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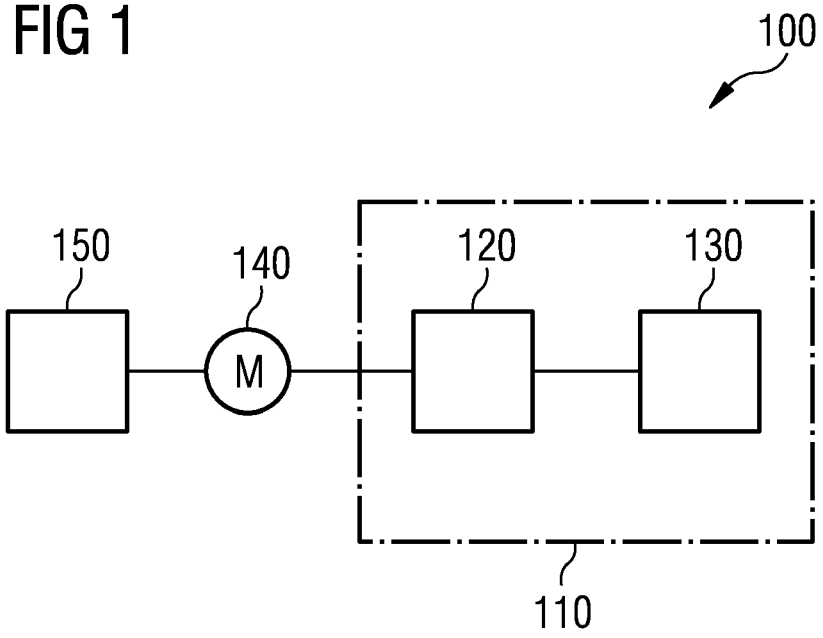
Remarks:
Amended claims in accordance with Rule 137(2) EPC.

(54) System for recovering energy used for raising a load of a draw work

(57) A system (110) for recovering energy used for raising a load of a draw work is described. The system comprises an energy transfer unit (120) for supplying energy to a motor unit (140) for raising the load (150) of the draw work, wherein the energy transfer unit is connectable to the motor unit, and a storage unit (130), wherein the storage unit is connected to the energy transfer unit and wherein the storage unit is adapted for storing energy, which energy is released by the motor unit to the energy transfer unit, when the load is lowered.

FIG 1



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Description

Field of invention

[0001] The present invention relates to the field of draw works. In particular, the present invention relates to a system for recovering energy used for raising a load of a draw work. Further, the present invention relates to a draw work arrangement comprising such a system. Moreover, the present invention relates to a drilling rig. Furthermore, the present invention relates to a method for recovering energy used for raising a load of a draw work.

Art Background

[0002] In the field of drilling rigs, draw works may be used for raising and lowering a load. In an active heave situation, the draw work has to move the load up and down for raising and lowering or for compensating wave movements. For this purpose, power may be transferred from a drive circuit into the load. If the load is lowered, power may be transferred back from the load into the drive circuit. This power may be absorbed for example by braking resistors. The braking resistors are adapted to burn off this power. As the system may reach a high temperature due to the burning off, cooling, for example with water, may be necessary. The power transferred back from the load is thus dissipated. There may be a need for recovering the power transferred back from the load into the system.

Summary of the Invention

[0003] This need may be met by the subject matter according to the independent claims. Advantageous embodiments of the present invention are described by the dependent claims.

[0004] According to a first aspect of the invention there is provided a system for recovering energy used for raising a load of a draw work. The system comprises an energy transfer unit for supplying energy to a motor unit for raising the load of the draw work, wherein the energy transfer unit is connectable to the motor unit, and a storage unit, wherein the storage unit is connected to the energy transfer unit and wherein the storage unit is adapted for storing energy, which energy is released by the motor unit to the energy transfer unit, when the load is lowered.

[0005] This aspect of the invention is based on the idea that, instead of burning off the energy, which is transferred back to the system, the energy may be stored and reused. Energy in this context may be any electric energy or power.

[0006] The term "energy transfer unit" may refer to a part of a system being responsible for transferring energy to one or more motor units. The energy transfer unit may be coupled to any external energy source like a voltage source, current source, generator or the like. The energy transfer unit may be adapted to operate in both directions, from the storage unit to the motor unit and from the motor unit to the storage unit. The energy transfer unit may work as an electric motor drive unit and as an energy recover unit.

[0007] The term "motor unit" may refer to a part of a system, which is responsible for raising and lowering a load. The motor unit may be used for raising and lowering the load due to a movement of a drill, for example, or due to compensation of wave movements. The energy transfer unit may be coupled to one or more motor units, wherein each motor unit may be coupled to different parts of the system, for example to a load.

[0008] A motor unit may be any kind of engine, for example an AC or DC engine. When the load has to be raised, the motor unit may need a certain first amount of energy. When the load is lowered, a certain second amount of energy may be released. This second amount of energy may be braking energy. The motor unit may be adapted to transfer the released energy back to the energy transfer unit. The energy transfer unit may then supply this energy to the storage unit, in which storage unit the released energy may be stored. The storage unit may work as an electric motor drive unit and as an energy recover unit.

[0009] The storage unit and the energy transfer unit may be coupled for example via a controller area network (CAN) bus system, which may be commonly used.

[0010] According to a further embodiment of the invention, the storage unit is adapted for supplying the stored energy back to the energy transfer unit for reusing the stored energy.

[0011] In a next cycle, for example during the next wave, the stored energy may be transferred back to the energy transfer unit. In this case, the energy transfer unit may need no further energy from an external energy source. If the stored energy is not sufficient for operating the motor unit, the energy transfer unit may further be adapted for receiving, in addition to the stored energy, energy from an external energy source.

[0012] According to a further embodiment of the invention, the storage unit comprises a capacitor.

[0013] The storage unit may be a capacitor bank. The capacitor may be charged in case of lowering the load and discharged in the next cycle, when the load is raised again. The term "cycle" may refer for example to a repetitive movement of the draw work to compensate the wave movements. One cycle may be for instance from one wave top to the next.

[0014] According to a further embodiment of the invention, the storage unit comprises a battery.

[0015] The storage unit may comprise in addition to the capacitor a battery. The battery may also replace the capacitor. The battery may be any kind of common battery which is suitable for storing energy when energy is released in the system.

[0016] According to a further embodiment of the inven-

tion, the system further comprises a resistor unit for absorbing excessive energy being released when the load is lowered.

[0017] If the amount of the released power is too high to be consumed completely by the capacitor or if the capacity of the capacitor is exceeded, the excessive power/energy may be absorbed or burned off in an additional resistor unit. The resistor unit may also be connected to the energy transfer unit.

[0018] According to a further embodiment of the invention, the storage unit is connected to a DC/DC converter of the energy transfer unit being adapted to work as a step up/step down converter.

[0019] As the voltage in the storage unit increases during charging the storage unit or storing the energy, it may be desirable to couple the storage unit via a DC/DC converter to the energy transfer unit. The DC/DC converter may be adapted to operate bidirectional. To be able to process the increasing voltage within the capacitor, the DC/DC converter may be configured as a step up/step down converter.

[0020] According to a further embodiment of the invention, the energy transfer unit is adapted for supplying energy supplied by the storage unit to further parts of the system for reusing the stored energy.

[0021] If the storage unit stores more energy than needed by the motor unit within the next cycle, the energy transfer unit may supply also further parts of the overall system with the remaining energy.

[0022] According to a further aspect of the invention, there is provided a draw work arrangement, the draw work arrangement comprising a load to be raised and lowered, a motor unit for raising the load, and a system having the above mentioned features.

[0023] The term "draw work arrangement" may refer to a primary hoisting machinery that is a component of a rotary drilling rig. Its main function may be to provide a means of raising and lowering traveling blocks.

[0024] According to a further embodiment of the invention, the draw work arrangement is adapted for moving a drill, in particular a drill of a drilling rig.

[0025] The draw work may be part of a drilling rig or vessel with thruster or propulsion.

[0026] According to a further embodiment of the invention, the draw work arrangement is adapted for moving a compensation weight, in particular for compensating wave movements of a drilling rig.

[0027] The load may be a compensation weight, which may be used in combination with thrusters or propulsions for compensating movements of drill ships or drilling rigs based on wave movements.

[0028] According to a further aspect of the invention, a drilling rig is provided, which comprises a draw work arrangement having the above mentioned features.

[0029] According to a further aspect of the invention, a method for recovering energy used for raising a load of a draw work is provided, the method comprising supplying energy to a motor unit by an energy transfer unit for raising the load of the draw work, wherein the energy transfer unit is connectable to the motor unit, lowering the load, and storing energy by a storage unit, wherein the storage unit is connected to the energy transfer unit, which energy is released by the motor unit to the energy transfer unit, when the load is lowered.

[0030] It has to be noted that embodiments of the invention have been described with reference to different subject matters. In particular, some embodiments have been described with reference to method type claims whereas other embodiments have been described with reference to apparatus type claims. However, a person skilled in the art will gather from the above and the following description that, unless other notified, in addition to any combination of features belonging to one type of subject matter also any combination between features relating to different subject matters, in particular between features of the method type claims and features of the apparatus type claims is considered as to be disclosed with this document.

[0031] The aspects defined above and further aspects of the present invention are apparent from the examples of embodiment to be described hereinafter and are explained with reference to the examples of embodiment. The invention will be described in more detail hereinafter with reference to examples of embodiment but to which the invention is not limited.

Brief Description of the Drawing

[0032]

Figure 1 shows a system for recovering energy according to an embodiment of the invention.

Figure 2 shows a system for recovering energy according to a further embodiment of the invention usable in a draw work arrangement.

Figure 3 shows a system for dissipating energy usable in a draw work arrangement.

Detailed Description

[0033] The illustration in the drawing is schematically. It is noted that in different figures, similar or identical elements are provided with the same reference signs or with reference signs, which are different from the corresponding reference signs only within the first digit.

[0034] Figure 1 shows a system 110 for recovering energy according to an embodiment of the invention. The system 110 may be part of an overall system 100, which may be for example a draw work arrangement.

[0035] The system 110 for recovering energy used for raising a load 150 of a draw work comprises an energy transfer unit 120 for supplying energy to a motor unit 140. The motor unit may raise the load of the draw work. The energy transfer unit is connectable to the motor unit.

[0036] When the load is lowered again, energy may be released. The system 110 comprises therefore a storage unit 130. The storage unit is connected to the energy transfer unit. The storage unit is adapted for storing energy, which energy is released, when the load is lowered.

[0037] The load may refer to the electrical load of the draw work machine, which is dependent on the mechanical load of the system, for example used for hoisting a drill string.

[0038] The draw work may be used for moving a drill, for example of a drill ship. When the drill is connected to a shore and waves are moving the drill ship or drilling rig up and down, the draw work may compensate this movement. The energy recovery unit may be used in both cases. The benefit of using the energy recovery system may be biggest when the draw work has to compensate the wave movements.

[0039] The system 110 may also be seen as an electric drive with an energy recovery system, as both units, the energy transfer unit 120 and the storage unit 130, are electric motor drive and energy recovery units.

[0040] Further features of the energy recovery system are described with the reference to Figure 2.

[0041] Figure 2 shows a system 120 for recovering energy according to a further embodiment of the invention usable in a draw work arrangement 200.

[0042] The system 120 comprises an energy transfer unit 120 and a storage unit 130. The energy transfer unit comprises one or more parts 122, each of which consist of a DC/AC converter coupled to a switch. The switch is coupled to a DC bus system 160. The DC/AC converter is coupled to one or more motor units 140, which may be AC motors.

[0043] The storage unit 130 is also coupled to the DC bus system. The storage unit comprises a capacitor 131 for storing energy, which is released, when a load coupled to one or more of the motor units is lowered. The capacitor is coupled to the DC bus system via a DC/DC converter 121. The draw work arrangement 200 may also comprise more than one storage unit.

[0044] The system comprises further a resistor unit 132, which may be part of the energy transfer unit or the storage unit or may be an individual part of the system. The resistor unit may be used for burning off excessive energy, which may not be stored in the storage unit. The resistor unit 132 is coupled to the DC bus system via a DC/DC converter 123 which is adapted to work as a switch, i.e. unidirectional.

[0045] An AFE unit 151 may be coupled to the DC bus system. The AFE (active front end) inverter unit may be coupled to an external source 152. Via the AFE unit, excessive energy may be retransferred into further parts of the system.

[0046] In an active heave situation of the system, for example when the draw work has to move the load up and down to compensate the wave movement, power is transferred into the energy transfer unit, for example into the parts 122 of the energy transfer units, also called drive units, and some seconds later back again. The power changes in time as a nearby sine function with a period time of approximately 12 seconds, for example. The energy transferred from the load back to the drive units has to be burned off in one or more braking resistors. This may be seen in Figure 3 showing a conventional system 300 for dissipating energy usable in a draw work arrangement. In this figure, the braking resistors 132 are coupled to the DC bus system via DC/DC converters 121, which are working only as unidirectional switches. To burn the released energy off, big cooled braking resistors are used to dissipate the energy.

[0047] Instead of burning off the energy, the energy may be recovered, for example by using bidirectional rectifiers. This may be used in an equipment, where there is a cable connection to shore, for example a container crane. However, the isolated electrical system on board of a vessel may not be able to use this energy and the stability of the generators might be reduced.

[0048] According to embodiments of the invention, a storage unit, for example capacitors, may be used in combination with some power electronic to store the energy in one half cycle instead of being dissipated in a resistor and be brought back to the system in the next cycle. The storage unit may be connected to the DC part of the inverter, at the same place as the braking resistors are connected in the conventional system of Figure 3.

[0049] With the system according to embodiments of the invention, a more stable power consumption from generators may be achieved, which is desirable as a change in power is always a risk of trip of generators. Further, abrasion of the generators may be reduced.

[0050] The braking resistors of the conventional system are consuming big amount of cooling water due to the huge amount of heat to get rid of. This may be avoided with embodiments of the invention. Further, needed infrastructure, energy consumption and emissions may be reduced.

[0051] It should be noted that the term "comprising" does not exclude other elements or steps and the use of articles "a" or "an" does not exclude a plurality. Also elements described in association with different embodiments may be combined. It should also be noted that reference signs in the claims should not be construed as limiting the scope of the claims.

Claims

1. A system (110) for recovering energy used for raising a load of a draw work, the system comprising
   an energy transfer unit (120) for supplying energy to a motor unit (140) for raising the load (150) of the draw work, wherein the energy transfer unit is connectable to the motor unit, and
   a storage unit (130), wherein the storage unit is connected to the energy transfer unit and wherein the storage unit is adapted for storing energy, which en-

ergy is released by the motor unit to the energy transfer unit, when the load is lowered.

2. The system (110) as set forth in claim 1, wherein the storage unit (130) is adapted for supplying the stored energy back to the energy transfer unit (120) for reusing the stored energy.

3. The system (110) as set forth in one of the preceding claims, wherein the storage unit (130) comprises a capacitor (131).

4. The system (110) as set forth in one of the preceding claims, wherein the storage unit (131) comprises a battery.

5. The system (110) as set forth in one of the preceding claims, wherein the system further comprises a resistor unit (132) for absorbing excessive energy being released when the load (150) is lowered.

6. The system (110) as set forth in one of the preceding claims, wherein the storage unit (130) is connected to a DC/DC converter (121) of the energy transfer unit (120) being adapted to work as a step up/step down converter.

7. The system (110) as set forth in one of the preceding claims, wherein the energy transfer unit (120) is adapted for supplying energy supplied by the storage unit (130) to further parts of the system for reusing the stored energy.

8. A draw work arrangement (100), comprising
a load (150) to be raised and lowered,
a motor unit (140) for raising the load, and
a system (110) as set forth in claims 1 to 7.

9. The draw work arrangement (100) as set forth in claim 8,
wherein the draw work arrangement is adapted for moving a drill, in particular a drill of a drilling rig.

10. The draw work arrangement (100) as set forth in one of the claims 8 and 9, wherein the draw work arrangement is adapted for moving a compensation weight, in particular for compensating wave movements of a drilling rig.

11. A drilling rig comprising a draw work arrangement (100) as set forth in claims 8 to 10.

12. A method for recovering energy used for raising a load of a draw work, the method comprising
supplying energy to a motor unit by an energy transfer unit for raising the load of the draw work, wherein the energy transfer unit is connectable to the motor unit,
lowering the load, and
storing energy by a storage unit, wherein the storage unit is connected to the energy transfer unit, which energy is released by the motor unit to the energy transfer unit, when the load is lowered.

Amended claims in accordance with Rule 137(2) EPC.

1. A draw work arrangement (100) being part of a drilling rig or vessel, the draw work arrangement comprising

a load (150) to be raised and lowered,
a motor unit (140) for raising the load, and
a system (110) for recovering energy used for raising the load of the draw work,
wherein the system comprises
an energy transfer unit (120) for supplying energy to a motor unit (140) for raising the load (150) of the draw work, wherein the energy transfer unit is connectable to the motor unit, and
a storage unit (130), wherein the storage unit is connected to the energy transfer unit and wherein the storage unit is adapted for storing energy, which energy is released by the motor unit to the energy transfer unit, when the load is lowered,
wherein the storage unit (130) comprises a capacitor (131) and/or a battery.

2. The draw work arrangement (100) as set forth in claim 1, wherein the storage unit (130) is adapted for supplying the stored energy back to the energy transfer unit (120) for reusing the stored energy.

3. The draw work arrangement (100) as set forth in one of the preceding claims, wherein the system further comprises a resistor unit (132) for absorbing excessive energy being released when the load (150) is lowered.

4. The draw work arrangement (100) as set forth in one of the preceding claims, wherein the storage unit (130) is connected to a DC/DC converter (121) of the energy transfer unit (120) being adapted to work as a step up/step down converter.

5. The draw work arrangement (100) as set forth in one of the preceding claims, wherein the energy transfer unit (120) is adapted for supplying energy supplied by the storage unit (130) to further parts of the system for reusing the stored energy.

6. The draw work arrangement (100) as set forth in claim 8,
wherein the draw work arrangement is adapted for

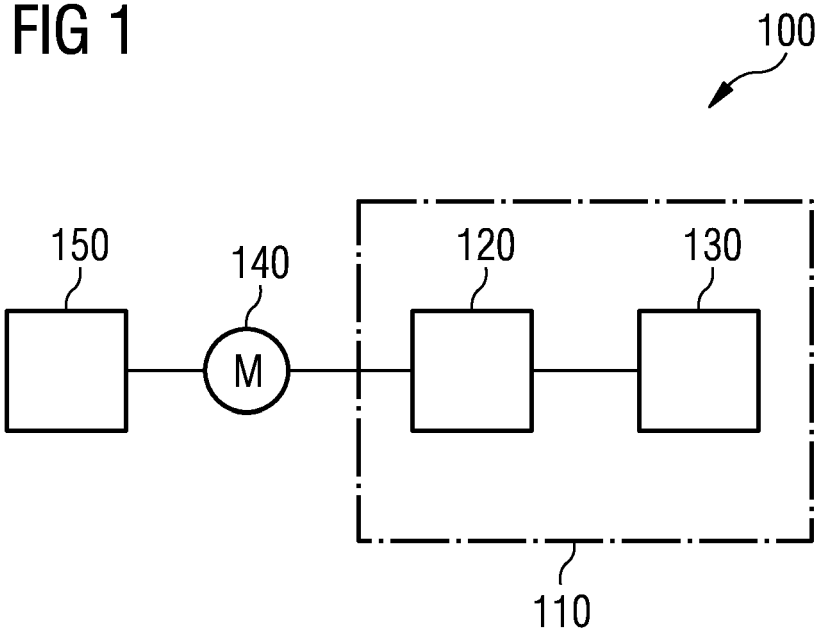
moving a drill, in particular a drill of a drilling rig.

7. The draw work arrangement (100) as set forth in one of the preceding claims, wherein the draw work arrangement is adapted for moving a compensation weight, in particular for compensating wave movements of a drilling rig.

8. A drilling rig comprising a draw work arrangement (100) as set forth in one of the preceding claims.

9. A method for recovering energy used for raising a load of a draw work arrangement (100) being part of a drilling rig or vessel, the draw work arrangement comprising a load (150) to be raised and lowered, a motor unit (140) for raising the load, and a system (110) for recovering energy used for raising the load of the draw work,
the method comprising
supplying energy to a motor unit by an energy transfer unit for raising the load of the draw work, wherein the energy transfer unit is connectable to the motor unit,
lowering the load, and
storing energy by a storage unit, wherein the storage unit is connected to the energy transfer unit, which energy is released by the motor unit to the energy transfer unit, when the load is lowered,
wherein the storage unit (130) comprises a capacitor (131) and/or a battery.

FIG 1



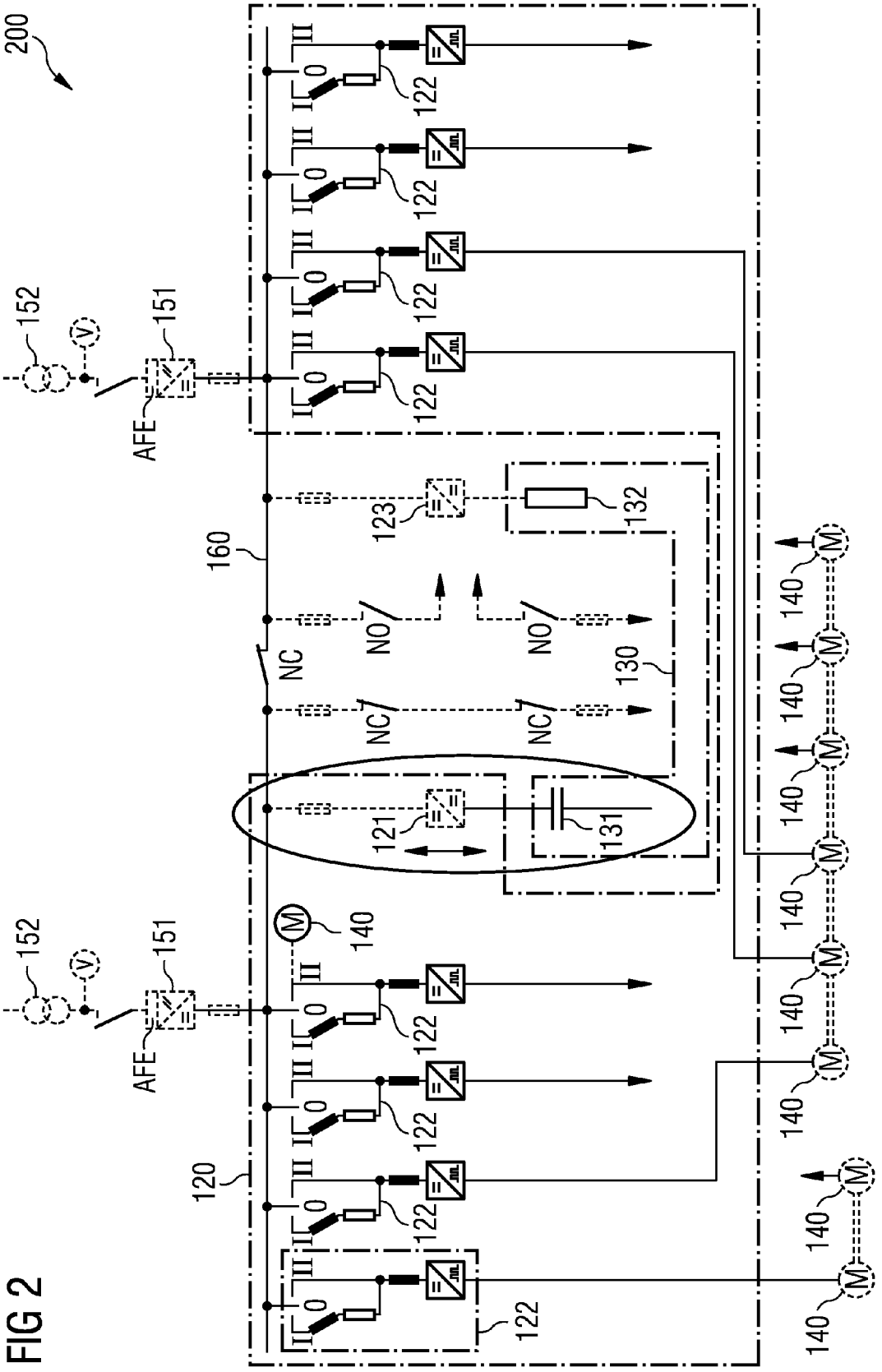


FIG 2

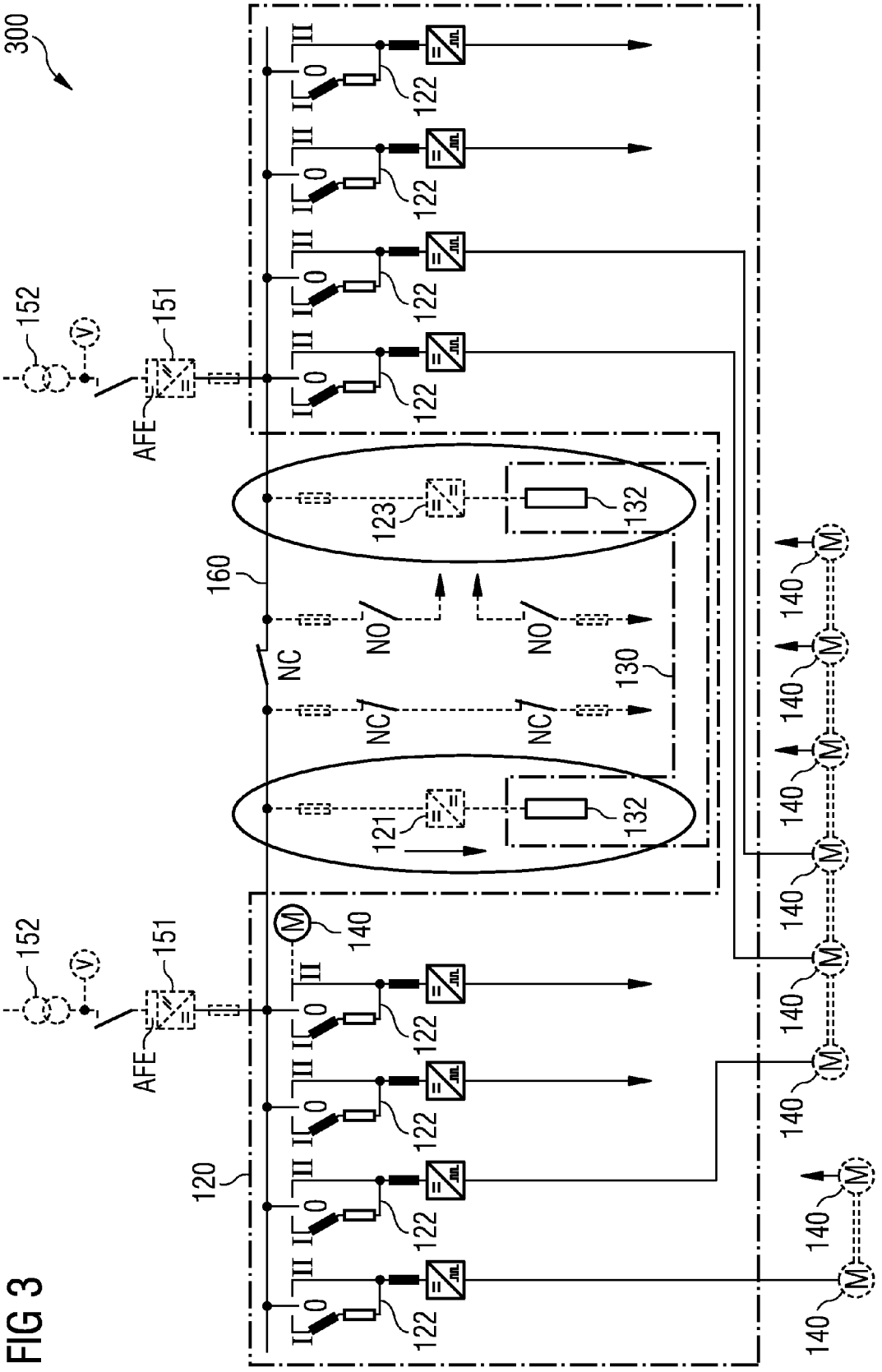


FIG 3

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EUROPEAN SEARCH REPORT

Application Number
EP 10 18 8707

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 A	US 2005/173198 A1 (TAKEHARA TORU [US] ET AL) 11 August 2005 (2005-08-11) * paragraphs [0005], [0 35] - [0038], [0 51] - [0054] * * figures 3,4 *	1-3,5,6, 8,12 4	INV. H02J7/00 E21B41/00 B66C13/28
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X	JP 2001 163574 A (MITSUBISHI HEAVY IND LTD) 19 June 2001 (2001-06-19) * abstract * * figures *	1,2,4,8, 12	
X	ZHANG ET AL: "An energy-saving oil drilling rig for recovering potential energy and decreasing motor power", ENERGY CONVERSION AND MANAGEMENT, ELSEVIER SCIENCE PUBLISHERS, OXFORD, GB, vol. 52, no. 1, 31 July 2010 (2010-07-31), pages 359-365, XP027443498, ISSN: 0196-8904, DOI: DOI:10.1016/J.ENCONMAN.2010.07.009 [retrieved on 2010-07-31] * the whole document *	1,2,7-9, 11,12	TECHNICAL FIELDS SEARCHED (IPC) H02J E21B B66C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	22 March 2011	Özsoy, Sevda

CATEGORY OF CITED DOCUMENTS

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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
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