Title: POWER SUPPLY TO AND CONTROL OF MULTIPLE SUBSEA ELECTRIC ACTUATORS

Abstract: An assembly of subsea equipment (1) and a plurality of subsea devices (2) each of which is individually mountable on and separable from the subsea equipment wherein each device includes a respective stab connector (4) for establishing electrical connection with the equipment and further has a respective terminal connector (5) for a jumper lead, each device having at least dual redundancy whereby connection through the respective jumper terminal can substitute for the connection though the respective stab connector.
POWER SUPPLY TO AND CONTROL OF MULTIPLE SUBSEA ELECTRIC ACTUATORS

Field of the invention

This invention concerns the electrical connection of subsea equipment which is retrievable to subsea structures such as trees and manifolds.

Introduction

It is now commonplace to provide various items of subsea equipment in the form of sealed units which can be individually retrieved from the main structure, such as a manifold, tree or other device with which it cooperates in use. The facility is particularly useful for such items as electrical actuators for valves and/or power supply units, which receive electrical power in one form (such as direct current at a particular voltage) and convert the electrical power into a form and/or voltage level suitable for the main structure or device.

Retrievable subsea equipment with electrical connections is typically connected by means of one of two techniques. The equipment may have 'stab' connections that mate with connectors on a mounting base during installation. Alternatively the equipment may have 'jumper' or 'flying' leads that have a connector at one end or both ends. These connections are usually made up after the equipment has been properly located in position.

Stab-type connections allow mating to be completed as part of the installation of the item on the main equipment. Wiring and cabling can be organised and arrangement to avoid danger of damage during the installation if the item, which often has to be performed by a ROV. However, stab connections often require special tooling to ensure that sufficient force is applied to make the connections, especially of there are multiple connections that have to made at the same time. Moreover, if there be a failure in the associated cabling or a connector, it cannot easily be individually changed.

Jumper connections allow jumpers that fail (typically owing to the ingress of water) to be replaced without the need to retrieve the equipment. If a connector on the retrievable item fails, the item may be retrieved and changed. However, where many
connections are required the handling of them by a ROV and the organisation of the jumper may well become difficult or complex.

Summary

The present invention concerns the use of both type of connection for retrievable equipment, such that the stab connections and the jumper connections provide dual redundancy. The invention is applicable to retrievable electrical actuators but has utility in relation to other retrievable items.

The invention provides an assembly comprising subsea equipment and a plurality of subsea devices each comprising an electrical actuator, each of which devices is individually mountable on and separable from the subsea equipment and includes a respective stab connector for establishing electrical connection with the equipment and further has a respective terminal connector for a jumper lead, each device having at least dual redundancy whereby connection through the respective jumper terminal can substitute for the connection through the respective stab connector; and in which the assembly includes a control module which can communicate with each of the said devices by way of the stab connections thereof and includes a terminal for at least one jumper lead for establishing a substitute connection to at least one of the said devices.

The control module may be mountable on and separable from the subsea equipment and include a stab connector for establishing electrical connection with the equipment.

There is herein described a subsea device which is individually mountable on and separable from operationally associated fixed subsea equipment and includes a stab connector for establishing electrical connection with the equipment and further has a terminal connector for a jumper lead, the device having at least dual redundancy whereby connection through the jumper terminal can substitute for the connection though the stab connector.

There is also herein described an assembly comprising subsea equipment and a plurality of subsea devices each of which is individually mountable on and separable from the subsea equipment and includes a respective stab connector for establishing electrical connection with the equipment and further has a respective terminal connector for a jumper lead, each device having at least dual redundancy whereby
connection through the respective jumper terminal can substitute for the connection though the respective stab connector.

The assembly may include a control module which can communicate with each of the said devices by way of the stab connections thereof and includes a terminal for at least one jumper lead for establishing a substitute connection to at least one of the said devices.

The control module may be mountable on and separable from the subsea equipment and include a stab connector for establishing electrical connection with the equipment.

There follows a description of one embodiment of the invention by way of example and with reference to the accompanying drawings.

15 **Brief description of the drawings**

Figure 1 illustrates schematically a multiplicity of retrievable items in place on permanent equipment;

Figure 2 is similar to Figure 1 but further illustrates the use of jumper leads.

**Detailed description**

Figure 1 illustrates a one exemplary embodiment of the invention, and shows schematically a subsea structure 1 which is substantially permanent in the sense that it is intended to remain in situ for an extended period such as the lifetime of a subsea well. The structure 1 may be a wellhead, a tree, a control module, a manifold or other structure.

Attached to the structure 1 are retrievable devices. In this example they comprise a plurality of electric actuators 2 and a control module 3. In other dispositions at least one could be a power supply module. These devices can be individually removed and replaced. In the present example it is presumed that the module 3 can control each of the actuators 2 in accordance with commands directed to it from the structure 1.
Each of the items 2 and 3 is shown with a respective one of the stab connections 4 so that the module 3 is connected to circuits within the structure and so that each of the actuators 2 is connected for control by way of wiring or cabling within the fixed structure 1 to the control module 3.

Each of the actuators has dual redundancy so that it can be operated not only by way of the stab connection but alternatively by way of a respective jumper terminal 5. Actuators which are adaptable for such dual inputs are for example described in our international patent application No. PCT/GB2012/000225.

In normal circumstances each actuator is driven by way of its stab connection.

The module 3 has a jumper terminal 6. This may be a terminal for a single jumper lead but may be capable of use with a plurality of jumper leads. Thereby the module can be connected as shown in Figure 2 to one or more of the actuators in the event of, for example, failure of the stab connection or wiring associated with the respective actuator. The Figure shows jumper leads 7 from the module 3 to the second and fifth actuators.

The communication between the electronics control module and the actuators may be Ethernet or other suitable communication format.
Claims

1. An assembly comprising subsea equipment (1) and a plurality of subsea devices (2) each comprising an electrical actuator, each of which devices is individually mountable on and separable from the subsea equipment and includes a respective stab connector (4) for establishing electrical connection with the equipment and further has a respective terminal connector (5) for a jumper lead, each device having at least dual redundancy whereby connection through the respective jumper terminal can substitute for the connection through the respective stab connector; and in which the assembly includes a control module (3) which can communicate with each of the said devices by way of the stab connections thereof and includes a terminal (6) for at least one jumper lead for establishing a substitute connection to at least one of the said devices.

2. An assembly according to claim 1 in which the control module (3) is mountable on and separable from the subsea equipment (1) and includes a stab connector (4) for establishing electrical connection with the equipment (1).
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 H01R H02B

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 practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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<td>VIDAR STEN-HALVORSEN FMC TECHNOLOGIES ET AL: &quot;AI Electrical Subsea Tree System&quot;, OFFSHORE TECHNOLOGY CONFERENCE, no. 0TC 19547, 5 May 2008 (2008-05-05), pages 1-9, XP007920076, the whole document</td>
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Further documents are listed in the continuation of Box C. See patent family annex.

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Date of the actual completion of the international search: 26 August 2014
Date of mailing of the international search report: 02/09/2014

Authorized officer: Brassart, P
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