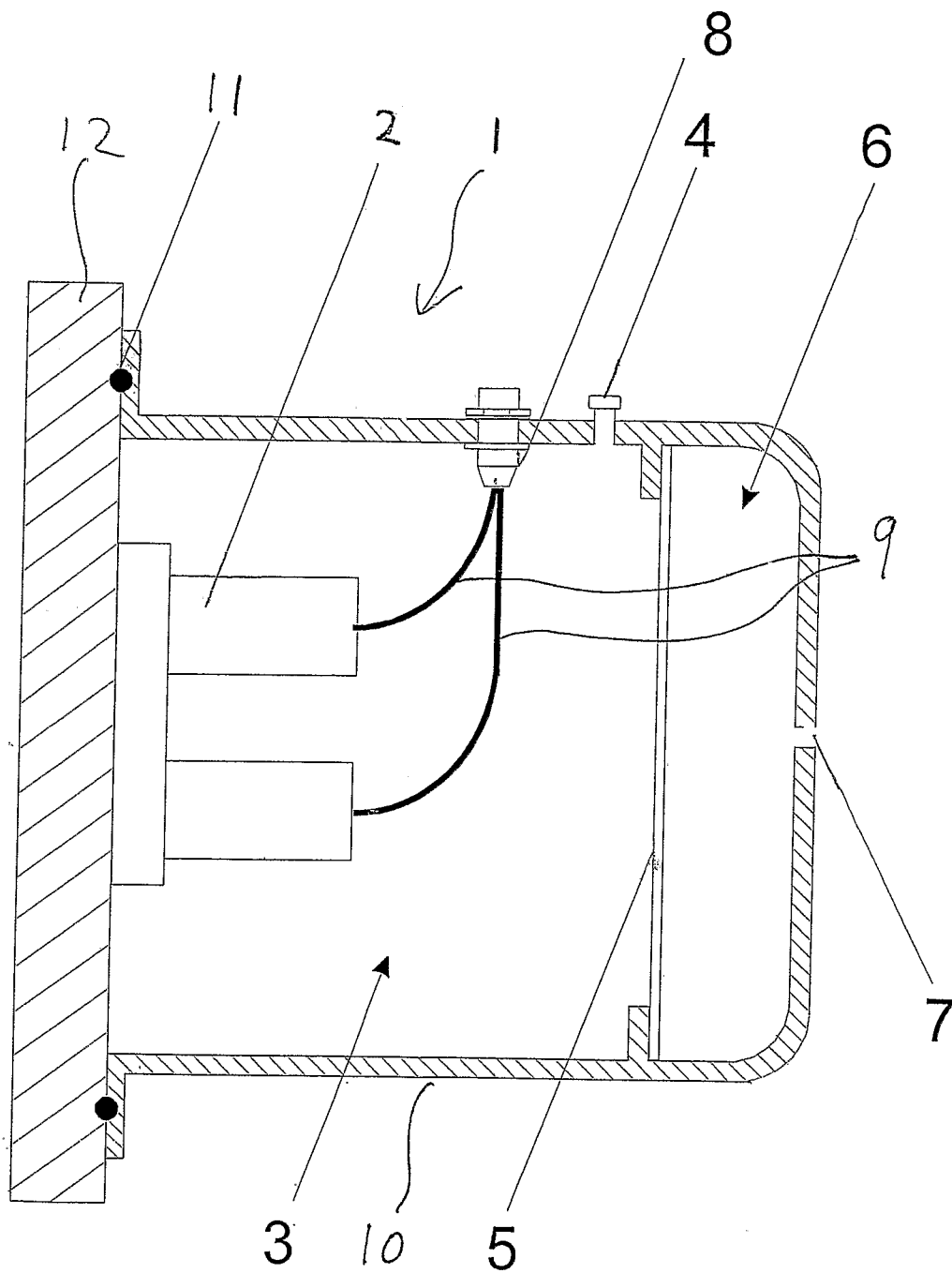


Fig 1 - Prior Art

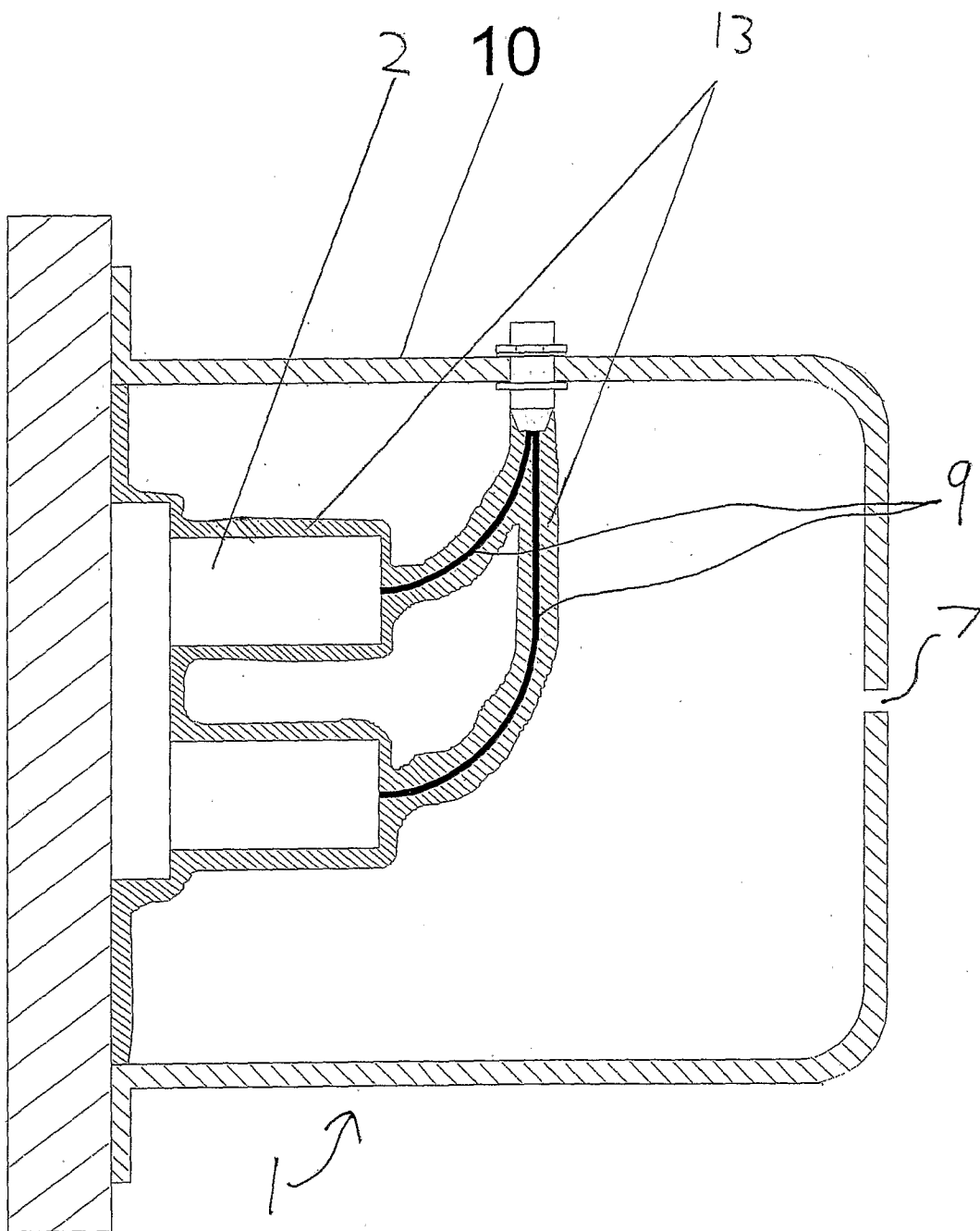


Fig 2

INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2006/002336

A. CLASSIFICATION OF SUBJECT MATTER INV. E21B47/01		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED		
Minimum documentation searched (classification system followed by classification symbols) E21B		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practical, search terms used) EPO-Internal		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 3 780 243 A (KOOMEY P, US ET AL) 18 December 1973 (1973-12-18)	1, 4-7, 9-11
Y	column 3, lines 16-35; figure 2 -----	8, 12
Y	WO 99/20872 A (OVERFIELD, TIMOTHY, MARK; CUMMING, MICHAEL) 29 April 1999 (1999-04-29) page 8, lines 10-23 page 11, lines 10-14; figure 3 -----	8, 12
X	US 3 339 632 A (LEWIS GEORGE E) 5 September 1967 (1967-09-05) column 4, lines 63-42; figure 5 -----	1-7, 9-11
X	US 3 377 549 A (NEWMAN JAMES L ET AL) 9 April 1968 (1968-04-09) column 5, lines 16-34; figure 6 ----- -/--	1, 4, 5, 9, 10
☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.		
* Special categories of cited documents :		
A document defining the general state of the art which is not considered to be of particular relevance *E* earlier document but published on or after the international filing date *L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) *O* document referring to an oral disclosure, use, exhibition or other means *P* document published prior to the international filing date but later than the priority date claimed *T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention *X* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone *Y* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art. *&* document member of the same patent family		
Date of the actual completion of the international search 18 September 2006		Date of mailing of the international search report 04/10/2006
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016		Authorized officer BELLINGACCI, F

INTERNATIONAL SEARCH REPORT

International application No

PCT/GB2006/002336

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 310 286 A (GILBERT ET AL) 10 May 1994 (1994-05-10) column 4, lines 48-52 -----	1,8,10
A	US 5 037 242 A (NILL ET AL) 6 August 1991 (1991-08-06) column 1, lines 57-60 -----	

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/GB2006/002336

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
US 3780243	A	18-12-1973	CA 981351 A1	06-01-1976
			DE 2347744 A1	18-04-1974
			FR 2203184 A1	10-05-1974
			GB 1436210 A	19-05-1976
			JP 49093889 A	06-09-1974
			NL 7314052 A	16-04-1974
			SE 394230 B	13-06-1977
WO 9920872	A	29-04-1999	AU 9175398 A	10-05-1999
			EP 1023523 A1	02-08-2000
			NO 20001866 A	15-06-2000
US 3339632	A	05-09-1967	NONE	
US 3377549	A	09-04-1968	NONE	
US 5310286	A	10-05-1994	NONE	
US 5037242	A	06-08-1991	NONE	