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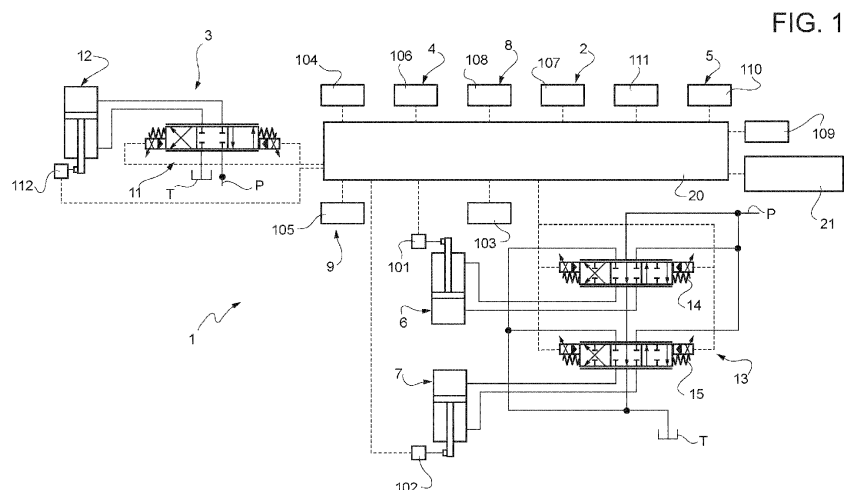
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(54) **AUTOMATIC WARM UP SYSTEM FOR HYDRAULIC CIRCUIT OF A WORK VEHICLE**

(57) Earth moving vehicle provided with a bucket carried by a boom to execute a work operation, a torque source (8), a hydrostatic transmission (2), a joystick (5) for controlling actuators (6, 7) for moving said bucket and said boom, a parking brake system (4), a service brake system (9) and an accelerator pedal, the vehicle comprising a plurality of sensor means (101-112) said vehicle comprising a warm up system (1) comprising an electronic control unit (20) and user input means (21),

the electronic control unit (20) comprising elaboration means configured to acquire the data from sensor means and, if a preset condition of the data retrieved by the sensor means (101-112) is met, and the user requests via input means (21) a warm up procedure, the electronic control unit (20) is configured to provide preset control signals to start an automatic warm-up procedure to torque source (8) and to actuators (6, 7) according to preset steps.



Description

TECHNICAL FIELD

[0001] The present invention concerns an automatic warm up system for a hydraulic circuit, in particular for a work vehicle.

[0002] The present invention finds its preferred, although not exclusive, application in a wheel loader.

BACKGROUND OF THE INVENTION

[0003] Work vehicles such as earth moving machines are provided with a plurality of hydraulic circuits for operating their operational systems.

[0004] In particular, earth-moving machines such as wheel loaders are provided with a bucket and a boom operated by a hydraulic circuit and with other essential hydraulic systems such as the hydrostatic transmission, the brake system or the steering.

[0005] As known, the oil in the hydraulic circuit varies its physical properties according to the temperature. Therefore, in very cold operative conditions, e.g. in cold environment wherein the earth moving machine should operate, the oil could be at a very low temperature that may lead to damages to the hydraulic components.

[0006] Accordingly, the driver is requested to execute a procedure consisting in starting the engine and operating the vehicle elements, such as boom or bucket, to warm up the oil so that it is suitable for correctly operating.

[0007] However it is clear that the above known procedure is intrinsically unsafe. Indeed, the operator may forget to execute the manual procedure thereby using directly the vehicle than the oil is too cold.

[0008] Furthermore, the operator may execute a not correct procedure that may lead to a not correct warming of the oil or malfunctioning in the vehicle.

[0009] Therefore, the need is felt to provide a warm up system for work vehicles that is efficient and safe and that remove the burden of such operation from the driver.

[0010] An aim of the present invention is to satisfy the above mentioned needs in a cost effective and optimized way.

SUMMARY OF THE INVENTION

[0011] The aforementioned aim is reached by a warm up system and method for oil into a hydraulic circuit as claimed in the appended set of claims.

BRIEF DESCRIPTION OF DRAWINGS

[0012] For a better understanding of the present invention, a preferred embodiment is described in the following, by way of a non-limiting example, with reference to the attached drawing wherein the only figure 1 is a schematic representation of the oil warm up system of the invention.

DETAILED DESCRIPTION OF THE INVENTION

[0013] Figure 1 discloses a hydraulic warm up system 1 according to the invention for an earth-moving machine such as a wheel loader (not shown in its entirety for sake of brevity).

[0014] In particular, the earth moving machine comprises a main hydrostatic transmission 2 (as per se known, comprising a hydraulic pump and a hydraulic motor), a steering system 3, a parking brake 4, a boom and a bucket. These latter are controlled via a joystick 5 suitable for actuating respective actuators 6, 7 configured to control the operation of the boom and of the bucket.

[0015] The earth-moving machine further comprises a torque source 8, e.g. an internal combustion engine, and a brake system 9.

[0016] In particular, the steering system 3 may be an electrohydraulic steering system provided with an electric valve 11 configured to control the steering actuator 12 in function of control signals acting on respective sides of the valve 11 itself.

[0017] In particular valve 11 may be a four ways - three positions proportional valve wherein the four ways are fluidly connected respectively to a tank T of the vehicle, to a source P of fluid in pressure and to two sides of the steering actuator 12. The valve 11 may therefore assume at least the following limit positions: a first position wherein fluid may flow from source P to a first side of the actuator 12 and the opposite one is fluidly connected to tank T, a second position opposite with respect to the preceding and a third position wherein both tank T and source P are not fluidly connected to actuator 12 (as represented in figure 1).

[0018] In greater detail, the actuators 6, 7 of the boom and bucket are controlled by valve arrangement 13 that may be designed as an open center distribution system provided with a pair of electric valves 14, 15 respectively voted to control the actuators 6, 7 in function of control signals acting on respective sides of the valves 14, 15 themselves.

[0019] In particular, valves 14, 15 may be proportional six ways - three position valves wherein the six ways are fluidly connected, respectively (making reference to one of valves 14, 15) to tank T, two of them to source P, to two sides of the actuator 6, 7 and one to the other valve 14, 15. The valves 14, 15 may therefore assume at least the following limit positions: a first position wherein fluid may flow from source P to a first side of the actuator 6, 7 and the opposite one is fluidly connected to tank T, a second position opposite with respect to the preceding and a third position wherein the source P is directly connected to tank (the one represented in figure 1).

[0020] The oil warm up system 1 comprises an electronic control unit 20 comprising elaboration means configured to detect data from a plurality of sensor means, as described in the following, related to the different above described elements of the vehicle.

[0021] In particular the sensor means comprises at

least the following:

- A boom position sensor 101 configured to detect an inclination or a relative position (vertical or horizontal) of a point of the boom with respect to a fixed point on the vehicle
- A bucket position sensor 102, configured to detect an inclination or a relative position (vertical or horizontal) of a point of the bucket of the vehicle with respect to a fixed point on the boom or on the vehicle;
- An accelerator sensor 103, e.g. a pedal position sensor, configured to detect an acceleration input provided by the user;
- A vehicle speed sensor 104, e.g. a speed sensor housed in the transmission of the vehicle, configured to detect vehicle speed;
- A service brake sensor 105 configured to detect an activation of service brake system 9;
- A park brake sensor 106, configured to detect an activation of park brake system 4;
- A travel direction sensor 107, e.g. a FNR switch, configured to detect the setting of the displacement of the pump of the hydrostatic transmission in forward position (positive displacement) or in rearward position (negative displacement) or in neutral position (displacement = 0);
- An input speed sensor 108, configured to detect the speed provided by torque source 8, e.g. an output shaft of the torque source 8, i.e. of the internal combustion engine;
- A hydraulic function switch 109, configured to detect enabling the hydraulic circuit that moves the bucket and the boom; and
- A joystick position sensor 110, configured to detect the position of the joystick, i.e. the input to be provided to boom and bucket actuators 6, 7;

[0022] Optionally, the system 1 may further comprises a:

- An oil temperature sensor 111 configured to detect the temperature of the oil flowing into circuit 1; and
- A steering actuator position sensor 112, configured to detect the steering angle.

[0023] Advantageously, vehicle 1 comprises user input means 21, e.g. realized as a button or a display, configured to be electronically connected, by wire or wireless, to the electronic control unit 20. The button or the display are configured to receive, e.g. by pressure, an input by the user and generate a signal that may be detected by the electronic control unit 20.

[0024] The electronic control unit 20 comprises elaboration means configured to acquire the data from the above sensors 101- 112 and, if a preset condition of the data retrieved by the sensors 101-112 is met, and the user request via input means 21 a warm up procedure, the electronic control unit 20 is configured to provide pre-

set control signals to start an automatic warm-up procedure.

[0025] Such automatic warm-up procedures foresees the control of torque source 8 and of boom and bucket actuators 6, 7 and steering actuator 12, if it is present an electronic control steering system, to make oil circulating into the described circuits thereby warming up this latter. The above procedure is aborted if at least one of a preset list of conditions is met, as detailed below.

[0026] In particular, the preset conditions that allows the starting of automatic warm-up procedure is the following:

- i) Hydraulic function is enabled;
- ii) Engine is ON at low idle;
- iii) Vehicle speed is equal to zero;
- iv) Joystick is released;
- v) Accelerator pedal is released;
- vi) Parking brake is engaged; and
- vii) Hydraulic transmission is in neutral position.

[0027] If the above conditions i) to vii) are all met, then the following actions are controlled by electronic control unit 20, one in succession to the other:

- Step 1) control the torque source 8 to run at a preset speed, e.g. 1200 rpm, for a first predetermined period of time, e.g. four minutes;
- Step 2) activate floating of the boom actuator 6 to lay the bucket on ground;
- Step 3) activate rolling back of the bucket till an end stroke position for a second predetermined period of time, e.g. two minutes;
- Step 4) activate lifting of the boom and dumping of the bucket till preset positions that allow to move boom and bucket without any contacts with ground and suitable to avoid any end stroke positions during the movements to be executed in following Step 5);
- Step 5) activate boom and bucket actuators 6, 7 with a control signal having a variable value for a third predetermined period of time, e.g. one minute;
- Step 6) activate lifting of the boom till another preset position that allows to steer the unit without any contacts of the boom and bucket with ground;

[0028] If it is present an electronic control steering system, the further steps may be foreseen in addition to the preceding ones:

- Step 7) activate the steering actuator 12 till a preset position that allows to steer the unit suitable to avoid any end stroke positions during the movements to be executed in following next Step 8);
- Step 8) activate the steering actuator 12 with a control signal having a variable value for a fourth predetermined period of time, e.g. one minute; and
- Step 9) control the steering actuator 12 to be positioned into a straight position.

[0029] In particular, the control signal in step 5 and 8 are a sinusoidal signal. In particular, such sinusoidal signal may have a variable amplitude and frequency in function of data related to the oil temperature detected by sensor means 111, if present.

[0030] In particular, the torque source speed in step 1, and/or the first, the second, the third and the fourth predetermined periods of time and/or may be varied according to in function of data related to the oil temperature detected by sensor means 111, if present.

[0031] If anyone among the below conditions is met, the electronic control unit 20 will abort the automatic procedure:

- a. Accelerator pedal is pressed;
- b. Joystick is moved;
- c. Service brake is activated;
- d. Hydraulic function is deactivated;
- e. Parking brake is disengaged; or
- f. Hydraulic transmission is set in forward or rearward motion.

[0032] In particular, if it is present an electronic control steering system also the further condition may be detected by control unit 20 to abort the automatic procedure:

g. Steering is activated.

[0033] The operation of the above defined warm up system is the following.

[0034] The electronic control unit 20 is activated by input of the user by user input means 21 and starts to continuously control the data retrieved by sensor means 101-112. If all the above conditions i) to vii) are met, then the automatic procedure is started. The automatic procedure is continued till

- 1) To the end; or
- 2) Till further input on button 21.

[0035] Clearly, if the electronic control unit 20 detects one of data a) to g), then the warm up procedure is interrupted.

[0036] In view of the above, the present invention further relates to oil warm up method for a earth moving vehicle as described in the preceding and comprising the following phases:

- Retrieving data from sensors 101-112 of the vehicle;
- Receiving an input from the user to start a warm-up procedure;
- Executing the warm-up procedure comprising the above mentioned steps 1) to 9).

[0037] In particular the method further comprises the step of:

- Interrupting the warm up procedure if one of the conditions a. to g. is detected by sensors 101-112.

[0038] In view of the foregoing, the advantages of the warm up system and method according to the invention are apparent.

[0039] Thanks to the proposed system and method an automatic and efficient warm-up procedure may be carried out without risk of stall of the engine, or incorrect execution by the driver.

[0040] Moreover, the automatic detailed warm-up procedure is optimized for wheel loaders machine provided with an open center main valve, as described that allows a complete circulation of the oil, thereby making a quick warm-up.

[0041] Furthermore, the provided warm up procedure is safe since if it is detected that the users is making operations that may lead to moving the vehicle (i.e. conditions a. to g. listed above), then the procedure is automatically stopped to avoid hydraulic problems.

[0042] It is clear that modifications can be made to the described warm up system and method which do not extend beyond the scope of protection defined by the claims.

[0043] For example, the electronic control steering system, as said, is optional such as the temperature sensor. Moreover, the described valve may be realized in different ways.

Claims

1. Earth moving vehicle provided with a bucket carried by a boom to execute a work operation, said vehicle comprising a torque source (8), a hydrostatic transmission (2), a joystick (5) for controlling actuators (6, 7) for moving said bucket and said boom, a parking brake system (4), a service brake system (9) and an accelerator pedal,

said vehicle comprising a plurality of sensor means among which:

- A boom position sensor (101) configured to detect a position of a point of said boom with respect to a fixed point on said vehicle
- A bucket position sensor (102) configured to detect a position of a point of said bucket with respect to a fixed point on the boom or on the vehicle;
- An accelerator sensor (103) configured to detect an acceleration input provided by the user via said accelerator pedal;
- A vehicle speed sensor (104), e.g. a speed sensor housed in the transmission of the vehicle, configured to detect vehicle speed;
- A service brake sensor (105) configured to detect an activation of service brake system (9);
- A park brake sensor (106), configured to detect an activation of park brake system

- (4);
- A travel direction sensor (107) configured to retrieve the displacement of the pump of the hydrostatic transmission in forward, rearward or neutral position;
 - An input speed sensor (108) configured to detect the speed provided by said torque source (8);
 - A hydraulic function switch (109), configured to detect the enabling of the hydraulic circuit that moves the bucket and the boom; and
 - A joystick position sensor (110), configured to detect the position of said joystick (5)
- said vehicle comprising a warm up system (1) comprising an electronic control unit (20) and user input means (21),
- said electronic control unit (20) comprising elaboration means configured to acquire the data from said sensors means and, if a preset condition of the data retrieved by said sensor means (101-112) is met, and the user requests via said input means (21) a warm up procedure, the electronic control unit (20) is configured to provide preset control signals to start an automatic warm-up procedure to said torque source (8) and to said actuators (6, 7), said automatic warm-up procedure comprising the following steps:
- Step 1) control said torque source (8) to run at a preset speed for a first predetermined period of time;
 - Step 2) activate floating of said boom actuator (6) to lay the bucket on ground;
 - Step 3) activate rolling back of said bucket till an end stroke position for a second predetermined period of time;
 - Step 4) activate lifting of said boom and dumping of said bucket till preset positions; and
 - Step 5) activate said boom and bucket actuators (6, 7) with a control signal having a variable value for a third predetermined period of time.
2. Earth moving vehicle according to claim 1, said vehicle further comprising an electronic control steering system configured to control a steering actuator (12) and a steering actuator position sensor (112) configured to detect the steering angle, said warm-up procedure then further comprising the following steps in addition to steps 1) to 5):
- Step 6) activate lifting of said boom till another preset position to steer the unit;
 - Step 7) activate said steering actuator (12) till
- a preset position;
- Step 8) activate said steering actuator (12) with a control signal having a variable value for a fourth predetermined period of time; and
 - Step 9) control said steering actuator (12) to be positioned into a straight position.
3. Earth moving vehicle according to claim 1 or 2, said vehicle further comprising an oil temperature sensor (111) configured to detect the temperature of oil flowing into circuit (1), wherein said control signal having a variable value is variable in function of such oil temperature detected by said temperature sensor (111).
4. Earth moving vehicle according to claims 1 to 3, wherein said control signal having a variable value is a sinusoidal signal.
5. Earth moving vehicle according to any of the preceding claims, wherein said user input means (21) comprises a button or display means electrically connected to said electronic control unit (20) .
6. Earth moving vehicle according to any of the preceding claims, wherein said preset condition of the starting of the warm up procedure comprises the following conditions:
- i) Hydraulic function is enabled;
 - ii) Engine is ON at low idle;
 - iii) Vehicle speed is equal to zero;
 - iv) Joystick is released;
 - v) Accelerator pedal is released;
 - vi) Parking brake is engaged; and
 - vii) Hydraulic transmission is in neutral position.
7. Earth moving vehicle according to any of the preceding claims, wherein said warm up procedure is interrupted if at least one among the following conditions is met:
- a. Accelerator pedal is pressed;
 - b. Joystick is moved;
 - c. Service brake is activated;
 - d. Hydraulic function is deactivated;
 - e. Parking brake is disengaged; or
 - f. Hydraulic transmission is set in forward or rearward motion.
8. Earth moving vehicle according to claim 7 when depending on claim 2, wherein said warm up procedure is interrupted also if the following conditions is met:
- g. steering is activated.
9. Method for warming up oil temperature in a earth moving vehicle as claimed in any of the preceding claims and comprising the following phases:

- Retrieving data from said sensors (101-112);
 - Receiving an input from the user to start a warm-up procedure;
 - Executing the warm-up procedure comprising said steps 1) to 9) .
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10. Method according to claim 9, further comprising the phase of:

- Interrupting the warm up procedure if one of the conditions a. to g. is met.
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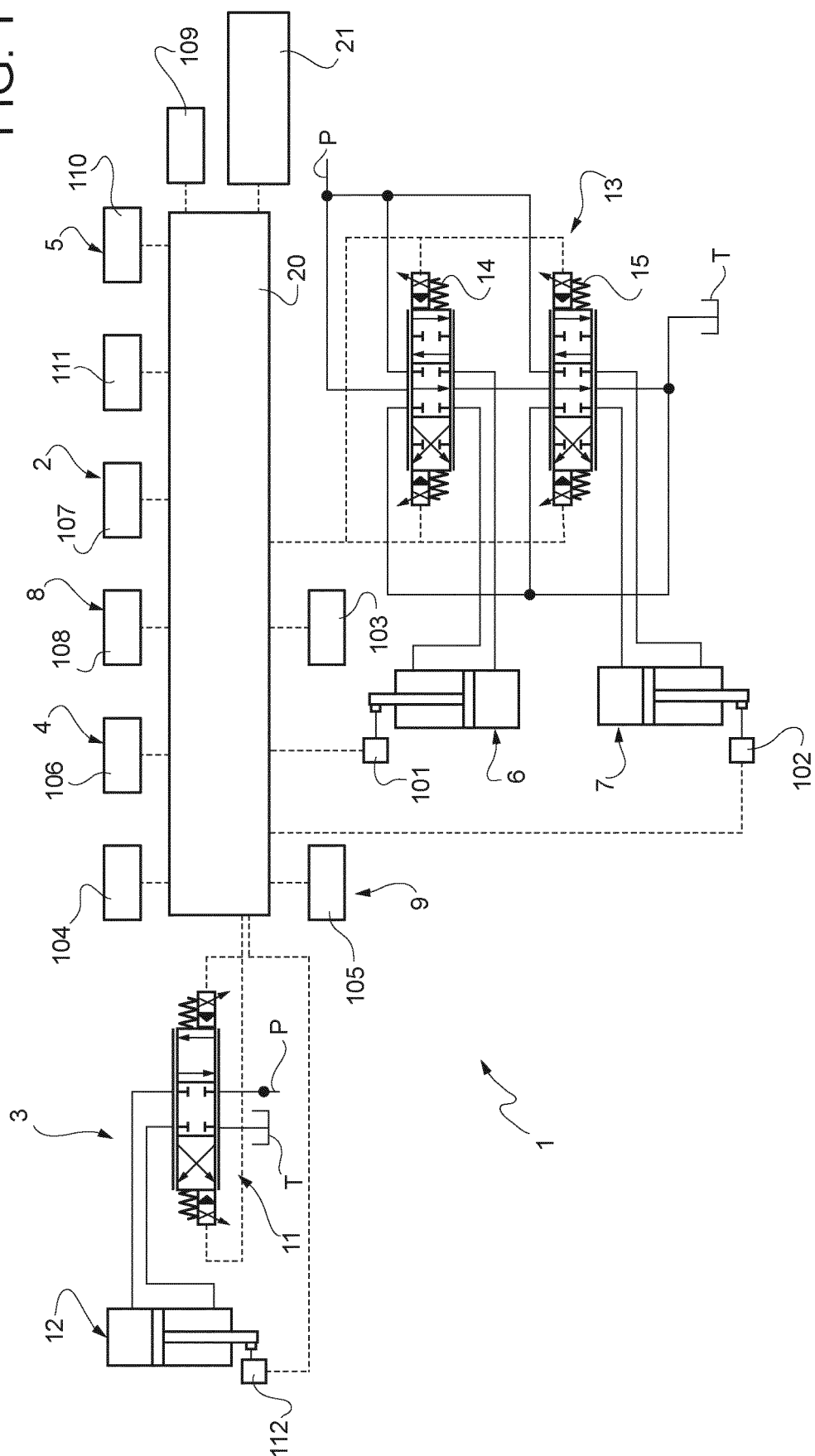
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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO.

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