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(54) CONTROL METHOD FOR AUTOMATICALLY SELECTING AN OPERATING MODE OF A WORK VEHICLE, CORRESPONDING CONTROL SYSTEM AND WORK VEHICLE COMPRISING THE CONTROL SYSTEM

(57) A control method for automatically selecting an operating mode of a work vehicle is disclosed, wherein the control method comprises the steps of: a) determining a current position of a boom along a travel path of the boom over time; b) determining a current travel speed of the work vehicle over time; c) determining the value of pressure of a first working fluid within a forward line over time; d) determining the value of pressure of the first working fluid within a reverse line over time; e) selecting one operating mode of the work vehicle from the plurality of selectable operating modes, based on the detected current position of the boom along a travel path of the boom, the detected current travel speed of the work vehicle, the detected value of pressure of the first working fluid within the forward line, and the detected value of pressure of the first working fluid within the reverse line; f) setting the work vehicle in the selected operating mode. In addition, a control system for a work - 2 - vehicle and a work vehicle are disclosed.

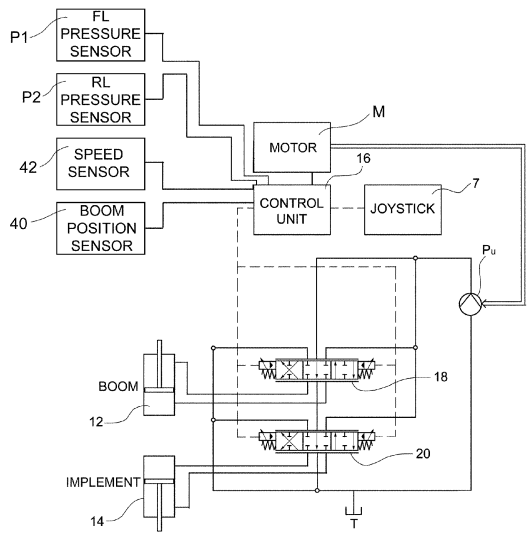

FIG.4a

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Description

Technical field

[0001] The present invention relates generally to a work vehicle, such as for example a compact wheel loader, and particularly to a control method for automatically selecting an operating mode of work vehicle, a corresponding control system and a work vehicle comprising such control system.

Prior art

[0002] Motorized work vehicles are well known for use in material handling that carry an implement (for example, a bucket) and have a hydraulically operated lifting arm for moving the implement. Examples of such vehicles are tractors and loaders.

[0003] A loader is a heavy equipment machine used in construction to move aside on the ground or load materials such as asphalt, demolition debris, dirt, snow, feed, gravel, logs, raw minerals, recycled material, rock, sand, woodchips, etc. into or onto another type of machinery (such as a dump truck, conveyor belt, feed-hopper, or railroad car). There are many types of loader, which, depending on design and application, are called by various names, including implement loader, front loader, front-end loader, pay loader, scoop, shovel, skip loader, wheel loader, or skid-steer. In particular, compact wheel loaders are compact vehicles that have road wheels and carry a working implement attached to a lift arm or boom that is hydraulically powered.

[0004] Referring to figure 1, a work vehicle 1, such as a compact wheel loader, is shown. However, the invention is not limited to such a kind of work vehicle, but is applicable to any other kind of work vehicle.

[0005] A compact wheel loader includes a boom 5 pivotally connected to one end to the frame 3. An implement 2 is pivotally connected to the opposite end of the boom for tilting movement relative to the frame 3 about a generally horizontal axis. The above-described features form no substantial part of the present invention and are generally well known in the art. An implement, e.g. a bucket, may be replaced in operation by any other type of implement, e.g. a blade.

[0006] Usually, the movement of the boom 5 and of the implement 2 is controlled by the operator through a joystick 7 placed inside an operator's cab or cabin 9 of the work vehicle 1.

[0007] As can be seen in figure 2, which shows a control diagram of the work vehicle 1, the boom 3 and the implement 2 are moved by an hydraulic control circuit 10 comprising a first and a second hydraulic actuators 12, 14 which are controlled by an electronic control unit 16 through respective solenoid valves 18, 20 according to the position of the joystick 7 controlled by the operator.

[0008] For example, each hydraulic actuator comprises an hydraulic cylinder operatively connected respectively to the boom and the implement, that uses hydraulic power of a working fluid to facilitate mechanical operation, the working fluid being controlled by means of directional solenoid valves 18, 20, e.g. an open centre valve. As liquids are nearly impossible to compress, a hydraulic actuator can exert a large force. The rate of actuation of the boom and implement is controlled by the opening degree of the respective directional solenoid valve 18, 20 by means of a driving current thereof as a function of the position of the joystick.

[0009] The hydraulic flow rate of the working fluid required to operate the boom and the implement is produced by a hydraulic pump Pu connected to a fluid reservoir T and driven by an internal combustion engine or an electrical motor M (hereinafter simply referred to as motor) of the vehicle, e.g. by a mechanical linkage. The same motor is also used to drive the wheels as a propulsion means of the work vehicle.

[0010] Figure 3 shows an exemplary joystick of a work vehicle. A movement of the joystick in an associated bi-dimensional control area A according to a first direction y causes the actuation of the boom and a movement of the joystick in said bi-dimensional control area A according to a second direction x causes the actuation of the implement. The intersection of said x and y directions is defined as origin O of the control area A, and corresponds to the neutral position of the joystick.

[0011] A neutral region N around the neutral position of the joystick is a region where the boom and implement are not actuated. A region externally surrounding the neutral region is defined a driving region and indicated D in this figure.

[0012] For example, according to the orientation depicted in figure 3, when the joystick is moved up from the origin 0 of the control area A according to the y direction the boom is lowered with respect to ground and when the joystick is moved down from the origin O according to the y direction the boom is lifted with respect to ground. Further, when the joystick is moved right from the origin O according to the x direction the implement, is tilted towards a dumping position, and when the joystick is moved left from the origin O according to the x direction the implement, is tilted towards a dig or rollback position and beyond.

[0013] A combination of movement in both directions x and y of the joystick is allowed in order to move simultaneously the boom and the implement.

[0014] For example, the component of a position P of the joystick 7 along direction y (boom actuation axis) is indicated y_P in figure 3 and is the projection over y axis of a vector representing the position P of the joystick in the control area A. The component of the position P of the joystick 7 along direction x (implement actuation axis) is indicated x_P in figure 3 and is the projection over x axis of the vector representing the position P of the joystick in the control area A. The components y_P, x_P of the position P of the joystick may take on any combination of a "positive" value and a "negative" value on the y axis and

x axis, respectively with respect to origin O of the control area A that corresponds to the neutral position of the joystick.

[0015] In known work vehicles, it is possible to manually set an operating mode of the work vehicle. In such work vehicles, it is the operator that, according to the current working condition, selects the operating mode.

[0016] Disadvantageously, this leads to an increased workload by the operator, who may not always select the most adapted operating mode of the work vehicle for the real working condition.

Summary of the invention

[0017] The aims of the present invention are to increase the usability, the performance and the efficiency of the work vehicle.

[0018] Another aim of the present invention is to provide a solution that allows a reduction of the workload by the operator, hereby increasing the comfort of the operator.

[0019] According to the invention, these aims are achieved by a control method for automatically selecting an operating mode of a work vehicle having the features claimed in claim 1.

[0020] Preferred embodiments are defined in the dependent claims, whose content is also to be considered an integral part of the present description. Features of the dependent claims may be combined with the features of the independent claims as appropriate, and in combinations other than those explicitly set out in the claims.

[0021] Further subjects of the invention are control systems for a work vehicle, as well a work vehicle, as claimed.

[0022] In summary, the proposed invention allows to dynamically change the operating mode of the work vehicle (i.e. setting the aggressiveness of boom or an implement movements) depending on an hydrostatic transmission pressure and the boom position. This function automatically set the boom and bucket aggressiveness proper to the working vehicle digging working conditions in order to increase the performance, the comfort of the operator and the efficiency of the work vehicle.

Brief description of the drawings

[0023] Further functional and structural characteristics and advantages of the present invention are set out in the detailed description below, provided purely as a non-limiting example, with reference to the attached drawings, in which:

- figure 1 shows a prior art exemplary work vehicle, in particular a compact wheel loader;
- figure 2 shows a prior art control diagram of a work vehicle;
- figure 3 shows a prior art exemplary joystick of a work vehicle;
- figure 4a shows a control diagram of a work vehicle according to the invention;
- figure 4b shows an exemplary hydrostatic transmission of a work vehicle;
- figure 5 shows an exemplary travel path of a boom;
- figure 6a shows a first exemplary case of curves representing the modified driving currents for three different operating modes (low, medium and high aggressiveness) of the work vehicle; and
- figure 6b shows a second exemplary case of curves representing the modified driving currents for three different operating modes (low, medium and high aggressiveness) of the work vehicle.

Detailed description

[0024] In the following description, unless otherwise defined, all terms (including technical and scientific terms) are to be interpreted as is customary in the art. It will be further understood that terms in common usage should also be interpreted as is customary in the relevant art and not in an idealized or overly formal sense unless expressly so defined herein. All orientation terms, such as upper and lower, are used in relation to the drawings and should not be interpreted as limiting the invention.

[0025] In the following, a first embodiment of a control method for automatically selecting an operating mode of a work vehicle is described, with reference to figure 4a.

[0026] The work vehicle includes a motor M arranged to power the work vehicle, a boom and an implement attached to the boom.

[0027] Moreover, the work vehicle includes a boom position sensor means 40 arranged to detect a position of the boom along a travel path TP of the boom, a speed sensor means 42 arranged to detect a travel speed of the work vehicle, and a joystick 7 operatively controlled by an operator for actuating the boom and the implement. The speed sensor means may be for example an encoder.

[0028] An exemplary travel path is shown in figure 5.

[0029] The joystick is movable in a predetermined control area with respect to a first preset axis for actuating the boom and with respect to a second preset axis for actuating the implement.

[0030] In addition, the work vehicle includes a hydrostatic transmission comprising a first hydraulic pump HP, a hydraulic motor HM , a forward line FL arranged to hydraulically connect an outlet of the hydraulic pump to an inlet of the hydraulic motor, and a reverse line RL arranged to hydraulically connect an outlet of the hydraulic motor HM to an inlet of the hydraulic pump HP, in such a manner to define a closed hydraulic circuit within which a first working fluid is arranged to flow. The work vehicle further comprises a first pressure sensor means P1 arranged to detect a pressure value of the first working fluid flowing within the forward line of the hydrostatic transmission, and a second pressure sensor means P2 arranged to detect a pressure value of the first working fluid

flowing within the reverse line of the hydrostatic transmission. An exemplary hydrostatic transmission is shown in figure 4b.

[0031] The work vehicle includes also an hydrostatic circuit for actuating the boom and the implement. The hydrostatic circuit includes a second hydraulic pump connected to a fluid reservoir and driven by said motor of the vehicle. A second working fluid is arranged to flow within said hydrostatic circuit.

[0032] The work vehicle comprises a plurality of selectable operating modes of the work vehicle.

[0033] The actuation of the boom occurs by means of first hydraulic actuating means including at least one first hydraulic cylinder operatively connected to the boom, and a first directional solenoid valve 18 whose opening degree is adapted to control the flow of the second working fluid to the at least one first hydraulic cylinder. A rate of actuation of the boom is controlled by the opening degree of the first directional 18 solenoid valve by means of a first driving current thereof, wherein a value of the first driving current is dependent on a component of the position of the joystick along said first preset axis for actuating the boom and on the selected operating mode of the work vehicle.

[0034] Similarly, the actuation of the implement occurs by means of second hydraulic actuating means including at least one second hydraulic cylinder operatively connected to the implement, and a second directional solenoid valve 20 whose opening degree is adapted to control the flow of the second working fluid to the at least one second hydraulic cylinder. A rate of actuation of the implement is controlled by the opening degree of the second directional solenoid valve 20 by means of a second driving current thereof, wherein a value of the second driving current is dependent on a component of the position of the joystick along said second preset axis for actuating the implement and on the selected operating mode of the work vehicle.

[0035] In said first embodiment, the control method for automatically selecting an operating mode of a work vehicle comprises the steps of:

a) determining the current position of the boom along a travel path of the boom over time;

b) determining the current travel speed of the work vehicle over time;

c) determining the value of pressure of the first working fluid within the forward line over time;

d) determining the value of pressure of the first working fluid within the reverse line over time;

e) selecting one operating mode of the work vehicle from the plurality of selectable operating modes, based on the detected current position of the boom along a travel path of the boom, the detected current travel speed of the work vehicle, the detected value of pressure of the first working fluid within the forward line, and the detected value of pressure of the first working fluid within the reverse line;

f) setting the work vehicle in the selected operating mode.

[0036] Preferably, the selectable operating modes of the work vehicle includes:

- a first operating mode, in which a variation of the component of the position of the joystick along the first preset axis, due to a travel of the joystick from a first operating position to a second operating position, is arranged to determine a variation of the value of the first driving current according to a first increasing or decreasing rate over time, and a variation of the component of the position of the joystick along the second preset axis, due to the travel of the joystick from the first operating position to the second operating position, is arranged to determine a variation of the value of the second driving current according to a first increasing or decreasing rate over time;
- a second operating mode, in which a variation of the component of the position of the joystick along the first preset axis, due to the travel of the joystick from the first operating position to the second operating position, is arranged to determine a variation of the value of the first driving current according to a second increasing or decreasing rate over time, higher than the first increasing or decreasing rate, and a variation of the component of the position of the joystick along the second preset axis, due to the travel of the joystick from the first operating position to the second operating position, is arranged to determine a variation of the value of the second driving current according to a second increasing or decreasing rate over time, higher than the first increasing or decreasing rate;
- a third operating mode, in which a variation of the component of the position of the joystick along the first preset axis, due to the travel of the joystick from the first operating position to the second operating position, is arranged to determine a variation of the value of the first driving current according to a third increasing or decreasing rate over time, higher than the first and second increasing or decreasing rates, and a variation of the component of the position of the joystick along the second preset axis, due to the travel of the joystick from the first operating position to the second operating position, is arranged to determine a variation of the value of the second driving current according to a third increasing or decreasing rate over time, higher than the first and second increasing or decreasing rates. See for example figures 6a and 6b.

[0037] For example, the operating mode may be also called aggressiveness mode, e.g. the first operating mode may be called "low aggressiveness mode", the second operating mode may be called "medium aggressive-

ness mode", and the third operating mode may be called "high aggressiveness mode".

[0038] Preferably, the step c) may include the step of measuring the value of pressure of the first working fluid within the forward line by means of a first pressure sensor means, and the step d) may include the step of measuring the value of pressure of the first working fluid within the reverse line by means of a second pressure sensor means.

[0039] Preferably, the step b) may include the step of measuring the current travel speed of the work vehicle by means of a speed sensor means.

[0040] Preferably, the step a) may include the step of determining the current position of the boom along a travel path of the boom by means of an angle detection sensor coupled to the boom, or, the step a) may include the step of determining the current position of the boom along a travel path of the boom by means of a linear sensor means coupled to the first hydraulic cylinder operatively connected to the boom.

[0041] The two possible solutions above are each a boom position sensor means, e.g. a boom position sensor.

[0042] The present invention relates also to a control system for a work vehicle.

[0043] In a preferred embodiment of the control system, the control system includes:

- first input means adapted to receive at least a signal or data indicative of a current position of a boom along a travel path of the boom;
- second input means adapted to receive at least a signal or data indicative of a current travel speed of the work vehicle over time;
- third input means adapted to receive a at least a signal or data indicative of a value of pressure of a first working fluid within a forward line of a hydrostatic transmission of the work vehicle over time;
- fourth input means adapted to receive a at least a signal or data indicative of a value of pressure of the first working fluid within a reverse line of the hydrostatic transmission of the work vehicle over time;
- first output means adapted to issue at least a signal indicative of a selected operating mode of the work vehicle;

[0044] In this embodiment, the control system is arranged to carry out a method according to any of the embodiments of the method explained before.

[0045] In a further aspect, the invention relates to a work vehicle.

[0046] In an embodiment of the work vehicle, in particular compact wheel loader, the work vehicle comprises:

- a motor arranged to power the work vehicle;
- a boom and an implement attached to the boom;
- a boom position sensor means arranged to detect a position of the boom along a travel path of the boom;
- a speed sensor means arranged to detect a travel speed of the work vehicle;
- a joystick operatively controlled by an operator for actuating the boom and the implement, the joystick being movable in a predetermined control area according to a first preset axis for actuating the boom and according to a second preset axis for actuating the implement.

[0047] Moreover, the work vehicle includes a hydrostatic transmission. The hydrostatic transmission comprises a first hydraulic pump, a hydraulic motor, a forward line arranged to hydraulically connect an outlet of the hydraulic pump to an inlet of the hydraulic motor, and a reverse line arranged to hydraulically connect an outlet of the hydraulic motor to an inlet of the hydraulic pump in such a manner to define a closed hydraulic circuit within which a first working fluid is arranged to flow.

[0048] The work vehicle further includes a first pressure sensor means arranged to detect a pressure value of the first working fluid flowing within the forward line of the hydrostatic transmission, and a second pressure sensor means arranged to detect a pressure value of the first working fluid flowing within the reverse line of the hydrostatic transmission.

[0049] In addition, the work vehicle includes an hydrostatic circuit for actuating the boom and the implement. The hydrostatic circuit includes a second hydraulic pump connected to a fluid reservoir and driven by said motor of the vehicle, wherein a second working fluid is arranged to flow within said hydrostatic circuit.

[0050] The work vehicle further includes a plurality of selectable operating modes of the work vehicle, and a control system according to the embodiments described above.

[0051] The actuation of the boom occurs by means of first hydraulic actuating means including at least one first hydraulic cylinder operatively connected to the boom, and a first directional solenoid valve whose opening degree is adapted to control the flow of the second working fluid to the at least one first hydraulic cylinder. A rate of actuation of the boom is controlled by the opening degree of the first directional solenoid valve by means of a first driving current thereof, wherein a value of the first driving current is dependent on a component of the position of the joystick along said first preset axis for actuating the boom and on the selected operating mode of the work vehicle.

[0052] Similarly, the actuation of the implement occurs by means of second hydraulic actuating means including at least one second hydraulic cylinder operatively connected to the implement, and a second directional solenoid valve whose opening degree is adapted to control the flow of the second working fluid to the at least one second hydraulic cylinder. A rate of actuation of the implement is controlled by the opening degree of the second

directional solenoid valve by means of a second driving current thereof, wherein a value of the second driving current is dependent on a component of the position of the joystick along said second preset axis for actuating the implement and on the selected operating mode of the work vehicle.

[0053] The example embodiments are described in sufficient detail to enable those of ordinary skill in the art to implement a control system in a work vehicle arranged to carry out the disclosed control method herein described.

[0054] Naturally, the principle of the invention remaining unchanged, the embodiments and the constructional details may vary widely from those described and illustrated purely by way of non-limiting example, without thereby departing from the scope of the invention as defined in the appended claims.

Claims

1. A control method for automatically selecting an operating mode of a work vehicle, wherein said work vehicle includes:

- a motor arranged to power the work vehicle;
- a boom and an implement attached to the boom;
- a boom position sensor means arranged to detect a position of the boom along a travel path of the boom;
- a speed sensor means arranged to detect a travel speed of the work vehicle;
- a joystick operatively controlled by an operator for actuating the boom and the implement, the joystick being movable in a predetermined control area according to a first preset axis for actuating the boom and according to a second preset axis for actuating the implement;
- a hydrostatic transmission comprising
a first hydraulic pump, a hydraulic motor, a forward line arranged to hydraulically connect an outlet of the hydraulic pump to an inlet of the hydraulic motor, and a reverse line arranged to hydraulically connect an outlet of the hydraulic motor to an inlet of the hydraulic pump in such a manner to define a closed hydraulic circuit within which a first working fluid is arranged to flow;
- a first pressure sensor means arranged to detect a pressure value of the first working fluid flowing within the forward line of the hydrostatic transmission, and a second pressure sensor means arranged to detect a pressure value of the first working fluid flowing within the reverse line of the hydrostatic transmission;
- an hydrostatic circuit for actuating the boom and the implement including a second hydraulic pump connected to a fluid reservoir and driven by said motor of the vehicle, wherein a second working fluid is arranged to flow within said hydrostatic circuit;
- a plurality of selectable operating modes of the work vehicle;

wherein the actuation of the boom occurs by means of first hydraulic actuating means including at least one first hydraulic cylinder operatively connected to the boom, and a first directional solenoid valve whose opening degree is adapted to control the flow of the second working fluid to the at least one first hydraulic cylinder;
wherein the actuation of the implement occurs by means of second hydraulic actuating means including at least one second hydraulic cylinder operatively connected to the implement, and a second directional solenoid valve whose opening degree is adapted to control the flow of the second working fluid to the at least one second hydraulic cylinder;
a rate of actuation of the boom is controlled by the opening degree of the first directional solenoid valve by means of a first driving current thereof, wherein a value of the first driving current is dependent on a component of the position of the joystick along said first preset axis for actuating the boom and on the selected operating mode of the work vehicle;
a rate of actuation of the implement is controlled by the opening degree of the second directional solenoid valve by means of a second driving current thereof, wherein a value of the second driving current is dependent on a component of the position of the joystick along said second preset axis for actuating the implement and on the selected operating mode of the work vehicle;
the control method comprising the steps of:

a) determining the current position of the boom along a travel path of the boom over time;
b) determining the current travel speed of the work vehicle over time;
c) determining the value of pressure of the first working fluid within the forward line over time;
d) determining the value of pressure of the first working fluid within the reverse line over time;
e) selecting one operating mode of the work vehicle from the plurality of selectable operating modes, based on the

detected current position of the boom along a travel path of the boom, the detected current travel speed of the work vehicle, the detected value of pressure of the first working fluid within the forward line, and the detected value of pressure of the first working fluid within the reverse line;
f) setting the work vehicle in the selected operating mode.

2. The control method according to claim 1, wherein the selectable operating modes of the work vehicle includes:

- a first operating mode, in which a variation of the component of the position of the joystick along the first preset axis, due to a travel of the joystick from a first operating position to a second operating position, is arranged to determine a variation of the value of the first driving current according to a first increasing or decreasing rate over time, and a variation of the component of the position of the joystick along the second preset axis, due to the travel of the joystick from the first operating position to the second operating position, is arranged to determine a variation of the value of the second driving current according to a first increasing or decreasing rate over time;
- a second operating mode, in which a variation of the component of the position of the joystick along the first preset axis, due to the travel of the joystick from the first operating position to the second operating position, is arranged to determine a variation of the value of the first driving current according to a second increasing or decreasing rate over time, higher than the first increasing or decreasing rate, and a variation of the component of the position of the joystick along the second preset axis, due to the travel of the joystick from the first operating position to the second operating position, is arranged to determine a variation of the value of the second driving current according to a second increasing or decreasing rate over time, higher than the first increasing or decreasing rate;
- a third operating mode, in which a variation of the component of the position of the joystick along the first preset axis, due to the travel of the joystick from the first operating position to the second operating position, is arranged to determine a variation of the value of the first driving current according to a third increasing or decreasing rate over time, higher than the first and second increasing or decreasing rates, and a variation of the component of the position of the joystick along the second preset axis, due to the travel of the joystick from the first operating position to the second operating position, is arranged to determine a variation of the value of the second driving current according to a third increasing or decreasing rate over time, higher than the first and second increasing or decreasing rates.

3. The control method according to claim 1 or 2, wherein the step c) includes:

- measuring the value of pressure of the first working fluid within the forward line by means of a first pressure sensor means;

and the step d) includes:

- measuring the value of pressure of the first working fluid within the reverse line by means of a second pressure sensor means.

4. The control method according to any one of the preceding claims, wherein the step b) includes:

- measuring the current travel speed of the work vehicle by means of a speed sensor means.

5. The control method according to any one of the preceding claims, wherein the step a) includes:

- determining the current position of the boom along a travel path of the boom by means of an angle detection sensor coupled to boom.

6. The control method according to any one of claims 1 to 4, wherein the step a) includes:

- determining the current position of the boom along a travel path of the boom by means of a linear sensor means coupled to the first hydraulic cylinder operatively connected to the boom.

7. A control system for a work vehicle, said control system comprising:

- first input means adapted to receive at least a signal or data indicative of a current position of a boom along a travel path of the boom;
- second input means adapted to receive at least a signal or data indicative of a current travel speed of the work vehicle over time;
- third input means adapted to receive a at least a signal or data indicative of a value of pressure of a first working fluid within a forward line of a hydrostatic transmission of the work vehicle over time;
- fourth input means adapted to receive a at least a signal or data indicative of a value of pressure of the first working fluid within a reverse line of

the hydrostatic transmission of the work vehicle over time;
- first output means adapted to issue at least a signal indicative of a selected operating mode of the work vehicle;
the control system being arranged to carry out a control method according to any one of claims 1 to 6.

8. Work vehicle, in particular compact wheel loader, comprising:

- a motor arranged to power the work vehicle;
- a boom and an implement attached to the boom;
- a boom position sensor means arranged to detect a position of the boom along a travel path of the boom;
- a speed sensor means arranged to detect a travel speed of the work vehicle;
- a joystick operatively controlled by an operator for actuating the boom and the implement, the joystick being movable in a predetermined control area according to a first preset axis for actuating the boom and according to a second preset axis for actuating the implement;
- a hydrostatic transmission comprising
a first hydraulic pump, a hydraulic motor, a forward line arranged to hydraulically connect an outlet of the hydraulic pump to an inlet of the hydraulic motor, and a reverse line arranged to hydraulically connect an outlet of the hydraulic motor to an inlet of the hydraulic pump in such a manner to define a closed hydraulic circuit within which a first working fluid is arranged to flow;
- a first pressure sensor means arranged to detect a pressure value of the first working fluid flowing within the forward line of the hydrostatic transmission, and a second pressure sensor means arranged to detect a pressure value of the first working fluid flowing within the reverse line of the hydrostatic transmission;
- an hydrostatic circuit for actuating the boom and the implement including a second hydraulic pump connected to a fluid reservoir and driven by said motor of the vehicle, wherein a second working fluid is arranged to flow within said hydrostatic circuit;
- a plurality of selectable operating modes of the work vehicle;
- a control system according to claim 7;

wherein the actuation of the boom occurs by means of first hydraulic actuating means including at least one first hydraulic cylinder operatively connected to the boom, and a first directional solenoid valve whose opening degree is adapted to control the flow of the second working fluid to the at least one first hydraulic cylinder;
wherein the actuation of the implement occurs by means of second hydraulic actuating means including at least one second hydraulic cylinder operatively connected to the implement, and a second directional solenoid valve whose opening degree is adapted to control the flow of the second working fluid to the at least one second hydraulic cylinder;
a rate of actuation of the boom is controlled by the opening degree of the first directional solenoid valve by means of a first driving current thereof, wherein a value of the first driving current is dependent on a component of the position of the joystick along said first preset axis for actuating the boom and on the selected operating mode of the work vehicle;
a rate of actuation of the implement is controlled by the opening degree of the second directional solenoid valve by means of a second driving current thereof, wherein a value of the second driving current is dependent on a component of the position of the joystick along said second preset axis for actuating the implement and on the selected operating mode of the work vehicle.

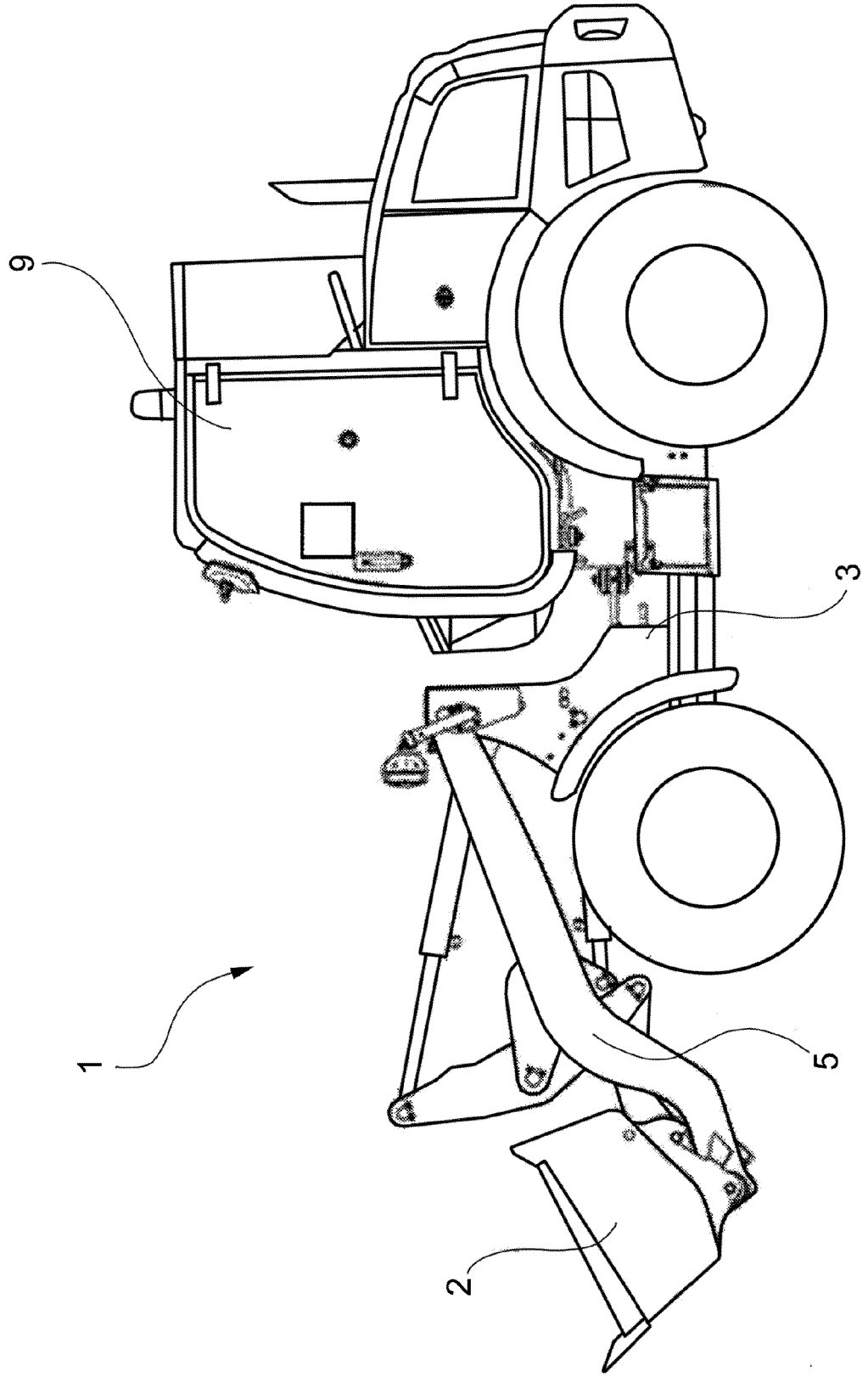


FIG.1
(PRIOR ART)

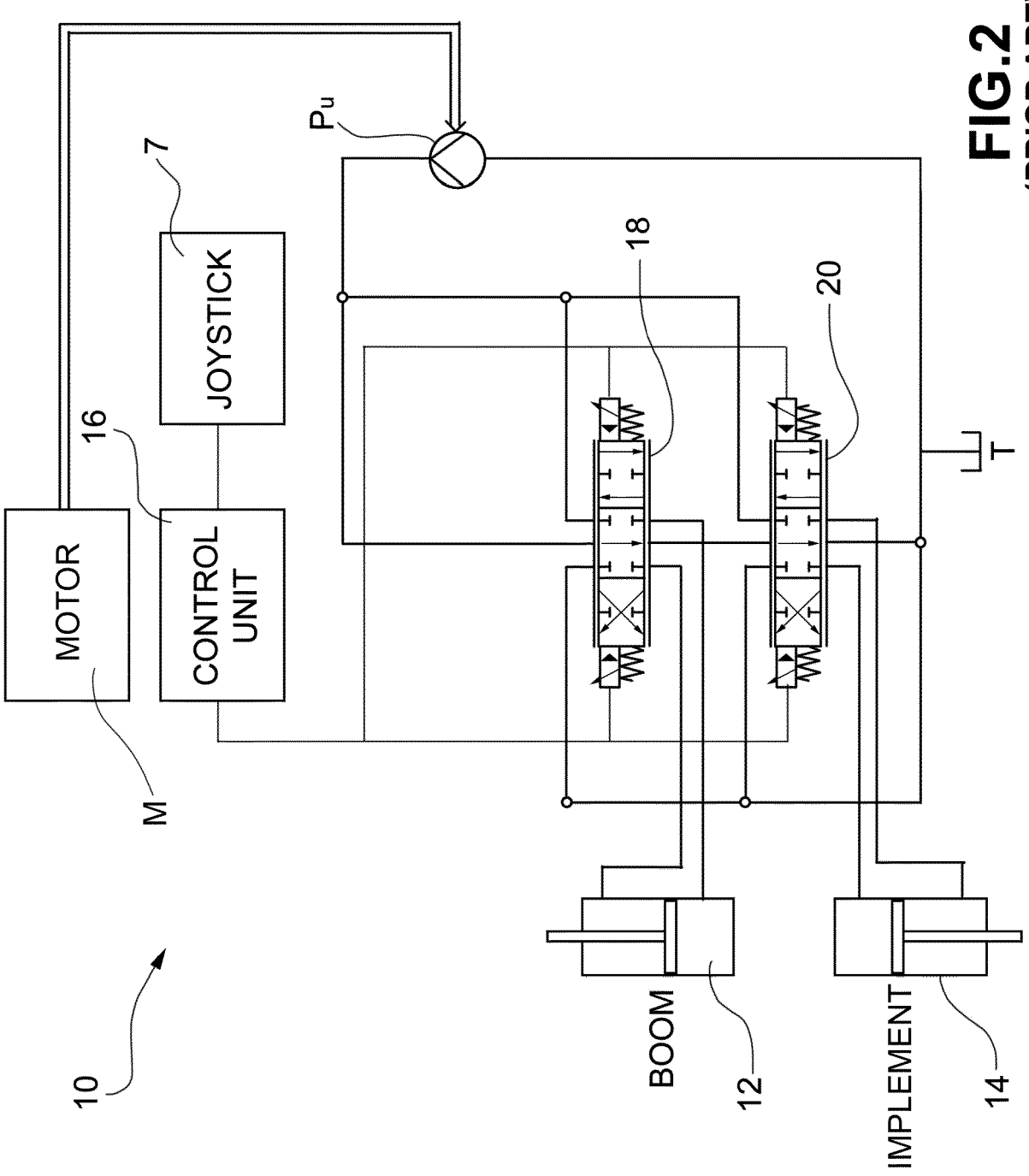


FIG.2
(PRIOR ART)

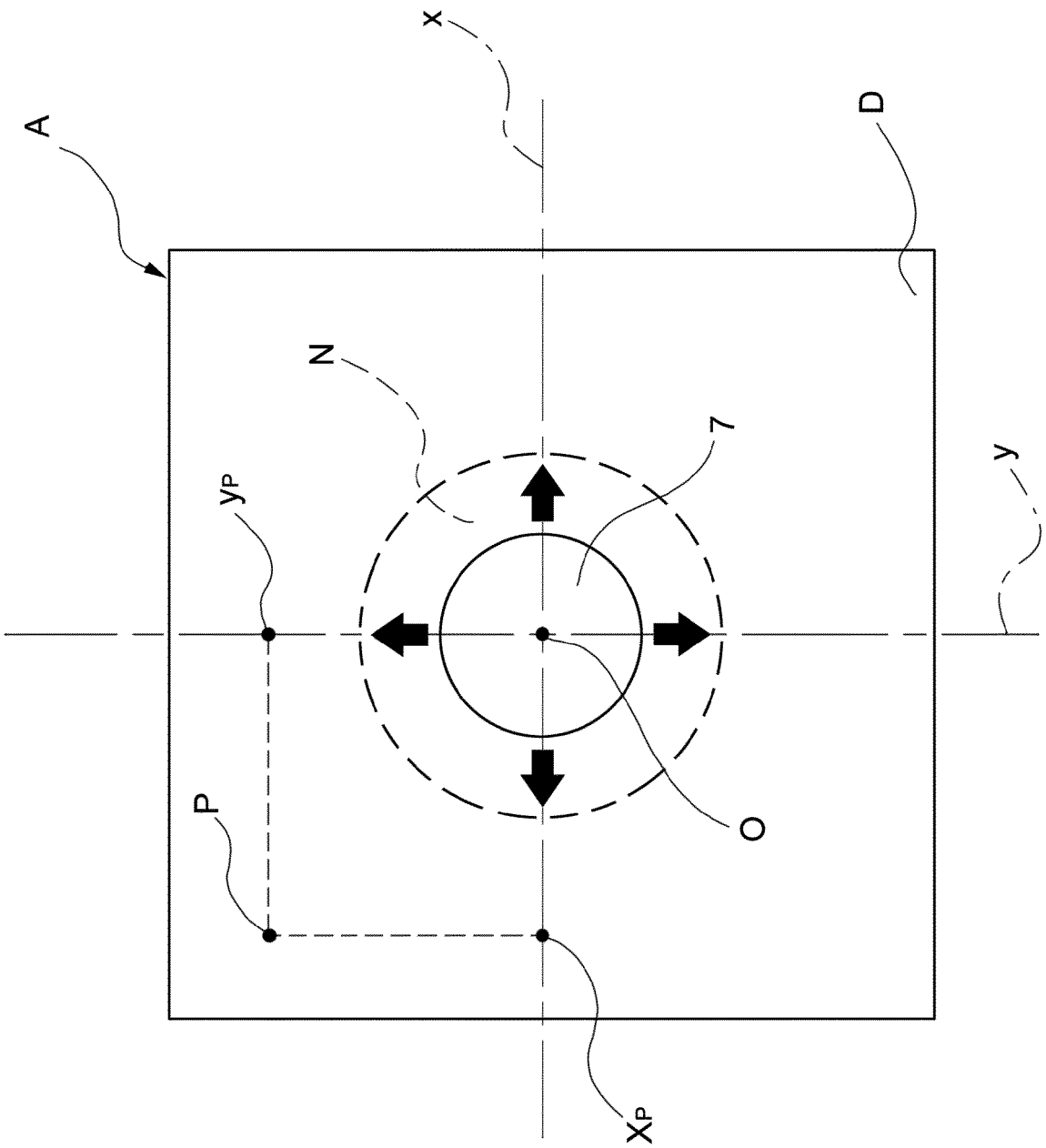


FIG.3
(PRIOR ART)

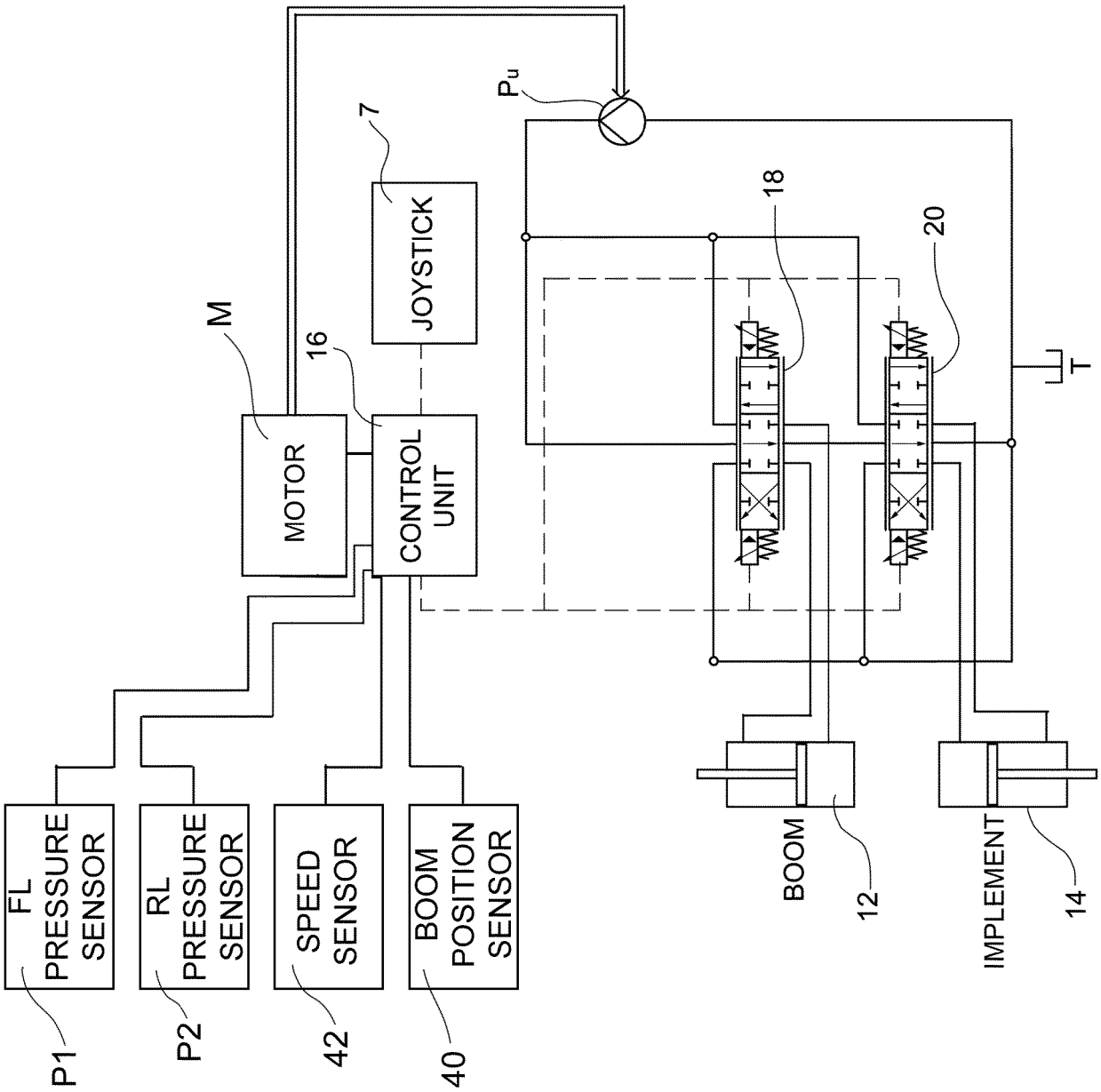
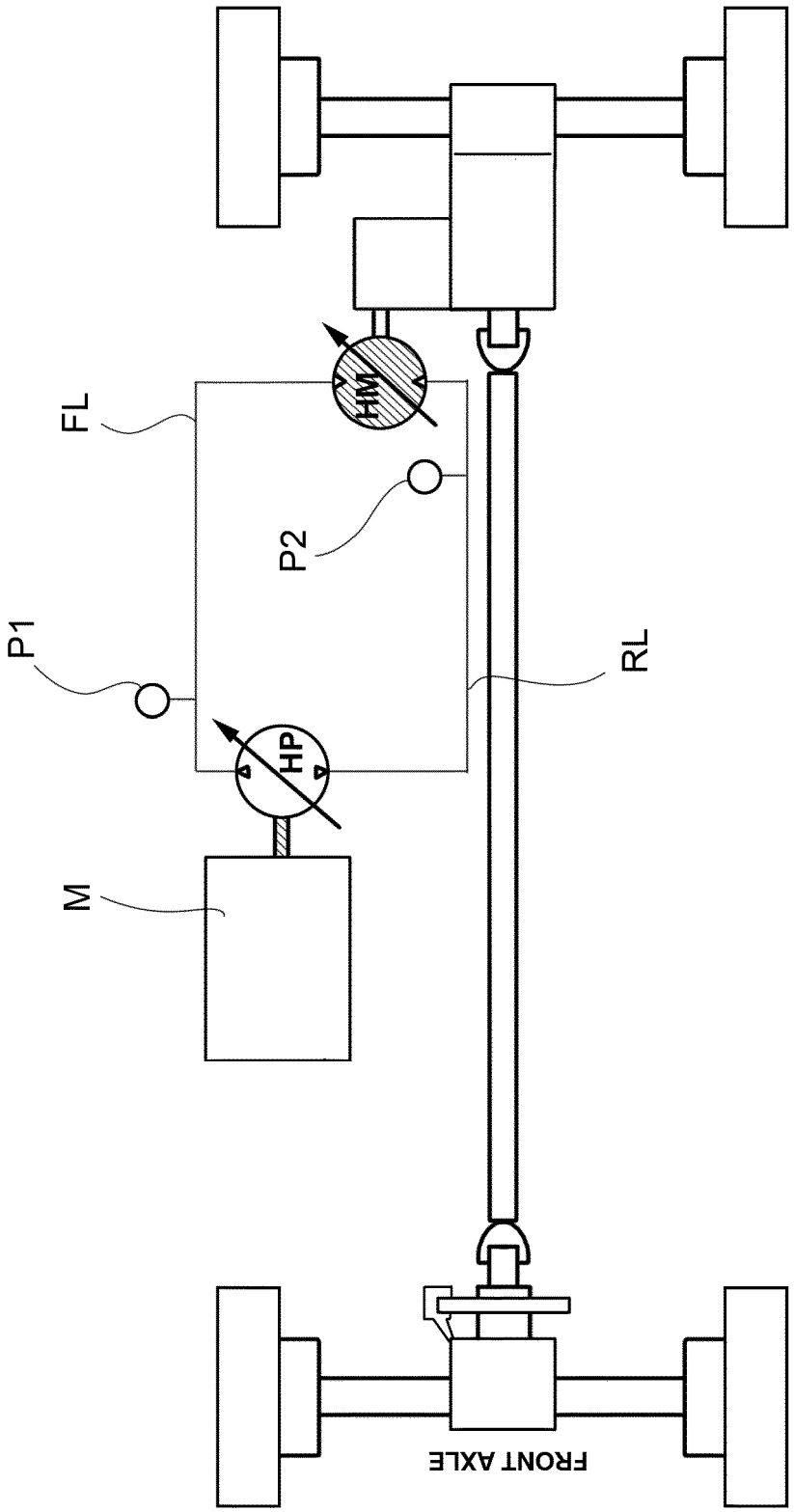

FL PRESSURE SENSOR
RL PRESSURE SENSOR
SPEED SENSOR
BOOM POSITION SENSOR
P1
P2
42
40
MOTOR
CONTROL UNIT
JOYSTICK
M
16
7
P_u
18
20
T
BOOM
IMPLEMENT
12
14

FIG.4a

FIG.4b



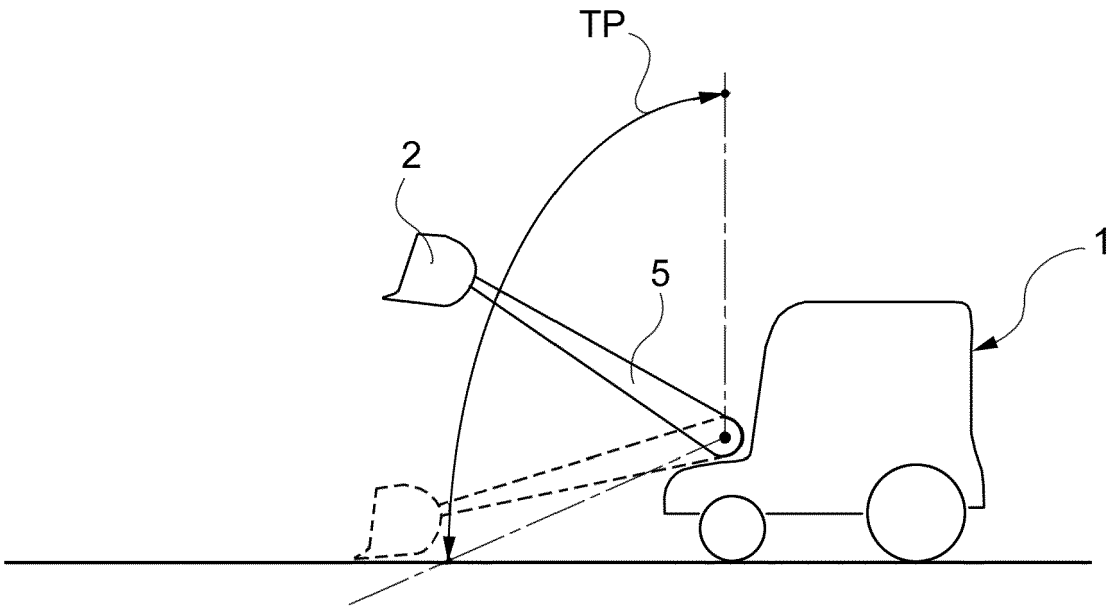


FIG.5

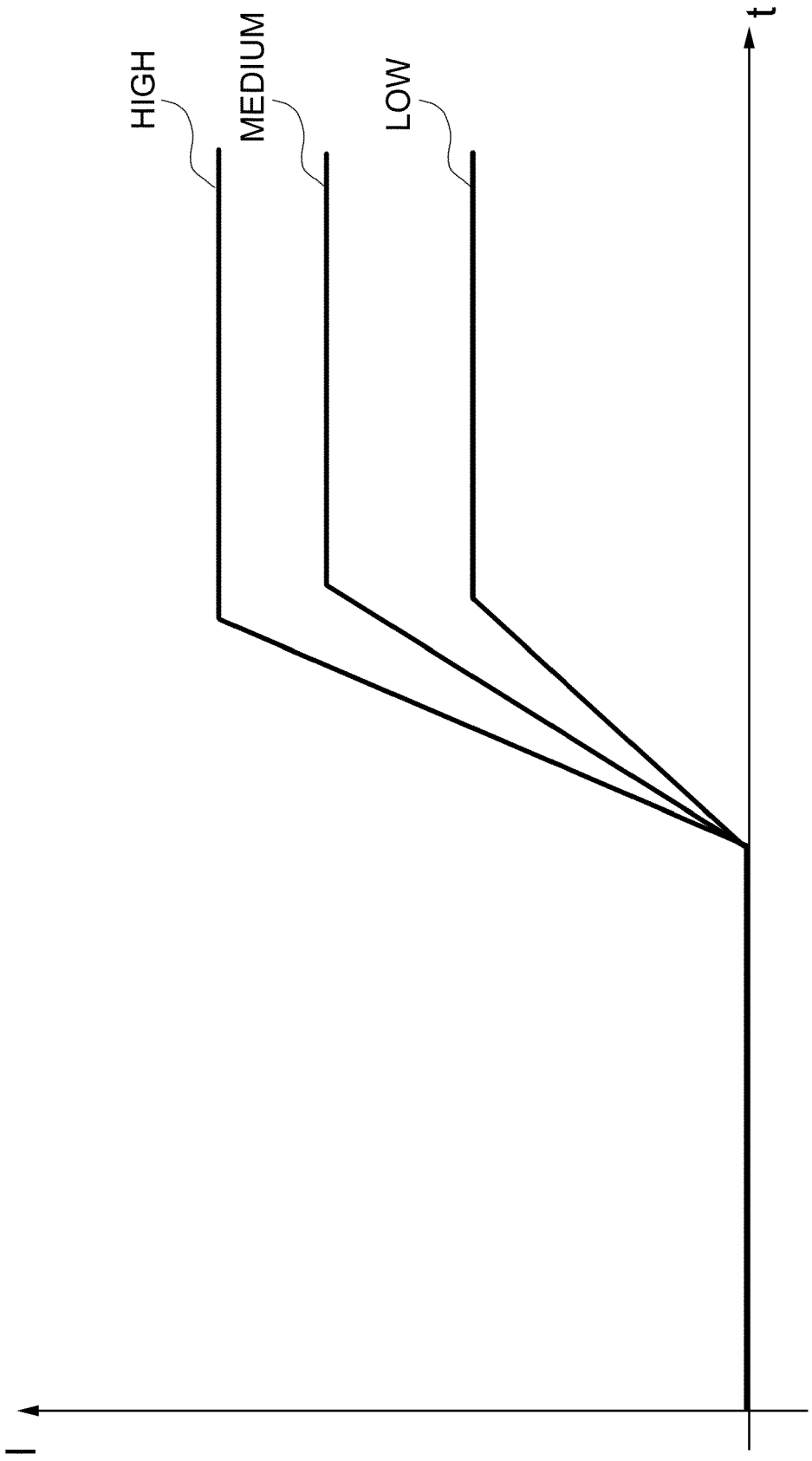


FIG.6a

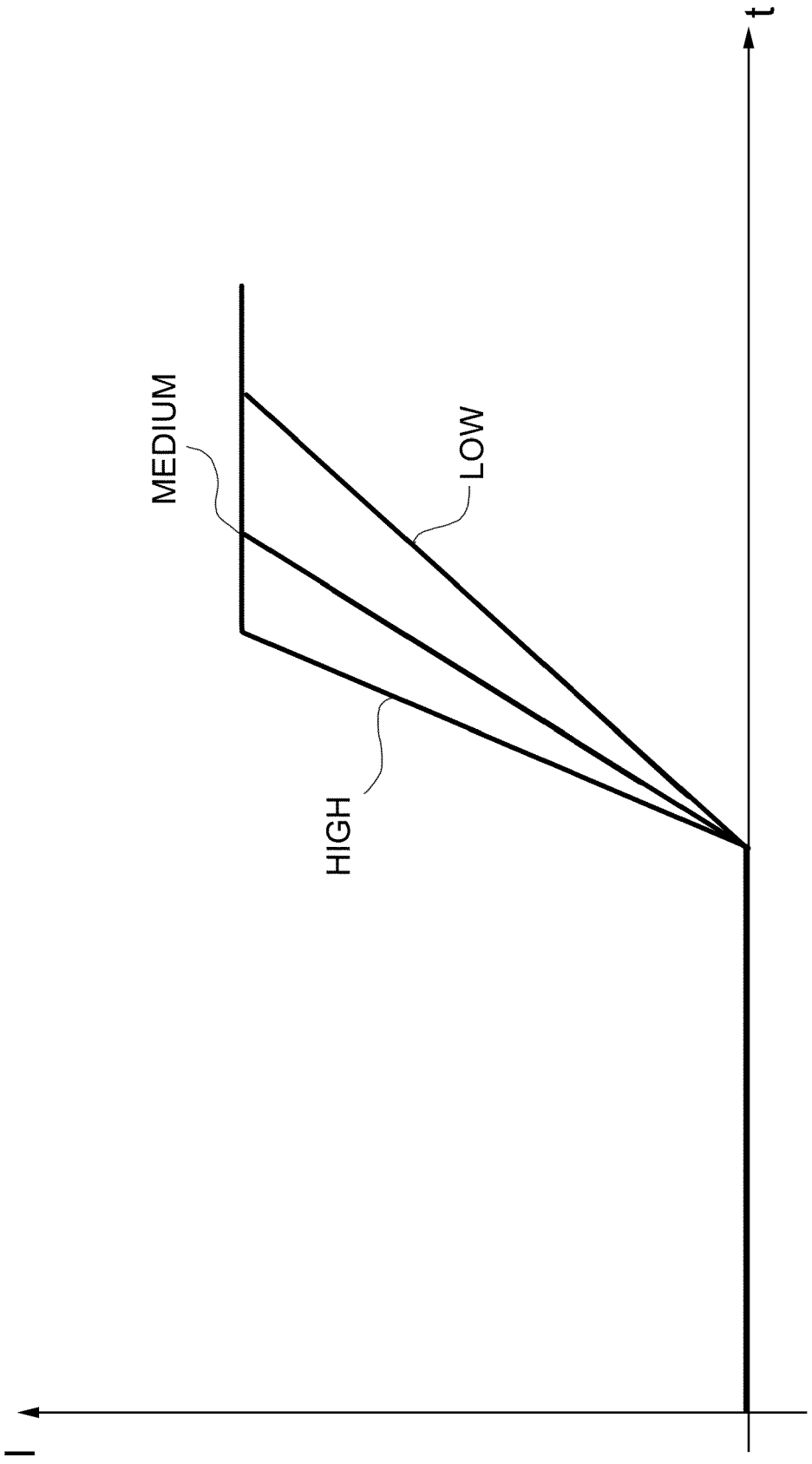


FIG.6b

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EUROPEAN SEARCH REPORT

Application Number
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	11 May 2022	Papadimitriou, S

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