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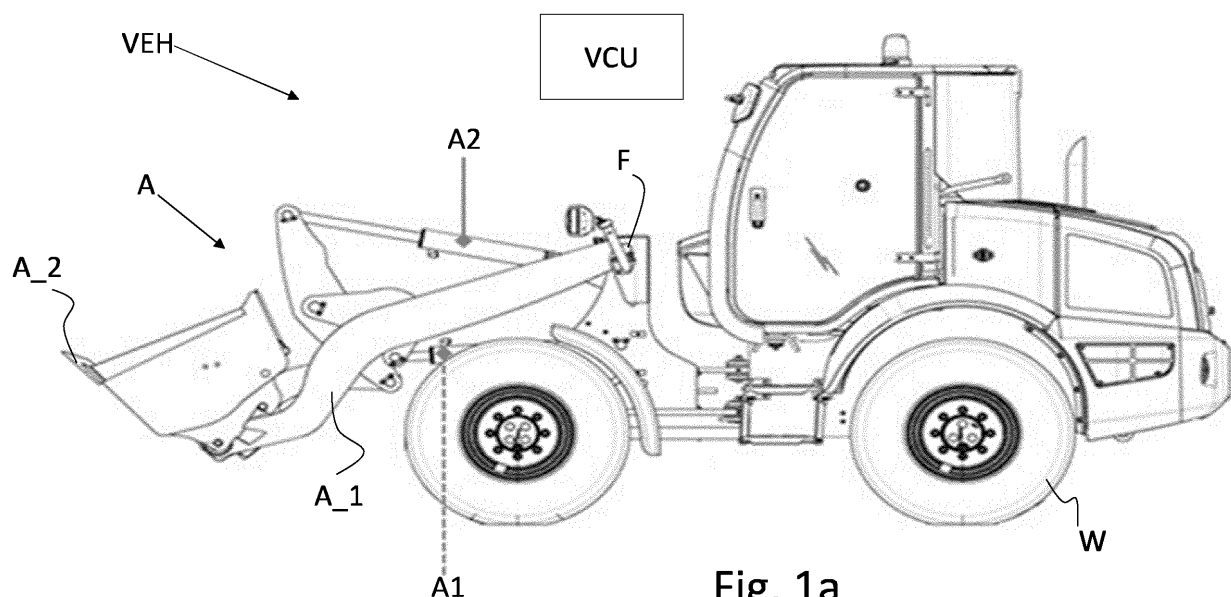
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(54) **METHOD FOR SUPPORTING AN EXECUTION OF A MISSION OF AN AGRICULTURAL OR WORK VEHICLE AND A CONTROL UNIT IMPLEMENTING THE METHOD**

(57) Method of supporting the execution of a mission of an agricultural or work vehicle operated by computer, in which the vehicle is equipped with an articulated arm (A) connected to a frame (F) of the vehicle such as to assume a plurality of operational configurations, of a propulsion system such as to allow movement of the vehicle with respect to a support surface, of a human/machine interface device (20) for administering a recorded message,

the method including an observation step (Step 1), for a predetermined time interval, a frequency and time duration of each operational configuration, and activation of the propulsion system, a step (Step 2) of determining a current mission of the vehicle, a step (Step 3) of verifying whether said mission of the vehicle coincides with a hauling mission, and if so then a step (Steps 5 and 6) suggesting or enabling a ride control function.

**Fig. 1a****EP 4 575 106 A1**

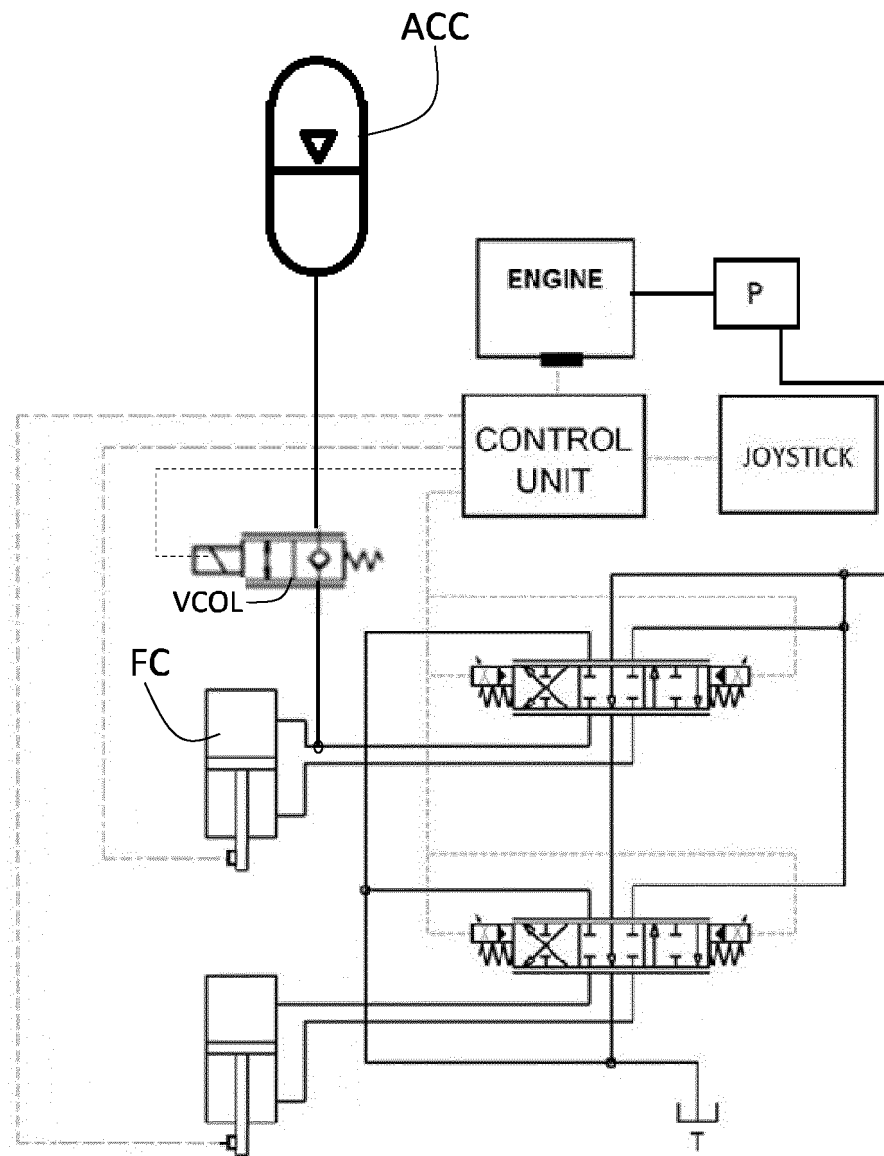


Fig. 1b

Description

Field of the invention

[0001] The present invention relates to a method for supporting the execution of a mission of an agricultural or work vehicle and a control unit implementing the method.

State of the art

[0002] Agricultural or work vehicles are equipped with at least one work component, such as for example an arm or a lift and a transmission which has the purpose of allowing the travelling of the vehicle.

[0003] The transmission can be driven by a prime mover, usually internal combustion, although in recent years vehicles have been developed in which the prime mover is defined by an electric motor.

[0004] As regards the movement of working tools, such as arms, lifters, blades, etc., they are operated by double-action hydraulic actuators.

[0005] A directional valve is arranged to connect one of the opposing chambers of a hydraulic actuator to a source of pressurized hydraulic oil and at the same time the other chamber to a hydraulic oil collection tank, generally at low pressure, i.e. at ambient pressure.

[0006] The source of pressurized hydraulic oil is generally a hydraulic pump driven in rotation by the prime mover.

[0007] It is known that the same vehicle can be involved in several missions. Some missions involve cycling through a sequence of vehicle movements. Furthermore, in the same mission, similar movements, for example the advancement of the vehicle, may require two different execution speeds. In fact, while a loader loads the material with the bucket in the excavation or "dig" position, the forward movement of the vehicle requires low speed and high torque. On the contrary, when the vehicle needs to move from the loading location to the unloading location, the forward movement of the vehicle requires a relatively higher speed and lower driving torque. The vehicle transmission is designed to adapt to working conditions, for example the displacement of the hydraulic motor is a function of the resistance torque detected, however adaptation requires time, time lost in carrying out the mission and therefore in vehicle productivity.

[0008] More specifically, for construction vehicles equipped with an articulated arm, the speed of movement and precision of the arm depend on the type of mission. the unloading location, the forward movement of the vehicle requires a relatively higher speed and lower driving torque. The main missions for wheel loaders and excavators are:

- Loading onto trucks: removing material or soil by throwing it directly into a truck through a bucket;
- Hauling: transporting a load of material at various

- distances across a construction site using a bucket;
- Pick & Place: using the fork or the bale clamp accessory to pick up and lift the material and then place it in a destination on the ground or on a shelf;
- Stockpile: definition of a pile across the bucket, in a storage location for bulk materials, which is part of the process of handling bulk materials.

[0009] There are some functions that need to be enabled beforehand.

[0010] Some of them are activated automatically, others require the operator to press a button present for example on an articulated arm control joystick or on a vehicle dashboard. However, all of them need to be enabled so that there can subsequently be automatic activation or activation by the operator.

[0011] Machine learning and deep learning are well-known concepts. The implementation of deep learning in all fields seems to have remarkable development.

[0012] The same Applicant is the owner of a European patent application no. 21217267, which describes a signal conditioning technique to be input to a neural network, for the purpose of recognizing a current mission of the vehicle. The Applicant, after long experimentation, has identified parameters and functions relating to the working parts and/or transmission and/or on-board systems that can exploit the identification of the current mission of the vehicle.

[0013] Unless specifically excluded in the detailed description that follows, what is described in this chapter is to be considered as an integral part of the detailed description.

Summary of the invention

[0014] The main purpose of the present invention is to facilitate the execution of a mission of an agricultural or work vehicle.

[0015] The basic idea of the present invention is to monitor the operations carried out by a work vehicle within a predetermined time interval and when it turns out that the mission coincides with a hauling mission, then it is enabled or suggested to the operator to enable the "ride control" function.

[0016] The "ride control" function includes the procedure of operationally connecting the pressurized chamber of the arm actuator with a hydraulic accumulator upon exceeding a predetermined settable vehicle speed value, so that when the vehicle moves, the roughness of the ground can be filtered, cushioning the hinge point between the articulated arm and the frame.

[0017] The hydraulic accumulator behaves as a spring and therefore allows the rigidity of the vehicle to be reduced and in particular of the connection between the articulated arm supporting a load and the vehicle frame. This is particularly advantageous for the human operator, who in this way is less subject to jolts. The two main advantages are:

- Greater comfort from an ergonomic point of view for the operator of the agricultural or work vehicle, who experiences less fatigue and can therefore work for longer periods;
- Increased productivity, thanks to less loss of material during transport.

[0018] This function, like other functions, must be enabled via a button on the control panel and is subsequently activated automatically when the aforementioned speed threshold is exceeded, which is generally set at around 5 km/h.

[0019] According to the present invention, the ride control function is suggested to the operator or enabled automatically.

[0020] These and other objectives are achieved by means of the attached claims, which describe preferred embodiments of the invention, forming an integral part of the present description.

Brief description of the figures

[0021] The invention will be fully clear from the following detailed description, provided as a purely illustrative and nonlimiting example, to be read with reference to the attached drawing figures, in which:

- Fig. 1a shows a work vehicle with its arm in any of the possible configurations it can assume,
- Fig. 1b shows a hydraulic circuit for actuating an articulated arm according to Fig. 1, equipped with a hydraulic accumulator operationally connected to an actuator of the arm by means of a control valve;
- Figs. 2 - 4 show examples of human/machine interfaces. In particular, Fig. 2 shows a button panel, Fig. 3 an instrument panel and Fig. 4 a joystick;
- Fig. 5 shows an example of a flow diagram representative of the method object of the present invention.

[0022] The same reference numbers and letters in the figures designate equal or functionally equivalent parts.

[0023] According to the present invention, the term "second element" does not imply the presence of a "first element", first, second, etc. They are used only to enhance the clarity of the description and should not be construed in a restrictive manner.

Detailed description

[0024] Fig. 1a illustrates a work vehicle such as a wheel loader VHE equipped with an arm A including a first element A₁, substantially elongated, hinged to the vehicle frame F and a second element A₂, such as a bucket or a fork, hinged to the first element. More specifically, a first end of the first element A₁ is connected to the frame F of the vehicle, while a second end, opposite to

the first, supports the second element.

[0025] It is clear that the first element can assume more angular positions with respect to the frame F.

[0026] The hydraulic actuator A1 is arranged to control the angular position of the first element A₁ with respect to the vehicle frame.

[0027] The hydraulic actuator A2 is arranged to control the angular position of the second element A₂ with respect to the first element A₁.

[0028] The hydraulic actuators A1, A2 are of the double action type, with two opposing chambers separated by a mobile partition integral with the stem of the respective actuator.

[0029] When the arm is at least partially raised to support a load, a first chamber FC of the two chambers of the actuator A1 is pressurized, while the second chamber, opposite to the first, is connected to a hydraulic oil collection tank T in a per-se known manner.

[0030] An electro-hydraulic valve VDIR controls the connection of each of these opposing chambers alternatively with a source of hydraulic oil P or with the hydraulic oil collection tank T.

[0031] Generally, when one chamber is connected with the hydraulic oil source, the opposite chamber is connected with the collection tank. This allows to raise or lower the articulated arm. However, when the arm is stationary, i.e. in static conditions, and at least partially raised, the first chamber of the hydraulic actuator is kept pressurized and closed, i.e. disconnected from both the source of hydraulic oil and the collection tank.

[0032] An electro-hydraulic valve, generally with an open centre, therefore takes care of the control of the respective actuator associated with the arm.

[0033] The activation of the valve is instead controlled by a human/machine interface device, such as a joystick JK, shown in Fig. 4.

[0034] According to the present invention, the ride control function connects the first chamber of the actuator with a hydraulic accumulator ACC, via a respective connection valve VCOL, which behaves like a spring capable of allowing the arm to oscillate with respect to the frame of the vehicle, cushioning the effects of rough terrain on which the work vehicle moves. Evidently, to operate properly, the hydraulic accumulator must be pressurized to the same pressure as the actuator chamber that keeps the articulated arm raised.

[0035] There may be various buttons on the joystick, the functionality of which can be fixed or programmable depending on the settings given by the operator via the button panel 21 in Fig. 2 or the instrument panel 20 shown in Fig. 3.

[0036] The joystick includes a wheel 26 or a lever that can assume three stable positions that allows you to make adjustments to some operational settings. Preferably, the joystick further comprises at least one button 23, 24, 25.

[0037] According to the present invention, a first software module is responsible for monitoring the configura-

tions assumed by the arm and the activation of the propulsion system and determining the current mission of the vehicle.

[0038] Based on this recognition, it is verified whether the current mission coincides with a hauling mission.

[0039] Evidently, a second software module can be provided configured to receive the current recognized mission as input and to access a look up table in which the functions relating to this mission are listed.

[0040] More preferably, a processing unit VCU is configured to implement the first and second software modules and to control the instrument panel 20 in particular to reproduce messages via the respective display 22.

[0041] In particular, the processing unit is configured to check whether the function(s) are enabled or not.

[0042] In particular, when the vehicle carries out a hauling mission repetitively for at least a predetermined time interval, for example of 30 minutes, then it is checked whether the ride control function is enabled and if not, a message is shown on the display which suggests its enablement.

[0043] The operator can set the automatic enabling of the functions, using one of the buttons available to him on the dashboard, handing control over to the processing unit VCU.

[0044] In this case, no suggestion is given, but the ride control function is automatically enabled when hauling is recognized as the current mission. However, it can be foreseen that the processing unit notifies the operator that the ride control function has been enabled.

[0045] Advantageously, the processing unit can also intervene on other parameters. Among the parameters that can be set, in the case of hauling, the displacement of the hydraulic pump and/or of the hydraulic motor of the hydrostat that makes up the vehicle transmission can be controlled.

[0046] Advantageously, without intervening on the vehicle speed set by the operator, the transmission ratio can be modified to reduce fuel consumption.

[0047] With reference to Fig. 5, an exemplary flow diagram of the present invention is shown. The dotted blocks are optional:

- Step 1: Observation of frequency and duration of each operational configuration of the articulated arm and activation of the propulsion system;
- Step 2: determination of the vehicle current mission;
- Step 3: checking whether said vehicle mission coincides with a hauling mission;
- Step 4: optional checking whether the automatic enabling of the hydraulic functions is active, in positive case,
- Step 5: automatic enabling of the ride control function; or
- Step 6: Suggestion to enable ride control function.

[0048] After the ride control function is enabled automatically or by the operator, the system returns to obser-

ving the operation of the arm and transmission and determining the current mission.

[0049] To generalize, in the flowchart there may be a further Step, immediately after Step 1, in which the currently enabled function(s) is acquired and immediately after step 3 there may be a step to check whether the automatic functions and possibly the relevant parameters currently active are related to the hauling mission, in the affirmative case the cycle starts again from step 1, while in the negative case it continues with steps 4 and following. Advantageously, in this way the sending of unnecessary messages to the operator is avoided. According to a preferred variant of the invention, the first software module is configured to detect the vehicle mission as a function of the frequency balance of the arm configurations and the respective time durations and as a function of the transmission enablement and the frequency of the values discrete vehicle speeds and respective durations. A position sensor is associated with each hydraulic actuator, therefore, it is immediate to acquire the operating configurations of the arm over time and analyse the frequency in discrete domains.

[0050] To make the solution easily implementable, the domains are segmented in such a way that the mutual positions of the elements composing the arm, which fall within a segment, are assumed to be approximately in the middle of the same segment. For further details, see the Applicant's European patent application n.21217267.

[0051] It is worth highlighting that suggestions can be given to the operator not only through writings that appear on the instrument panel or by the flashing of a light associated with an automatic function enable button, but also through voice messages.

[0052] Likewise, the operator can confirm the enabling of the ride control function vocally.

[0053] Therefore, the processing unit can advantageously be equipped with a speech synthesis module, an acoustic speaker and/or a microphone to give suggestions to the operator or to receive orders given by the operator.

[0054] The present invention may advantageously be implemented in a computer program comprising program code means for performing one or more steps of such method, when such program is executed on a computer. For this reason, the patent will also cover such computer program and computer readable medium comprising a recorded message, such computer readable medium comprising program code means for carrying out one or more steps of such method, when such program is run on a computer.

[0055] Many changes, modifications, variations and other uses and applications of the subject invention will be apparent to those skilled in the art after considering the accompanying description and drawings, which describe preferred embodiments thereof as described in the accompanying claims.

[0056] The features disclosed in the background of the prior art are introduced only to better understand the

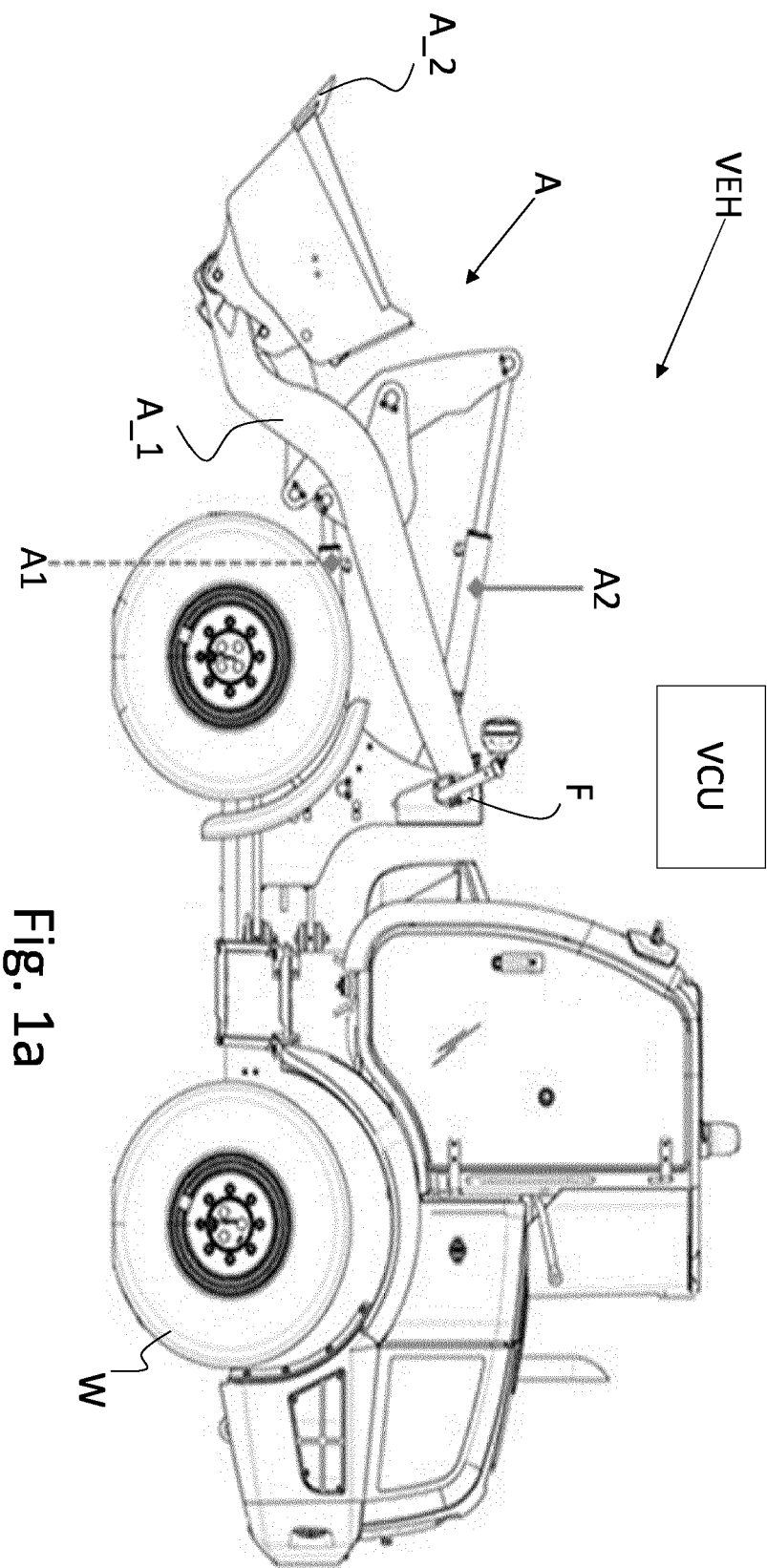
invention and not as a statement of the existence of the prior art. Furthermore, said characteristics define the context of the present invention, therefore such characteristics will be considered in common with the detailed description.

[0057] Further implementation details will not be described, as the person skilled in the art is able to carry out the invention starting from the teaching of the above description.

Claims

1. Method computer-operated for supporting the execution of a mission of an agricultural or work vehicle, wherein the vehicle is equipped with
 - an articulated arm (A) connected to a frame (F) of the vehicle such as to assume a plurality of operating configurations,
 - a propulsion system that allows the vehicle to be moved with respect to a support surface,
 - a human/machine interface device (20) to administer a recorded message,
 the method including in succession:
 - (Step 1) Observation, for a predetermined continuous time interval, of a frequency and duration of each operational configuration and activation of the propulsion system,
 - (Step 2) Determining a current mission of the vehicle,
 - (Step 3) checking whether said vehicle mission coincides with a hauling mission, and if so, then
 - (Steps 5 and 6) suggesting or enabling a ride control function.
2. Method according to claim 1, wherein said articulated arm comprises a double-acting hydraulic actuator (A1), comprising a first chamber (FC) arranged to be pressurized and closed when the articulated arm supports a load, and wherein the function of ride control includes a procedure of connecting said first chamber with a hydraulic accumulator (ACC).
3. Method according to claim 2, wherein said hydraulic accumulator is previously pressurized to the same pressure as the first chamber (FC).
4. A computer program comprising computer program code means adapted to perform all steps of claims 1 - 3, when said program is executed on a control unit (VCU) of an agricultural or work vehicle.
5. A computer readable medium having stored the program of claim 4.

6. Work or agricultural vehicle (VEH) comprising an articulated arm (A) connected to a frame (F) of the vehicle such as to assume a plurality of operating configurations, a propulsion system such as to allow movement of the vehicle with respect to a surface support, a human/machine interface device (20), associated with a vehicle dashboard to administer a recorded message, a processing unit (VCU) configured to observe, for a predetermined continuous interval of time, a frequency and duration of time of each operational configuration, and a frequency and duration of activation of the propulsion system and consequently to determine a current mission of the vehicle and to check whether said mission of the vehicle coincides with a hauling mission, and if so to suggest or enable a function of ride control.



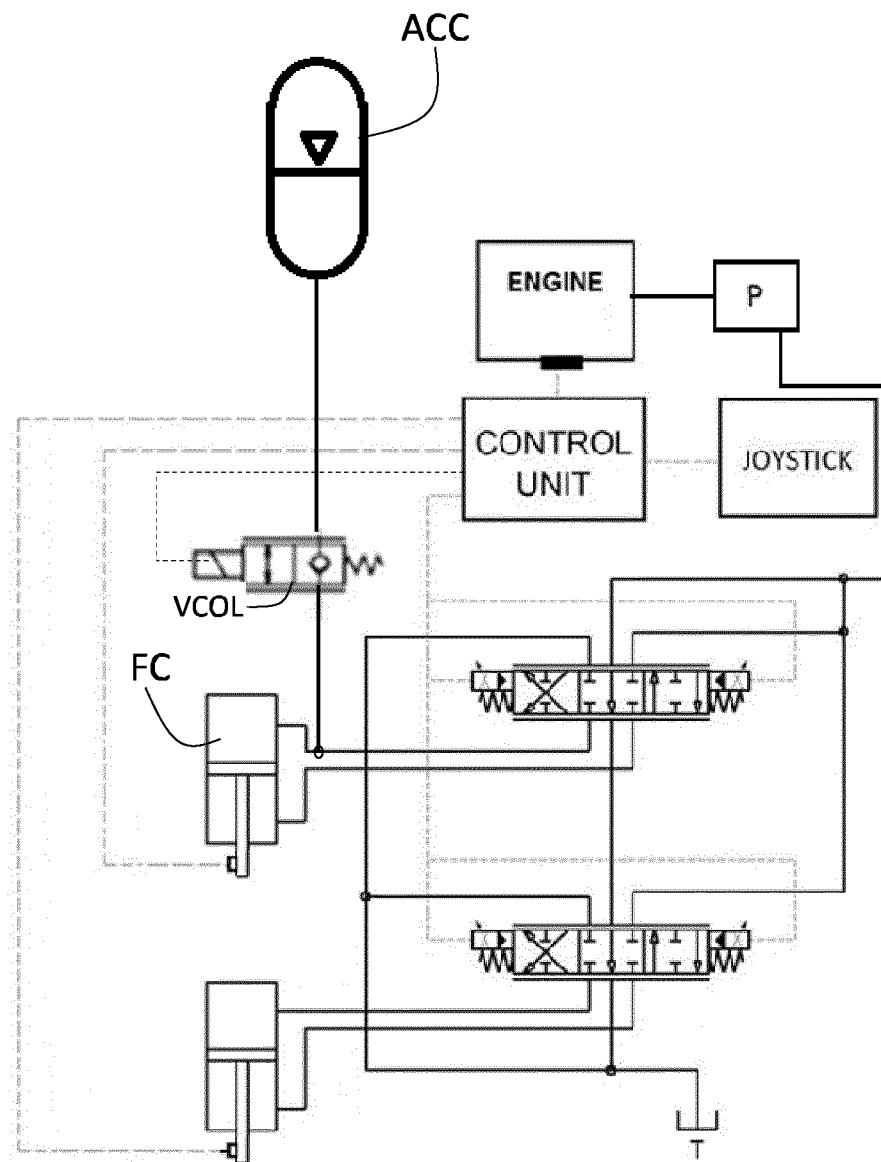


Fig. 1b

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FIG. 2

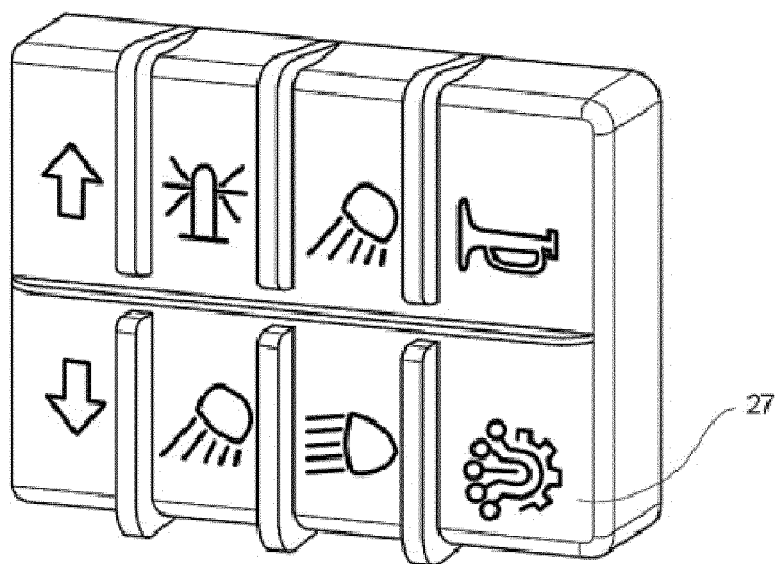


FIG. 3

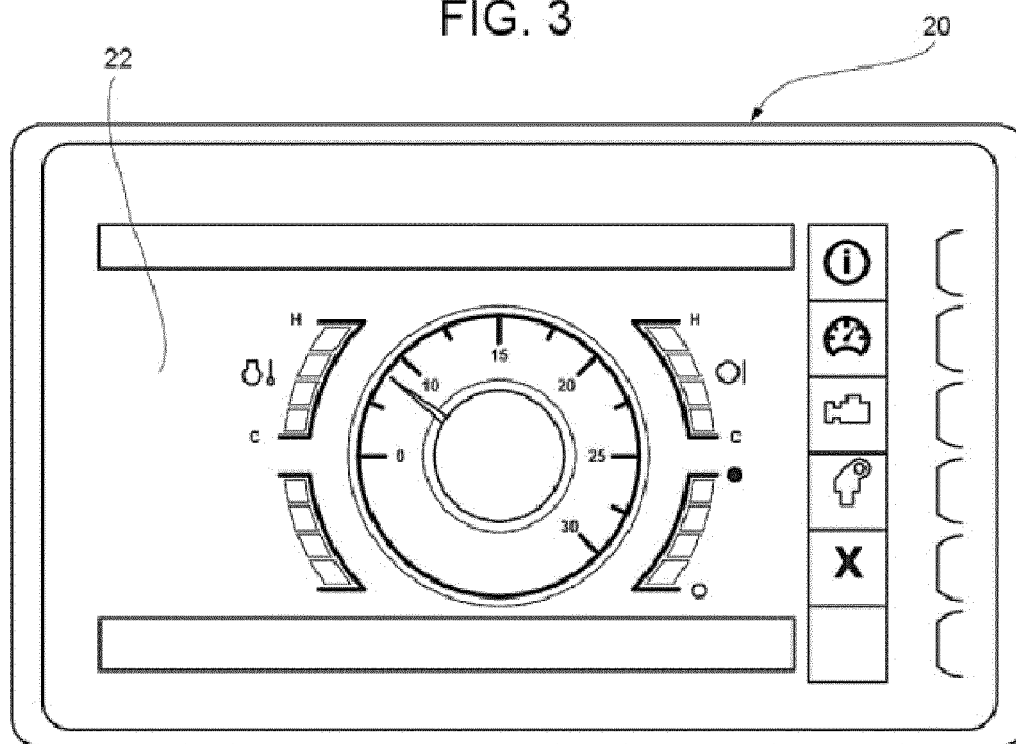
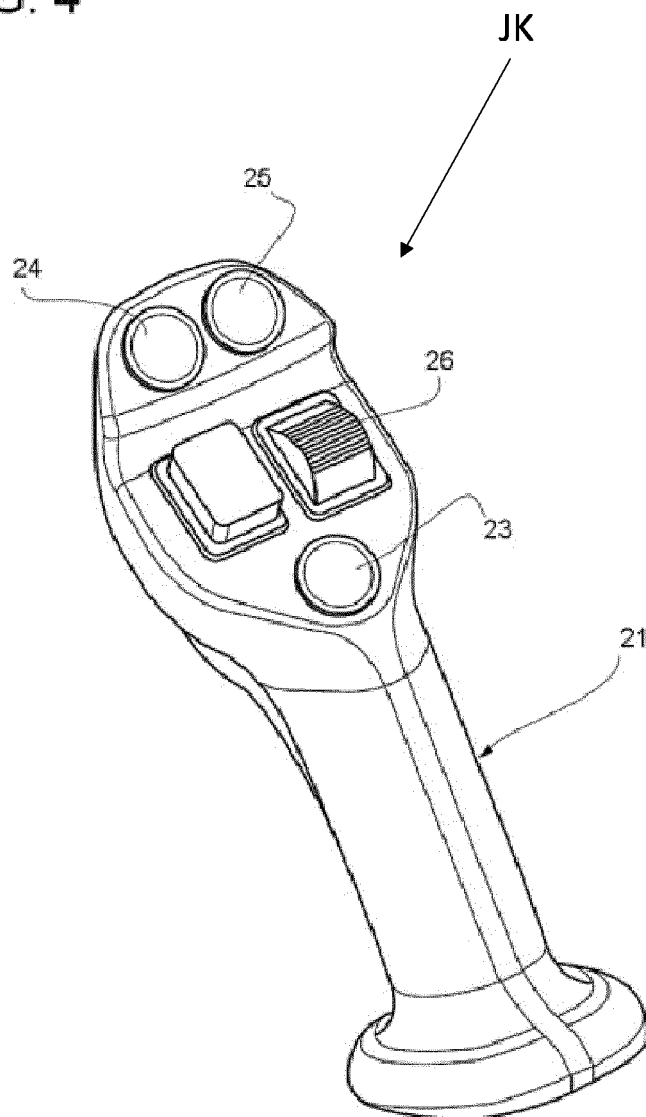


FIG. 4



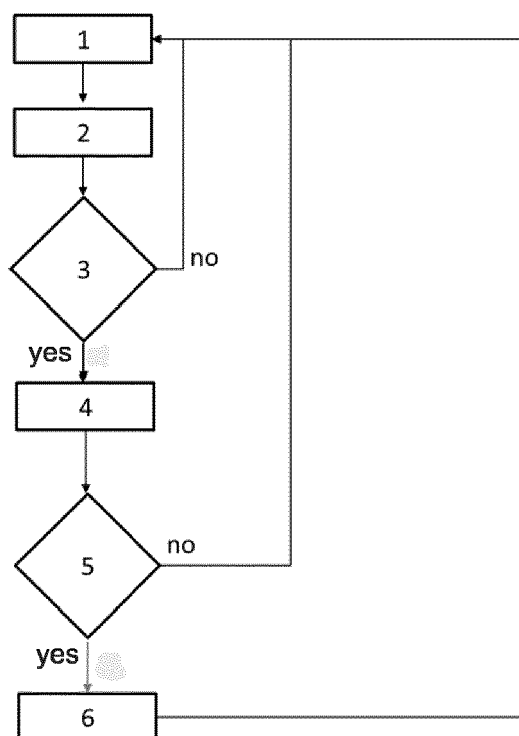


Fig. 5



EUROPEAN SEARCH REPORT

Application Number

EP 24 22 1308

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			TECHNICAL FIELDS SEARCHED (IPC)
			E02F
The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
Munich		17 April 2025	Autran, Adrien
CATEGORY OF CITED DOCUMENTS		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	
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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

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