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

(11) **EP 4 234 817 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
30.08.2023 Bulletin 2023/35

(21) Application number: **23153783.8**

(22) Date of filing: **27.01.2023**

(51) International Patent Classification (IPC):
E02F 3/43 *(2006.01)* ***E02F 9/20*** *(2006.01)*

(52) Cooperative Patent Classification (CPC):
E02F 3/434; E02F 9/2012; E02F 9/2041;
F15B 13/0424

(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 ME MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA
Designated Validation States:
KH MA MD TN

(30) Priority: **23.02.2022 IT 202200003371**

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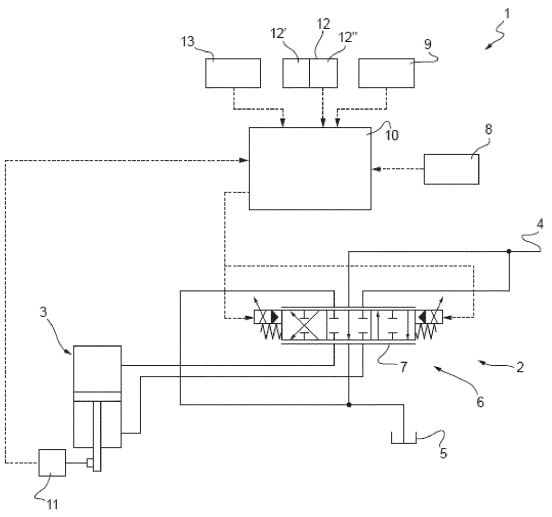
(54) **IMPROVED SYSTEM AND METHOD FOR CONTROLLING A RETURN FUNCTIONALITY IN A WORK VEHICLE**

(57) Work vehicle comprising an implement provided with at least a bucket comprising a control system (1) for controlling the movement of said implement and comprising a valve arrangement (6), a bucket actuator (3), an electronic control unit (10), a joystick (8) and a command means (12) for activating a return to dig, RTD, of the implement, the electronic control unit (10) being electrically connected to the valve arrangement (6) and to the command and to retrieve data related to the joystick (8) and data (9) related to engine speed of the work vehicle, the electronic control unit (10) comprising elaboration means configured to

- activate a RTD operation of said implement according to an enabling status of the command of the command means (12),
- activate a soft stop function of the implement if it is detected a release of the joystick, the soft stop function foreseeing an automatic smooth movement of the implement till a preset stop position, the soft stop function being inhibited if the RTD operation is active.

FIG. 1



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Description

TECHNICAL FIELD

[0001] The present invention concerns a system and method for controlling a return functionality of a work vehicle.

[0002] The present invention finds its preferred, although not exclusive, application in a system and a method for controlling an earth-moving machine such as a wheel loader.

BACKGROUND OF THE INVENTION

[0003] Earth-moving vehicles such as wheel loaders comprise an implement such as a bucket carried by a boom for moving the earth. In particular, the boom and the bucket are carried by respective hydraulic actuators that moves the bucket and the boom with respect to their hinge points.

[0004] Such hydraulic actuators are controlled by a joystick that is hand operated by the user to move the boom and bucket thereby moving the earth.

[0005] Work vehicles may be provided with a so-called return functionality, RTF, configured to automatically control the actuators of the boom and the bucket to move these latter to a predefined position according to the specific functionality.

[0006] One among the most common RTFs is the so-called return to dig, RTD, functionality wherein the bucket of the work vehicle is controlled to return to a preset position suitable for digging operation.

[0007] In the aforementioned, and other possible RTFs, the user usually active a command, such as by pressing a bottom or selecting a display icon, to activate the RTF. Such activation of command provides suitable input signals to boom and/or bucket actuators that move the boom and/or bucket to their target position.

[0008] Another function of which the work vehicles are provided is the so-called soft stop function. In such function an implement controlled by a joystick by the driver is controlled to smooth return to a standard position if the joystick is suddenly released by the user.

[0009] It is clear that the presence of a RTF functionality and of a soft-stop functionality may conflict each other thereby decreasing the productivity and the ergonomic of the user.

[0010] Therefore, the need is felt to improve the comfort, efficiency of a RTF on a work vehicle.

[0011] An aim of the present invention is to satisfy the above mentioned needs in a cost effective and optimized way.

SUMMARY OF THE INVENTION

[0012] The aforementioned aim is reached by a system and related control method as claimed in the appended set of claims.

BRIEF DESCRIPTION OF DRAWINGS

[0013] 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, Figure1 that is a schematic representation of the control system according to the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0014] Figure 1 discloses a control system 1 of a work vehicle provided with an implement (not shown) that preferably comprises a bucket (not shown) carried by a boom (not shown) and may advantageously be configured as a wheel loader.

[0015] The work vehicle comprises a hydraulic circuit 2 configured to control the operation of the implement of the work vehicle, in particular comprising at least a bucket actuator 3. In particular, the hydraulic circuit controls the passage of fluid between a source 4 of fluid in pressure and a tank 5 of the work vehicle.

[0016] In particular, the hydraulic circuit 5 comprises a valve arrangement 6 that may be designed as an open center distribution system provided with an electric valve 7 respectively voted to control the actuator 3 in function of control signals acting on respective sides of the valve 7 itself. In particular, the actuator 3 is a double effect hydraulic cylinders.

[0017] In particular, valve 6 may be a proportional six ways - three position valve fluidly connected, respectively two of them to tank 5, two of them to source 5, two of them to two sides of the actuator 3.

[0018] The valve 6 may therefore assume at least the following limit positions: a first position wherein fluid may flow from source 4 to a first side of the actuator 3 and the opposite side of the latter is fluidly connected to tank 5, a second position operatively opposite with respect to the preceding and a third position wherein the source 4 is directly connected to tank 5 (the one represented in figure 1).

[0019] The control system 1 further comprises a joystick 8 configured to be handled to the user to impart a control signal for controlling bucket actuators 3 via valve arrangement 6.

[0020] The control system 1 further comprises an electronic control unit 10 that is electronically connected to joystick and comprising elaboration means configured to retrieve data related to joystick position and data related to the speed of the engine of the work vehicle, to elaborate this latter to provide control signals to control valve arrangement 6, i.e. in the disclosed arrangement valve 7.

[0021] Work vehicle further comprises sensor means 11 configured to detect the position of bucket. In particular sensor means 11 may be position sensors carried by actuator means 3.

[0022] It is clear that sensor means 11 may be of any typology, e.g. radar means or image acquisition means

carried or rotation position sensor carried in the hinges connection of the work vehicle.

[0023] Work vehicle may further comprises other sensor means, such as pressure sensor means, configured to allow the electronic control unit 10 to control the boom/bucket movements.

[0024] The work vehicle further comprises return to function, RTF, command mean 12, in particular a return to dig, RTD, function, electrically connected to the control unit 10. The elaboration means of this latter are configured to execute the aforementioned RTD operation if the RTF command means 12 is controlled by the driver to activate the RTF function.

[0025] In particular, the RTF command 12 comprises:

- RTF enable switch 12', such as a button, an icon or a display, configured to enable the RTF functionality; and
- A RTF selection means 12'', such as a button, an icon or a display, configured to select the activation of the RTF function;

[0026] The work vehicle further comprises a main hydraulic switch 13 configured to enable the operation of the hydraulic systems of the vehicle.

[0027] The data related to joystick position may comprise at least the following parameters:

- i) the position in a Cartesian reference plane with respect to joystick longitudinal axis of the joystick handle; and, possibly,
- ii) the time of permanence of the joystick in the position at point i).

[0028] The operation of the above described system is the following.

[0029] The electronic control unit 10 controls the operation of the implement providing control signals to hydraulic arrangement 1, taking into account the data related by joystick 8, by engine speed 9 of the work vehicle and by sensor means 11 as per se known, e.g. according to the method disclosed in EP3719217 A1.

[0030] In particular, electronic control unit 10 is configured to detect the position of the joystick 8 to determine a release of this latter. In particular, the release of the joystick may be determined by detecting a passage from a [Xi, Yi] position to a [0, 0] position into the reference Cartesian plane. Furthermore, the release of the joystick may be detected by retrieving the speed of such passage in 0, 0 position from the [Xi, Yi] position and/or the permanence of the joystick into the [0, 0] position for a preset time.

[0031] If such release is detected, than a smoot transition of the bucket to a preset stop position is controlled by the electronic control unit 10 by providing specific control signals to valve arrangement 6, i.e. to actuator 3. The data related to the preset stop position are stored in the elaboration means of the electronic control unit 10 that control accordingly the actuator 3.

[0032] If the driver control a RTD command, then the RTD function is enabled and executed according to specific control by the user, e.g. by moving the joystick or pushing a specific button 12''. The data related to typology of enabled RTD operation are stored in the elaboration means that control accordingly this latter.

[0033] As per se known (e.g. EP3719217 A1), the RTD operation is controlled thanks to sensor means 11 whose data are elaborated in combination of data retrieved by joystick 8 and engine speed to control actuator 3.

[0034] If the electronic control unit detect a joystick release as defined above, then the soft stop function is inhibited and the electronic control unit 10 control the actuator 3 to move according to RTD functionality. In other words, the RTD functionality is predominant with respect to the soft stop function.

[0035] In view of the above, the invention is furthermore related to a method for controlling a RTD functionality in presence of a soft stop functionality of the described work vehicle comprising the following steps:

i) Acquiring data related to the movement of the joystick 8 of the work vehicle;
ii)Acquiring data related to operational status of the work vehicle;
iii) Acquiring data related to the request of a RTD functionality of the work vehicle;
iv) Elaborate the data retrieved in step i) to determine a variation of position of the joystick 8 with respect to a starting position of the joystick 8,
v) If (i) said variation of position is detected as a release of the joystick, and (ii) RTD functionality is not activated, then activate a soft stop functionality of said vehicle memorized in said control unit;
vi) If (i) said variation of position is not detected as a release of the joystick, and (ii) RTD functionality is not activated, then control the operation of the actuator 3 according to the data retrieved in steps i) and ii) via said electronic control unit; and
vii) If (i) said variation of position is not detected as a release of the joystick, and (ii) RTD functionality is activated, then control the operation of the actuator 3 to achieve said RTD functionality memorized in said control unit

[0036] As said, the data related to joystick 8 position comprise:

- i) the position in a Cartesian reference plane with respect to joystick longitudinal axis of the joystick handle; and, possibly,
- ii) the time of permanence of the joystick in the position at point i).

[0037] The data related to operational status of the vehicle comprises at least the speed 9 of the engine.

[0038] The data related to command of a RTD func-

tionality of the work vehicle comprises:

- An enabling signal from main hydraulic switch 13 representing that hydraulic functions of the work vehicle are enable;
- An enabling signal from main command means 12 representing that RTD is enabled and requested; and
- Position sensor means from sensor means 11.

[0039] In view of the foregoing, the advantages of the control system and method according to the invention are apparent.

[0040] In particular, the efficiency and comfort of the operation is increased because there is no need to manually alternatively activate the soft stop function and/or the RTD function.

[0041] Furthermore, the proposed system is substantially compact and indeed may be integrated or provided into already existing systems, without substantial modification of existing systems.

[0042] According to the above, the work operation speed is increased, thereby increasing the productivity of the overall vehicle operation.

[0043] It is clear that modifications can be made to the described control system and method which do not extend beyond the scope of protection defined by the claims.

[0044] In particular, the provided valve arrangement may vary, such as the composition of implement or the control of its actuators may comprise different data coming from other operational data of the work vehicle.

Claims

1. Work vehicle comprising an implement provided with at least a bucket, said work vehicle comprising a control system (1) for controlling the movement of said implement and comprising:

   a valve arrangement (6), a bucket actuator (3), said valve arrangement (6) being configured for providing fluid from a source (4) of fluid in pressure towards said bucket actuator (4);
   an electronic control unit (10), a joystick (8) and a command means (12) for activating a return to dig, RTD, of said implement,
   said electronic control unit (10) being electrically connected to said valve arrangement (6) and to said command and to retrieve data related to said joystick (8) and data (9) related to engine speed of said work vehicle,
   said electronic control unit (10) comprising elaboration means configured to elaborate the joystick and speed engine data and provide consequently a control signal towards said valve arrangement (6) for controlling said implement,
   said elaboration means being configured to activate a RTD operation of said implement according to an enabling status of said command of said command means (12),
   said elaboration means being configured to activate a soft stop function of said implement if it is detected a release of said joystick, said soft stop function foreseeing an automatic smooth movement of said implement till a preset stop position,
   said soft stop function being inhibited if said RTD operation is active.

2. Work vehicle according to claim 1, wherein said data related to joystick position (8) comprise the position in a Cartesian reference plane with respect to joystick longitudinal axis of the joystick handle.

3. Work vehicle according to claim 2, wherein said data related to joystick position (8) further comprise the time of permanence of the joystick in a specific position.

4. Work vehicle according to any of the preceding claims, wherein said command means (12) comprise

   • RTD enable switch (12'), configued to enable the RTD functionality; and
   • RTF selection means (12'') configured activate the RTF function.

5. Work vehicle according to any of the preceding claims, comprising a hydraulic main switch (13) configured to enable hydraulic functions of the work vehicle.

6. Work vehicle according to claim any of said preceding claims, wherein said valve arrangement (6) is an open center valve arrangement.

7. Work vehicle according to any of the preceding claims, comprising sensor means (11) configured to detect data related to the position of said bucket, said electronic control unit (10) being electrically connected to said sensor means (11), said elaboration means being configured to elaborate said data to control said valve arrangement (6) to control said actuators (3).

8. Method for controlling a return to dig, RTD, functionality in presence of a soft stop functionality in a work vehicle according to any of the preceding claims, said method comprising the following steps:

   i) Acquiring data related to the movement of the joystick (8) of the work vehicle;
   ii)Acquiring data related to operational status of the work vehicle;

iii) Acquiring data related to the request of a RTD functionality of the work vehicle;
iv) Elaborate the data retrieved in step i) to determine a variation of position of the joystick (8) with respect to a starting position of the joystick (8),
v) If (i) said variation of position is detected as a release of the joystick, and (ii) RTD functionality is not activated, then activate a soft stop functionality of said vehicle memorized in said control unit;
vi) If (i) said variation of position is not detected as a release of the joystick, and (ii) RTD functionality is not activated, then control the operation of the actuator (3) according to the data retrieved in steps i) and ii) via said electronic control unit; and
vii) If (i) said variation of position is not detected as a release of the joystick, and (ii) RTD functionality is activated, then control the operation of the actuator (3) to achieve said RTD functionality memorized in said control unit

9. Method according to claim 8, wherein said data related to joystick position (8) comprise the position in a Cartesian reference plane with respect to joystick longitudinal axis of the joystick handle.

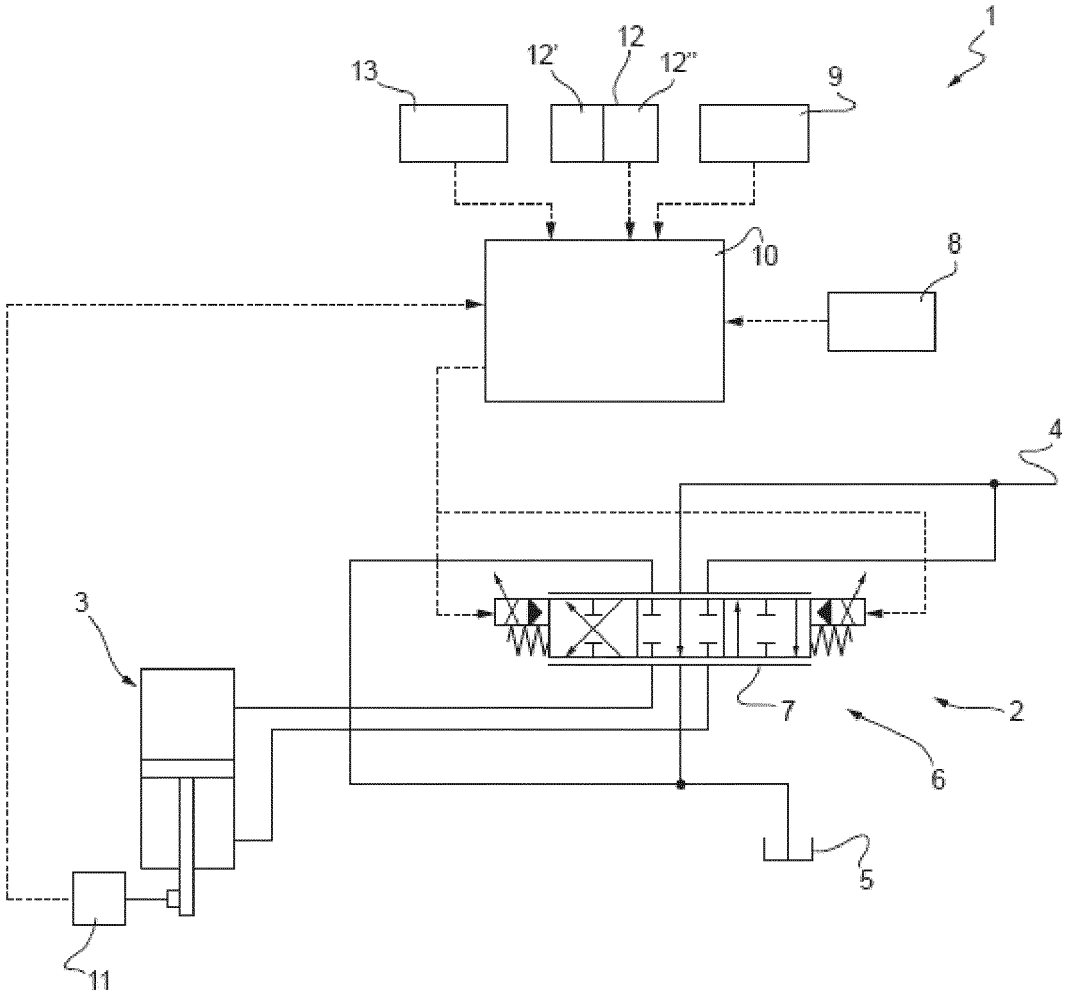
10. Method according to claim 9, wherein said data related to joystick position (8) further comprise the time of permanence of the joystick in a specific position.

11. Method according to any of claims 8 to 10, wherein said data related to operational status of the vehicle comprises at least the speed (9) of the engine of said work vehicle.

12. Method according to any of claims 8 to 11, wherein the data related to command of a RTD functionality of the work vehicle comprises:

- An enabling signal from main hydraulic switch (13) representing that hydraulic functions of the work vehicle are enable;
- An enabling signal from main command means (12) representing that RTD is enabled and requested; and
- Position sensor means from sensor means (11).

FIG. 1



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EUROPEAN SEARCH REPORT

Application Number
EP 23 15 3783

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A,D	EP 3 719 217 A1 (CNH IND ITALIA SPA [IT]) 7 October 2020 (2020-10-07) * the whole document *	1	INV. E02F3/43 E02F9/20
A	EP 3 114 284 B1 (CNH IND ITALIA SPA [IT]) 31 October 2018 (2018-10-31) * the whole document *	1	

TECHNICAL FIELDS SEARCHED (IPC)

E02F
F15D
F15B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	23 March 2023	Kühn, Thomas

CATEGORY OF CITED DOCUMENTS

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23-03-2023

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 3719217 A1	07-10-2020	NONE	
EP 3114284 B1	31-10-2018	BR 112016020335 A2	15-08-2017
		CN 106068353 A	02-11-2016
		EP 3114284 A1	11-01-2017
		US 2017073924 A1	16-03-2017
		WO 2015132178 A1	11-09-2015

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Patent documents cited in the description

- EP 3719217 A1 **[0029] [0033]**