(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 2 397 658 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
21.12.2011 Bulletin 2011/51

(51) Int Cl.:
F01K 13/00 *(2006.01)* ***F01K 13/02*** *(2006.01)*
F01K 7/16 *(2006.01)*

(21) Application number: **10166280.7**

(22) Date of filing: **17.06.2010**

(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 SE SI SK SM TR
Designated Extension States:
BA ME RS

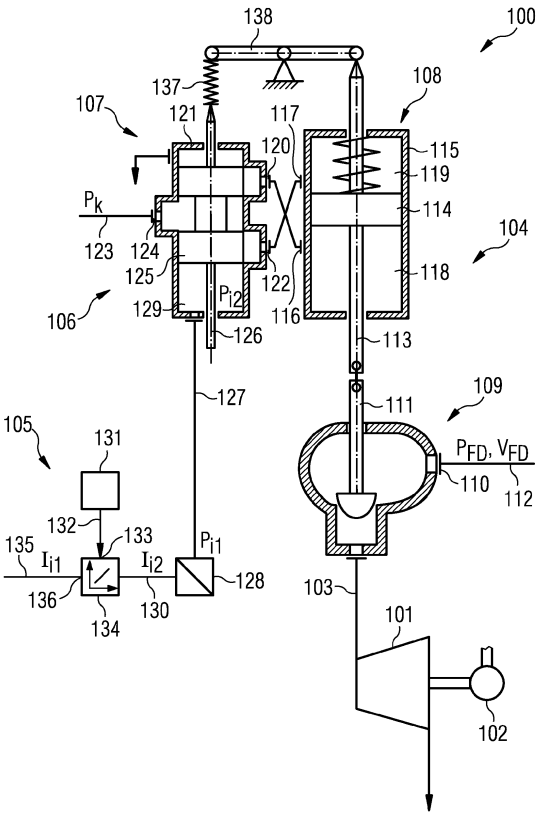
(71) Applicant: **SIEMENS AKTIENGESELLSCHAFT**
80333 München (DE)

(72) Inventor: **Leidinger, Bernd**
01159 Dresden (DE)

(54) Controller and method for controlling a steam supply control device of a steam turbine and steam turbine

(57) Controller and method for controlling a steam supply control device of a steam turbine and steam turbine

It is described a controller (105) for controlling a steam supply control device (106) of a steam turbine, the steam supply control device controlling a supply of steam (112) into the steam turbine, the controller comprising: an electric control input terminal (136) for receiving an electric control signal; an electric acceleration input terminal (133) for receiving an electric acceleration signal being indicative for an acceleration of the steam supply control device; a processor (134) being adapted to determine a modified control signal (130) based on the control signal and the acceleration signal; and an electrohydraulic converter (128) having a hydraulic terminal for supplying a hydraulic fluid and being adapted to adjust a supply of the hydraulic fluid to the steam supply control device in accordance with the modified control signal. Further, A system for controlling a supply of a steam into a steam turbine, a steam turbine and a method for controlling a steam supply control device of a steam turbine are provided.



EP 2 397 658 A1

Description

[0001] Controller and method for controlling a steam supply control device of a steam turbine and steam turbine

Field of invention

[0002] The present invention relates to a controller and to a method for controlling a steam supply control device of a steam turbine, to a system for controlling a supply of a steam into a steam turbine and to a steam turbine. In particular, the present invention relates to a controller and to a method for controlling a steam supply control device of a steam turbine, wherein an acceleration of the steam supply control device is taken into account during controlling the steam supply control device.

Art Background

[0003] A steam turbine is a mechanical device that is configured to extract thermal energy from pressurized steam, such as water steam, and to convert it into rotary motion. Thereby, steam is supplied into a working volume of the steam turbine, wherein the steam drives one or more rotor blades fixed at a rotation shaft. Supply of steam is thereby accomplished by controlling one or more valves being arranged at an inlet towards the working container. In a conventional steam turbine the one or more valves in turn may be controlled by a setting or adjustment or control arrangement comprising for example a hydraulic setting motor which is controlled by a control piston which moves within a control container in dependence of a supply of a hydraulic control fluid fed into the control container to arrange the control piston at a particular position.

[0004] It may have been observed that controlling a steam supply control device may be difficult leading to undesired and deteriorating running conditions of the steam turbine.

[0005] There may be a need for a controller and for a method for controlling a steam supply control device of a steam turbine which provide more accurate control of the steam supply control device and thus provide more accurate control of the steam turbine. In particular, there may be a need for a controller and a method for controlling a steam supply control device of a steam turbine providing a more reliable control and a secure operation of the steam supply control device and also of the steam turbine. In particular, there may be a need for a controller and for a method for controlling a steam supply control device of a steam turbine, when the steam turbine and also the steam supply control device is located offshore, such as for example on a ship.

Summary of the Invention

[0006] 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.

[0007] According to an embodiment, a controller for controlling a steam supply control device of a steam turbine is provided, wherein the steam supply control device controls a supply of steam into the steam turbine, wherein the controller comprises an electric control input terminal for receiving an electric control signal, an electric acceleration input terminal for receiving an electric acceleration signal being indicative for an acceleration of the steam supply control device, a processor being adapted to determine a modified control signal based on the control signal and the acceleration signal, and an electrohydraulic converter having a hydraulic terminal for supplying a hydraulic fluid and being adapted to adjust a supply of the hydraulic fluid to the steam supply control device in accordance with the modified control signal.

[0008] The steam supply control device may be a system, an arrangement or a number of components which are adapted to control a supply of steam or an input of steam into a working container of the steam turbine in which thermal energy is extracted from the steam, in order to generate rotational energy. The steam supply control device may in particular comprise one or more vessels or containers, one or more pistons, in particular being connected to a valve, one or more valves for adjusting a supply of steam into the working container. The electric control signal may be generated by a turbine controller depending in particular on a rotational speed of the steam turbine, an energy demand, steam properties, such as temperature and/or pressure, a load connected to the rotation shaft of the steam turbine, an operation condition of the steam turbine, external parameters, to mention just some exemplary factors. In particular, the electrical control signal may be representative of a valve position allowing a particular flow rate of the steam into the working container.

[0009] The acceleration signal being indicative for an acceleration of the steam supply control device may be measured within the reference system of the earth. In particular, the acceleration signal may be measured close to or at the steam supply control device or close to at least one component of the steam supply control device, such as a control piston of the steam supply control device. In particular, the steam supply control device, in particular the control piston, may be sensitive to an acceleration and may perform a movement due to its inertia upon occurrence of an acceleration. In particular, the movement of the control piston may lead to an erroneous controlling of a steam supply towards the working container of the steam turbine which may lead to undesired running conditions of the steam turbine, such as to an undesired acceleration or deceleration of the rotational speed of the steam turbine. Thus, it may be necessary to take the acceleration occurring at the steam supply control device into account, in order to more accurately control the steam supply control device or to modify the

control of the steam supply control device.

[0010] The processor may comprise a computer, a processing unit, a calculation system and/or a logic arithmetic unit which may in particular run a computer program being adapted to determine the modified control signal based on the control signal and the acceleration signal. In particular, a direction of the acceleration being measured relative to the orientation of the steam supply control device, in particular the control piston, may be taken into account when determining the modified control signal. In particular, when the acceleration comprises a large component in the direction of the control piston of the steam supply control device, the control signal may be modified to a larger degree than when the acceleration has only a smaller component in the direction of the control piston. In particular, the modified control signal may be decrease or increase the control signal depending on a direction of the acceleration represented by the acceleration signal. Due to an inertia of one or more components of the steam supply control device an acceleration occurring at the steam supply control device, such as on a ship on the sea, the steam supply control device may control the supply of steam into the working container in an erroneous way. In particular, a force balance in the steam supply control device or components thereof may be influenced by the occurring acceleration. Thereby, in particular a pilot piston or control piston of a hydraulic actuator may be affected. These accelerations may have a similar effect as increasing or decreasing a control oil pressure applied to the control piston or pilot piston, thus simulating changes of the set values for the controlled quantities. Especially for turbo sets being the only source of electrical power on ships, this effect will cause not acceptable frequency deviations of the electrical power generated by the steam turbine.

[0011] The electrohydraulic converter may be adapted to generate a supply of a hydraulic fluid, such as oil, having a predetermined pressure and/or flow properties. In particular, the electrohydraulic converter may hydraulically control the steam supply control device by increasing or decreasing a pressure of the hydraulic fluid being delivered to the steam supply control device, in particular being delivered to a control container of the steam supply control device harbouring a control piston within the control container. By taking into account an acceleration occurring at the steam supply control device controlling the steam supply control device may be improved compared to a conventional control procedure. Thereby, also a running condition of the steam turbine may more accurately be controlled or achieved. Thereby, operating a steam turbine in particular on a ship being subjected to a number of accelerations on the sea may be improved.

[0012] According to an embodiment the controller further comprises an accelerometer for generating the electric acceleration signal at an output terminal, wherein the output terminal of the accelerometer is connected to the electric acceleration input terminal of the controller. The accelerometer may in particular be located close to or at the steam supply control device, in order to measure as accurately as possible an acceleration occurring at the steam supply control device. In particular, the accelerometer may be a single or a multi-axes-type accelerometer being adapted to measure magnitude and direction of the acceleration as a vector quantity. In particular, the accelerometer may be adapted to measure accelerations between 0 and 5 g, in particular between 0 and 1 g, wherein g is the acceleration at the surface of the earth due to the mass of the earth. In particular, the accelerometer may comprise piezoelectric, piezoresistive and/or capacitive components which are adapted to convert mechanical motion caused by the acceleration into an electrical signal which may be representative of the acceleration occurring at the steam supply control device. In particular, the accelerometer may comprise piezoceramics or single crystals. Further, the accelerometer may comprise a microelectromechanical system (MEMS). Thereby, a highly accurate acceleration measurement of the steam supply control device may be provided for improving the control of the steam supply control device.

[0013] According to an embodiment the controller further comprises the hydraulic fluid, in particular oil, to be supplied to the steam supply control device. Thereby, the steam supply control device may simply and reliably be controlled.

[0014] According to an embodiment the hydraulic fluid comprises oil. In particular, the hydraulic fluid may comprise pressurized oil which may be supplied from the electrohydraulic converter to the steam supply control device using one or more hydraulic connection lines.

[0015] According to an embodiment a system for controlling a supply of a steam into a steam turbine is provided, wherein the system comprises a controller according to an embodiment as described above, and the steam supply control device which is being controlled by the controller, wherein the steam supply control device comprises a control container and a control piston movable within the control container, wherein the control container is connected to the hydraulic terminal of the electrohydraulic converter such that the hydraulic fluid is supplyable to at least one portion of the control container to move the control piston.

[0016] The hydraulic terminal in general may comprise a closable opening and connection means for connecting a hydraulic line or hydraulic tubing to the hydraulic terminal. The control piston may also be referred to as pilot piston. In particular, not the electrohydraulic converter may directly control a valve at an entry of the working container of the steam turbine but the valve may only indirectly be controlled by the electrohydraulic converter, namely via the steam supply control device which may directly be controlled by the electrohydraulic converter. In particular, a position of the control piston movable within the control container may be controlled by the electrohydraulic converter by supplying the hydraulic fluid to at least one portion of the control container in which the control piston is movable. The hydraulic fluid may be sup-

plied to the control container via one or more supply openings or supply terminals. Thereby, the electrohydraulic converter may supply the hydraulic fluid or pump the hydraulic fluid into at least one portion of the control container, wherein the portion of the control container may be limited by a surface of the control piston. Thus, the pressurized hydraulic fluid supplied to the portion of the control container may exert a force onto the surface of the control piston to cause the control piston to move. The movement of the control piston or a change of a position of the control piston within the control container may in turn cause controlling of one or more other components of the steam supply control device which finally control or set a valve position defining a flow rate or amount of steam supplied to the working container of the steam turbine.

[0017] According to an embodiment the control container comprises an input hydraulic terminal for supplying a hydraulic setting fluid, a first hydraulic terminal; and a second hydraulic terminal, wherein, depending on a position of the control piston within the control container, a first flow path of the hydraulic setting fluid or a second flow path of the hydraulic setting fluid is selectively established, wherein the first flow path is formed between the input hydraulic terminal and the first hydraulic terminal and the second flow path is formed between the input hydraulic terminal and the second hydraulic terminal.

[0018] The hydraulic setting fluid may be different from the hydraulic fluid or may be in particular in communication with the hydraulic fluid. The hydraulic setting fluid may be supplied by an external compressor and/or hydraulic system which may continuously supply the hydraulic setting fluid to at least one portion of the control container. In particular, a flow path of the hydraulic setting fluid may be controlled by the position of the control piston within the control container. In particular a change of a position of the control piston may require a much smaller force than a change of a position or a state of a valve for controlling a supply of steam into the working container of the steam turbine. While the hydraulic fluid supplied by the electrohydraulic converter to the control container may not exert a force high enough to move or change a position or a state of the valve for supplying the steam to the steam turbine, the hydraulic setting fluid may be able to exert a force high enough to change a position or a state of the valve for supply of the steam into the working container of the steam turbine.

[0019] In addition to providing a first flow path and a second flow path depending on the position of the control piston within the control container (a first position of the control piston may correspond to the first flow path and a second position of the control piston may correspond to the second flow path) the control piston may assume an intermediate position (between the first position and the second position), wherein the hydraulic setting fluid is trapped within a particular portion of the control container, such that no communication is established between the input hydraulic terminal and the first hydraulic terminal and no communication is established between the input hydraulic terminal and the second hydraulic terminal.

[0020] The intermediate position may in particular be assumed or set by the electrohydraulic converter, when the position or the state of the valve controlling the supply of the steam into the working volume should not be changed, but should remain constant. Thereby, in particular a constant running condition may be established for the steam turbine. In contrast, if the first flow path is established the hydraulic setting fluid, in particular also oil, may flow along the first flow path towards other components of the steam supply control device, in particular towards a portion of a setting container having arranged a setting piston within the setting container. Further, when the second flow path is established the hydraulic setting fluid may flow along the second flow path to other components or to another component of the steam supply control device, in particular to another portion of the setting container. Thereby, a valve controlling the supply of steam into the working container may be controlled.

[0021] According to an embodiment the system for controlling a supply of a steam into a steam turbine further comprises a setting container; and a setting piston movable within the setting container; wherein the setting container comprises a third hydraulic terminal and fourth hydraulic terminal, wherein the first hydraulic terminal of the control container is connected to the third hydraulic terminal of the setting container and wherein the second hydraulic terminal of the control container is connected to the fourth hydraulic terminal of the setting container, wherein the setting container and the setting piston are adapted such that depending on which one of the first flow path and the second flow path is established the setting piston changes a position in a first direction or in a second direction.

[0022] In particular, the position of the setting piston may change due to the inflow of the hydraulic setting fluid into the setting container via the first flow path or via the second flow path. In particular, the first flow path may guide the hydraulic setting fluid towards a portion of the setting container being limited by a first surface of the setting piston which may cause exerting a force onto the first surface of the setting piston thus resulting in a corresponding change of the position of the setting piston. Further, the second flow path may guide hydraulic setting fluid towards another portion of the setting container being limited by a second surface of the setting piston thus causing a force to be exerted on the second surface by the hydraulic setting fluid resulting in a change of the position of the setting piston in an opposite direction compared to the situation when the force is exerted onto the first surface of the setting piston. Thereby, a first communication path of the hydraulic setting fluid between the control container and the setting container may be established via the first hydraulic terminal of the control container and the third hydraulic terminal of the setting container and a second communication path of the hydraulic

setting fluid between the control container and the setting container may be established via the second hydraulic terminal of the control container and the fourth hydraulic terminal of the setting container. Depending through which one of the first and second communication paths the hydraulic setting fluid flows the position of the setting piston may change in the first direction or in the second direction being in particular opposite to the first direction.

[0023] According to an embodiment the setting piston is connected to the control piston via a mechanical feedback arrangement. Thus, the position of the setting piston may not only be determined by the inflow of the hydraulic setting fluid via the first communication path or via the second communication path but may additionally be influenced by the position of the control piston within the control container. Thereby, the controlling the steam supply may further be improved.

[0024] According to an embodiment the feedback arrangement comprises a spring feedback and/or a hydraulic feedback. In particular, the spring may be arranged in line or in a direction of the control piston, in particular extending along a longitudinal axis of the control piston.

[0025] According to an embodiment the system further comprises a steam supply valve being adapted for adjusting a steam supply into a working container of the steam turbine depending on the position of the setting piston. In particular, the setting piston may be directly or indirectly connected to or fixed at a control bar of the steam supply valve. Alternatively, the control bar of the valve may be connected to the setting piston via a transmission device, such as for transferring a positional change of the position of the setting piston to an increased or decreased positional change of the position of the control bar of the steam supply valve. Thereby, the steam supply valve may be controlled in a simple and reliable manner.

[0026] According to an embodiment the system is adapted to move the setting piston across a path length between 2 cm and 20 cm, in particular between 5 cm and 15 cm, within a time interval between 0.05 s and 1 s, in particular between 0.1 s and 0.5 s, to switch the steam supply valve between a closed state and an opened state. Thereby, a rapid closing or opening of the steam supply valve may be achieved which may not be achievable by using only the electrohydraulic converter controlling the position of the control piston. Further, a running condition of the steam turbine may rapidly be changed.

[0027] According to an embodiment a steam turbine is provided, which comprises a working container for accommodating a steam and for extracting energy from the steam and a system for controlling a supply of the steam into the steam turbine according to an embodiment as described above, wherein the system is adapted for controlling a steam supply to the working container.

[0028] According to an embodiment a method for controlling a steam supply control device of a steam turbine is provided, the steam supply control device controlling a supply of steam into the steam turbine, in particular into a working container of the steam turbine, the method comprising receiving an electric control signal at an electric control input terminal, receiving an electric acceleration signal of the steam supply control device at an electric acceleration input terminal for, determining a modified control signal based on the control signal and the acceleration signal, and adjusting a supply of hydraulic fluid to the steam supply control device in accordance with the modified control signal.

[0029] It should be noted that any of the features disclosed with respect to the controller for controlling a steam supply control device of a steam turbine, with respect to the system for controlling a supply of a steam into a steam turbine may also be applied (individually or in any combination) to the method for controlling a steam supply control device of a steam turbine.

[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 Drawings

[0032] The Figure schematically illustrates a system for controlling a supply of a steam into a steam turbine according to an embodiment.

Detailed Description

[0033] The illustration in the drawing is schematically.

[0034] The Figure schematically shows a system 100 for controlling a supply of a steam into a steam turbine according to an embodiment. The system 100 is in particular suitable to be used on ships or similar offshore objects that face accelerations due to movements of the whole ship and in particular of the whole steam turbine. These accelerations may have influence on the force balance in control devices of the steam turbine, in particular on the pilot piston or control piston of hydraulic actuators. Accelerations of the pilot piston or control piston may have a similar effect as increasing or decreasing the con-

trol oil pressure of hydraulic fluid, thus simulating changes of the set values for the controlled quantities.

[0035] In the Figure the steam turbine is only schematically illustrated and comprises a working container 101 and an electric generator 102. Steam is supplied to the working container 101 via a steam supply pipe 103 and energy is extracted from the hot steam using not illustrated rotor blades fixed at a rotation shaft. The rotating rotor drives the electric generator 102 which produces electric energy.

[0036] For running the steam turbine according to a particular running condition (such as rotational speed) a particular amount of steam has to be supplied to the working container 101. Therefore, a system 104 for controlling a supply of a steam into the steam turbine is provided. The system 104 comprises a controller 105 for controlling a steam supply control device 106 of a steam turbine.

[0037] The steam supply control device 106 comprises a control actuator 107 and a setting actuator 108 and further a steam supply valve 109. Via an entry 110 steam having a predetermined pressure P_{FD} and having a predetermined temperature θ_{FD} is supplied to the steam supply valve 109. Depending on a position of a slidable valve shaft 111 an amount of steam 112 supplied via the steam tubing 103 to the working container 101 may be adjusted. The valve shaft 103 may slide in the vertical direction for adjusting the amount of the steam supplied to the working container 101.

[0038] In the illustrated embodiment the steam shaft 111 is connected to a shaft 113 of a piston 114 (also referred to as setting piston) being movable within a setting container 115. When the piston 114 (and thus the shaft 113 and the shaft 111 of the steam supply valve 109) moves upwards, the amount of steam 112 supplied via the steam tubing 103 to the working container 101 is increased. In contrast, when the piston 114 (and thus the shaft 113 and the steam supply valve shaft 111) moves downwards, the amount of steam supplied to the working container 101 is decreased.

[0039] To move the setting piston 114 within the setting container 115 hydraulic setting fluid is introduced via a third hydraulic terminal 116 or via a fourth hydraulic terminal 117. When the hydraulic setting fluid is introduced via the third hydraulic terminal 116 it is introduced into the portion 118 within the setting container 115. In contrast, when the hydraulic setting fluid is introduced via the fourth hydraulic terminal 117 the hydraulic setting fluid is introduced into the region 119 within the setting container 115.

[0040] The third hydraulic terminal 116 is connected to a first hydraulic terminal 120 at the control container 121. The fourth hydraulic terminal 117 is connected with a second hydraulic terminal 122 at the control container 121. Hydraulic setting fluid 123 is introduced into the control container 121 via an input hydraulic terminal 124. Within the control container 121 a control piston 125 comprising a control piston shaft 126 is slidable in the vertical direction. Depending on a position of the control piston 125 the hydraulic setting fluid 123 may flow through the first hydraulic terminal 120 and the third hydraulic terminal 116 into the region 118 of the setting container 115 to cause the setting piston 114 to move upwards and thus to open the steam supply valve 109. When the piston 125 is moved downwards the hydraulic setting fluid 123 flows via the second hydraulic terminal 122 and the fourth hydraulic terminal 117 into the region 119 of the setting container 115 causing the setting piston 114 to move downwards and thus causing the steam supply valve 109 to close (or diminish) supply of the steam 112 to the working container 101.

[0041] The position of the control piston 125 depends on a supply of a hydraulic fluid supplied via a hydraulic tubing 127. In particular, an electrohydraulic converter 128 supplies the hydraulic fluid via the hydraulic tubing 127 to a portion 129 within the control container 121 to cause the piston 125 to move upwards. The converter 128 is part of the controller 105 for controlling a steam supply control device 106. In particular, the converter 128 supplies the hydraulic fluid (adjusts the pressure and/or the amount) in response to a modified control signal 130. The controller 105 further comprises an accelerometer 131 for measuring an acceleration of the steam supply control device 106 and for providing an electric acceleration signal 132 being indicative of the acceleration of the steam supply control device 106. The electric acceleration signal is supplied to an electric acceleration input terminal 133 of a processor 134. Further, an electric control signal 135 is supplied to an electric control input terminal 136 of the processor 134. Based on the electric control signal 135 and on the electric acceleration signal 132 the processor 134 determines the modified control signal 130 which is supplied to the electrohydraulic converter 128. In particular, the modified control signal 130 takes the acceleration of the steam supply control device 106 into account which in conventional systems may lead to a movement of the control piston 125 causing an undesired, inaccurate and erroneous flow of the hydraulic setting fluid 123 towards the setting container 119 resulting in erroneous adjustments of the steam supply valve 109.

[0042] For feedback the shaft 126 of the control piston 125 is connected via a spring 137 and a bar 138 to the shaft 113 of the setting piston 114.

[0043] The position of the setting piston 114 is controlled via inflow of the hydraulic setting fluid 123 into the regions 118 or 119. This occurs in dependence of the position of the control piston 125. In the illustrated embodiment the control piston 125 is in an intermediate position in which no flow of the hydraulic setting fluid into the setting container 115 occurs. The positioning of the control shaft 125 in the intermediate position corresponds to a stationary operation state of the steam turbine.

[0044] The pressure of the hydraulic control fluid is generated by the electrohydraulic converter 128. If the pressure P_{i2} within the portion 129 within the control container 121 increases the control piston 125 moves up-

wards and allows inflow of the hydraulic setting fluid 123 into the region 118 of the setting container 115 which in turn causes the steam supply valve 109 to open (to a larger extent).

[0045] Acceleration of the turbine upwards results in a reduction and acceleration of the turbine downwards result in an increase of the pressure P_{i2} below the control piston 125 and thus triggers control movements. Consequently rotational speed oscillations and power oscillations of the steam turbine would occur in accordance to movements of the ship where the steam turbine is installed, if the controller 105 would not take into account the acceleration.

[0046] According to an embodiment the processor 134 is adapted as a transfer element which transforms the control signal 135 to a modified control signal 130 such that inertial forces resulting from the acceleration are compensated by a correspondingly increased or decreased pressure P_{i2}.

[0047] It should be noted that the term "comprising" does not exclude other elements or steps and "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 controller (105) for controlling a steam supply control device (106) of a steam turbine, the steam supply control device controlling a supply of steam (112) into the steam turbine, the controller comprising:

   - an electric control input terminal (136) for receiving an electric control signal;
   - an electric acceleration input terminal (133) for receiving an electric acceleration signal being indicative for an acceleration of the steam supply control device;
   - a processor (134) being adapted to determine a modified control signal (130) based on the control signal and the acceleration signal; and
   - an electrohydraulic converter (128) having a hydraulic terminal for supplying a hydraulic fluid and being adapted to adjust a supply of the hydraulic fluid to the steam supply control device in accordance with the modified control signal.

2. The controller according to claim 1, further comprising

   - an accelerometer (131) for generating the electric acceleration signal at an output terminal,

   wherein the output terminal of the accelerometer is connected to the electric acceleration input terminal (133).

3. The controller according to claim 1 or 2, further comprising

   - the hydraulic fluid to be supplied the steam supply control device.

4. The controller according to claim 3, wherein the hydraulic fluid comprises oil.

5. A system for controlling a supply of a steam into a steam turbine, the system comprising:

   - a controller (105) according to one of claims 1 to 4;
   - the steam supply control device (106), wherein the steam supply control device comprises:

     a control container (121); and
     a control piston (125) movable within the control container, wherein the control container is connected to the hydraulic terminal of the electrohydraulic converter such that the hydraulic fluid is supplyable to at least one portion (129) of the control container to move the control piston.

6. The system according to claim 5, wherein the control container comprises
   an input hydraulic terminal (124) for supplying a hydraulic setting fluid;
   a first hydraulic terminal (120); and
   a second hydraulic terminal (122),
   wherein, depending on a position of the control piston within the control container, a first flow path of the hydraulic setting fluid or a second flow path of the hydraulic setting fluid is selectively established,
   wherein the first flow path is formed between the input hydraulic terminal and the first hydraulic terminal and
   the second flow path is formed between the input hydraulic terminal and the second hydraulic terminal.

7. The system according to claim 6, further comprising

   - a setting container (115); and
   - a setting piston (114) movable within the setting container;

   wherein the setting container comprises a third hydraulic terminal (116) and fourth hydraulic terminal (117),
   wherein the first hydraulic terminal of the control container is connected to the third hydraulic terminal of the setting container and
   wherein the second hydraulic terminal of the control container is connected to the fourth hydraulic termi-

nal of the setting container,
wherein the setting container and the setting piston are adapted such that depending on which one of the first flow path and the second flow path is established the setting piston changes a position in a first direction or in a second direction.

8. The system according to claim 7, wherein the setting piston is connected to the control piston via a mechanical feedback arrangement (137, 138).

9. The system according to claim 8, wherein the feedback arrangement comprises a spring feedback and/or a hydraulic feedback.

10. The system according to one of claims 7 to 9, further comprising

- a steam supply valve (109) being adapted for adjusting a steam supply into a working container of the steam turbine depending on the position of the setting piston.

11. The system according to claim 10, wherein the system is adapted to move the setting piston across a path length between 2 cm and 20 cm, in particular between 5 cm and 15 cm, within a time interval between 0.05 s and 1 s, in particular between 0.1 s and 0.5 s, to switch the steam supply valve between a closed state and an opened state.

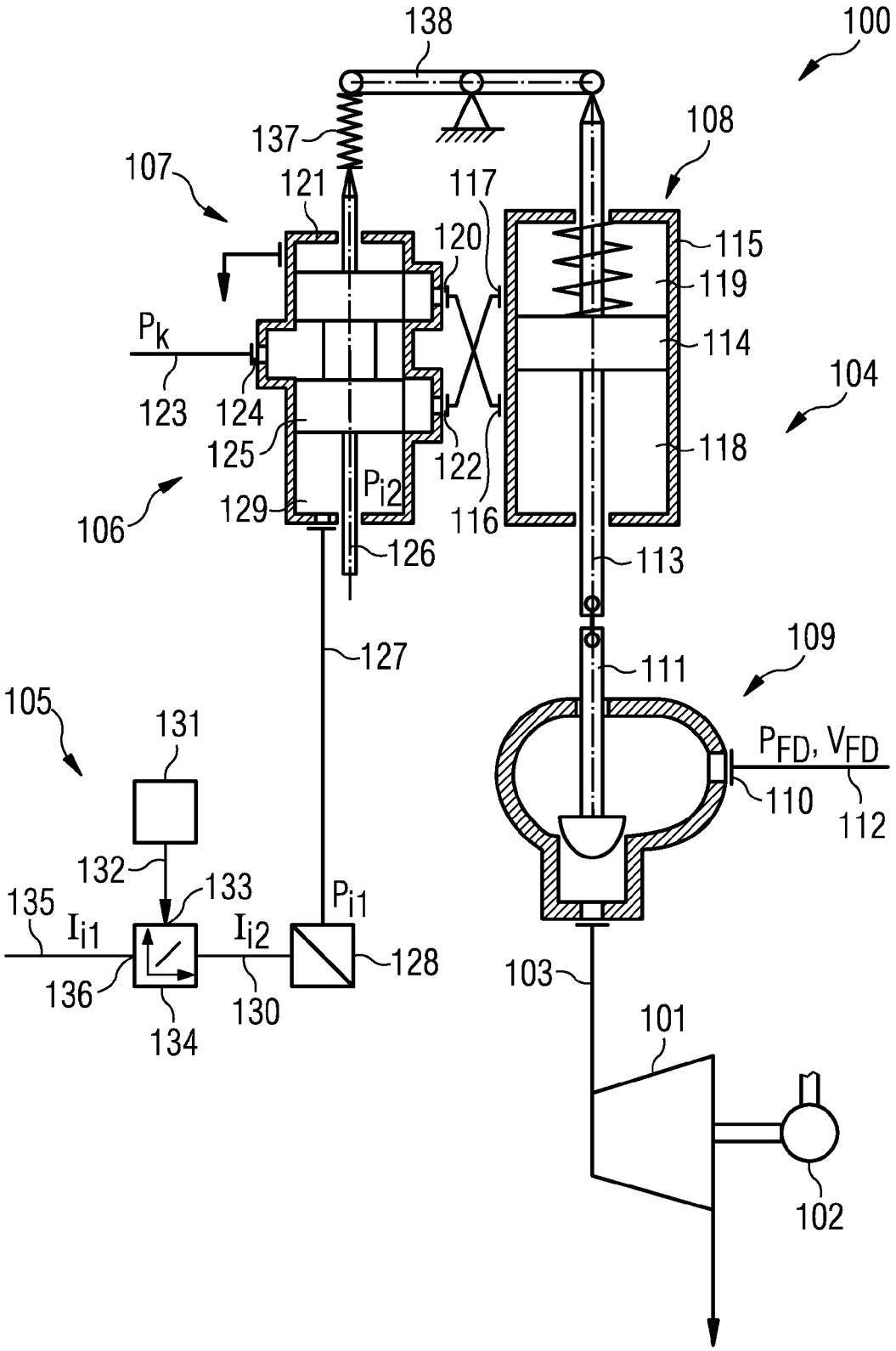
12. A steam turbine comprising:

- a working container (101) for accommodating a steam and for extracting energy from the steam; and
- a system according to one of claims 5 to 11,

wherein the system is adapted for controlling a steam supply to the working container.

13. A method for controlling a steam supply control device of a steam turbine, the steam supply control device controlling a supply of steam into the steam turbine, the method comprising:

- receiving an electric control signal at an electric control input terminal;
- receiving an electric acceleration signal of the steam supply control device at an electric acceleration input terminal for;
- determining a modified control signal based on the control signal and the acceleration signal;
- adjusting a supply of hydraulic fluid to the steam supply control device in accordance with the modified control signal.


138
100
137
108
107
121
117
120
115
119
P_k
114
104
123
124
125
122
118
106
129
P_{i2}
116
126
113
127
109
111
105
131
P_{FD}, V_{FD}
110
112
132
133
135
I_{i1}
I_{i2}
P_{i1}
128
103
136
130
101
134
102

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 10 16 6280

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 4 635 209 A (HWANG EDDIE Y [US] ET AL) 6 January 1987 (1987-01-06) * figure 1 * * column 2, line 59 - column 4, line 11 * -----	1,13	INV. F01K13/00 F01K13/02 F01K7/16
X	US 4 658 590 A (HIGASHI TOSHIHIKO [JP] ET AL) 21 April 1987 (1987-04-21) * figure 1 * * column 2, line 25 - column 3, line 18 * -----	1,13	
X	US 5 203 160 A (OZONO JIRO [JP]) 20 April 1993 (1993-04-20) * figures 2,3 * * column 6, line 7 - column 7, line 46 * * column 10, line 45 - column 11, line 7 * -----	1,13	
X	US 4 081 956 A (BAKER JACK M ET AL) 4 April 1978 (1978-04-04) * figures 1,2 * * column 2, line 10 - column 3, line 18 * -----	1,13	TECHNICAL FIELDS SEARCHED (IPC)
X	US 4 793 132 A (OKABE AKIRA [JP]) 27 December 1988 (1988-12-27) * figures 1,2 * * column 3, line 37 - column 4, line 21 * -----	1,13	F01K

~~The present search report has been drawn up for all claims~~

Place of search	Date of completion of the search	Examiner
Munich	7 February 2011	Röberg, Andreas

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

EPO FORM 1503 03.82 (P04C01)

Europäisches Patentamt
European Patent Office
Office européen des brevets

Application Number
EP 10 16 6280

CLAIMS INCURRING FEES

The present European patent application comprised at the time of filing claims for which payment was due.

☐ Only part of the claims have been paid within the prescribed time limit. The present European search report has been drawn up for those claims for which no payment was due and for those claims for which claims fees have been paid, namely claim(s):

☐ No claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for those claims for which no payment was due.

LACK OF UNITY OF INVENTION

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

see sheet B

☐ All further search fees have been paid within the fixed time limit. The present European search report has been drawn up for all claims.

☐ As all searchable claims could be searched without effort justifying an additional fee, the Search Division did not invite payment of any additional fee.

☐ Only part of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the inventions in respect of which search fees have been paid, namely claims:

☒ None of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims, namely claims:

see additional sheet(s)

☐ The present supplementary European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims (Rule 164 (1) EPC).

Europäisches Patentamt
European Patent Office
Office européen des brevets

LACK OF UNITY OF INVENTION
SHEET B

Application Number
EP 10 16 6280

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

1. claims: 1, 2, 13(completely); 3-12(partially)

   A controller for controlling a steam supply control device comprising an accelerometer.

   ---

2. claims: 1(completely); 3-12(partially)

   A controller for controlling a steam supply control device comprising the hydraulic fluid to be supplied the steam supply control device.

   ---

3. claims: 1(completely); 5-12(partially)

   A system for controlling a supply of a steam into a steam turbine. the system comprising a controller according to claim 1.

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 10 16 6280

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.

07-02-2011

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 4635209 A	06-01-1987	CA 1241409 A1	30-08-1988
		CN 85109563 A	13-08-1986
		IT 1210173 B	06-09-1989
		JP 1744805 C	25-03-1993
		JP 4028881 B	15-05-1992
		JP 61108812 A	27-05-1986
US 4658590 A	21-04-1987	NONE	
US 5203160 A	20-04-1993	JP 2593578 B2	26-03-1997
		JP 4159402 A	02-06-1992
US 4081956 A	04-04-1978	CA 1068492 A1	24-12-1979
		DE 2721168 A1	24-11-1977
		FR 2351251 A1	09-12-1977
		GB 1517906 A	19-07-1978
		IT 1078309 B	08-05-1985
		JP 1354892 C	24-12-1986
		JP 52151438 A	15-12-1977
		JP 61018649 B	13-05-1986
		NL 7705171 A	15-11-1977
		NO 771674 A	15-11-1977
US 4793132 A	27-12-1988	JP 1949978 C	10-07-1995
		JP 6078724 B	05-10-1994
		JP 62251409 A	02-11-1987

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82