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(54) **CONTROL METHOD FOR ACTUATION OF A SHOVEL OF A WORKING OR AGRICULTURAL VEHICLE**

(57) Control method for actuation of a shovel (BK) of a work or agricultural vehicle, the shovel being controllable in response to only a first control signal proportional to a position of a control lever (Joystick), and in which the lever is movable in two opposite directions to select a forward or backward rotation of the shovel, and in re-

sponse to at least a second approximately sinusoidal control signal which can be activated by means of a button to realize a shovel shaking function, and in which when the shaking function is active, the method comprises step (i) of combining the first signal with the second signal so that the first signal limits an amplitude of at least one half wave corresponding to a rotation opposite to that selected by the control lever.

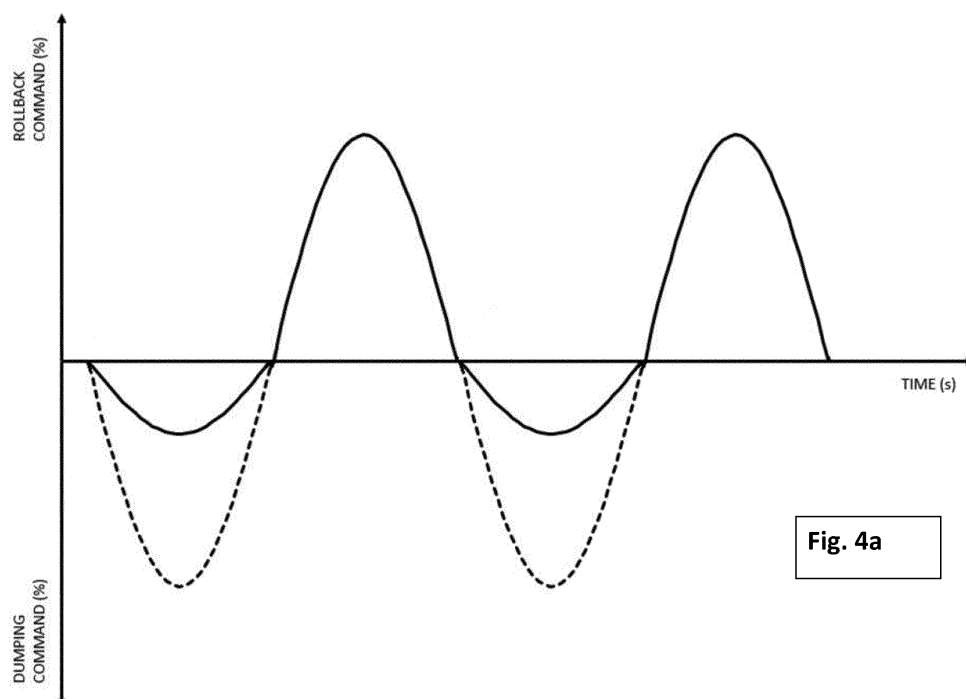


Fig. 4a

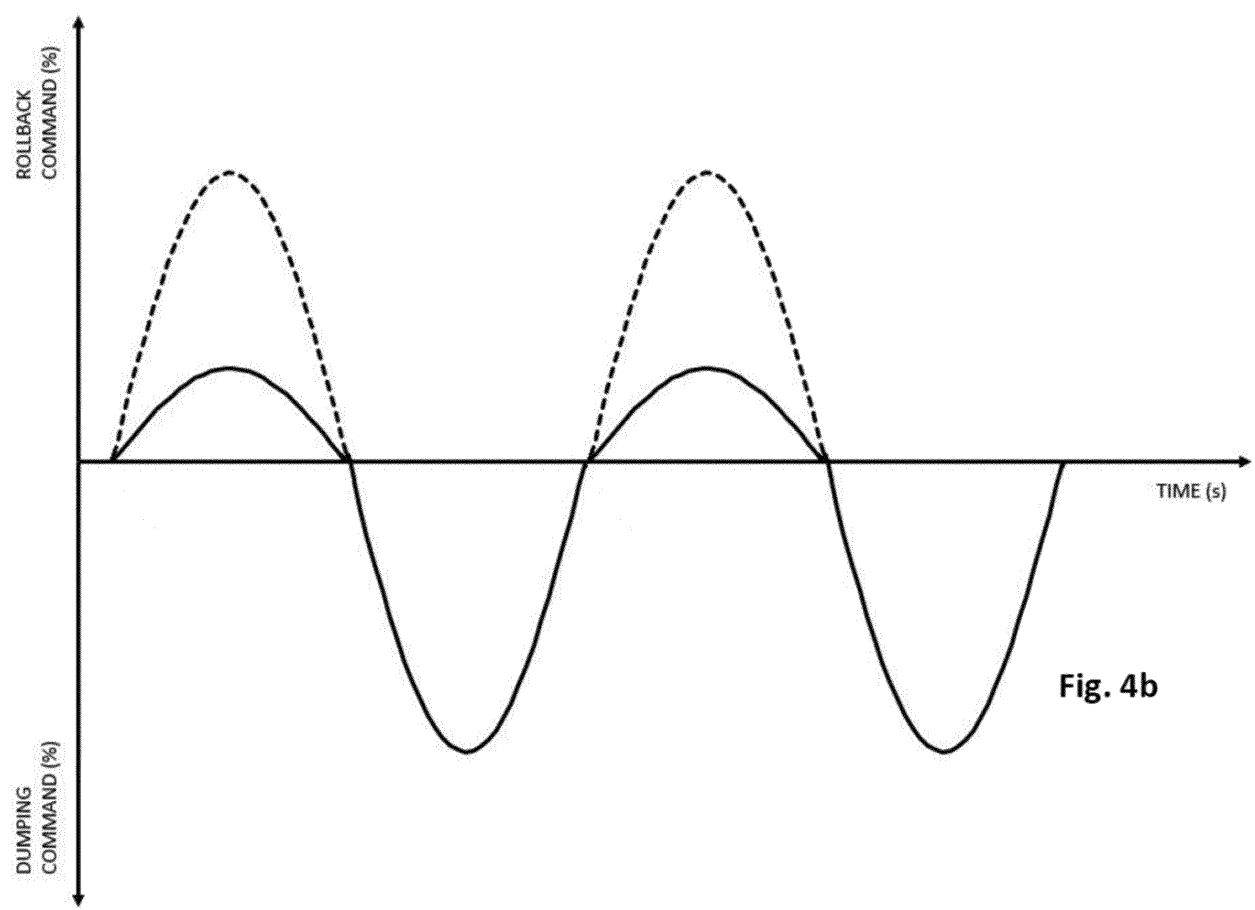


Fig. 4b

Description

Field of the invention

[0001] The present invention relates to the field of electro-hydraulic controls and in particular to a control method for implementing the shaking of a shovel of a work or agricultural vehicle.

State of the art

[0002] Motorized agricultural or work vehicles are well known for handling materials and performing specific demanding tasks. They are often equipped with a hydraulically operated lift arm to move a shovel or bucket.

[0003] DE102014111505A1 discloses a hydrostatic drive system with at least one hydraulic member which is controlled by a directional control valve. An electronic control device generates an actuation signal to operate the directional control valve when a button is pressed in order to generate a shaking function of the hydraulic organ when the button is pressed. The shaking function generates a signal that is added to a control signal for the actuation of the hydraulic organ.

[0004] It is therefore clear that the movement of the arm and the shovel are managed by the operator, while the corresponding control signals are added to those deriving from the shaking function.

[0005] US2018135274 describes another control system similar to the previous one, in which, however, the purpose is to sift, that is to spread material, typically gravel, on the ground, while the shovel and the relative arm are in an approximately fixed position suitable for the operation of sieving with fluctuations in a horizontal plane.

[0006] According to both solutions, it is possible to vary the amplitude of the oscillations of the shaking signal that is added to the control signal of the shovel.

[0007] It is believed that this level of assistance could trigger problems in the control of the valves when they are driven by the sum of the two shaking and control signals, because the sum of the two signals may not correspond to an increase in oscillation when the valve is already close to its own maximum aperture.

[0008] If not specifically excluded in the detailed description below, what is described in this chapter is to be considered as an integral part of the detailed description.

Summary of the invention

[0009] The purpose of the present invention is to present a method and system for emptying the shovel to assist the operator of a work vehicle equipped with a mechanical shovel.

[0010] The basic idea of the present invention relates to the fact that when the shaking function is active and at the same time the shovel control lever is operated according to one of the two opposite directions of move-

ment, the signal generated by the control lever is combined with the signal oscillatory function of the shaking function by limiting the half-wave defining a direction of rotation opposite to the direction of rotation selected with the control lever. Contrary to the known art, the combination of the two signals is subtractive, i.e. the signal generated by the control lever subtracts from the oscillatory signal. Contrary to the known art, the combination is not constant over time, but applies only to half-waves having the opposite direction of rotation to the direction indicated by the control lever signal.

[0011] Therefore, contrary to the known art, the half waves agree with the direction of movement identified by the shovel control lever are not affected by any variation due to the action of the shovel control lever.

[0012] Preferably, the amplitude of the oscillations can be selectively set by means of a switch arranged in a vehicle cabin. This switch preferably has three positions. The same functionality can be controlled through a touch screen interface.

[0013] According to a preferred aspect of the present invention, the same switch operates predetermined settings on some actuator drive parameters which simultaneously impact on the shaking function and on the lifting or unloading function of the shovel.

[0014] In fact, bearing in mind that the shovel displacement control lever does not intervene directly on the actuation of the shovel itself but indirectly by limiting the oscillatory signal of the shaking function, it is evident that the displacement of the shovel depends on both the characteristics of the oscillation signal and the signal limitation of the same.

[0015] The operation of the hydraulic actuator that controls the reciprocal position of the shovel with respect to the arm is achieved by means of a valve equipped with a movable spool. The drive parameters include the movement speed of the movable spool inside the valve body and the stroke of the movable spool.

[0016] The known art only shows the possibility of varying the amplitude of the oscillation half-waves. According to the present invention, the period of oscillation can also be varied in addition to the amplitude. This variation of the period can be controlled by means of the same switch described above or by means of a different switch dedicated to the control of the period of oscillation.

[0017] It should be understood that any alternating signal rather than perfectly sinusoidal can be implemented for shaking operation.

[0018] The dependent claims describe preferred variants of the invention, forming an integral part of this description.

Brief description of the figures

[0019] Further objects and advantages of the present invention will become clear from the following detailed description of an example of its embodiment (and its variants) and from the attached drawings given purely for

explanatory and non-limiting purposes, in which:

Figure 1 shows a diagram of a shaking control signal over time, according to three distinct amplitudes of oscillation, according to the known art;

Figure 2 shows a shovel supported by an arm, with the shovel oscillating according to the control signal of Figure 1;

Figure 3 shows an electro-hydraulic control scheme of the shovel modified according to the present invention;

Figures 4a and 4b show a control strategy, respectively backwards and forwards, of the shovel during the simultaneous shaking of the same according to the present invention;

Figure 5 shows a diagram of a shovel control signal over time, according to three distinct linear curves.

[0020] The same reference numbers and letters in the figures identify the same elements or components or functions.

[0021] It should also be noted that the terms "first", "second", "third", "upper", "lower" and the like can be used here to distinguish various elements. These terms do not imply a spatial, sequential or hierarchical order for the modified elements unless specifically indicated or inferred from the text.

[0022] The elements and features illustrated in the various preferred embodiments, including the drawings, can be combined with each other without however departing from the scope of this application as described below.

Detailed description of examples of realization

[0023] Figure 1 shows the possibility of imparting an alternating control signal to the shovel with different amplitudes, LOW, MEDIUM, HIGH. This possibility is also described by the known art. When the sinusoidal signal shown in figure 1 is activated, preferably by means of an activation button positioned on the control lever of the JOYSTICK shovel, the amplitude of the signal can be changed using a special switch indicated in figure 3 as MODE SELECTOR.

[0024] This switch can be a switch that allows to adjust the shovel shaking amplitude to minimum (LOW), medium (MEDIUM) and maximum (HIGH) shaking.

[0025] The activation of this button causes the generation of the sinusoidal signal that controls the movable spool of the valve V shown in figure 3.

[0026] This valve is preferably of the open center directional type.

[0027] The movable spool of the valve slides inside the relative valve body allowing to pressurize one of the opposite chambers of the shovel hydraulic cylinder BUCKET that controls the rotation of the shovel BK.

[0028] In particular, the spool assumes a rest position shown centrally in the representation of Figure 3, in which at least one of the chambers of the hydraulic cylinder is

closed, so that the shovel remains immobile in its position. The spool can move in two mutually opposite directions to determine a forward rotation DUMP, called "dump", or a back rotation, ROLLBACK, called "rollback".

[0029] When the aforementioned button activates the shaking function, the shovel rotates alternately forwards and backwards with the amplitude of the movement corresponding to the amplitude of the signal shown in figure 1.

[0030] Figure 2 shows the forward angular rotation β and backward α of the shovel BK around the hinge HG with which it is rotatably fixed to the arm B.

[0031] Figures 1, 4a, 4b and 5 show timing diagrams of the valve V control signal.

[0032] When the half wave is positive it is assumed by convention that the command is a rollback, vice versa, when it is negative it is assumed that the command is a dump. Obviously, the reference system can be inverted without altering the essence of what is described here.

[0033] Figures 4a and 4b show lines with continuous and discontinuous lines.

[0034] The lines with a continuous line are those that actually condition the valve V when the shaking function is active and at the same time, the control lever JOYSTICK of the shovel is activated, while the one with a discontinuous line is the one that would occur when the shaking function is active while JOYSTICK control lever is released.

[0035] According to figure 4a, the operator activates the shaking and maneuvers the shovel control lever to perform the rollback. The signal generated by the control lever towards the rollback rotation, according to the present invention, does not affect the rollback half-wave (s), but rather the dump half-wave (s) limiting its intensity in proportion to the deviation of the control lever itself with respect to the rest position.

[0036] The limitation affects one or more half-waves in relation to the duration of the action on the control lever.

[0037] Therefore, contrary to the known art, an action on the shovel control lever does not add up but subtracts from the sinusoidal shaking signal.

[0038] More precisely, this subtractive effect applies only to the dump half-waves, with the control lever actuated in rollback.

[0039] Conversely, referring to Figure 4b, when the shovel control lever is operated to dump while the shake signal is active, the shovel control lever control signal combines with the shake signal by limiting the amplitude of the rollback half-wave.

[0040] Therefore, with reference to Figure 2, the amplitude of the angle α is unchanged while the amplitude of the angle β is limited by the actuation of the control lever in rollback and vice versa.

[0041] It is worth highlighting that according to the present invention, the activation of the joystick lever does not impact in any way on the dynamics of the shovel drive, as the joystick only imposes a limitation on the amplitude of certain half waves.

[0042] The processing and control unit CONTROL UNIT autonomously generates the shaking signal when it detects the activation of the activation button. The same processing and control unit receives the signal generated by the shovel control lever at its input and combines it with the shaking signal as described above.

[0043] Figure 5 shows three linear curves that show the increase in the shovel control signal in relation to the setting selected with the switch MODE SELECTOR.

[0044] According to a preferred variant of the present invention, the slope of the variation of the shovel control signal also varies in relation to the setting selected with the switch MODE SELECTOR or with a distinct and separate switch. It is noted that not only the slope can be varied but also the relative limit value which corresponds to the stroke of the movable spool inside the relative valve body.

[0045] Furthermore, the settings selected through the switch MODE SELECTOR impacts not only on the amplitude of the half waves, but also on the period of oscillation.

[0046] For example, to remove the mud attached to the shovel, it is advisable to have oscillations with a longer period than when you want to spread the material.

[0047] Therefore, according to a preferred variant of the present invention it is possible not only to adjust the speed of movement of the spool in the valve body but also the relative stroke with the result that the operator has full control of the functionality of the shovel.

[0048] It is worth noting that any manipulation of the control parameters of the shovel drive applies both to the shaking function and to the movement function of the shovel during shaking.

[0049] A work or agricultural vehicle according to the present invention has a joystick for controlling the shovel with respect to the arm and the possibility of activating the shaking function by means of a dedicated command, which can be the aforementioned activation button.

[0050] When the shaking is active, the signal generated by the joystick can possibly be combined with the shaking control signal. In the absence of this signal generated by the joystick, the shovel oscillates with angular amplitudes $\alpha = \beta$.

[0051] The present invention can be advantageously carried out by means of a computer program which comprises coding means for carrying out one or more steps of the method, when this program is executed on a computer. Therefore it is intended that the scope of protection extends to said computer program and further to computer readable means comprising a recorded message, said computer readable means comprising program coding means for carrying out one or more steps of the method, when said program is run on a computer.

[0052] Implementation variants of the described non-limiting example are possible, without however departing from the scope of the present invention, including all the equivalent embodiments for a person skilled in the art, to the content of the claims.

[0053] From the above description, the person skilled in the art is able to realize the object of the invention without introducing further construction details.

Claims

1. Control method of actuation of a shovel (BK) of a work or agricultural vehicle, the shovel being hinged to an arm (B) and operable by means of an electro-hydraulic circuit (H) to rotate with respect to a hinge (HG) in forward to a dump condition (Dump) and backward to a holding condition (Rollback), the circuit comprising an electro-hydraulic valve (V) equipped with a spool, sliding in a relative valve body in response to

- only a first control signal proportional to a position of a control lever (Joystick), and wherein the lever is movable in two opposite directions to select the forward or reverse rotation of the shovel, and
- at least a second approximately sinusoidal control signal which can be activated by means of a button to perform a shovel shaking function,

when said shaking function is active, the method comprising step of combining the first signal with the second signal so that the first signal limits an amplitude of at least one half wave corresponding to a rotation opposite to the one selected by the control lever.

2. Method according to claim 1, wherein an intensity and a duration of said limitation is defined by means of said control lever (Joystick) of the shovel.
3. Method according to claim 1 or 2, further comprising a preliminary step of setting the signal amplitude approximately sinusoidal by means of a first switch (Mode selector) having at least three settings (Low, medium, High).
4. Method according to any one of claims 1 to 3, wherein said limitation impacts
 - a sliding speed of the movable spool and/or
 - one stroke of the movable spool.

5. Method according to one of claims 2 or 3, further comprising a preliminary step of setting an approximately sinusoidal signal oscillation period (MODE SELECTOR) together with the setting of the approximately sinusoidal signal amplitude.

6. Computer program comprising program coding means adapted to perform all steps of any one of claims 1 to 5, when said program is run on a com-

puter.

7. Computer readable means comprising a recorded program, said computer readable means comprising program coding means adapted to perform all steps of any one of claims 1 to 5, when said program is run on a computer. 5

8. Work or agricultural vehicle comprising an arm (B) and a shovel (BK) hinged to the arm (B) and operated by an electro-hydraulic circuit (H) to induce the shovel to rotate with respect to a hinge (HG) in forward to a dump (Dump) condition and backward to a holding condition (Rollback), the circuit comprising an electro-hydraulic valve (V) equipped with a spool, sliding in a relative valve body in response to 10
 - only a first control signal proportional to a position of a control lever (Joystick), and wherein the lever is movable in two opposite directions to select the forward or reverse rotation of the shovel, and 20
 - at least a second approximately sinusoidal control signal which can be activated by means of a button to perform a shovel shaking function, 25

when said shaking function is active, the electro-hydraulic circuit being arranged to combine the first signal with the second signal so that the first signal limits an amplitude of at least one half-wave corresponding to a rotation opposite to that selected by the control lever. 30

9. Vehicle according to claim 8, further comprising man/machine interface means to allow the amplitude of the signal to be set approximately sinusoidal by means of a switch (MODE SELECTOR) having at least three settings (Low, medium, High). 35

10. Vehicle according to claim 8 or 9, further comprising man/machine interface means for setting 40
 - a sliding speed of the movable spool and/or
 - one stroke of the mobile spool. 45

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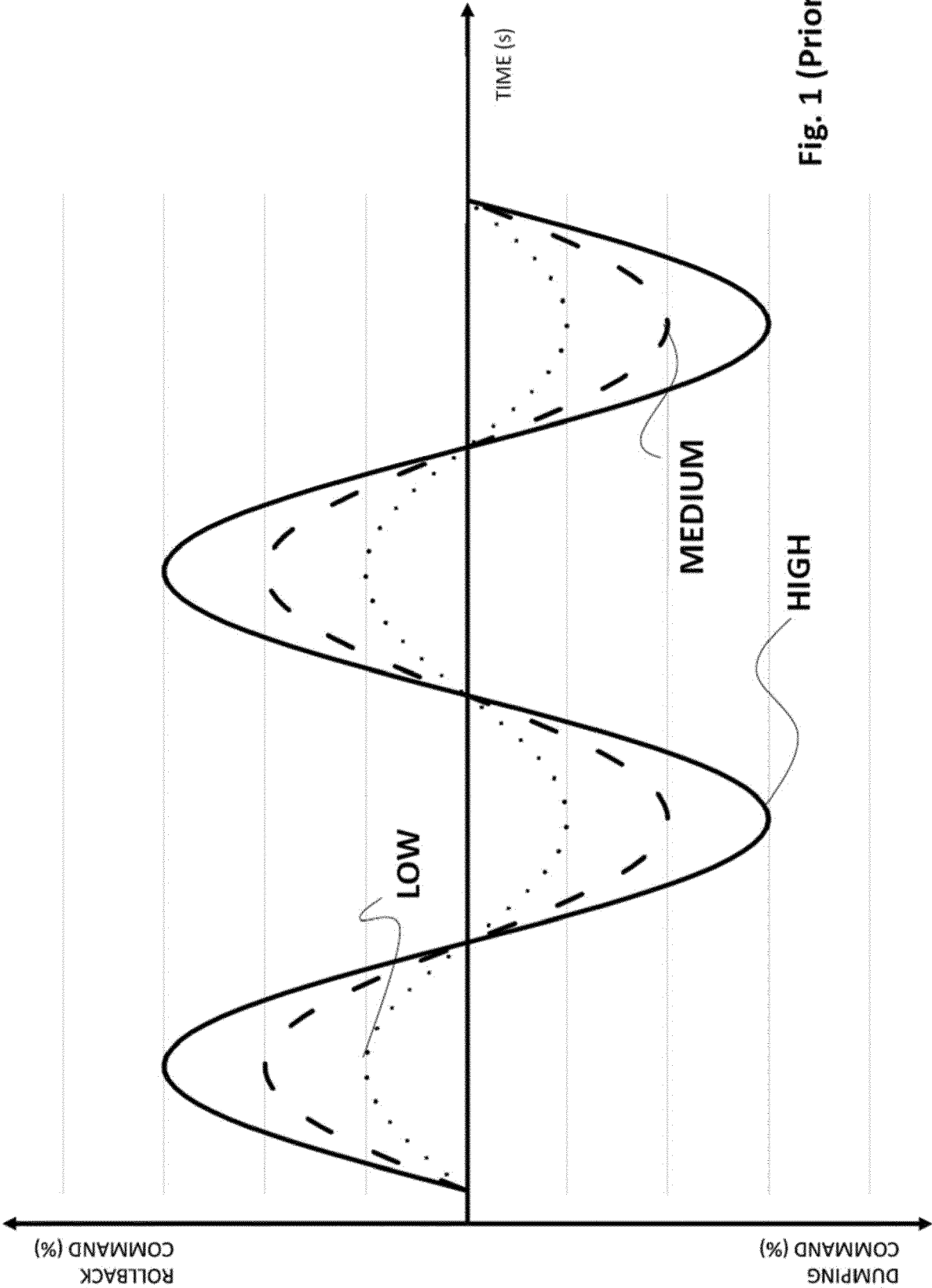


Fig. 1 (Prior art)

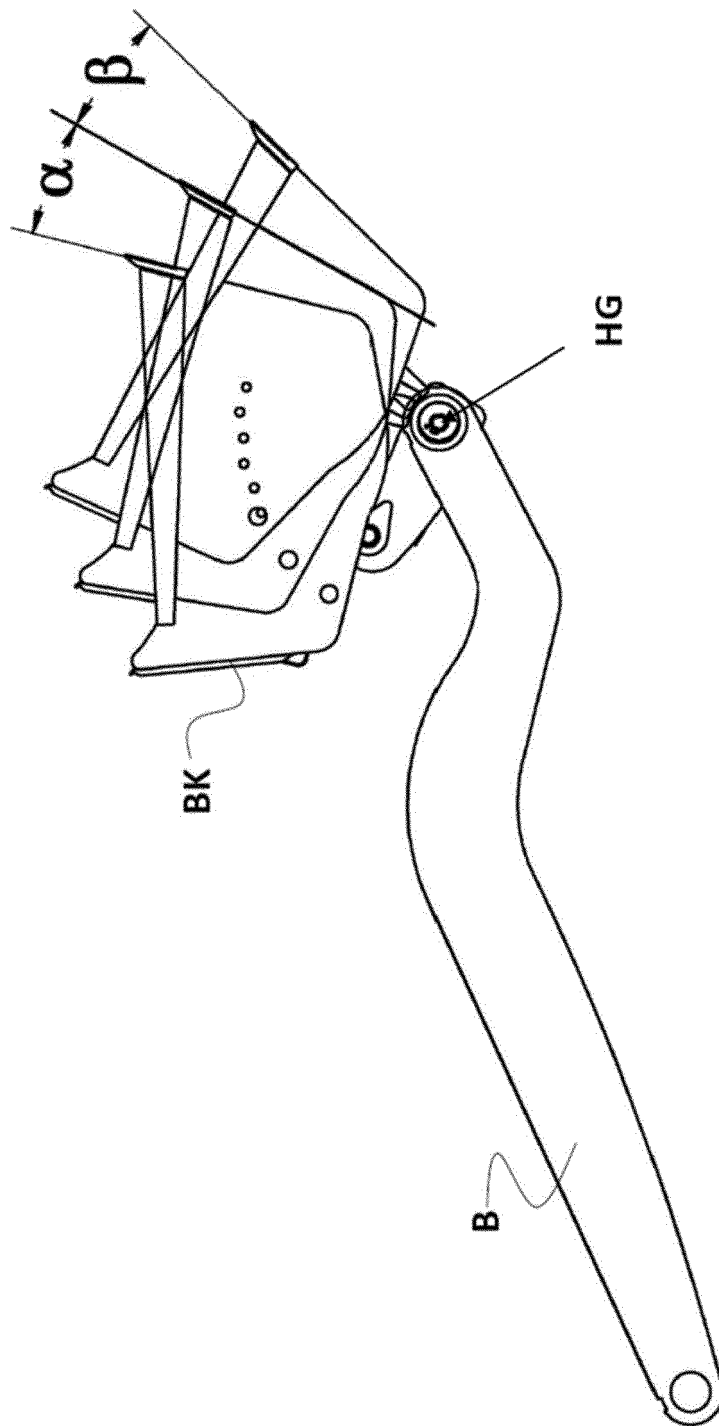
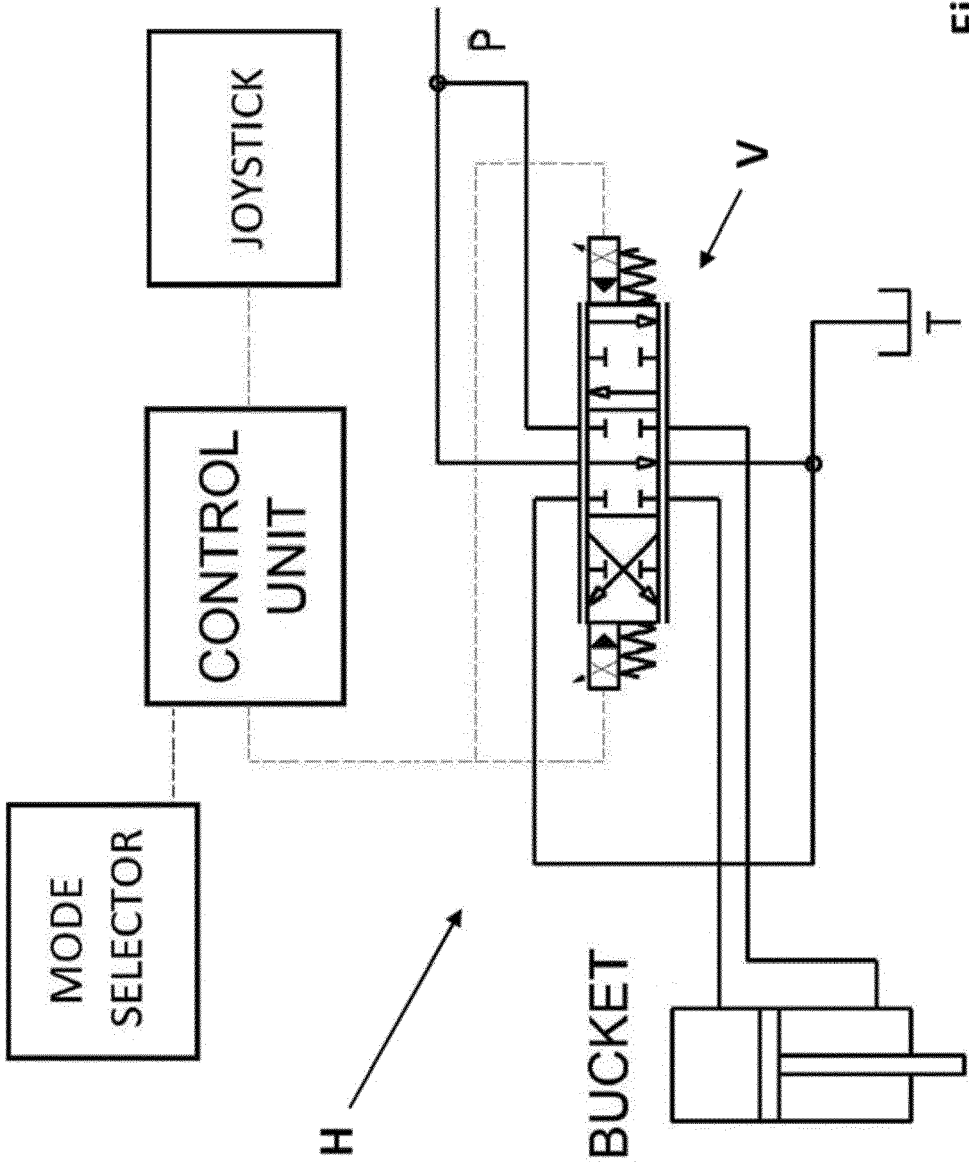


Fig. 2



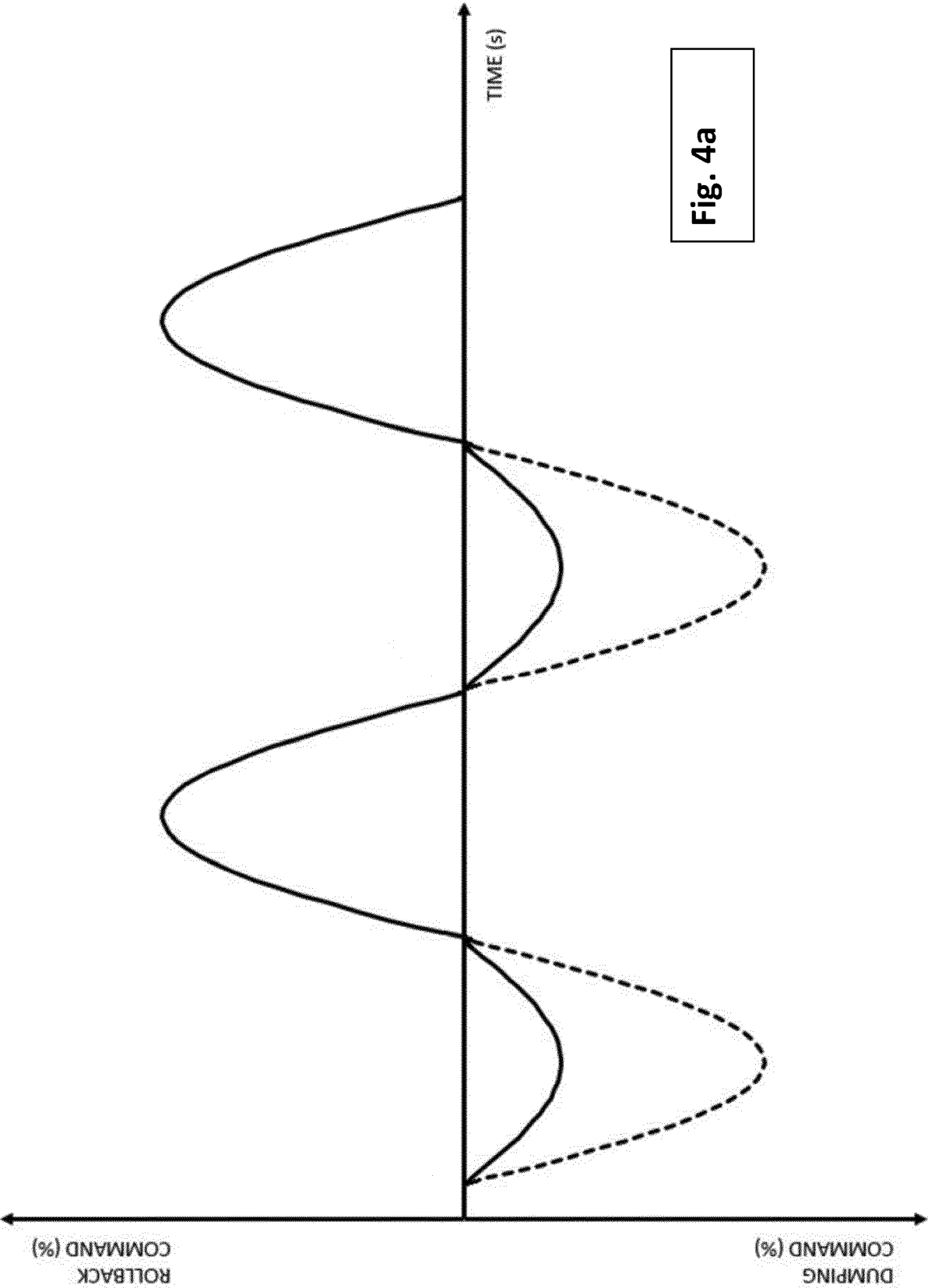


Fig. 4a

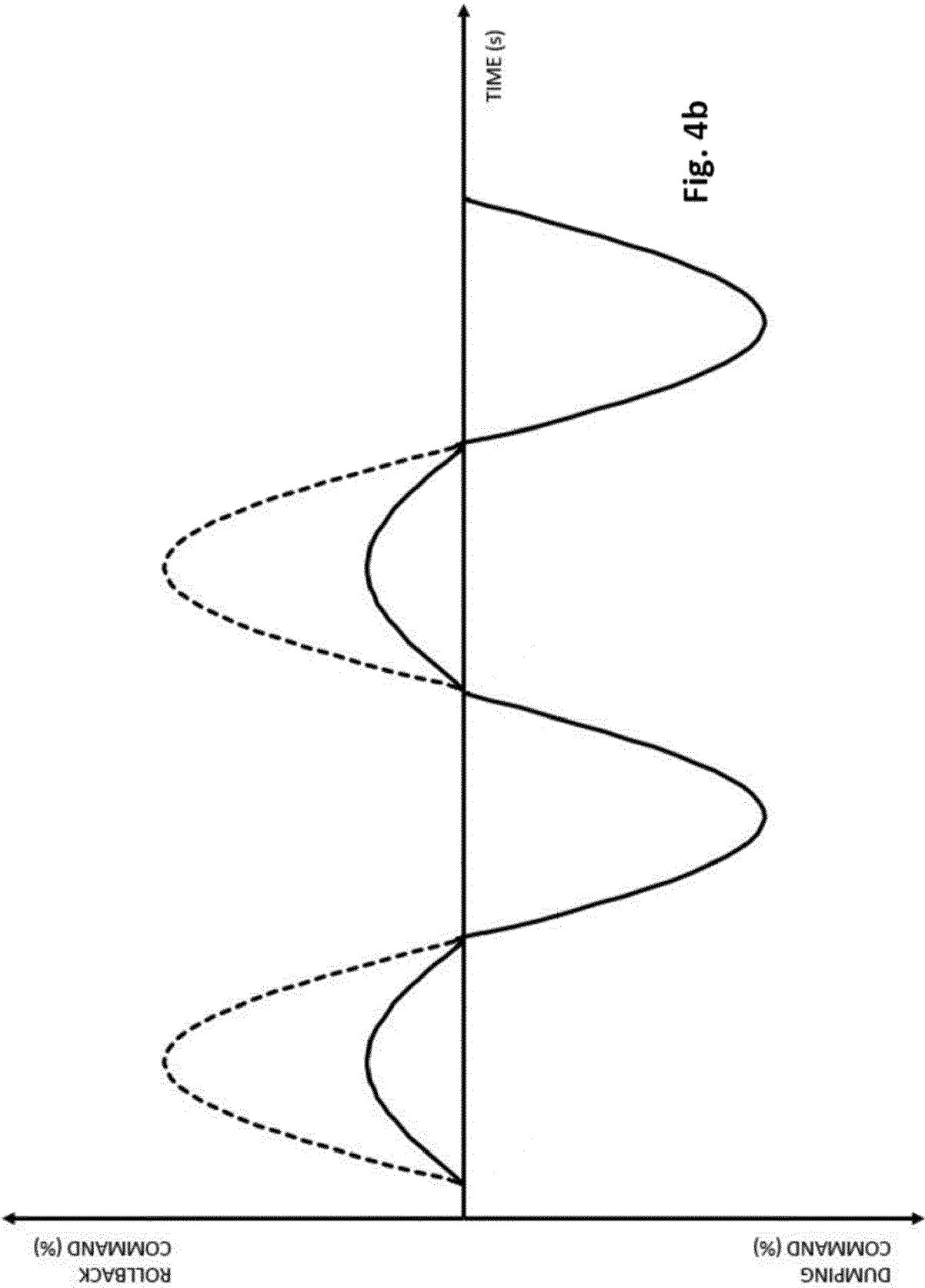


Fig. 4b

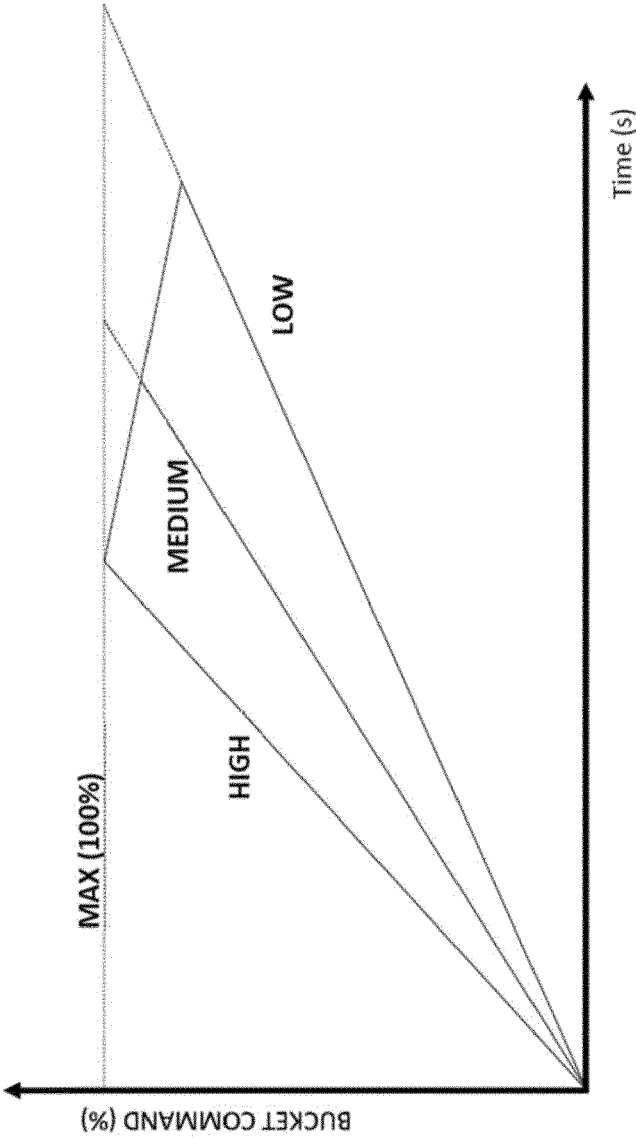


Fig. 5



EUROPEAN SEARCH REPORT

Application Number

EP 22 16 9835

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EPO FORM 1503 03.82 (P04C01)

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2019/093310 A1 (KENKEL AARON R [US] ET AL) 28 March 2019 (2019-03-28) * paragraphs [0020] - [0024]; figures 2, 3 * * paragraphs [0017] - [0019]; figure 1 * -----	1-10	INV. E02F3/40 E02F3/43 E02F9/22
A	US 2005/203691 A1 (KIM DONG S [KR]) 15 September 2005 (2005-09-15) * paragraph [0041]; figures 2, 4, 5 * * paragraphs [0028] - [0045] * -----	1-10	
			TECHNICAL FIELDS SEARCHED (IPC)
			E02F
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 15 November 2022	Examiner Luta, Dragos
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**ANNEX TO THE EUROPEAN SEARCH REPORT
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EP 22 16 9835

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2019093310 A1	28-03-2019	BR 102018069575 A2	30-07-2019
		US 2019093310 A1	28-03-2019

US 2005203691 A1	15-09-2005	CN 1667206 A	14-09-2005
		EP 1574625 A1	14-09-2005
		JP 2005256592 A	22-09-2005
		KR 20050090815 A	14-09-2005
		US 2005203691 A1	15-09-2005

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- DE 102014111505 A1 [0003]
- US 2018135274 A [0005]