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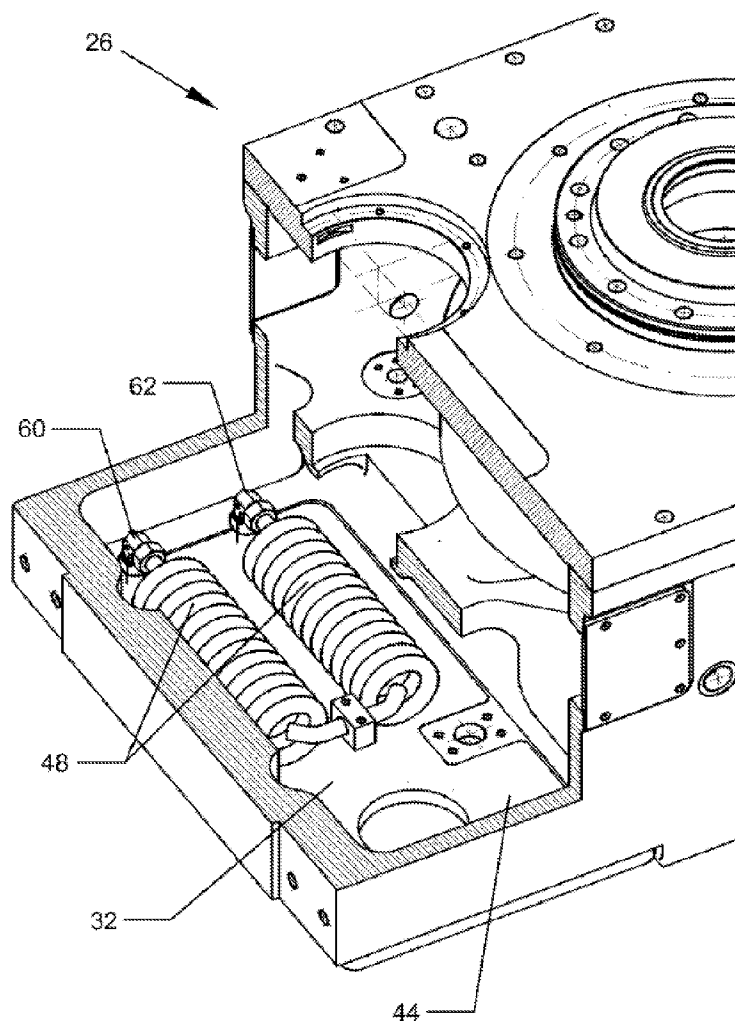
(19) **United States**(12) **Patent Application Publication**
MOSS(10) **Pub. No.: US 2016/0010392 A1**(43) **Pub. Date: Jan. 14, 2016**(54) **DRIVING DEVICE FOR DRIVING DRILL
PIPES AND METHOD FOR OPERATING
SUCH A DRIVING DEVICE****Publication Classification**(71) Applicant: **BENTEC GMBH DRILLING &
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CPC *E21B 3/02* (2013.01); *E21B 7/00* (2013.01)(72) Inventor: **Johannes MOSS**, Nordhorn (DE)(57) **ABSTRACT**(21) Appl. No.: **14/772,367**(22) PCT Filed: **Mar. 3, 2014**(86) PCT No.: **PCT/EP2014/054020**

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The invention relates to a so-called topdrive (16) in the form of a device to drive drill pipes and to a method for operating this drive, in which means are provided to heat the gearbox oil (46) used by the topdrive (16), which means can also be supplied by an emergency power unit and comprise a hydraulic unit (28) and a pressure limiting valve (40) of the topdrive (16), wherein hydraulic fluid (36) is circulated through the pressure limiting valve (40) to heat the gearbox oil (46) by the hydraulic unit (28), and the heat energy thus generated is transferred through a heat exchanger (48) through which the hydraulic fluid (36) flows to the gearbox oil (46).



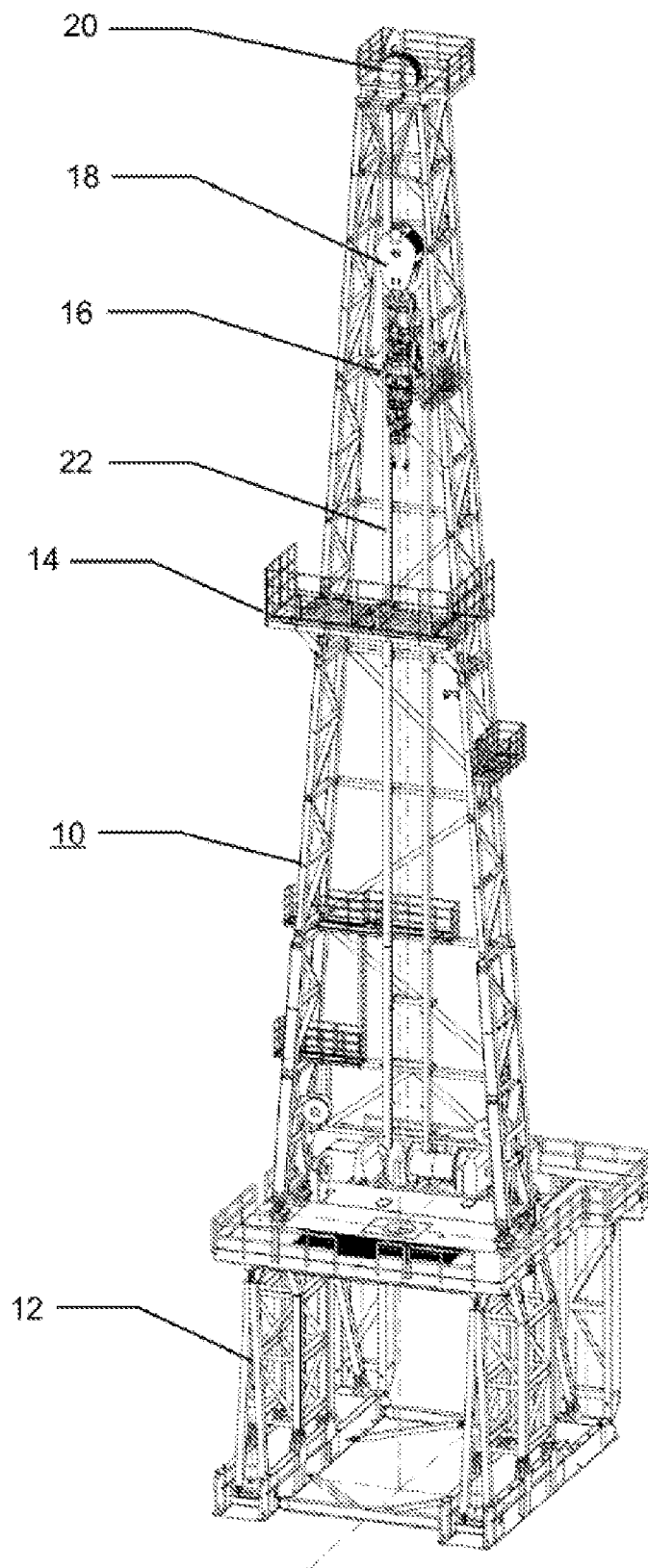


Fig. 1
(Prior Art)

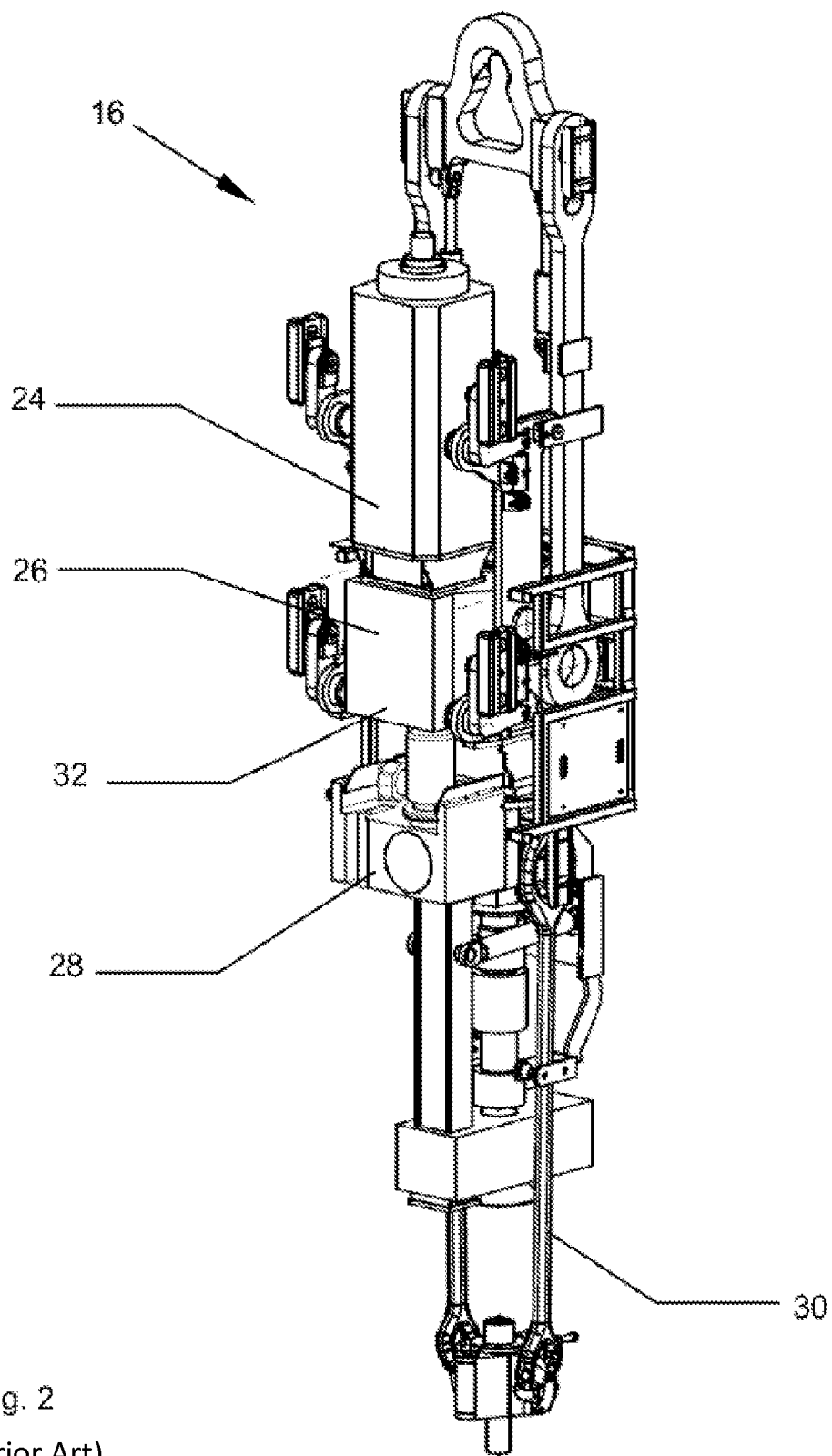


Fig. 2
(Prior Art)

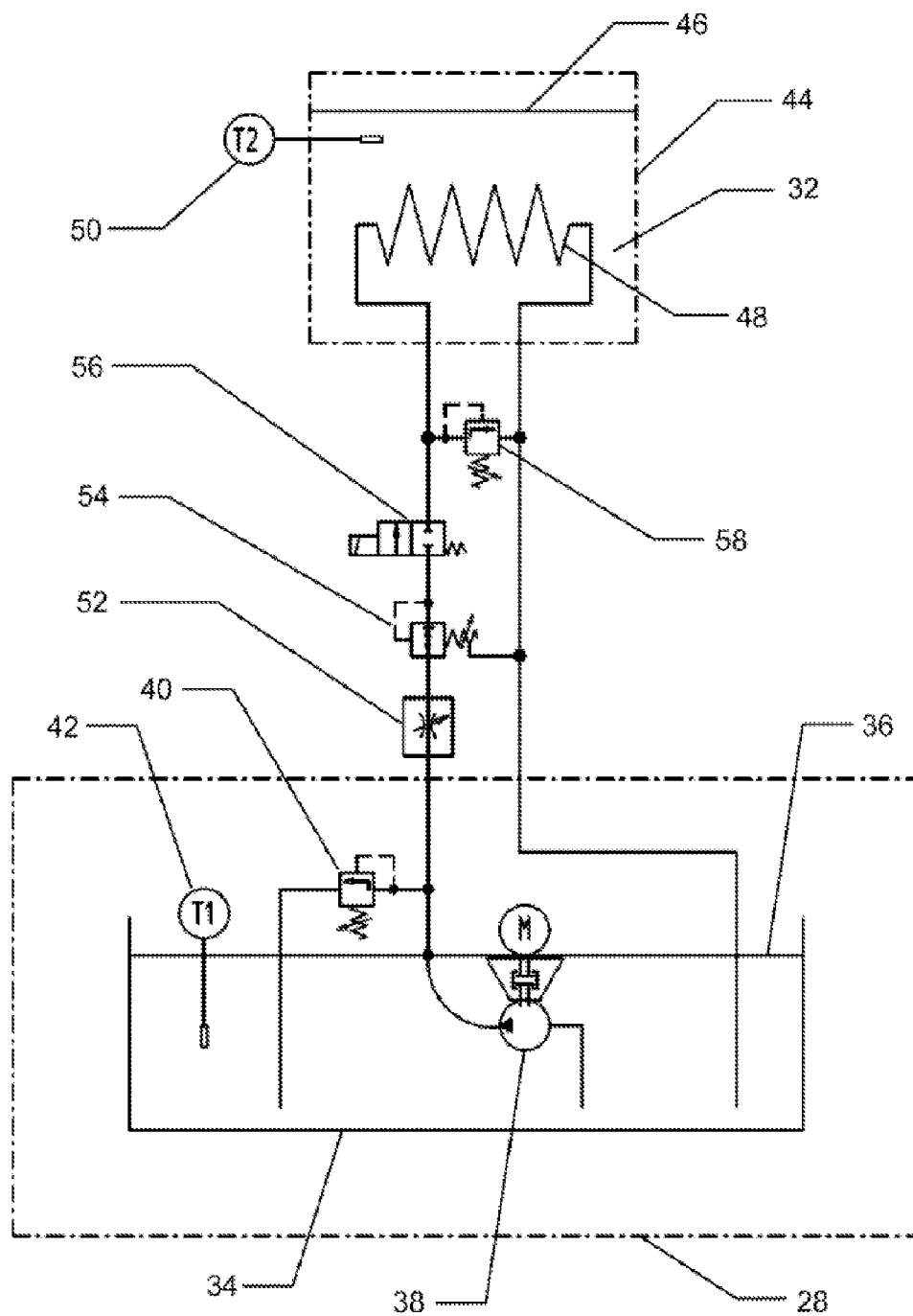


Fig. 3

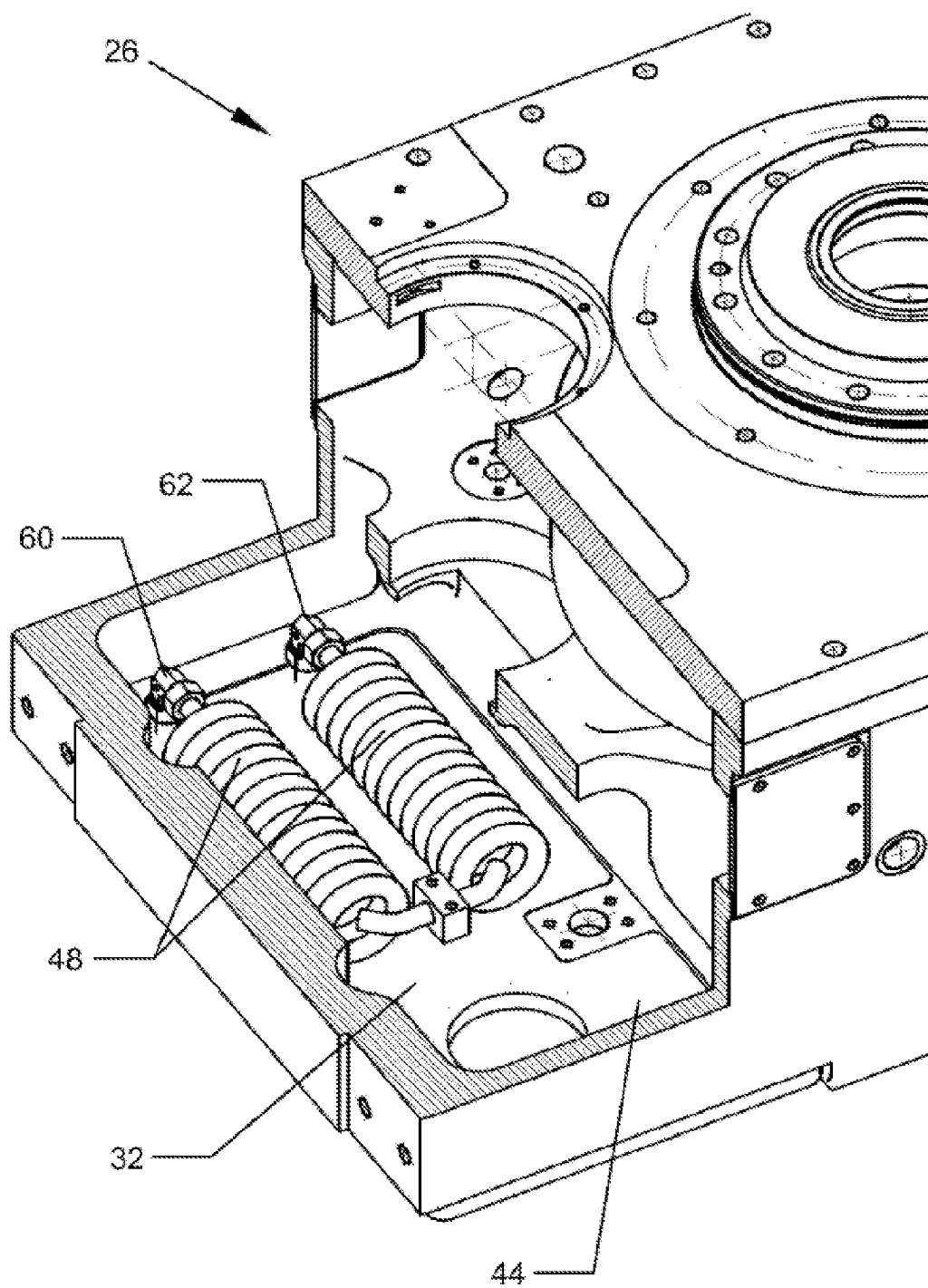


Fig. 4

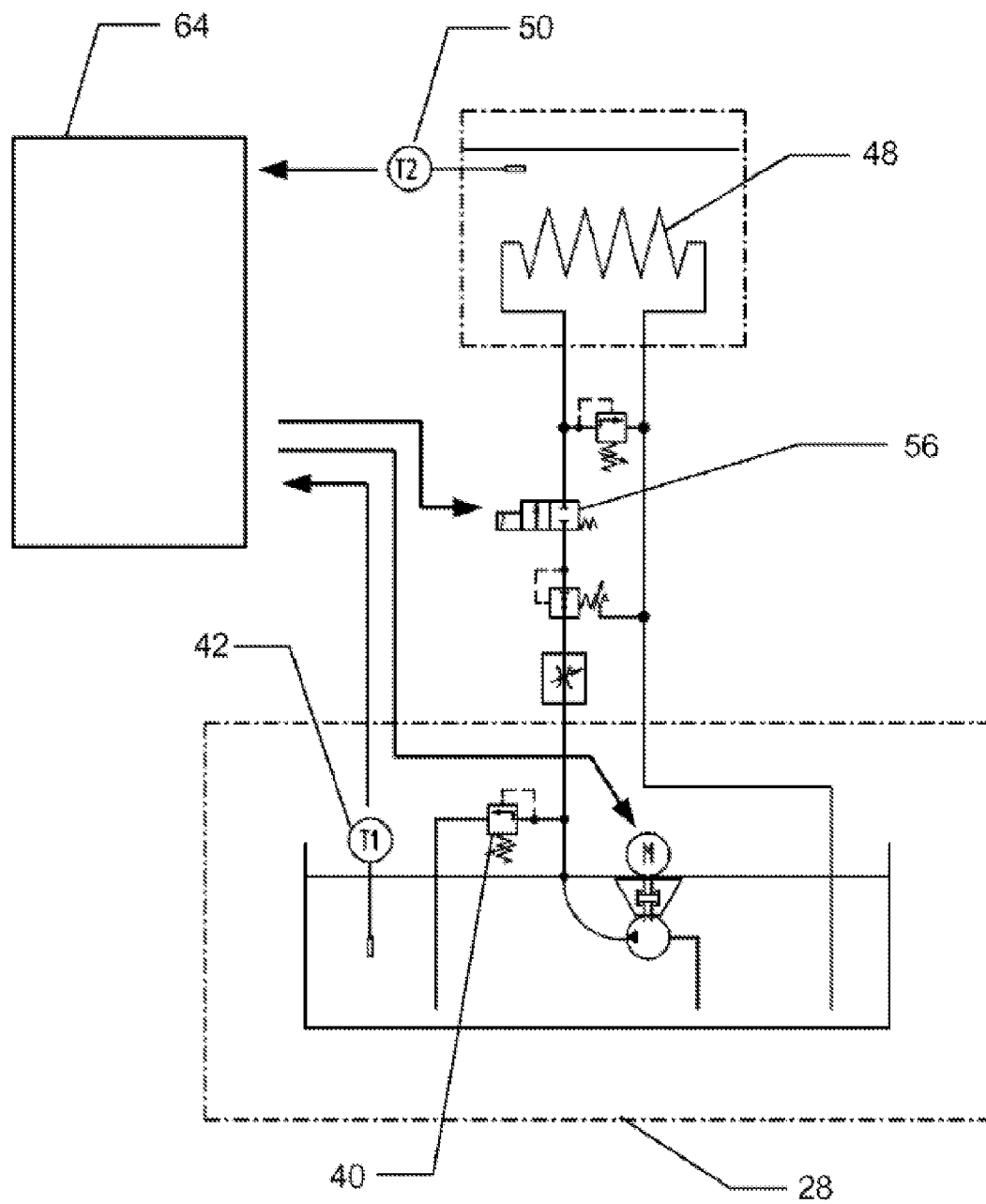


Fig. 5

DRIVING DEVICE FOR DRIVING DRILL PIPES AND METHOD FOR OPERATING SUCH A DRIVING DEVICE

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The following invention relates to a drive device, hereafter identified in abbreviated form in accordance with standard technical terminology as a topdrive, for driving drill pipes for drilling boreholes in hydrocarbon deposits, e.g., petroleum or natural gas, or for exploiting geothermal energy.

[0003] 2. Description of the Related Art

[0004] Topdrives of this type are well known per se and comprise a gearbox by which the torque of a drive motor, also included in the topdrive, is transferred to the drill pipes.

[0005] One aspect of the gearbox for topdrives that is well known is the fact that this drive must only be operated above a minimum temperature which is determined in particular by the type of gearbox oil. This minimum temperature is in the range, for example, of minus 20° C. When temperatures are below this minimum temperature the gearbox must first be warmed up until it reaches a specified minimum operating temperature. This minimum operating temperature, for example, is in the range of minus 15° C. A cold start procedure is provided to warm up the gearbox in this way.

[0006] The cold start procedure used up until now assumes that a stable line voltage of 600/690 V is available at the main motor (drive motor) and at a frequency inverter supplying the main motor.

[0007] This type of line voltage and, in particular, stable line voltage is not always available at locations where drilling rigs—and along with these the topdrives included therein—are operated. It would, therefore, be more advantageous if the above-described cold start procedure were possible using a voltage—for example, 442 V—available from an emergency power unit. Precisely because of the above-described problems relating to inconsistent line voltages, these emergency power units are typically available at the installation site of a drilling rig, and based on the typical application situation for these emergency power units these are normally also ready for use whenever a stable line voltage is not available.

[0008] Electrically operated heating, whether supplied from the grid or by an emergency power unit, to reliably provide the minimum operating temperature for the gearbox oil can generally be ruled out due to the latent risk of explosion when operating the rig and the so-called ATEX directives that must be complied with here. The minimum approach here would be to provide an extra fill level monitor for the gearbox oil so that this in principle possible electrical heating is not turned on or does not stay on if the electrically heated heating element—for example in the simplest case a resistance wire—is exposed and thus no heat is transferred to the gearbox oil, but instead the heating element is likely to burn out. Regardless of this factor, a possible electrically-operated heating with the necessary heating performance requires a substantial amount of space. This space is not available or is typically occupied by other systems in the topdrive which alternately moves up and down within the drilling mast during the drilling operation.

SUMMARY OF THE INVENTION

[0009] One object of the invention is therefore to propose a drive device of the type referenced above, that is, a topdrive in

which it is possible to heat the gearbox oil by another approach. Another object of the invention is to provide a method for operating this type of topdrive.

[0010] This object is achieved according to the invention by the features of the independent claims.

[0011] In terms of the topdrive, that is, a drive device to drive drill pipes when drilling boreholes in hydrocarbon deposits in the form of a topdrive, the following is provided: In the well-known approach the topdrive comprises a hydraulic unit including a pan for hydraulic fluid, in particular, hydraulic oil, in which pan hydraulic fluid is present in a topdrive that is ready to operate or is already operating. The topdrive furthermore by the known approach comprises a gearbox with a gearbox oil pan in which gearbox oil is located in a topdrive that is ready to operate or is already operating. A gearbox oil temperature value for the temperature of the gearbox oil in the gearbox oil pan can be measured by a temperature sensor identified with specific reference as a gearbox oil temperature sensor.

[0012] The hydraulic fluid can be circulated by the hydraulic unit through a pressure limiting valve included in the topdrive as a function of the gearbox oil temperature value.

[0013] Thus, if the gearbox oil temperature value is below a specified or specifiable limit, i.e., a corresponding processing and logical operation linking the gearbox oil temperature value and the limit effected by a circuit or software is provided for this purpose and is automatically able to detect that a cold start procedure must be initiated before the topdrive is put into operation. The cold start procedure that can also be initiated automatically by detecting this situation, that is, as a function of the gearbox oil temperature value, consists of having the hydraulic fluid circulated by the hydraulic unit through the pressure limiting valve. The thermal dissipation loss generated by the flow passing through the pressure limiting valve results in the hydraulic fluid being heated. The hydraulic fluid thus heated can be passed by the hydraulic unit through a heat exchanger installed in the gearbox oil pan as a function of temperature and/or time.

[0014] As a result, the heat generated at the pressure limiting valve by the hydraulic fluid is transferred through the heat exchanger installed in the gearbox oil pan to the gearbox oil. This allows the gearbox oil to be heated by the hydraulic fluid. This is sometimes also identified below as hydraulic gearbox oil heating. This approach can be transferred in an analogous or similar fashion to other units of a drilling rig.

[0015] Introduction of the heated hydraulic fluid into the heat exchanger can be effected as a function of temperature and/or time. When the heated hydraulic fluid is introduced into the heat exchanger as a function of temperature, this introduction can be effected whenever the hydraulic fluid has reached a specified temperature. When the heated hydraulic fluid is introduced into the heat exchanger as a function of time, this introduction can be effected whenever the circulation of the hydraulic fluid through the pressure limiting valve has been effected at least for a specified or specifiable period of time and it can be assumed that the hydraulic fluid has undergone a rise in temperature necessary to heat the gearbox oil.

[0016] In terms of a method of operating this topdrive or a topdrive that is described below in more detail, a provision is made whereby the hydraulic unit is activated automatically as a function of the gearbox oil temperature value to circulate the hydraulic fluid through the pressure limiting valve and whereby the hydraulic fluid is passed automatically as a func-

tion of temperature and/or time through a heat exchanger installed in the gearbox oil pan.

[0017] The above-referenced object of the invention is also achieved by a control device to control the operating method of the topdrive that performs the cold start procedure, which device functions according to the method described here and below, and for this purpose comprises means to implement the method. The invention is preferably implemented in software; it can just as well, however, be implemented in hardware, or in both software and hardware. The invention is thus also a computer program comprising program code instructions that can be executed by a computer, but is also a storage medium comprising this computer program—in other words a computer program product comprising program coding means, and finally also a control device, in the storage medium of which this computer program is loaded or can be loaded as means to implement the method.

[0018] Whenever reference is made here or below to the fact that a specific action is effected automatically, this must be understood to mean that the action is performed or initiated by the control device or at least under the control of the control device. Examples of such actions are comparing the gearbox oil temperature value with the limit for the gearbox oil temperature, and activating the hydraulic unit to circulate the hydraulic fluid through the pressure limiting valve as a function of the gearbox oil temperature value.

[0019] The advantage of the invention is the fact that components and units are used to heat the gearbox oil that are already included in the topdrive—specifically, the hydraulic unit and the pressure limiting valve. Another advantage is the fact that the action of heating the gearbox oil proposed here only requires the operation of the hydraulic unit. The hydraulic unit can be very easily operated by an emergency power unit. Heating the gearbox oil as proposed here is thus independent of any line voltage which is sometimes not available or is not available at a sufficient level of stability. Since components and units are being used to heat the gearbox oil that are already in any case included in the topdrive, no additional installation space is required in the region of the topdrive. The (additionally required) heat exchanger is located within the volumetric space of the gearbox oil pan, the geometry and outer dimensions of which do not require any modification, with the result that the heat exchanger located in the gearbox oil pan also does not require any additional installation space.

[0020] Advantageous embodiments of the invention are described in the dependent claims. References used here relate to the further development of the object of the main claim by means of the features of the specific dependent claim; they must not be understood to imply abandonment of obtaining independent, subject-matter-specific protection for the combination of features of the referenced dependent claims. Furthermore in terms of interpreting the claims relating to a more detailed description of a feature in a subordinate claim, it must be assumed that this restriction is not present in the respective preceding claims.

[0021] Since the various subject matter of the dependent claims can constitute separate and independent inventions in terms of the prior art on the priority date, the applicant reserves the right to make them the subject matter of independent claims or declarations of division. They can furthermore also contain independent inventions that comprise an embodiment which is independent of the various subject matter of the preceding claims.

[0022] In one embodiment of the drive device (the topdrive), this device or drive comprises a temperature sensor that is identified for purposes of differentiation as a hydraulic fluid temperature sensor. This hydraulic fluid temperature sensor enables a hydraulic fluid temperature value to be measured for a hydraulic fluid temperature in the pan of the hydraulic unit. The hydraulic fluid can then be passed by the hydraulic unit through the heat exchanger that is installed in the gearbox oil pan as determined by this hydraulic fluid temperature value.

[0023] An automatic and temperature-dependent introduction of the hydraulic fluid into the heat exchanger is thus possible based on the hydraulic fluid temperature value obtained by the hydraulic fluid temperature sensor. In terms of introducing the hydraulic fluid into the heat exchanger, the point of reaching a threshold value is monitored relative to the hydraulic fluid temperature value. Sufficient heating of the hydraulic fluid is recognized as soon as this threshold value has been reached. The heated hydraulic fluid can now be passed to the heat exchanger, thereby allowing heat to be transferred there to the gearbox oil surrounding the heat exchanger.

[0024] In another or alternative embodiment of the drive device (the topdrive), a directional control valve is disposed between the hydraulic unit and the heat exchanger in the flow direction of the hydraulic fluid. The directional control valve enables the hydraulic fluid to be automatically passed either to the pressure limiting valve or to the heat exchanger. It is possible to divert or divide the hydraulic fluid flow depending on the location of the directional control valve (upstream from the directional control valve or downstream from the directional control valve).

[0025] If the directional control valve is located upstream from the pressure limiting valve, the directional control valve can be used to pass the hydraulic fluid either exclusively through the pressure limiting valve or exclusively through the heat exchanger. A first hydraulic branch including the pressure limiting valve and a second hydraulic branch including the heat exchanger respectively connect to the heat exchanger. The first hydraulic branch or the second hydraulic branch is active depending on the position of the directional control valve.

[0026] If the directional control valve is located downstream from the pressure limiting valve, only the hydraulic branch through the pressure limiting valve is active when the directional control valve is closed. If the directional control valve is open, the hydraulic branch through the pressure limiting valve remains unaffected by this and continues to be active. The flow of hydraulic fluid divides, part of it following the first hydraulic branch through the pressure limiting valve and part of it following the second hydraulic branch with the open directional control valve and the heat exchanger that is connected thereto.

[0027] This type of directional control valve is thus both an efficient and simultaneously simple means of implementing a first hydraulic cycle in which a thermal dissipation loss can be generated by the pressure limiting valve located there, thereby heating the hydraulic fluid and simultaneously implementing a second hydraulic cycle in which a sufficiently heated hydraulic fluid can be passed to a heat exchanger in the gearbox oil pan in order to heat the gearbox oil there.

[0028] In one embodiment of the drive device (topdrive), in particular, which allows the volumetric flow generated by the hydraulic unit to be divided based on the location of the

directional control valve, a flow control valve (throttle valve) is disposed in the flow direction of the hydraulic fluid between the hydraulic unit and the heat exchanger. The volumetric flow to the heat exchanger that is provided by the hydraulic unit can be adjusted by the flow control valve. As the flow control valve is opened further, thus producing less resistance for the hydraulic fluid flowing through the flow control valve, more and more hydraulic fluid flows along the path with the flow control valve. Conversely, that much less hydraulic fluid flows along the path with the flow control valve as the flow control valve is closed further. More hydraulic fluid then flows along the path with the pressure limiting valve included in the hydraulic unit since the volumetric flow is divided. The flow control valve thus enables adjustments to be made as to the level at which the hydraulic fluid should continue to generate heat by further circulating the hydraulic fluid, and as to the level at which heating of the gearbox oil should be effected by introducing the hydraulic fluid into the heat exchanger.

[0029] What is also found with the flow through the flow control valve—just as was described above for the pressure limiting valve—is that a thermal dissipation loss is generated so as to produce heating of the hydraulic fluid flowing through the flow control valve. The heat thus generated is also passed to the heat exchanger where it is also effective in heating the gearbox oil.

[0030] In an optional approach, another pressure limiting valve can be provided in the flow direction of the hydraulic fluid between the hydraulic unit and the heat exchanger. This limits the effective pressure of the hydraulic fluid to the extent that the fluid can be passed without any risk to the heat exchanger.

[0031] One particularly capable form that has been found for the heat exchanger is a so-called finned tube since, as is well known, this tube has an even significantly greater surface area when compared with a tube rolled up in the shape of a coil and through which the hydraulic fluid flows, and thereby ensures an especially effective transfer of heat to the gearbox oil surrounding the heat exchanger/finned tube.

[0032] In one embodiment of the method referenced above for operating the drive device/topdrive, provision is made in this drive device that includes a gearbox oil temperature sensor to detect the gearbox oil temperature of the gearbox oil in the gearbox oil pan whereby the hydraulic unit is automatically activated to circulate the hydraulic fluid through the pressure limiting valve at a gearbox oil temperature value below a specified or specifiable temperature limit (for example, minus 20° C.). Circulation of the hydraulic fluid and thus heating of the hydraulic fluid are effected automatically, but also only as required based on this monitoring of the gearbox oil temperature value. When gearbox oil temperature value detected as the parameter for the gearbox oil temperature is below the temperature limit, a situation is recognized which requires a cold start procedure before starting up the topdrive. Recognizing the requirement for this cold start procedure and initiating this cold start procedure by circulating the hydraulic fluid through the pressure limiting valve can be effected automatically by implementing appropriate processing and logical operation linking the gearbox oil temperature value and the temperature limit by means of a dedicated circuit or software. As a result, automatic circulation of the hydraulic fluid through the pressure limiting valve is effected as a function of the gearbox oil temperature value.

[0033] In one embodiment of the method referenced above for operating the drive device/topdrive or embodiments thereof, A provision is made in this drive device, which additionally includes a hydraulic fluid temperature sensor to detect a hydraulic fluid temperature value for a temperature of the hydraulic fluid in the pan of the hydraulic unit, whereby the hydraulic fluid is passed automatically through the heat exchanger installed in the gearbox oil pan based on a hydraulic fluid temperature value above a specified or specifiable temperature threshold value. Detection of the temperature of the hydraulic fluid in the form of a hydraulic fluid temperature value and the comparison thereof with a temperature threshold value is an efficient and simple means of performing an automatic and temperature-dependent introduction of hydraulic fluid into the heat exchanger that is installed in the gearbox oil pan. One possible temperature for the temperature threshold value, for example, is a temperature of +40° C. Sufficient heating of the hydraulic fluid is detected when the hydraulic fluid temperature value reaches this temperature or the relevant temperature threshold value. The heat energy absorbed from the hydraulic fluid can be transferred to the gearbox oil in order to heat it. To this end the hydraulic fluid flow is passed to the heat exchanger or at least also to the heat exchanger, and for this purpose a path is enabled for the hydraulic fluid to move from the hydraulic unit to the heat exchanger.

[0034] In another embodiment of the method referenced above for operating the drive device/topdrive or embodiments thereof, provision is made in this drive device, which includes a directional control valve disposed upstream from the pressure limiting valve between the hydraulic unit and the heat exchanger, whereby the hydraulic fluid flow is switched between a first path through the pressure limiting valve and a second path through the heat exchanger by automatically activating the directional control valve. The directional control valve and the appropriate activation thereof is a simple and efficient means of opening a path for the hydraulic fluid from the hydraulic unit to the heat exchanger. The directional control valve passes the hydraulic fluid flow exclusively either through the pressure limiting valve (to heat the hydraulic fluid) or to the heat exchanger (to transfer heat to the gearbox oil).

[0035] In an alternative embodiment of the method referenced above for operating the drive device/topdrive or embodiments thereof, provision is made in this drive device, which unlike the above-described device includes a directional control valve between the hydraulic unit and the heat exchanger downstream from the pressure limiting valve instead of upstream from the pressure limiting valve, whereby the hydraulic fluid flow is switched by automatically activating the directional control valve between a first path through the pressure limiting valve and a second path that at least also includes the heat exchanger. The directional control valve and the appropriate activation thereof is in this embodiment thus also a simple and efficient means of opening a path for the hydraulic fluid from the hydraulic unit to the heat exchanger. Unlike the above-described embodiment, the first path for the hydraulic fluid through the pressure limiting valve is always open when the directional control valve is located downstream from the pressure limiting valve. Activating the directional control valve to open the path for the hydraulic fluid through the heat exchanger thus results in the hydraulic fluid flow being divided between the first path (through the pressure limiting valve) and the second path

(through the heat exchanger). The advantage here is that the hydraulic fluid flowing along the first path continues to be heated as is the case with the exclusive circulation through the pressure limiting valve, with the result that the heat continuing to be absorbed from the hydraulic fluid is available continuously for transfer to the gearbox oil.

[0036] The advantage of the invention and embodiments thereof also entails specifically the fact that there is a reliable expectation of producing a transferable heat output of 2 kW to 3 kW due to the heating of the hydraulic fluid and the circulation thereof through the pressure limiting valve. As a result, the gearbox oil of a topdrive that is offered by the applicant and identified as TD-500-HT can be heated from -40°C . to approximately -15°C . within about an hour. This heating of the gearbox oil as part of a cold start procedure—or maintenance of gearbox oil heat—is only possible by means of the auxiliary drives that can be readily supplied with power by an emergency power unit, specifically here the hydraulic unit. The heating or maintenance of gearbox oil heat are provided here by a “hydraulic gearbox oil heating” that essentially eliminates the need for additional functional units associated with the topdrive, specifically since the hydraulic unit and the pressure limiting valve by means of which the hydraulic fluid is circulated for heating purposes are already included in the topdrive. Other means instead of a temperature sensor (gearbox oil temperature sensor, hydraulic fluid temperature sensor) are possible for determining/detecting/calculating/estimating a temperature value—for example, a mathematical model that enables the relevant temperature value to be determined/calculated/and/or estimated based on other parameters, in particular, parameters detected at the topdrive, for example, based on an ambient temperature and a period of operation. What then replaces the gearbox oil temperature sensor and/or hydraulic fluid temperature sensor is an appropriate means of determining/detecting/calculating/estimating—collectively referenced as “determining” without abandoning the wider general applicability of meaning—the gearbox oil temperature or the hydraulic fluid temperature.

BRIEF DESCRIPTION OF THE DRAWINGS

[0037] The following discussion describes an exemplary embodiment of the invention in more detail based on the drawing. Corresponding items or elements in all figures are provided with identical reference numerals, although not all reference numerals are marked in all figures in order to maintain clarity.

[0038] The exemplary embodiment or each exemplary embodiment must not be understood as implying a restriction of the invention. On the contrary, numerous alterations and modifications are possible within the scope of the invention, in particular, those variants and combinations which can be derived by a person skilled in the art by, for example, combining or modifying individual features or elements or procedural steps that are described in general or in the specification and are contained in the claims and/or the drawing, with the aim of achieving the object of the invention, and which variants or combinations through combinable features result in a new inventive subject matter or in new procedural steps or procedural step sequences, including to the extent these relate to working methods.

[0039] FIG. 1 depicts a section of a drilling rig comprising a mast and a so-called topdrive of the type known per se which can move therein, such as that for employing a device for manipulating drill pipe elements;

[0040] FIG. 2 is a view of a topdrive including additional details, specifically a hydraulic unit and a gearbox housing;

[0041] FIG. 3 is a hydraulic diagram comprising a first and a second hydraulic cycle for hydraulic fluid conveyed by the hydraulic unit;

[0042] FIG. 4 is an enlarged view of the gearbox housing of the topdrive in FIG. 2, comprising a heat exchanger that is installed therein and functions to transfer heat to gearbox oil located in the gearbox housing, which heat exchanger in turn has hydraulic fluid flowing through it that has been heated by the hydraulic unit; and

[0043] FIG. 5 is the hydraulic diagram of FIG. 3 together with a control device that is provided and intended to receive measurement data from and send control signals to individual units included in the hydraulic diagram.

DETAILED DESCRIPTION OF ILLUSTRATED EMBODIMENTS

[0044] The diagram in FIG. 1 depicts as part of a drilling rig a mast 10 including a possible embodiment of an associated substructure 12. A so-called monkey board 14 is located here on mast 10, which monkey board is provided in the manner known per se for the upright, that is, vertical mounting of drill pipe elements. A so-called topdrive 16 is installed in the manner known per se in mast 10, which topdrive is provided during operation to lower and lift the drill pipes (not shown; indicated only by broken lines) and to rotate the drill pipes so as to perform the drilling operation. Topdrive 16 is thus a drive device to drive drill pipes when drilling boreholes in hydrocarbon deposits or for exploiting geothermal energy. The term topdrive is a typically used technical term identifying this type of drive device. This term is used accordingly here and below. The term topdrive is used here specifically also as the abbreviated form for the otherwise possible designation of this type of drive device in the form of drive device to drive drill pipes when drilling boreholes in hydrocarbon deposits or for the exploitation of geothermal energy.

[0045] Topdrive 16 is suspended in mast 10 on a roller block 18. Roller block 18 and a crown block 20 located in the area of a mast crown 20 function together like a pulley block. A cable (not shown) runs from crown block 20 for vertical movement of topdrive 16 to a lifting apparatus provided in the area of the drill rig. Topdrive 16 is held in mast 10 by guide rails 22 for vertical movement that can be actuated by the lifting apparatus.

[0046] The diagram in FIG. 2 reveals an embodiment of a topdrive 16 including additional details. In terms of a description of specific details of the topdrive, reference is made, for example, to DE 10 2009 039 022 A1. The details that are significant for the following description of topdrive 16 are: a drive unit 24 in the form of an electric motor, a gearbox housing 26 including a gearbox (not shown) located therein that appropriately changes the rotational speed and the torque of drive unit 24 so that the drill pipes can be driven appropriately during the drilling action, and a hydraulic unit 28 that, for example, supplies the operating pressure to hydraulically move so-called drill pipe bails 30. An oil sump 32 is created inside a bottom section of gearbox housing 26. This is where portions of the gearbox oil used for the gearbox are located.

[0047] The illustration in FIG. 3 is a schematic simplified view of the above-mentioned details of topdrive 16 (FIG. 2) in the form of a hydraulic diagram. The lower section of the diagram shows hydraulic unit 28. A pan 34 for hydraulic fluid 36 is included in hydraulic unit 28, hydraulic fluid being

located in the pan of topdrive 16 when the drive is ready to operate or in operation. In addition, hydraulic unit 28 furthermore includes a hydraulic pump 38 provided to convey hydraulic fluid 36 together with a motor to operate the pump, a pressure limiting valve 40, and a temperature sensor 42. Temperature sensor 42 measures a temperature of hydraulic fluid 36 (hydraulic fluid temperature). This temperature sensor is thus also identified as hydraulic fluid temperature sensor 42. Hydraulic fluid temperature sensor 42 supplies a hydraulic fluid temperature value T1 as the hydraulic fluid temperature or as a parameter for the hydraulic fluid temperature.

[0048] The hydraulic diagram of FIG. 3 in the region of hydraulic unit 28 illustrates how hydraulic fluid 36 can be circulated through pressure limiting valve 40 by hydraulic unit 28—specifically by hydraulic pump 38 included therein. Hydraulic fluid 36 is conveyed from pan 34 and then discharged from the outlet of pressure limiting valve 40 into pan 34. This creates a circuit for hydraulic fluid 36. This circuit is identified as the first circuit, or in abbreviated form as the first cycle, to differentiate it from another circuit that is described below.

[0049] When hydraulic fluid 36 is circulated in the first cycle through pressure limiting valve 40, heating of hydraulic fluid 36 is effected (hydraulic heating) by means of the thermal dissipation loss generated in pressure limiting valve 40. Pressure limiting valve 40 is part of hydraulic unit 28. Hydraulic unit 28 in turn is part of topdrive 16. This justifies the designation of pressure limiting valve 40 and hydraulic unit 28 as parts of topdrive 16, that is, as being comprised by topdrive 16.

[0050] The top area of the diagram in FIG. 3 shows a gearbox oil pan 44 located in gearbox oil housing 26 of topdrive 16. When topdrive 16 is operating, gearbox oil 46 is located in gearbox oil pan 44, the oil—just as for hydraulic fluid 36—is shown only by the surface of a fluid level provided as an example. Heat exchanger 48 is located in a lower section of gearbox oil pan 44, that is, at the level of oil sump 32 (FIG. 2). A temperature sensor 50 is furthermore located in gearbox housing 26.

[0051] This temperature sensor 50 measures a temperature of the gearbox oil (gearbox oil temperature) in the area of oil sump 32. For purposes of differentiation this temperature sensor 50 is also identified as gearbox oil temperature sensor 50. Gearbox oil temperature sensor 50 supplies a gearbox oil temperature value T2 as a parameter for the gearbox oil temperature.

[0052] Heat exchanger 48 is part of a second hydraulic cycle starting from hydraulic unit 28, where the first hydraulic cycle—as described above—is created inside hydraulic unit 28 and is active when hydraulic fluid 36 is circulated through pressure limiting valve 40. Included in second hydraulic unit 28 are: a flow control valve 52, pressure limiting valve 54, directional control valve 56, and another pressure limiting valve 58 provided to protect heat exchanger 48.

[0053] The illustration of FIG. 4 shows partially cutaway gearbox housing 26, thereby providing a view of the interior thereof, and gearbox oil pan 44 provided there together with oil sump 32 in a lower section of gearbox oil pan 44. Heat exchanger 48 is disposed in gearbox oil pan 44 in the area of oil sump 32, the heat exchanger being shown in the form of two tubular coils. The two tubular coils are interconnected so that the above-mentioned second hydraulic cycle comprises the two tubular coils. The coiled tubes or individual coiled

tubes or more than two coiled tubes shown can be implemented as so-called finned tubes in order to enlarge the effective surface area.

[0054] When the second cycle is active, hydraulic fluid 36 conveyed by hydraulic unit 28 flows into heat exchanger 48 at in-flow side 60, then leaves heat exchanger 48 and thus gearbox housing 26 on a return side 62.

[0055] The illustration in FIG. 5 is a partial repeat of the illustration in FIG. 3. Not all of the reference numerals are repeated so as not to diminish the clarity of FIG. 5. For this reason reference is made to the illustration of FIG. 3. FIG. 5 otherwise is a schematically simplified control device 64 as an example of means to implement the method described here and below. Control device 64 comprises, for example, in an approach known per se a processing unit, not shown, in the form of or analogous to a microprocessor and a storage medium, also not shown, that can be loaded with a control program that is executed when control device 64 is operating by the processing unit thereof.

[0056] The functionality implemented in the control program and the defined functionality of control device 64, which can alternatively also be realized by conventional means, that is, in hardware, is summarized as follows:

[0057] Control device 64 measures at least gearbox oil temperature value T2 supplied by gearbox oil temperature sensor 50. Hydraulic unit 28 is activated to circulate hydraulic fluid 36 through pressure limiting valve 40 as a function of gearbox oil temperature value T2. The gearbox oil temperature correlation can be implemented here by comparing gearbox oil temperature value T2 with a specified or specifiable temperature limit, and by activating hydraulic unit 28 to circulate hydraulic fluid 36 through pressure limiting valve 40 whenever gearbox oil temperature value T2 is below the temperature limit. The temperature limit can be implemented as the content of a memory location of control device 64. The temperature limit can thus be specified but at the same time can be adapted to the specific conditions, that is, for example, to the gearbox oil and the viscosity thereof. One possible example of a temperature limit is minus 20° C.

[0058] In addition, control device 64 functions to have hydraulic fluid 36 passed through heat exchanger 48 installed in gearbox oil pan 44 as a function of temperature and/or time. To this end directional control valve 56 is activated which in the configuration shown in FIG. 3 and FIG. 5 in the open state opens the cycle and thus the path for hydraulic fluid 36 into heat exchanger 48, while the first cycle through pressure limiting valve 40 remains active. Flow control valve 52 functions here to divide the volumetric flow of hydraulic fluid 36 between the first and the second cycle.

[0059] The above-described detection of measured values by control device 64 and the activation of individual units effected by control device 64 are illustrated by arrows in the diagram of FIG. 5. The paths of action thus shown are implemented in practice as wire connections through which the measured values can be received and control signals can be sent.

[0060] If control device 64 effects a time-dependent introduction of hydraulic fluid 36 into heat exchanger 48, control device 64 includes a timer that is started with the start of circulation of hydraulic fluid 36 through pressure limiting valve 40, and during the sequence generates a signal, on the basis of which control device 64 generates the signal to activate directional control valve 56 to open the second cycle for hydraulic fluid 36. The timer can be implemented by the

well-known approach as a decrementing or incrementing counter. The start and the target value of this counter can be specified as content of a memory location of control device 64. The relevant value used is thus an empirical value that can be adapted to the specific conditions. Provision can be made in one particular embodiment whereby control device 64 manages a plurality of these values from which a user selects a value appropriate to the given situation based on hydraulic fluid 36 is used, the delivery volume of hydraulic unit 28, that is, for example, twenty liters per minute, and the pressure at which pressure limiting valve 40 limits/reduces the pressure of hydraulic fluid 36, in other words, for example, 210 bar. The values managed by control device 64 can then, for example, be organized in a multi-dimensional matrix, and an appropriate time value is selected from a specified value or selection of individual parameters. This approach achieves the goal of eliminating the need to measure the hydraulic fluid temperature, and hydraulic fluid temperature sensor 42 that is otherwise provided to measure the hydraulic fluid temperature can accordingly be eliminated.

[0061] If hydraulic fluid temperature sensor 42 is present and is used, the temperature-dependent and/or time-dependent introduction of hydraulic fluid 36 into heat exchanger 48 is effected as a function of temperature or at least also as a function of temperature. To this end, control device 64 measures hydraulic fluid temperature value T1 supplied by hydraulic fluid temperature sensor 42 at least when hydraulic fluid 36 is circulated through pressure limiting valve 40, then compares this value with a specified or specifiable temperature threshold value. The temperature threshold value is implemented, in particular, as content of a memory location of control device 64. The temperature threshold value is thus specifiable, but can also be adapted to relevant conditions, such as, for example, the volumetric conditions of hydraulic fluid 36 and gearbox oil 46, and/or as a parameter for the transfer of heat at heat exchanger 48 to gearbox oil 46. One possible threshold value, for example, is a value of +40° C. Whenever hydraulic fluid temperature value T1 reaches or exceeds the relevant temperature threshold value, hydraulic fluid 36 that is then sufficiently heated is passed through heat exchanger 48 installed in gearbox oil pan 44. To this end control device 64 activates directional control valve 56, as described above.

[0062] This type of hydraulic gearbox oil heating remains active until at least one specified minimum operating temperature has been reached for gearbox oil 46. To accomplish this control device 64 monitors gearbox oil temperature value T2 continuously or at regular intervals following the initial activation of circulating hydraulic fluid 36 through pressure limiting valve 40. Once gearbox oil temperature value T2 has reached or exceeded the specified minimum operating temperature of gearbox oil 46, the hydraulic gearbox oil heating can be deactivated. The hydraulic gearbox oil heating again becomes active automatically under the control of control device 64 if gearbox oil temperature value T2 falls below the specified minimum operating temperature, or the at the latest whenever gearbox oil temperature value T2 falls below the minimum temperature.

[0063] The hydraulic gearbox oil heating, that is, the method for the operating topdrive 16 described here can be started automatically whereby control device 64 continuously monitors gearbox oil temperature value T2 and the hydraulic gearbox oil heating is activated if the minimum operating temperature or the minimum temperature at least

falls below a given level. Activation of the hydraulic gearbox oil heating can also be effected by an approach wherein gearbox oil temperature value T2 is evaluated as described above in connection with a manual or automatic activation of topdrive 16, and the hydraulic gearbox oil heating is activated as necessary. Activation of topdrive 16 is then delayed or prevented by control device 64 until at least the minimum operating temperature has been reached.

[0064] Heating of gearbox oil 46 can also be effected using other heat sources independently of the above-described hydraulic gearbox oil heating. Gearbox oil 46 and/or hydraulic fluid 36 can then function as a heat-sink for heat generated at other locations. A switchable heat exchanger or separate heat exchanger (not shown) can be provided for this purpose in gearbox oil pan 44 and/or pan 34 for hydraulic fluid 36, hot steam being introduced, for example, to dissipate heat from an external heat source.

[0065] Individual key aspects of the description submitted here can be summarized as follows: So-called topdrive 16 is described in the form of a device to drive drill pipes, and a method is described to operate the drive in which means are provided to heat gearbox oil 46 used by topdrive 16, which means can be supplied by an emergency power unit, and comprise hydraulic unit 28 and pressure limiting valve 40 of topdrive 16, wherein hydraulic fluid 36 is circulated by hydraulic unit 28 through pressure limiting valve 40 to heat gearbox oil 46, and the heat energy thus generated is transferred to gearbox oil 46 through heat exchanger 48 through which hydraulic fluid 36 flows.

REFERENCE LIST

- [0066] 10 mast (drilling mast)
- [0067] 12 substructure
- [0068] 14 monkey board
- [0069] 16 topdrive
- [0070] 18 roller block
- [0071] 20 crown block
- [0072] 22 guide rail
- [0073] 24 drive unit (in the topdrive)
- [0074] 26 gearbox housing (in the topdrive)
- [0075] 28 hydraulic unit (in the topdrive)
- [0076] 30 drill pipe bail (on the topdrive)
- [0077] 32 oil sump (in the gearbox housing)
- [0078] 34 pan (for the hydraulic fluid)
- [0079] 36 hydraulic fluid
- [0080] 38 hydraulic pump (in the hydraulic unit)
- [0081] 40 pressure limiting valve
- [0082] 42 temperature sensor/hydraulic fluid temperature sensor
- [0083] 44 gearbox oil pan
- [0084] 46 gearbox oil
- [0085] 48 heat exchanger
- [0086] 50 temperature sensor/gearbox oil temperature sensor
- [0087] 52 flow control valve
- [0088] 54 pressure limiting valve
- [0089] 56 directional control valve
- [0090] 58 additional pressure limiting valve
- [0091] 60 in-flow side (of the heat exchanger)
- [0092] 62 return flow side (of the heat exchanger)
- [0093] 64 control device
- [0094] T1 hydraulic fluid temperature value
- [0095] T2 gearbox oil temperature value

1. Drive device for driving drill pipes when drilling boreholes in hydrocarbon deposits in the form of a topdrive (16), wherein the topdrive (16) comprises:

- a hydraulic unit (28) including a pan (34) for hydraulic fluid (36) in which hydraulic fluid (36) is located in an operationally ready topdrive (16), and
- a gearbox including a gearbox oil pan (44) in which gearbox oil (46) is located in an operationally ready topdrive (16),

wherein a gearbox oil temperature value (T2) for the temperature of the gearbox oil (46) in the gearbox oil pan (44) can be measured by a gearbox oil sensor (50),

wherein the hydraulic fluid (36) can be circulated by the hydraulic unit (28) through a pressure limiting valve (40) included in the topdrive (16) as a function of the gearbox oil temperature value (T2), and

wherein the hydraulic fluid (36) can be passed by the hydraulic unit (28) through a heat exchanger (48) installed in the gearbox oil pan (44) as a function of temperature and/or time.

2. Drive device according to claim 1, wherein the topdrive (16) further comprises a hydraulic fluid temperature sensor (42) to measure a hydraulic fluid temperature value (T1) for a temperature of the hydraulic fluid (36) in the pan (34) of the hydraulic unit (28), and

wherein the hydraulic fluid (36) can be passed through the heat exchanger (48) installed in the gearbox oil pan (44) as a function of the hydraulic fluid temperature value (T1) by means of the hydraulic unit (28).

3. Drive device according to claim 1, wherein a flow control valve (52) is disposed between the hydraulic unit (28) and the heat exchanger (48).

4. Drive device according to claim 1, wherein a directional control valve (56) is disposed between the hydraulic unit (28) and the heat exchanger (48).

5. Drive device according to claim 1, comprising a heat exchanger (48) in the form of a finned tube.

6. Method for operating a drive device designed to drive drill pipes for drilling boreholes in hydrocarbon deposits, the drive device being in the form of a topdrive (16) according to claim 1,

wherein the hydraulic unit (28) is activated to circulate the hydraulic fluid (36) through the pressure limiting valve (40) as a function of the gearbox oil temperature value (T2), and

wherein the hydraulic fluid (36) is passed through a heat exchanger (48) installed in the gearbox oil pan (44) as a function of temperature and/or time.

7. Method according to claim 6, wherein the hydraulic unit (28) is activated to circulate the hydraulic fluid (36) through

the pressure limiting valve (40) when a gearbox oil temperature value (T2) is below a specified or specifiable temperature limit.

8. Method according to claim 6, wherein the to drive further comprises a hydraulic fluid temperature sensor (42) to measure a hydraulic fluid temperature value (T1) for a temperature of the hydraulic fluid (36) in the pan (34) of the hydraulic unit (28), and

wherein the hydraulic fluid (36) is passed through the heat exchanger (48) installed in the gearbox oil pan (44) when the hydraulic fluid temperature value (T1) is above a specified or specifiable temperature threshold.

9. Method according to claim 6, or 8 for wherein the topdrive (16) further comprises a directional control valve (56) disposed between the hydraulic unit (28) and the heat exchanger (48) upstream from the pressure limiting valve (40), and

wherein the hydraulic fluid flow is switched between a first path through the pressure limiting valve (40) and a second path through the heat exchanger (48) by automatically activating the directional control valve (56).

10. Method according to claim 6, wherein the topdrive (16) further comprises a directional control valve (56) disposed between the hydraulic unit (28) and the heat exchanger (48) downstream from the pressure limiting valve (40), and

wherein the hydraulic fluid flow is switched between a first path through the pressure limiting valve (40) and a second path through the pressure limiting valve (40) as well as through the heat exchanger (48) by automatically activating the directional control valve (56).

11. Method according to claim 7, wherein the topdrive (16) further comprises a hydraulic fluid temperature sensor (42) to measure a hydraulic fluid temperature value (T1) for a temperature of the hydraulic fluid (36) in the pan (34) of the hydraulic unit (28), and wherein the hydraulic fluid (36) is passed through the heat exchanger (48) installed in the gearbox oil pan (44) when the hydraulic fluid temperature value (T1) is above a specified or specifiable temperature threshold.

12. Drive device according to claim 2, wherein a flow control valve (52) is disposed between the hydraulic unit (28) and the heat exchanger (48).

13. Drive device according to claim 1, wherein a directional control valve (56) is disposed between the hydraulic unit (28) and the heat exchanger (48) upstream from the pressure limiting valve (40).

14. Drive device according to claim 1, wherein a directional control valve (56) is disposed between the hydraulic unit (28) and the heat exchanger (48) downstream from the pressure limiting valve (40).

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