Title: POWER CONNECTION TO AND/OR CONTROL OF WELLHEAD TREES

Abstract: A hydrocarbon extraction system (1) comprises a host facility (2), a wellhead tree (3) and a retrievable electrical power connection/control module (4). The module has a load (12) and is connected to the host facility and the tree via first and second wet mateable connectors (6, 8) respectively. The module also has switchgears (14, 15) controlled by the load for isolating the load from the host facility or the tree. The host facility is arranged to provide power to the module, and to the tree via the module when the switchgears (14, 15) are closed, and the load (12) of the module is arranged to control the via one (15) of the closed switchgears.
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POWER CONNECTION TO AND/OR CONTROL OF WELLHEAD TREES

The present invention relates to power connection to and/or control of wellhead trees, such as those trees used in an underwater oil/gas field.

Conventional oil/gas fields have a plurality of wells which remove the oil/gas from reservoirs beneath the seabed. Each well has a wellhead tree on the seabed, the trees being linked to a host facility via flow lines. Each wellhead tree incorporates a number of main valves which are often powered by hydraulically operated actuators. Most of the valves are emergency shut-down (ESD) valves, although some may be variable positional flow control valves also known as chokes. The ESD valves are normally operated in either fully open or fully closed positions. It is usual for each valve to be operated in turn.

If the trees are in close proximity to the host facility and few in number, they may be powered and controlled directly from the host facility. However, trees are often not close to the host facility and consequently each tree is equipped with its own control pod which contains the means for actuating the valves in the trees. These valves may be actuated by electric solenoid actuators or by hydraulically operated control valve actuators where both these systems require physical communication with the host facility. The tree valves are generally hydraulic and the control pod will generally have hydraulic connections with these valves in order to operate them. Such hydraulic connections have cleanliness/maintenance issues. If a control pod fails as a result of a component within it failing, for example, or due to the failure of an associated wet mateable connector between the control pod and the tree, then the tree ceases to operate as required and consequently production is lost whilst replacement or repairs are carried out.

It is an object of the present invention to improve the arrangement for powering/controlling wellhead trees.

According to one aspect of the present invention there is provided a retrievable electrical power connection/control module for a hydrocarbon extraction system, comprising:
first disconnectable connection means adapted to connect the module to at least one remote wellhead tree and second disconnectable connection means adapted to connect the module to a remote host facility;

power/control means adapted to provide power/control operation of at least one said wellhead tree via the first disconnection means; and isolating means for isolating the power/control means from at least one said wellhead tree.

One such retrievable electrical power connection/control module is able to provide power/control operation of a number of remote trees instead of there being a control pod for each tree. The module can control all the functions of the tree.

The retrievable module permits high voltages (e.g. 11/24KV) to be used between the host facility and such a module with there being a benefit of low losses over long step-out distances. It also enables relatively low voltages (e.g. 400V) to be used between the retrievable module and the wellhead tree or trees to which it is connected and also avoids the problems of using hydraulics. By having the control means in the retrievable electrical power connection module, this avoids local control equipment on the trees resulting in simpler and more reliable trees.

The power/control means may be adapted to receive power and/or control signals from the host facility and supply it to said at least one tree.

It may be desirable for the isolating means to isolate the power/control means from the host facility. The isolating means may comprise at least one switchgear, the or each switchgear adapted to be controlled from the power/control means of the module.

The module may include voltage reduction means for receiving electrical power at a first voltage level from the host facility and supplying electrical power at a second lower voltage level to at least one said wellhead tree.

There may be provided a hydrocarbon extraction system comprising a host facility, at least one wellhead tree, at least one retrievable electrical power connection/control module as previously described, the or each module being electrically disconnectably connected to the host facility by its second
connection means and to the at least one tree by its first connection means, the host facility being adapted to provide power to the or each module and the power/control means of any module being adapted to provide power and/or control at least one said tree via said first connection means.

The system may include power isolating means for enabling the power/control means to supply power or negligible or no power to said at least one tree. Each module may have a module based part of the power isolating means, and each wellhead tree may have a tree based part of the power isolating means.

It may be desirable for the power/control means to include power means for supplying power from the module to said at least one tree. The power/control means may include control means for controlling the power means and/or the power isolating means.

The hydrocarbon extraction system may include a system module remote from the at least one tree including the retrievable electrical power connection/control module.

At least one module may be connected by the first disconnectable connection means to a plurality of trees in parallel. At least one tree may be connected to a plurality of modules in parallel.

It may be desirable for a plurality of modules to be connected in series with the host facility to form a circuit. At least one tree may be connected in series between two modules. A plurality of the trees connected in series may be connected between two modules. At least one tree may be connected in parallel to a plurality of modules.

Conveniently, the system may include a plurality of modules and module isolating means for isolating at least one module so that the isolated module or modules can be removed without cutting off the supply of electrical power to any of the trees or any of the remaining modules of the system. The host facility may have a host facility based part of the module isolating means. Each wellhead tree may have a tree based part of the module isolating means. Each
module may have a module based part of the module isolating means. Preferably, parts of the module isolating means adjacent to the module to be removed are adapted to isolate the module. The module isolating means may be adapted to isolate a plurality of serially adjacent modules. The module isolating means and/or the power isolating means may comprise switchgears.

According to another aspect of the present invention there is provided a hydrocarbon extraction system comprising:

a host facility for supplying electrical power;
at least one retrievable electrical power connection/control module;
at least one wellhead tree remote from the or each module; and
means for powering/controlling at least one said tree including means for transmitting the electrical power from the host facility via the module to at least one said tree and/or transmitting electrical control signals from the module to at least one said tree.

According to yet another aspect of the present invention there is provided a method of powering/controlling at least one wellhead tree in a hydrocarbon extraction system including the steps of supplying at least one said tree with electrical power and/or electrical control signals from a remote retrievable electrical power connection/control module.

The method may include the steps of:

(a) activating the module to supply negligible or no power to at least one said tree;
(b) activating power isolating means to enable the module to be able to supply power to at least one said tree; and
(c) activating the module to supply power from the module to at least one said tree.

The method may include the step of activating the power isolating means to isolate the module from at least one said tree before step (a).

There may be the additional step (d) after step (c) of activating the module to supply negligible or no power to at least one said tree, and the
additional step (e) of activating the power isolating means to isolate the module from at least one said tree.

Step (b) may include the step of activating a tree based part of the module isolating means before a module based part of the module isolating means. Step (e) may include the step of activating the module based part of the module isolating means before the tree based part of the module isolating means.

The various activating steps may be controlled by a control means in the retrievable module.

The power isolating means may be switches/relays which are operated at no or negligible power, which means that reliability issues regarding switching at high power are avoided.

The control may be effected without using pressurised fluid control signals.

Electrical power may be transmitted at a first voltage from a host facility to voltage reduction means and transmitted at a second lower voltage from the voltage reduction means to the tree, and electrical control signals may be transmitted from a control means in a retrievable module to the wellhead tree. Alternatively, electrical power at a first voltage and control signals may be transmitted from a host facility to voltage reduction means and electrical power at a second lower voltage and control signals from the voltage reduction means may be transmitted to the tree.

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

Figure 1 is a schematic diagram of a substantially underwater system including a retrievable module according to a first embodiment of the invention;

Figure 2 is a schematic circuit diagram of the substantially underwater system;

Figures 3 and 4 show a schematic diagram of a modified substantially underwater system in accordance with an aspect of the invention; and

Figures 5 to 9 show schematic diagrams of further modified substantially
underwater systems in accordance with further aspects of the invention; and

Figures 10 and 11 are modifications of Figure 2.

Referring to Figure 1 of the accompanying drawings, a substantially underwater system 1 is shown. A top side host facility 2 is connected to a wellhead tree 3 via a retrievable module 4 or control pod in a substantially autonomous system module on the seabed (not shown) remote from the tree. The host facility provides the source of power for both the retrievable module 4 and the tree, the module 4 forming part of an electrical power connection to the tree. The host facility 2 has a switchgear 5 which is connected to an underwater mateable connector 6 on one side of the module by an integrated power/control cable 7. The opposite side of the module 4 also has an underwater mateable connector 8 that is connected to an underwater mateable connector 9 on the wellhead tree 3 by another integrated power/control cable 10, the module mateable connectors 6,8 enabling the module to be retrieved. The tree 3 has a load 11 to which the tree connector 9 is connected.

The module 4 has a load 12 connected to an integrated power/control cable 13 which links the two connectors 6,8 of the module together. The load 12 is electrically isolatable from the mateable connectors 6 and 8 by first and second switchgears 14 and 15 respectively, each switchgear being controlled by the load 12. Accordingly, the first switchgear 14 connects the load with the host facility 2 and the second switchgear 15 connects it to the wellhead tree 3.

Each power/control cable or umbilical 7,13,10 comprises a three-phase power supply cable, each including three supply lines 7a,13a,10a;7b,13b,10b; 7c,13c,10c as illustrated in the simplified circuit diagram shown in Figure 2. The power supply line 7a,13a,10a forms a series connection from the host facility switchgear 5 to the tree load 11 through the module 4. The power supply line 7b,13b,10b also forms a series connection from the host facility switchgear 5 to the tree load 11 through the module 4 as does the power supply line 7c,13c,10c. The module load 12 is connected across the power supply lines 13a,13b,13c as shown. The host facility switchgear 5 and the module switchgears 14,15 effect the switching of all three power supply lines. The module also includes a transformer
16 for reducing high voltage input from the host facility 2, the transformer being across the power supply lines between the module's mateable connector for the host facility and the first switchgear 14.

The retrievable module 4 has a control pod which is divided into two compartments by means of a bulkhead. The two compartments house the control electronics, which forms part of the module load 12, and the switchgears 14,15 respectively. The control electronics controls the normal running of the module 4 and the connected wellhead tree 3 and the module load 12 is in communication with the host facility 2 from where it may, for example, be reprogrammed or be instructed to shut down the tree. The control pod is constructed as a pressure vessel and has penetrators for cables from outside the pod to connect to the control electronics and switchgear.

In normal use, the host facility switchgear 5 and the two module switchgears 14,15 are closed so that the module load 12 and the tree load 11 receive power from the host facility 2 and so that the module load is able to electrically control the wellhead tree 3 via the closed second switchgear 15.

Referring to Figure 3, a more complex substantially underwater system 20 is shown, the system being similar to the underwater system 1 described in Figures 1 and 2 except where noted. The system 20 has first and second substantially autonomous seabed modules 21,22, the load 23,24 of each module being connected to separate switchgears 25,26 of a host facility 27. The system 20 also has first and second wellhead trees 28,29, the load 23,24 of each module being interconnected with the load 30,31 of each wellhead tree 28,29. Each module 21,22 and each tree 28,29 has a pair of parallel switchgears 32a,32b;33a,33b;34a,34b;35a,35b connected to its respective load 23,24,30,31, the pair of switchgears for each module and each wellhead tree being controlled by its respective load, although the switchgears of the trees may also or instead be controlled by either of the modules. One 32a of the pair of switchgears of the first module 21 is connected via an integrated power/control cable 36 to one 34a of the switchgears of the first tree 28 and the other 32b of the pair of switchgears of the
first module is connected via another integrated power/control cable 37 to one 35a of the switchgears of the second tree 29. The pair of switchgears 33a,33b of the second module 22 are similarly connected to the other switchgears 34b,35b of both the trees 28,29 via integrated power/control cables 38,39 respectively.

The electrical connectors are such that the load 23,24 of each module 21,22 can control either or both of the trees 28,29. For example, the load 23 of the first module 21 can control the first tree 28 and the load 24 of the second module 22 can control the second tree 29. This is achieved by having the first module first switchgear 32a closed and the first module second switchgear 32b opened and the second module first switchgear 33a opened and the second module second switchgear 33b closed. Also, the host facility switchgears 25,26 and the tree switchgears 34a and 35b need to be closed. In a similar way the first module load 23 can control the second tree 29 and the second module load 24 can control the first tree 28 by having the first module first switchgear 32a opened and the first module second switchgear 32b closed and the second module first switchgear 33a closed and the second module second switchgear 33b opened.

If one module needs to be retrieved, the switchgears can be set so that the two trees can be controlled by the load of the other module with the trees still being provided with power from the host facility 27. For example, to retrieve the second module 22, as illustrated in Figure 4, the second switchgear 34b in the first tree 28 and the second switchgear 35b in the second tree 29 are opened and the second switchgear 26 in the host facility 27 is opened, causing the second module 22 to be isolated. The first switchgears 34a,35a in the first and second trees 28,29 remain closed as do the pair of first module switchgears 32a,32b to which they are respectively connected. Hence, both trees 28,29 are able to be controlled by the load 23 in the first module and receive power from the host facility 27 via the closed first host facility switchgear 25. The second module 22, being isolated, can then be retrieved, whilst permitting the remaining module and trees to continue to operate. Once retrieved the second module 22 may be inspected/adjusted before being lowered back or a separate replacement module may be lowered and installed in
the place hitherto occupied by the second module.

In a similar way, the first module 21 can be isolated and retrieved with both wellhead trees 28,29 being controlled by the load 24 in the second module 22 and the trees receiving power from the host facility 27 via the second switchgear 26 of the host facility.

In a like manner a single module could be connected to two or more trees. Alternatively, plural modules could be connected to a single tree. Further alternatives include two or more modules connected to two or more trees.

Also, one or more trees may be removed by first being isolated by the relevant switchgears, and at the same time permitting the remaining trees and modules to continue to operate.

In Figures 5 to 9, other possible alternative substantially underwater systems are shown.

The system 40 shown in Figure 5 is similar to the system 20 shown in Figures 3 and 4 except that each module 41,42 is adapted to be connected to four wellhead trees 43,44,45,46, each module having four parallel switchgears 47a,47b,47c,47d, each one of these switchgears being provided for a respective tree. In addition, the two modules 41,42 are connected in series between the two switchgears 25,26 of the host facility 27 to form a circuit and each module has an additional switchgear 48 for the series connection to the power supply of the load of the adjacent module. The host facility switchgears 25,26 are adapted to isolate the modules 41,42 from the power supply at the host facility 27, and from control signals which may be sent from the host facility. By having the modules 41,42 connected in series between the two host facility switchgears 25,26, either of the modules may be isolated by operating the host facility switchgear and the module switchgear 48 on adjacent opposite sides of the module to be removed and the tree switchgear 49 adjacent to the module to be removed. Hence, a module is able to be recovered without affecting power to the trees 43,44,45,46 or to the remaining module nor effecting the control of the trees by the remaining module.

In a like manner two or more modules could be connected to any number of
trees.

The system 50 shown in Figure 6 is similar to the system 40 shown in Figure 5 except that there are three modules 51,52,53 in series and two wellhead trees 54,55. Each module 51,52,53 is adapted to be connected to the two trees 54,55 and each tree has three parallel switchgears 56a,56b,56c, with there being one switchgear for each module. Although three modules are provided only two power/control cables need to extend from the host facility 27 to the subsea location where the modules and trees are installed.

Figure 7 shows an arrangement of four modules 61,62,63,64 connected in series between the two host facility switchgears 25,26 with three wellhead trees 65,66,67 being interconnected with the first two modules 61,62 and another three wellhead trees 68,69,70 being interconnected with the third and fourth modules 63,64. The first two modules 61,62 and the trees 65,66,67 comprise one of two system groups and the third and fourth modules 63,64 and the trees 68,69,70 comprise the other system group. A module in one system group is able to power and/or control any tree in the other group via the power/control link 73 between the second and third modules 62,63. Thus, if say the first 61 or fourth module 64 is to be removed the substantially underwater system can continue production.

Grouping of modules and trees interconnected in a like manner could alternatively be used. For example, any number of groups could be used with each group containing any number and preferably a plurality of modules and trees.

Figure 8 illustrates an arrangement where a number of modules 71a-d are connected in series between the two host facility switchgears 25,26. A number of wellhead trees 72a-e are connected in series and are connected to two of the modules, the series of trees being parallel to the modules in series. Thus, there is a complete ring circuit for power and/or control of the trees 72 from the modules 71 with duplicate power and/or control supplies from the host facility. With such an arrangement, isolation of any module or tree for removal purposes can be effected by opening the two serially adjacent switchgears on opposite sides of the particular module or tree, whilst permitting the remaining modules and trees to continue to
operate. If, say, the switchgear 25 fails, the power/control continues to the modules and trees from the switchgear 26 via the ring circuit. If, say, module 71a is removed, although the ring circuit is broken, supply continues via switchgear 26. Also, if the load 12 within the module 71a for controlling the trees fails, control would be supplied by any one of the other modules via a clockwise route around the ring circuit via module 71d.

In a like manner any number, and preferably a plurality, of modules could be connected to any number, and preferably a plurality, of trees.

The arrangement of Figure 9 is similar to Figure 8 except that there are two groups of trees 72, each tree of a group being connected to other trees in the group in series, each group being connected in parallel to the modules and being connected to different modules. If a module is removed, the trees connected thereto are able to receive control signals from the load of a remaining adjacent module and the trees and the remaining modules are still able to receive power from host facility, control signals/power being received via any intervening modules or trees. In a like manner the system may include any number of groups, each group comprising any number, and preferably a plurality, of modules connected to any number, and preferably a plurality, of series connected trees.

Referring to Figure 10, a modified schematic circuit diagram of the arrangement shown in Figure 2 is illustrated. The wellhead tree 3 includes five valves 80a-e, such as choke valves, which are each actuated by an associated valve actuator comprising a motor 81a-e. Also, the retrievable module 4 has a three-phase drive system 82 which receives its power from the host facility (not shown) via the power/control cable 7 including the three supply lines 7a-c. The drive system 82 is connected via the three power supply lines 10a-c carried by the integrated power/control cable 10 between the module and the tree, to each valve actuator motor 81a-e in parallel. The drive system has an associated low power switch/relay 83 across the three power supply lines 10a-c between it and the tree. Each motor 81a-e also has an associated simple low power switch/relay 84a-e. The module 4 also includes a control system 85 which is connected by parallel control
lines 86a-e carried by the integrated power/control cable 10, each control line 86a-e connecting to a respective switch/relay 84a-e in the tree. The control system controls the speed and direction of operation of the valve actuators in the tree. The control system 85 is also connected to the drive system 82 by a control line 87. It also is connected to the host facility by a control line 88 carried by the integrated power/control cable 7 to the host facility.

The drive system 82, the switch/relay 83 and the control system 85 are all contained within the retrievable control pod or module 4. This ensures that these components with a propensity for failure are contained within the retrievable control pod and can be readily replaced.

The control system 85 is so configured to ensure that the switches 84a-e are only operated when the drive system 82 is not providing power to the power/control cable 10 between the module 4 and the tree 3.

When, for example, valve 80a is required to be operated, all the switches/relays 83, 84a-e are initially open and the drive system 82 is set by the control system 85 to ensure that there is negligible/no power on the supply lines 10a-c. The control system 85 then closes the switch/relay 84a associated with the valve 80a and then the drive system’s switch/relay 83. By closing the switches/relays in this order, any of the switches/relays in the tree are prevented from being damaged by any residual power, ensuring that any possible damage is confined to the readily retrievable control pod 4 in the system module. The drive system is then instructed by the control system 85 to provide the required power to the motor 81a to operate the valve 80a. Once the valve has been operated, the drive system 82 is actuated to ensure that there is negligible/no power on the supply lines 10a-c. The control system 85 then causes the switch/relay 83 to be opened and then the valve switch/relay 84 to be opened.

The other valves 80b-e of the tree 3 are operated in a similar manner.

Referring to Figure 11, a modification of the arrangement of Figure 10 is shown in which the tree 3 additionally has an emergency shut-down (ESD) facility 90a-d on four of the valves 80a-d. The ESD facility comprises part of the
valve actuator and does not require the valve motor 81a-e to operate to facilitate closure of the valve. Each ESD facility 90a-d is connected to a common ESD supply from an ESD control device 91 in the control pod 4 via a supply line 92 in the integrated power/control cable 10. The ESD control device 91 is controlled by signals from the host facility supplied via the control system 85 in the control pod 4 and receives its power from the drive system 82 via a supply line 93.

When there is an absence of the ESD supply from the ESD control device 91, then this causes the valves 80a-d to automatically close.

The arrangements in Figures 10 and 11 can easily be incorporated into substantially underwater systems described with reference to Figures 3 to 9, and may constitute an invention independently of the other features referred thereto.

The systems described are all electric. Electrical systems can operate over greater distances / deeper levels, transmit emergency signals instantaneously, such as to shut down a wellhead tree, and are cheaper than existing systems. The systems use industry standard networking protocols to signals sent from the seabed modules to the trees or from the host facility to the seabed modules and/or trees which enables a signal to be received by the intended recipient tree or module to be interpreted as a control signal for that particular tree or module.

The system of retrievable modules and wellhead trees may comprise any suitable arrangement for the particular oil/gas field being exploited. While the invention has been described in the context of a sub-sea hydrocarbon field it could also be used in other environments and, in particular, environments in which access is not readily available such as in swamps or marshes.

It is to be understood that each cable, such as cables 7,10,36-39, shown by a single line in the Figures 1 and 3 to 9 may comprise three lines (e.g. 7a,7b,7c;10a,10b,10c), each line carrying one phase of a three phase electrical supply and running parallel to each other as shown for example in Figure 2. Any of the integrated power/control cables or umbilicals 7,13,10 may be replaced by separate power and control lines.

There does not have to be a discrete umbilical or discrete lines between a
module and a tree, as this could be replaced by an intervening unit, such as a termination block, to which at least one module and at least one tree is connected by at least one umbilical or power and control lines. The intervening unit may be a docking manifold in which cross-linking between at least one tree and at least one module is hard wired. A single umbilical may connect at least one module to the docking manifold and another single umbilical may connect at least one tree to the docking manifold. At least one module and at least one tree may be connected together by a "loomed" umbilical.

The integrated power/control cable between a module and a tree may be used to additionally carry chemical injection fluid into the tree. A retrievable module may comprise a retrievable subsea power and control pod which may be contained within a system module.

Any of the arrangements described in the Figures may be modified to provide single phase electrical supply.

Unless otherwise stated, connectors referred to are to be taken as electrical connectors.

While emergency shut down valves have been described as being closed upon actuation, the present invention would be equally applicable to valves which are opened upon actuation.
CLAIMS

1. A retrievable electrical power connection/control module (4) for a hydrocarbon extraction system (1), comprising:
   first disconnectable connection means (8) arranged to connect the module to at least one wellhead tree (3) and second disconnectable connection means (6) arranged to connect the module to a host facility (2);
   power/control means (12) arranged to provide power and/or control operation of at least one said wellhead tree via the first connection means; and
   isolating means (14,15) for isolating the power/control means from at least one said wellhead tree.

2. A module as claimed in claim 1, wherein the power/control means (12) is arranged to receive power and/or control signals from the host facility (2) and to supply it to at least one said wellhead tree.

3. A module as claimed in claim 1 or 2, wherein the isolating means (14,15) is arranged to isolate the power control means (12) from the host facility (2).

4. A module as claimed in claim 1, 2 or 3, including voltage reduction means (16) for receiving electrical power at a first voltage level from the host facility (2) and supplying electrical power at a second lower voltage level to at least one said wellhead tree (3).

5. A module as claimed in any preceding claim, wherein the isolating means comprises at least one switchgear (14,15), the or each switchgear arranged to be controlled from the power control means (12) of the module (4).

6. A hydrocarbon extraction system (1) comprising a host facility (2), at least one wellhead tree (3), at least one retrievable electrical power
connection/control module (4) as claimed in any preceding claim, the or each module being electrically disconnectably connected to the host facility by its second connection means (6) and to the at least one tree by its first connection means (8), the host facility being arranged to provide power to the or each module and the power/control means (12) of any said module being arranged to provide power and/or control to at least one said tree via said first connection means (8).

7. A system as claimed in claim 6, including power isolating means for enabling the power/control means (12) to supply power or negligible or no power to said at least one tree.

8. A system as claimed in claim 7, wherein each module (4) has a module based part (83) of the power isolating means, and each wellhead tree (3) has a tree based part (84a-e) of the power isolating means.

9. A system as claimed in claim 6, 7 or 8, wherein the power/control means (12) includes power means (82) for supplying power from the module (4) to said at least one tree (3).

10. A system as claimed in claims 7 or 9, wherein the power/control means includes control means (85) for controlling the power means (82) and/or the power isolating means (83,84a-e).

11. A system as claimed in any one of claims 6 to 10, wherein the power/control means (12) is arranged to send control signals to at least one said tree (3) in parallel to the power.

12. A system as claimed in any one of claims 6 to 11, including a system module including said retrievable module (4) and being remote from the at least
one tree (3).

13. A system as claimed in any one of claims 6 to 12, wherein at least one said module (21,41,51,61) is connected by said first disconnectable connection means (8) to a plurality of said trees (28,29;43-46;54,55;65-67) in parallel.

14. A system as claimed in any one of claims 6 to 13, wherein at least one said tree (28,43,54,65) is connected to a plurality of said modules (21,22;41,42;51-53;61,62) in parallel.

15. A system as claimed in anyone of claims 6 to 14, wherein a plurality of said modules (41,42,51-53,61-64,71a-d) are connected in series with the host facility (27) to form a circuit.

16. A system as claimed in any one of claims 6 to 15, wherein at least one said tree (28,43,54,65,72) is connected in series between two said modules (21,22;41,42;51,53;61,62;71).

17. A system as claimed in claim 15, wherein at least one said tree (43,54,65,72) is connected in parallel to a plurality of said modules (41,42;51-53;61,62;71).

18. A system as claimed in any one of claims 6 to 17, including a plurality of modules and module isolating means for isolating at least one module so that the isolated module (22,42) or modules can be removed without cutting off the supply of electrical power to any of the trees (28,29,43-46) or any of the remaining modules (21,41) of the system.

19. A system as claimed in claim 18, wherein the host facility (27) has a host facility based part (25,26) of the module isolating means.
20. A system as claimed in claim 18 or 19, wherein each wellhead tree (28,29,43-46) has a tree based part (34a,34b;35a,35b;49) of the module isolating means.

21. A system as claimed in claim 18, 19 or 20, wherein each module (41,42) has a module based part (48) of the module isolating means.

22. A system as claimed in any one of claims 18 to 21, wherein parts (25,48,49) of the module isolating means electrically adjacent to the module (41) to be removed are arranged to isolate the module.

23. A system as claimed in any one of claims 18 to 22, wherein the module isolating means is arranged to isolate a plurality of serially adjacent modules.

24. A system as claimed in any one of claims 18 to 23, wherein the module isolating means and/or the power isolating means comprises switchgears.

25. A system as claimed in any one of claims 6 to 24, wherein at least one said tree (3) has a parallel supply of power from a said module (4) and an emergency shut down facility (90a-d) for closing at least one valve (80a-d) in the tree (3) when there is an absence of the parallel supply of power.

26. A hydrocarbon extraction system (1) comprising:
a host facility (2) for supplying electrical power;
at least one retrievable electrical power connection/control module (4);
at least one wellhead tree (3) remote from the or each module; and
means (12) for powering/controlling at least one said tree including means for transmitting the electrical power from the host facility to the tree
and/or transmitting electrical control signals from the module to at least one said
27. A method of powering/controlling a wellhead tree (3) in a hydrocarbon extraction system (1) including the step of supplying at least one said tree (3) with electrical power and/or electrical control signals from a remote retrievable power/control module (4).

28. A method as claimed in claim 27, including the step of supplying the module (4) with power and/or control signals from a host facility (2).

29. A method as claimed in claim 27 or 28, wherein at least one said tree (3) is supplied with control signals in parallel to the electrical power.

30. A method as claimed in claim 29, including the steps of:
   (a) activating the module (4) to supply negligible or no power to at least one said tree (3);
   (b) activating power isolating means to enable the module (4) to be able to supply power to at least one said tree (3); and
   (c) activating the module to supply power from the module (4) to at least one said tree (3).

31. A method as claimed in claim 30, including before step (a) the step of activating the power isolating means to isolate the module (4) from at least one said tree (3).

32. A method as claimed in claim 30 or 31, including after step (c), the steps of: (d) activating the module (4) to supply negligible or no power to at least one said tree (3); and (e) activating the power isolating means to isolate the module (4) from at least one said tree (3).
33. A method as claimed in claim 32, wherein step (e) includes activating a module based part (83) of the power isolating means before a tree based part (84a-e) of the power isolating means.

34. A method as claimed in any one of claims 30 to 33, wherein step (b) includes activating a tree based part (84a-e) of the power isolating means before a module based part (83) of the power isolating means.

35. A method as claimed in any one of preceding claims 30 to 34, including controlling the activating steps by control means (85) in the retrievable module (4).

36. A method as claimed in any one of claims 28 to 35, including transmitting electrical power at a first voltage from the host facility (2) to voltage reduction means (16) and transmitting electrical power at a second lower voltage from the voltage reduction means to at least one said tree (3), and transmitting said electrical control signals from control means (12) in the retrievable module (4) to at least one said tree (3).

37. A method as claimed in any one of claims 28 to 35, including transmitting electrical power and control signals from the host facility (2) to said at least one tree (3), and reducing the voltage between the host facility (2) and said at least one tree (3).
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 E21B43/017 E21B33/035 E21B33/038 H01R13/523

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)
IPC 7 E21B H01R

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, PAJ, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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Further documents are listed in the continuation of box C.

" X " Patent family members are listed in annex.

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* "P" document published prior to the international filing date but later than the priority date claimed

X Date of the actual completion of the international search
25 June 2002

Date of mailing of the international search report
03/07/2002

Name and mailing address of the ISA
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2330 HJ Rijswijk
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Fax: (+31-70) 340-3016

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