



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
03.07.2013 Bulletin 2013/27

(51) Int Cl.:
E21B 41/00 (2006.01)

(21) Application number: **11196114.0**

(22) Date of filing: **29.12.2011**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME

(72) Inventors:
• **Hallundbæk, Jørgen**
3230 Græsted (DK)
• **Barfoed, Jens**
2450 København SV (DK)

(71) Applicant: **Welltec A/S**
3450 Allerød (DK)

(74) Representative: **Hoffmann Dragsted A/S**
Rådhuspladsen 16
1550 Copenhagen V (DK)

(54) **An electrical power distribution method for a wireline tool string downhole**

(57) The present invention relates to an electrical power distribution method between two or more operating units of a wireline tool string downhole performing at least one operation. The electrical power distribution method comprises the steps of recording information (10) indicative of at least one operating condition (15) using one or more sensors comprised in the tool string, comparing the recorded information (20) to a set of predefined

intervals (25) of the at least one operating condition, defining a power distribution (30) between the two or more operating units based on the comparison of the recorded information with a predefined interval of the at least one operating condition, and controlling the electrical power distribution (40) of the operating units. Furthermore, the present invention relates to a wireline system for carrying out the method according to the invention.

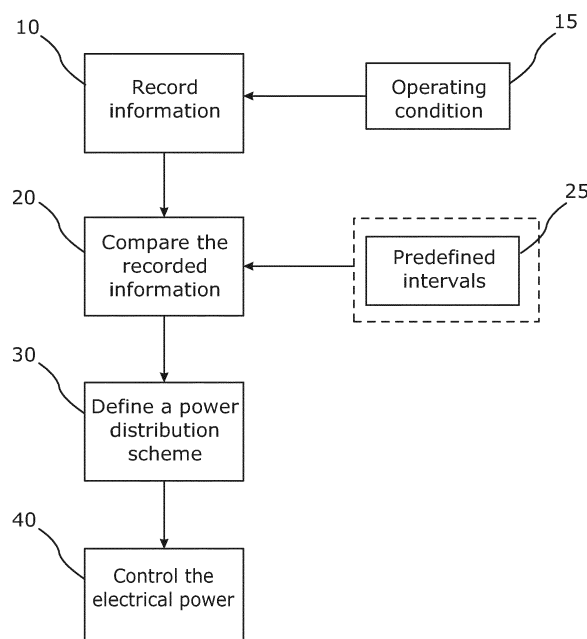


Fig. 1

Description

Field of the invention

[0001] The present invention relates to an electrical power distribution method between two or more operating units of a wireline tool string downhole performing at least one operation. Furthermore, the present invention relates to a wireline system for carrying out the method according to the invention.

Background art

[0002] Downhole wireline tool strings are becoming increasingly complex, as they typically consist of several specialised operational tools to perform more complex operations downhole, e.g. operations involving different types of operations such as drilling, closing valves, setting patches, or logging formation or casing characteristics etc.

[0003] As the complexity and number of tools increase, the amount of electrical power required in the wireline tool string also increases. In order to provide significant power downhole, typically the voltage applied to the wireline is increased to overcome the huge voltage drop over the long length of a wireline. However, increasing the voltage may lead to dangerous situations such as electrical breakdown, electrical discharge, and is therefore limited. Also, the possible power transmitted through the wireline is limited due to ordinary heat dissipation in a long wire. Therefore, power transmitted through a wireline to provide power to downhole operating tools is inherently limited.

[0004] One currently used way of accommodating the increased need for electrical power is to increase the number of conductive wires in the wireline and thus increase the total thickness of the conducting part of the wireline delivering the electrical power. Also, many attempts have been made to make the tools use less electrical power while maintaining their ability to perform the same tasks.

[0005] Using a thicker wireline or a wireline containing more conductors increases the weight and cost of the wireline. Furthermore, it increases the power required to transport the wireline, e.g. by use of a tractor, in horizontal parts of a well. This again increases the electrical power required for the tool string, thereby using some or more of the additional power facilitated by the thicker wireline. Minimising energy consumption by the electrical components downhole may be a long and expensive process, since the components used downhole already represent state-of-the-art in respect of minimisation of power consumption due to the inherent shortage of power for power tools and components downhole.

Summary of the invention

[0006] It is an object of the present invention to wholly

or partly overcome the above disadvantages and drawbacks of the prior art. More specifically, it is an object to provide an improved system able to perform several operations downhole by a normal cable and an improved method for controlling system downhole.

[0007] The above objects, together with numerous other objects, advantages, and features, which will become evident from the below description, are accomplished by a solution in accordance with the present invention by an electrical power distribution method between two or more operating units of a wireline tool string downhole performing at least one operation, comprising the steps of:

- recording information indicative of at least one operating condition, using one or more sensors comprised in the tool string,
- comparing the recorded information to a set of predefined intervals of the at least one operating condition,
- defining a power distribution between the two or more operating units based on the comparison of the recorded information with a predefined interval of the at least one operating condition,
- controlling the electrical power distribution of the operating units.

[0008] By having a method for distributing the electrical power between two or more operating units in the wireline tool based on an operation, the method may utilise the limited available electrical power to and in the wireline tool string. By comparing the operating condition to a predefined interval, a detection of the recorded operating condition may be done to see if the operating condition lies in a dangerous interval for an operating unit and thus affects the electrical power to the operating unit.

[0009] The electrical power distribution method as described above may further comprise a step of classifying the set of predefined intervals.

[0010] By classifying the predefined intervals of the at least one operating condition according to classification parameters which have the same level of importance independent of the predefined intervals, the classification parameter may be linked to the operating condition and the distribution of the electrical power according to the most important classification parameter of the operating condition is distributed in a more smart way than just by comparing to a single interval.

[0011] Moreover, the step of comparing the recorded information may comprise comparing the recorded information to at least one additional predefined interval.

[0012] Also, the electrical power distribution method as described above may further comprise the step of prioritising the operating conditions and basing the step of defining an appropriate electrical power distribution on the prioritisation of the operating conditions.

[0013] Furthermore, by comparing the classification parameters, a better decision on what operating condition to consider and on how to distribute the electrical

power to the operating unit comprising the operating condition may be performed.

[0014] By using the information concerning which operating unit is performing an operation, this information may be useful in making a decision on how to distribute the electrical power if two or more classification parameters from two or more operating units are equal.

[0015] Additionally, the operating unit may comprise a plurality of operating conditions.

[0016] Further, using the information of a predefined order of the operating units in the system may be useful if two or more classification parameters are equal and two or more operating units are performing an operation on how to distribute the electrical power.

[0017] Also, by using the information of a predefined order of the rank of the operating units in the system and having the operating conditions in an operating unit to also be ordered according to a predefined rank, this may be useful if two or more classification parameters are equal and two or more operating units are performing an operation on how to distribute the electrical power when using a plurality of operating units and a plurality of operation conditions comprised in the operating unit.

[0018] By having an operating unit comprising at least one operating condition and by recording, evaluating, deciding and controlling according to the method, a master-slave relationship between the two or more operating may be configured.

[0019] The steps of comparing the recorded information, defining the appropriate electrical power distribution, and controlling the electrical power distribution of the wireline tool string may be performed uphole at a surface.

[0020] The evaluation, decision and control may be performed at the surface by a computer or by human interaction.

[0021] Moreover, the steps of comparing the recorded information, defining the appropriate electrical power distribution, controlling the electrical power distribution, evaluating, and/or deciding, and/or controlling the wireline tool string may be performed downhole in the wireline tool string.

[0022] The evaluation, decision and control may be performed downhole by a computer or logic.

[0023] In the electrical power distribution method as described above, the operating condition may be a temperature, a pressure, a power, a vibration, a sound, a voltage, a current, a light, an angle, a velocity or a frequency or another operating condition during downhole operations.

[0024] Also, the sensor may be a temperature sensor, a pressure sensor, a wattmeter, an accelerometer, a microphone, a voltmeter, an ammeter, a light sensor, an angle measuring tool, a transducer, a laser or other sensors for measuring operating conditions downhole.

[0025] Further, the operating unit may be a downhole tractor, a milling tool, a cleaning tool, a stroker tool, a key tool, a capacitance tool, a laser tool, a laser, a computer,

a sensor, processing unit, an electrical circuit or other operating units for downhole use.

[0026] The present invention also relates to a wireline system for carrying out the method as described above, wherein the wireline system comprises a power distribution unit, two or more operational tools and two or more sensors for measuring operating conditions.

Brief description of the drawings

[0027] The invention and its many advantages will be described in more detail below with reference to the accompanying schematic drawings, which for the purpose of illustration show some non-limiting embodiments and in which

Fig. 1 shows a schematic diagram of a method for distributing electrical power in a wireline tool,

Fig. 2 shows a schematic diagram of another method for distributing electrical power in a wireline tool string,

Fig. 3 shows an example of a temperature range divided into predefined intervals,

Fig. 4 shows a schematic diagram of yet another method for distributing electrical power in a wireline tool string,

Fig. 5 shows a schematic diagram of another method for distributing electrical power in a wireline tool, and

Fig. 6 shows a cross-sectional view of a well comprising a wireline tool string.

[0028] All the figures are highly schematic and not necessarily to scale, and they show only those parts which are necessary in order to elucidate the invention, other parts being omitted or merely suggested.

Detailed description of the invention

[0029] Fig. 1 shows a schematic diagram of an electrical power distribution method for distributing power between two or more operating units of a wireline tool string performing at least one operation downhole. The operating units may be used to perform operations such as milling, cleaning, measuring, stroking or other operations. Due to the fact that power is highly limited downhole due to the power loss in the long wireline when the wireline tool string operates several thousands of metres downhole, the electrical power distribution method intelligently distributes the power available in order to have the possibility of performing operations demanding high amounts of electrical power. By basing power distribution between operating units on information recorded by means of various sensor inputs, the power available

downhole for a given tool string may therefore always be distributed optimally. Also, depending on the type of operation, different distribution schemes may be set by the present method.

[0030] A first step of the method concerns recording information 10 of at least one operating condition 15 of at least one operating unit. The operating condition 15 is recorded by using one or more sensors comprised in the wireline tool string in order to control the electrical power distribution. The operating condition 15 may be e.g. a temperature in the borehole, a pressure in the borehole, a power usage of an electrical motor, a vibration during drilling, a sound during drilling, a magnitude of a supply voltage, a current, a light, an angle, a frequency or a velocity. The sensor may be e.g. a temperature sensor, a pressure sensor, a wattmeter, an accelerometer, a microphone, a gyroscope, a voltmeter, an ammeter, a light sensor, an angle measuring tool, a transducer, a laser or another appropriate sensor. The operating unit may be a downhole tractor, a milling tool, a drilling tool, a cleaning tool, a stroker tool, a key tool, a capacitance tool, a laser tool, a laser, a computer, a sensor, processing unit, an electrical circuit or another operating tool for downhole use. Thus, the step of recording information may to measure a temperature in a milling tool. The step of recording information 10 of the operating condition 15 may be performed by the sensor itself or by sending the information to a computing unit. By separating the sensor and computing unit, the sensor can for example be made more resistant to vibrations as compared to sensors comprising means for recording the information.

[0031] A second step of the method as shown in Fig. 1 concerns comparing the recorded information 20 to a set of predefined intervals 25, e.g. comparing a temperature of a milling tool during operating condition 15 to a predefined temperature interval for optimal operation temperature.

[0032] When the recorded information 10 has been compared 20 to the set of predefined intervals 25, a next step is to define an appropriate electrical power distribution 30 between the two or more operating units. The comparison of the recorded information 20 with predefined intervals 25 is used as basis for deciding on an appropriate distribution of the electrical power between operating tools. For example, if information is recorded which is indicative of a temperature in a drill head, and if the recorded information 10 is found to be within a predefined interval 25 which is e.g. considered to be dangerous for the drilling operation, the definition of an appropriate electrical power distribution is may be to redistribute the electrical power such that the electrical power between the drill bit and a cooling unit is altered and the electrical power for the drill bit is decreased and electrical power for the cooling unit is increased in order to increase the cooling of the drill bit. Due to the limited power the cooling may only be used when necessary since the main purpose of the drilling operation is to drill and not to cool the drill bit.

[0033] The last step of the method shown in Fig. 1 is a step of controlling the electrical power distribution 40 between the two or more operating units based on the step of defining an appropriate electrical power distribution 30 such as decreasing the power to the drill bit and increasing the power to the cooling unit. The controlling 40 may be performed by using a computer, a circuit or other electronics capable of distributing the amount of power to the two or more operating units based on the defining an appropriate electrical power distribution 30. The controlling of the electrical power distribution 40 may, in its simplest form, control two operating units, e.g. where one of the two operating units gets more electrical power and consequently the other one of the two operating units gets less electrical power so as to use all the electrical power available downhole for performing the operation. In a more advanced form of controlling the electrical power distribution 40, a plurality of operating units may be controlled by distributing the electrical power by powering down one or more operating units and distributing the remaining available electrical power to one operating unit, or vice versa.

[0034] An example of a wireline tool string 80 may be seen in Fig. 6, comprising a downhole tractor 66 having an electronic section 72, a drill bit 60 comprising a temperature sensor 62, and a cooling unit 63. The wireline tool string 80 may have been programmed to establish a flow path through an isolation valve that failed to open by drilling a hole in the isolation valve with the drill bit 60. The temperature sensor 62 records information of a temperature in the drill bit 60 during the operation and send the recorded information 10 to the electronic section for comparing the information with a predefined interval 25.

[0035] A predefined interval 25 may represent a temperature interval e.g. $T > 150^{\circ}\text{C}$. When the milling tool drills the hole in the valve with, the downhole tractor 66 provides a force by which the drill bit 60 presses against the valve so the drill 60 may penetrate the valve. If, during the operation, the temperature reaches 160°C in the drill bit 60 because the pressure generated by the downhole tractor 66 is too high when the drill bit 60 is pressed against the valve, the comparison of the recorded information 10 is found to be within the predefined interval 25 of $T > 150^{\circ}\text{C}$. The electronic section 72 comprising processing means defines, based on the comparison and a programmed knowledge, e.g. the predefined interval 25 $T > 150^{\circ}\text{C}$ considered dangerous for the drill bit 60, how to distribute the electrical power in an appropriate way, e.g. by lowering the electrical power to the downhole tractor 66, thus reducing the force by which the drill bit 60 is pressed against the valve. The definition may also be another appropriate power distribution to avoid overheating, e.g. to increase electrical power to a cooling unit, allowing the cooling unit to increase the cooling effect on the drill. Finally, the computing means controls the distribution of the electrical power between the operating units, such as the downhole tractor 66 and the cooling unit 63, by distributing less electrical power to the down-

hole tractor 66 and thus more to the cooling unit 63 and make use of the new available amount of electrical power to perform the operation.

[0036] By using the method comprising the steps described above for distributing the electrical power between two or more operating units in the wireline tool string 80 performing at least one operation, it may be detected if one or more operations is performed on inappropriate or even dangerous operating conditions 15 for the two or more operating units and therefore distribute the power appropriately to avoid problems. The steps of comparing the recorded information 20, defining an appropriate electrical power distribution 30 and controlling the electrical power distribution 40 of the wireline tool string 80 may be performed uphole by a computer, aided by human interaction, an electronic circuit or similar electrical devices capable of performing the steps mentioned above in part or as a whole. To minimise data transfer over the wireline, the steps may, however, preferably be performed downhole in the wireline tool string 80 by the electronic section 72 comprising the computing means capable of performing the steps mentioned above.

[0037] As shown in Fig. 2, the step of comparing 20 may further comprise a subroutine with a step of classifying the predefined intervals 27 with a set of classification parameters, e.g. according to a level of importance, level of risk etc. of the operating condition 15. The classification parameter may be a grade, a number or similar indication of whether the operating condition 15 is within an appropriate or inappropriate interval and/or to which degree of risk, such as whether it is classified as no risk, moderate risk, high risk.

[0038] Fig. 3 shows an example of three predefined intervals 25, a first 50, a second 51 and a third 52 predefined interval 25 that may be classified by three classification parameters A, B and C. As seen in the example of predefined intervals 25 shown in Fig. 3, the set of predefined intervals 25 may be temperature intervals, which further may be classified by parameters A, B and C, where $A < 150^{\circ}\text{C}$, $150^{\circ}\text{C} \leq B \leq 175^{\circ}\text{C}$ and $C > 175^{\circ}\text{C}$, wherein the classification parameter A, may be defined as no risk of damaging the operating unit, B may be defined as moderate risk of damaging the operating unit, and C may be defined as high risk of damaging the operating unit during operation.

[0039] Using classification parameters, the method of distributing the electrical power to two or more operating units facilitate distribution of the electrical power in a more intelligent way than when only comparing the information of the operating condition 15 to the predefined intervals 25.

[0040] The schematic diagram in Fig. 4 shows a method in which the step of defining an appropriate electrical power distribution 30 further comprises a step of comparing classification parameters 35 of at least two different operating conditions 15, e.g. temperature, rotational speed, current draw etc. As an example, a milling tool performs an operation of drilling a hole in a valve blocking

a flow path inside the well according to the described method. A temperature sensor records information of the operating condition 15 indicative of a temperature of the drill in the milling tool and the sensor for measuring the rotation of the drill records information of the operating condition 15 indicative of revolutions per minute (RPM) of the drill during the step of recording of information 10. The operating conditions 15 indicative of the temperature and the RPM of the drill bit 60 is each compared to a set of predefined intervals 25 classified by a set of classification parameters. The classification of the predetermined interval is chosen e.g. to define that one operating condition 15, e.g. the temperature of the drill bit 60, always has to be within an acceptable tolerance interval of $100\text{--}150^{\circ}\text{C}$, depending on the material used, since the drill bit may simply break down during too high temperatures, whereas a second operating condition 15 such as the RPM of the drill bit 60 would have an acceptable tolerance interval of $10000\text{--}15000$ RPM due to e.g. optimal drilling performance. Comparing the classification parameters of the predefined intervals 25 between the two operating conditions 15 therefore allows an appropriate power distribution 30 to be defined, and thereby it is possible to control the operating units accordingly.

[0041] By having several operating units each performing the steps of recording of information 10, comparing of the recorded information 20 and defining an appropriate electrical power distribution 30 for operating conditions 15 of the specific operating units, a master-slave configuration between the two or more operating units may be configured such that a master unit comprises the comparison of classification parameters 35 based on inputs of classification parameters and corresponding appropriate power distributions from each of the operating units, and furthermore the master unit controls the power distribution 40.

[0042] Basing the power distribution on a comparison of classification parameters may, in some instances, be difficult if e.g. all operating conditions 15 suddenly lie within a high risk interval. However, as shown in Fig. 5, the definition of an appropriate electrical power distribution 30 may further be based on the preference of the classification parameter of the operating unit performing the at least one operation by a prioritising step 37 prioritising the classification parameters. If, during the comparison of classification parameters 35, two or more classification parameters with equal values from two or more operating units are identified, an optimal power distribution between the units may be achieved by prioritising the operating conditions 37. Furthermore, specific operations may need specific priorities such that during e.g. movement of the tool string 80, the prioritisation is different than the prioritisation during drilling. With respect to the above example, the comparison 35 compares the classification parameter of the temperature of the drill bit 60. The comparison 35 may then identify that the classification parameters are equal and additional information may be needed to make a decision. If the operating classifi-

cation parameters are prioritised, e.g. the temperature is prioritised over the RPM of the drill bit 60, the drill bit 60 may be given as much power as possible to perform the drilling operation without compromising the tool by overheating, i.e. if the temperature has higher priority, the drill bit may be given as much power as possible as long as the temperature stays below a certain predefined interval 25, and on the other hand if the temperature increases above a critical temperature, power to the drill bit may not be increased even though the drill bit may operate at RPM's which are not optimal for the drilling process. Alternatively, during a temperature increase the electrical power to the drill bit may be kept constant, and the electrical power to a drill cooling unit may be increased etc. By prioritising the classification parameters, the prioritisation may be used to define an appropriate electrical power distribution 30 if two or more classification parameters are equal. The prioritisation of the operating units may be selected based on e.g. temperature tolerances, power tolerances, pressure tolerances, vibration tolerances, cost/benefit, time consumption etc. of the operating units and/or other parameters.

[0043] Prioritising the plurality of operating conditions 15 and/or prioritising the plurality of the operating units allows appropriate power distributions during complex operations involving many operational tools and many operating conditions 15.

[0044] Fig. 6 shows a wireline tool string 80 comprising a drive unit, such as a downhole tractor 66, a hydraulic section 68, an electric motor 70, a power distribution unit 73 and a wireline 74.

[0045] Although the invention has been described in the above in connection with preferred embodiments of the invention, it will be evident for a person skilled in the art that several modifications are conceivable without departing from the invention as defined by the following claims.

Claims

1. An electrical power distribution method between two or more operating units of a wireline tool string downhole performing at least one operation, comprising the steps of:

- recording information (10) indicative of at least one operating condition (15), using one or more sensors comprised in the tool string,
- comparing the recorded information (20) to a set of predefined intervals (25) of the at least one operating condition (15),
- defining a power distribution (30) between the two or more operating units based on the comparison of the recorded information (20) with a predefined interval (25) of the at least one operating condition (15), and
- controlling the electrical power distribution (40)

of the operating units.

2. An electrical power distribution method according to claim 1, further comprising a step of:

- classifying the set of predefined intervals (27),

3. An electrical power distribution method according to claim 1 or 2, wherein the step of comparing the recorded information (20) comprises comparing the recorded information (10) to at least one additional predefined interval (25).

4. An electrical power distribution method according to any of claims 1-3, further comprising the step of:

- prioritising the operating conditions (37) and basing the step of defining an appropriate electrical power distribution (30) on the prioritisation of the operating conditions (15).

5. An electrical power distribution method according to any of claims 1-4, wherein the steps of comparing of the recorded information (20), defining the appropriate electrical power distribution (30), and controlling the electrical power distribution (40) of the wireline tool string are performed uphole at a surface.

6. An electrical power distribution method according to any of claims 1-5, wherein the steps of comparing the recorded information (20), defining the appropriate electrical power distribution (30), controlling the electrical power distribution (40) are performed downhole in the wireline tool string (80).

7. An electrical power distribution method according to any of claims 1-6, wherein the operating condition (15) is a temperature, a pressure, a power, a vibration, a sound, a voltage, a current, a light, an angle, a velocity and/or a frequency.

8. An electrical power distribution method according to any of claims 1-7, wherein the sensor is a temperature sensor, a pressure sensor, a wattmeter, an accelerometer, a microphone, a voltmeter, an ammeter, a light sensor, an angle measuring tool, a transducer, a laser and/or other sensors for measuring operating conditions (15) downhole.

9. An electrical power distribution method according to any of claims 1-8, wherein the operating unit is a downhole tractor, a milling tool, a cleaning tool, a stoker tool, a key tool, a capacitance tool, a laser tool, a laser, a computer, a sensor, processing unit, an electrical circuit and/or other operating units for downhole use.

10. A wireline system for carrying out the method ac-

according to any of claims 1-9, wherein the wireline system comprises a power distribution unit (73), two or more operational units and two or more sensors for measuring operating conditions (15).

5

- 11.** A wireline system according to claim 10, wherein the operating unit is a downhole tractor, a milling tool, a cleaning tool, a stroker tool, a key tool, a capacitance tool, a laser tool, a laser, a computer, a sensor, processing unit, and/or an electrical circuit.

10

- 12.** A wireline system according to claim 10 or 11, wherein the sensor is a temperature sensor, a pressure sensor, a wattmeter, an accelerometer, a microphone, a voltmeter, an ammeter, a light sensor, an angle measuring tool, a transducer, and/or a laser.

15

20

25

30

35

40

45

50

55

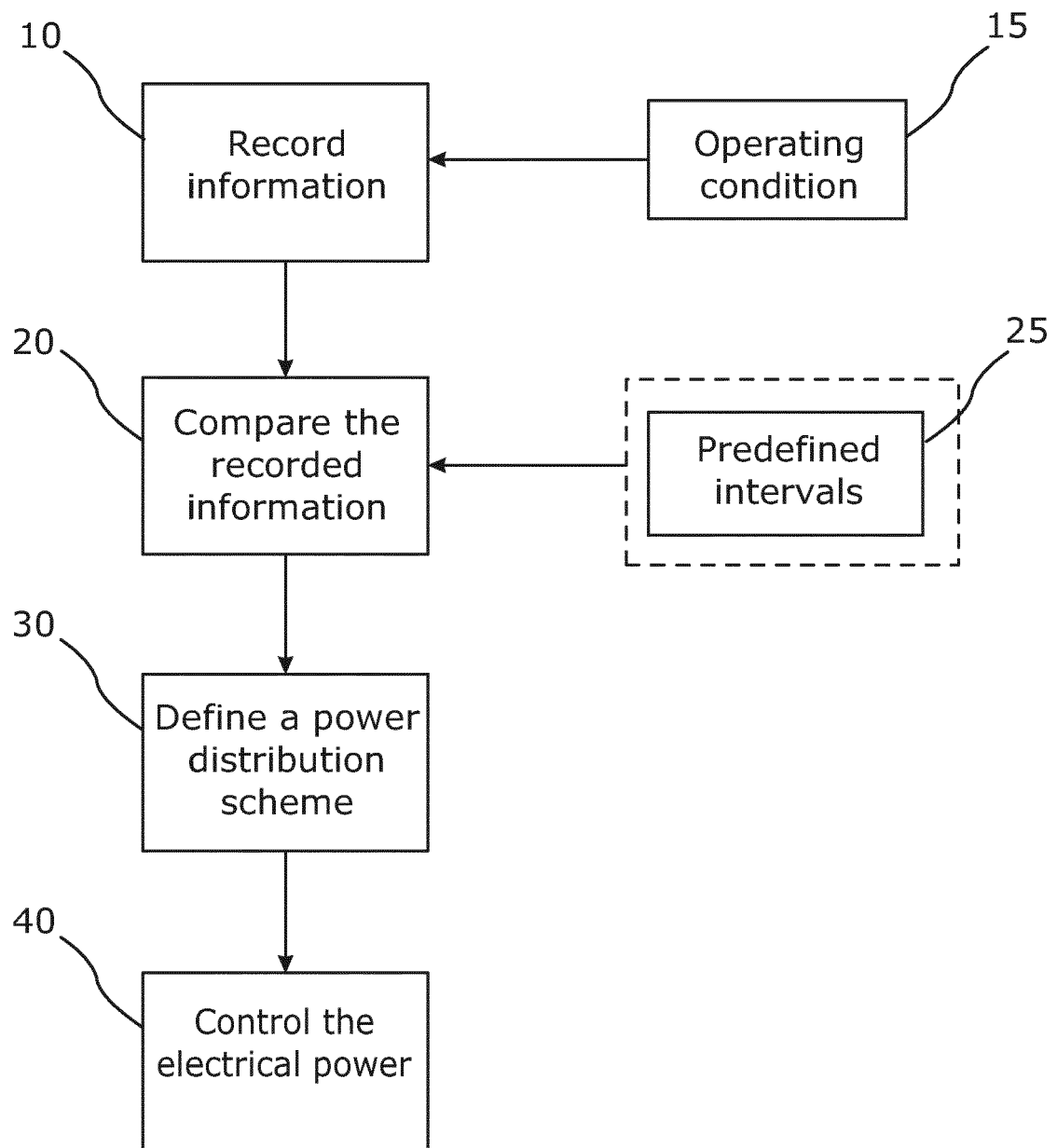


Fig. 1

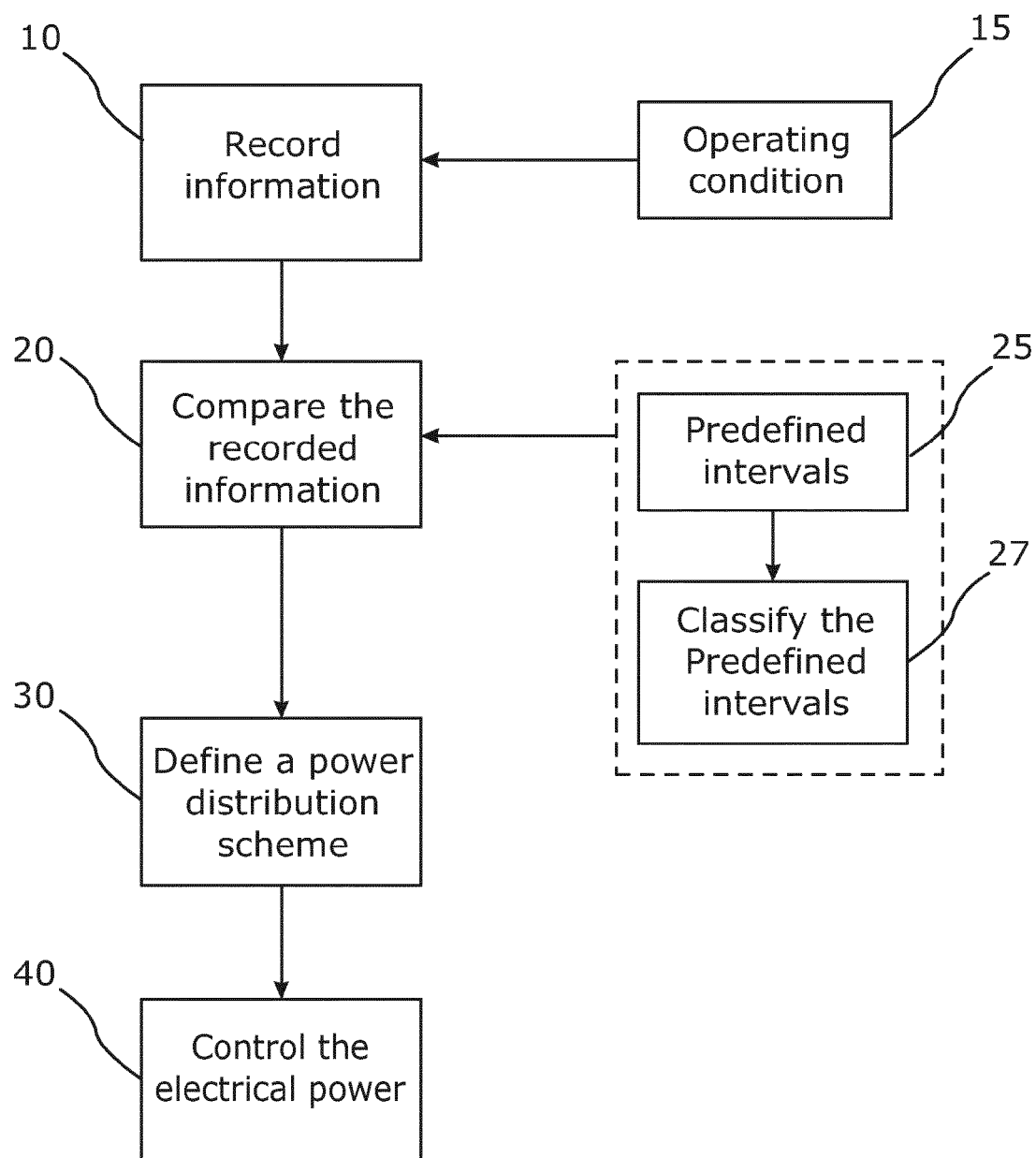


Fig. 2

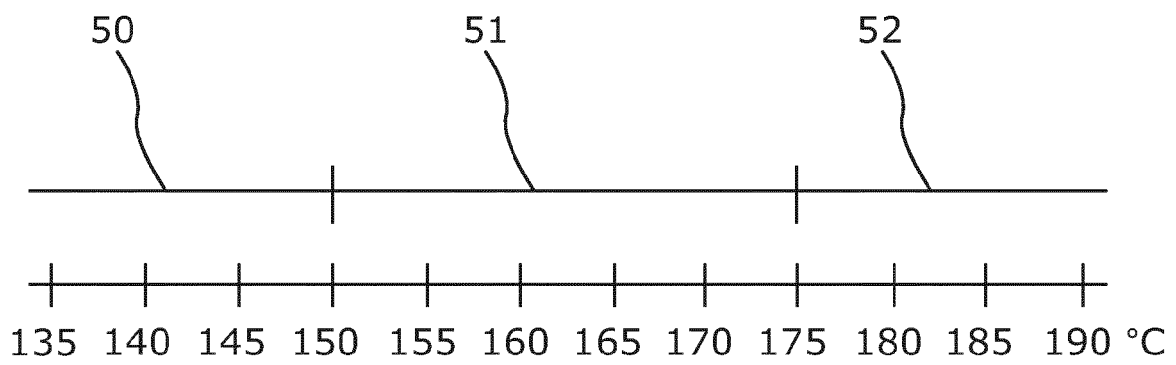


Fig. 3

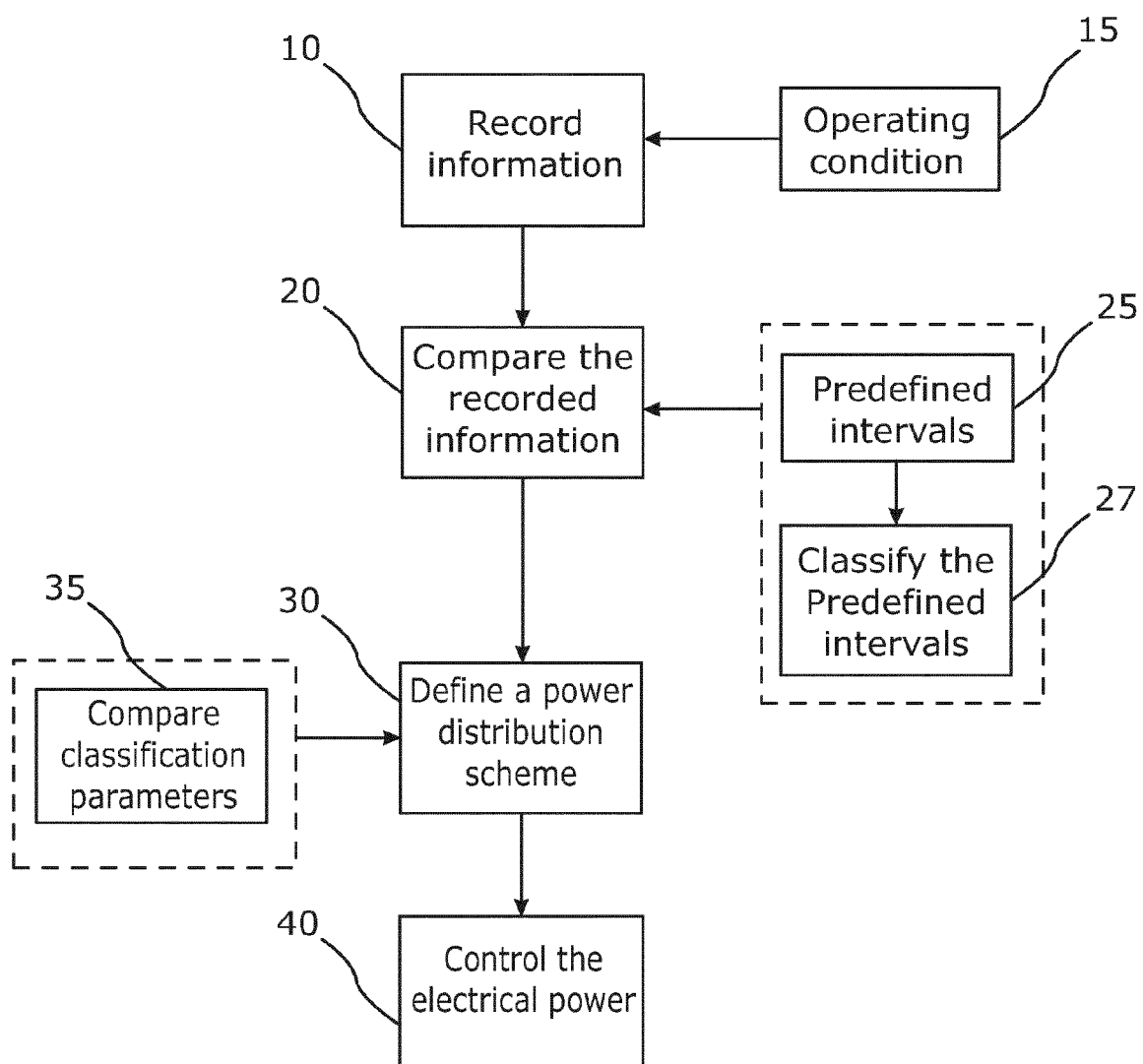


Fig. 4

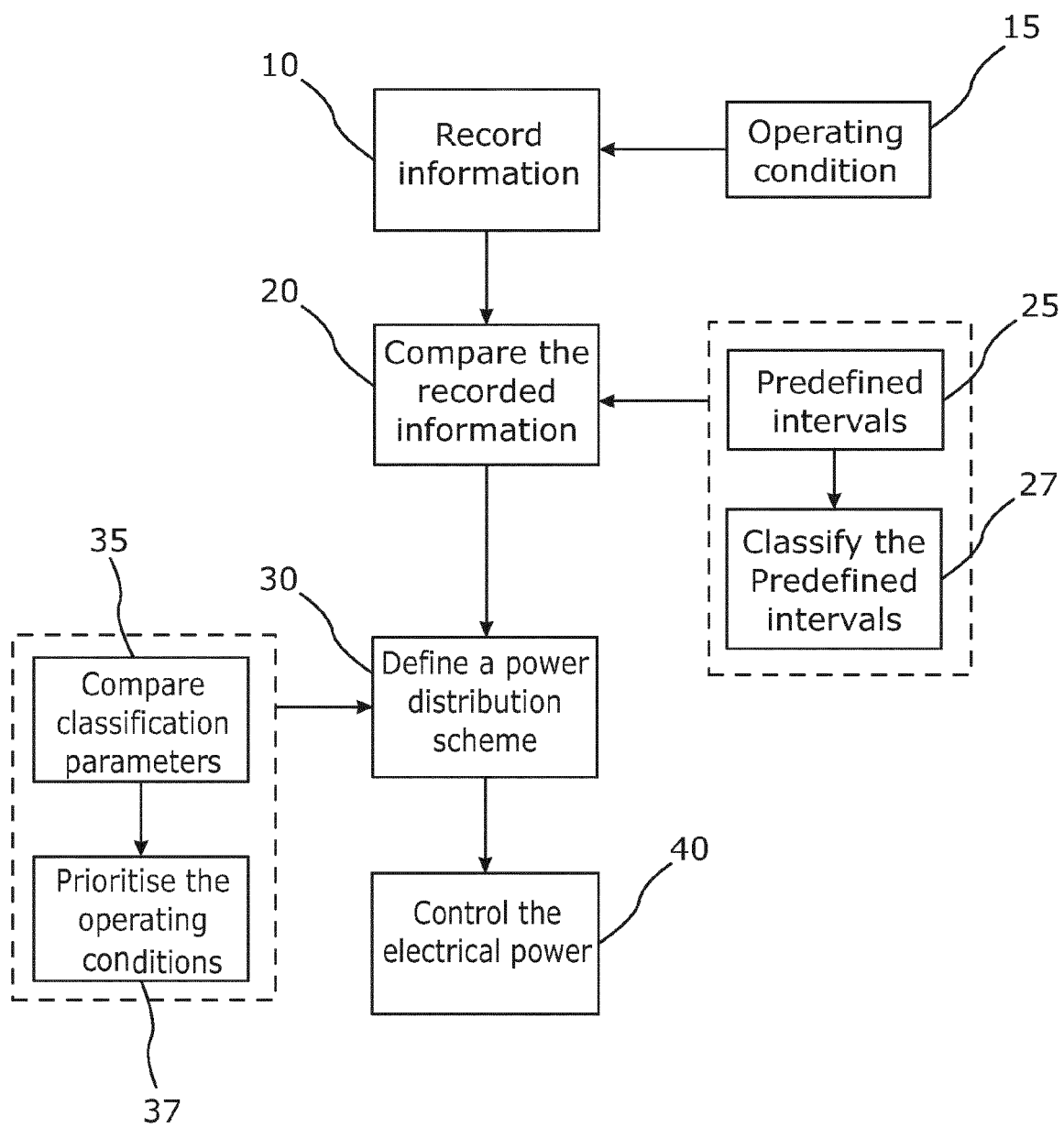


Fig. 5

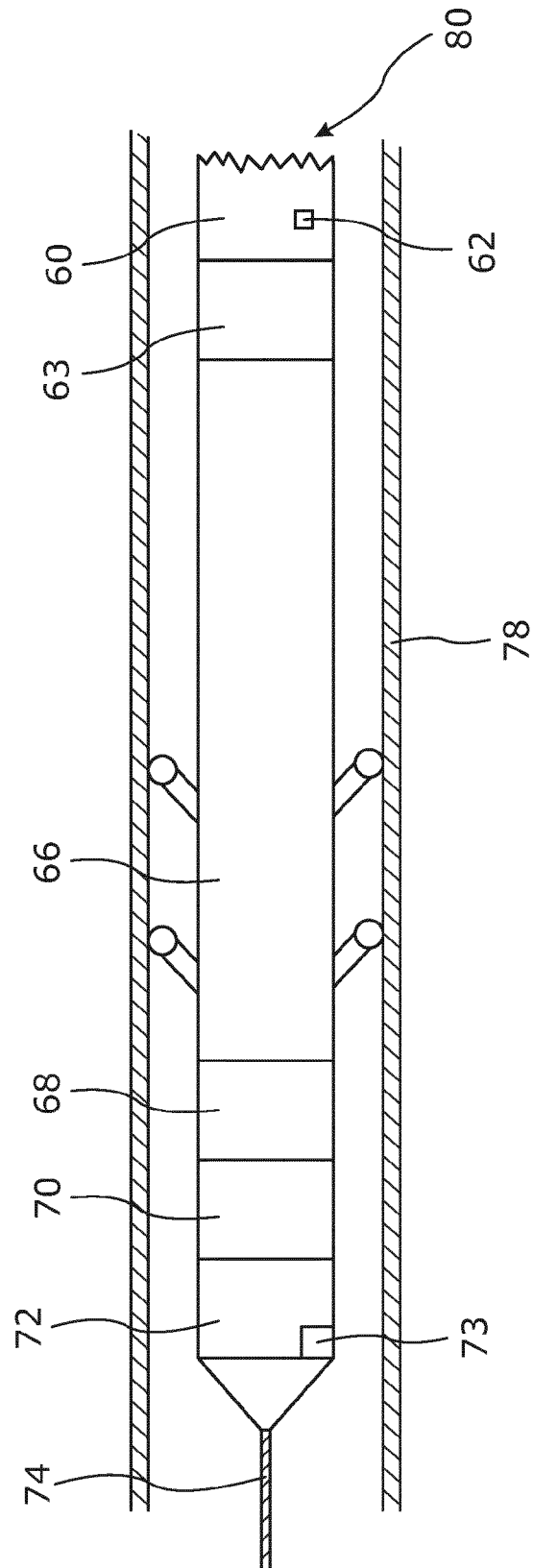


Fig. 6



EUROPEAN SEARCH REPORT

Application Number
EP 11 19 6114

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2006/191681 A1 (STORM BRUCE H [US] ET AL) 31 August 2006 (2006-08-31) * paragraph [0026] - paragraph [0028]; figures 8,11,12 * * paragraph [0039] - paragraph [0040] * * paragraph [0055] - paragraph [0059] * * paragraph [0062] * * paragraph [0064] - paragraph [0065] * * paragraph [0074] * * paragraph [0084] *	1-12	INV. E21B41/00
X	US 5 744 877 A (OWENS STEVE [US]) 28 April 1998 (1998-04-28) * claims 1,7,13; figure 1 *	1,5,7-12	
X	US 2011/309678 A1 (SHAW JOEL D [US]) 22 December 2011 (2011-12-22) * paragraph [0007]; figures 1,2 * * paragraph [0018] * * paragraph [0033] - paragraph [0036] *	1,7-12	
X	US 2009/151932 A1 (HALL DAVID R [US] ET AL) 18 June 2009 (2009-06-18) * claim 17; figures 1,8 *	1,7-12	TECHNICAL FIELDS SEARCHED (IPC)
X	US 2006/100968 A1 (HALL DAVID R [US] ET AL) 11 May 2006 (2006-05-11) * paragraph [0124] - paragraph [0125]; figures 1,4,5,6 * * paragraph [0065] - paragraph [0067] *	1,4,7-12	E21B H02J G01V
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 1 June 2012	Examiner Dantinne, Patrick
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

1
EPO FORM 1503 03 82 (P04C01)

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

EP 11 19 6114

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

01-06-2012

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2006191681 A1	31-08-2006	US 2006191681 A1 WO 2006060673 A1	31-08-2006 08-06-2006
US 5744877 A	28-04-1998	US 5744877 A WO 9937009 A1	28-04-1998 22-07-1999
US 2011309678 A1	22-12-2011	US 2011309678 A1 WO 2011162919 A1	22-12-2011 29-12-2011
US 2009151932 A1	18-06-2009	NONE	
US 2006100968 A1	11-05-2006	NONE	