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(54) **METHOD FOR CONTROLLING AN OPEN CENTER ELECTRO-HYDRAULIC CONTROL VALVE, IN PARTICULAR FOR OPERATING AN ORGAN OF AN AGRICULTURAL OR WORK VEHICLE**

VERFAHREN ZUR STEUERUNG EINES ELEKTRO-HYDRAULISCHEN STEUERVENTILS, INSBESONDERE ZUM BETÄTIGEN EINES HILFSMITTELS EINES LANDWIRTSCHAFTS- ODER ARBEITSFAHRZEUGS

PROCÉDÉ DE COMMANDE D'UNE SOUPAPE DE COMMANDE ÉLECTROHYDRAULIQUE À CENTRE OUVERT, EN PARTICULIER POUR FAIRE FONCTIONNER UN ORGANE D'UN VÉHICULE AGRICOLE OU DE TRAVAIL

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Description

Field of the invention

[0001] The present invention relates to the field of control methods for open center electro-hydraulic control valves, in particular for the actuation of an organ of an agricultural or work vehicle, generally equipped with a hydraulic circuit for the actuation of an actuator enslaved for the actuation of an organ such as an arm or a bucket and the like.

State of the art

[0002] The open center electro-hydraulic control valves are widely used in the field of operating machines and in particular in the field of agricultural and work vehicles for the control of the related hydraulic components such as arms and buckets.

[0003] Such valves are controlled by means of a current signal generated in proportion to the angular position of a control lever arranged, for example, in the vehicle cabin.

[0004] As a consequence of the current signal applied to the electro-hydraulic valve, a relative movable spool moves inside the valve, partitioning a first flow of hydraulic oil addressed to a hydraulic actuator and a second flow of hydraulic oil addressed to the hydraulic oil recovery tank T; in particular, when the spool is at a first end position of the relative displacement, the first flow is zero and the second flow is maximum, while when the spool is in a second end position opposite to the first one, the first flow is maximum and the second flow is zero.

[0005] A pump, generally with a fixed displacement, takes the hydraulic oil from the hydraulic tank T and pumps it into the hydraulic circuit that feeds the electro-hydraulic control valve.

[0006] Figures 1 and 2 show respectively an electro-hydraulic diagram and a block diagram of the known controls implementing electro-hydraulic open center control valves.

[0007] A problem with open-center control valves OCV is that the partitioning of the flows depends not only on the position of the spool, but also on the load applied to the hydraulic actuator.

[0008] This means that in relation to this load, the operator must start to operate the control lever of the hydraulic organ really slowly as long as the partitioning of the first and second flows is such that to balance the load. This means that there is no fixed relationship between the position of the organ control lever and the beginning of the movement of the organ itself.

[0009] It is clear that the load applied to the organ affects the relative hydraulic actuator, therefore it is equivalent referring to the load applied to the organ or its hydraulic actuator. It is also evident that the position of the actuator control lever affects the position of the movable spool, but this is not sufficient to ensure that the actuator and thus the relative member begins to move when the lever reaches a predetermined position. On the contrary, this means that the operator must gradually act on the control lever, until the organ begins to move, and then he can further adjust the progression of its movement.

[0010] In the first phase of "offset search", the operator must act gradually, as sudden actions could induce, once the position of the spool balances the load applied to the organ is exceeded, sudden, uncontrolled and potentially dangerous movements of the operated organ.

[0011] A known solution is to replace the open center control valve with a closed center electrohydraulic valve. An other example is shown in patent application WO2019050064A1 that describe a control device to regulate the signal pressure as a function of the input and a speed of the engine to control the flow control valve. Further examples are disclosed in patent US6615114B1 about a Calibration system and method for work machines using electro hydraulic controls, or patent US6401456 about a method for controlling a work machine, or patent US7512460B2 related to a valve calibration routin. Closed center valves are much more complex and expensive.

[0012] 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

[0013] The purpose of the present invention is to present in independent claim 1 a control system and in independent claim 2 a control method for control of an open center electro-hydraulic control valve, which overcomes the problems of the known art.

[0014] In other words, the main object of the present invention is to cause an open center valve to behave like a closed center valve.

[0015] The basic idea of the present invention is to implement a feedback control that identifies the offset of the control signal corresponding to the offset of the spool position, such as to balance the load, by means of the implementation of an associated position sensor to the hydraulic actuator.

[0016] Obviously, the weight of the load varies from time to time and therefore the offset of the spool control signal must also vary accordingly.

[0017] In other words, the idea is to manipulate the signal generated by the control lever of the organ so that in a predetermined angular position of the control lever of the organ controlled by the lever begins to move regardless of the load applied to it.

[0018] Advantageously, a "drowback" in the open center valves is compensated through the control of the same, so that in practical terms, the operator control the hydraulic parts of an operating machine as in case the control valves of the relative actuators were of the closed type.

[0019] To avoid uncontrolled movements following the implementation of the present invention, a so-called dead band is provided, adjacent to the release position of the control lever of the controlled organ, in which the signal generated by the same lever is null or considered null, so that only when the dead band is exceeded, the calculation of the offset signal value to be applied to the signal generated by the control lever is triggered.

[0020] Since the amount of the load can vary even suddenly, for example because it is released, then the offset signal is reset when the lever is released or in any case when it enters the dead band.

[0021] The dependent claims describe preferred variants of the invention, forming an integral part of this description.

Brief description of figures

[0022] 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 by way of non-limiting explanation, in which:

Figure 1 shows an electro-hydraulic diagram for controlling the operation of a hydraulic actuator of an organ (bucket or arm) of a work vehicle according to the known art;

in figure 2 the same diagram of figure 1 of the prior art is shown according to a block diagram, in which the dotted connectors indicate electrical control lines, while the continuous connectors indicate hydraulic lines;

Figure 3 shows an electro-hydraulic diagram for controlling the operation of a hydraulic actuator according to the present invention, based on the diagram in Figure 1;

Figure 4 shows a block diagram based on the diagram of Figure 2 and modified on the basis of the diagram of Figure 3 of the present invention;

Figure 5 shows the comparison between the graph of the control signal according to the present invention, as a function of a position of a control lever and as a function of the absence or presence of a load applied to the controlled actuator;

Figure 6 shows a flow chart representative of an implementation example of the method object of the present invention;

Figure 7 shows a work or agricultural vehicle implementing the method object of the present invention.

[0023] The same reference numbers and letters in the figures identify the same elements or components or functions.

[0024] The blocks shown in hatched are optional.

[0025] 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.

[0026] 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 exemplary embodiments

[0027] With reference to Figures 3 and 4, a position sensor SS is associated with the hydraulic actuator ACT controlled by the open center control valve OCV and when from a release condition the control lever J reaches the limit of the dead band DB, then it is increased control signal OCV of the control valve until actuator ACT movement is detected by the sensor SS. Then, the signal value is stored and added stably to the signal generated by the control lever.

[0028] Therefore, the control method of the open center electro-hydraulic control valve OCV for operating a hydraulic actuator ACT of an organ A, B of a work or agricultural vehicle VHE, powered by a pump P, in which a control signal of the control valve is generated in proportion to a position of a control lever J, the method, with reference to Figure 6, comprises

- a first step (Step 1) to detect the exceeding of a predetermined position DB of the control lever J of the hydraulic unit,
- a second and consequent step Step 2 of increasing control signal and measuring a control signal value (Offset) at a staring movement of said hydraulic actuator and
- a third step (Step 3) to set a positive offset to the control signal LS approximately equal to said value, as long as the position of the control lever J of the hydraulic organ exceeds said predetermined position DB.

[0029] With reference to Figure 4, the second step is a closed loop control in which the feedback variable consists of the movement start of the hydraulic actuator. In fact, all the signals converge in the processing unit CPU which receives the signal generated by the control lever J at its input and generates an increase in the valve control signal based on the position signal received from the position sensor SS.

[0030] The AMP block representing a signal amplifier is voluntarily represented as external to the CPU block to make the invention easier to understand, but it must be clear that the entire method object of the present invention can be entirely implemented in the processing unit CPU.

[0031] Figure 5 shows a comparison of the control signal generated by the block AMP in two different conditions, i.e. when the organ, for example the arm of a

loader, is lifted without load (left in figure 5) or if it is lifted with load (on the right in figure 5).

[0032] When the load is not applied, the behavior of the control is completely identical to what occurs according to the known art.

[0033] Conversely, in the case of applied load, the intensity of the command signal is manipulated by adding the Offset value calculated in step 2, while the remaining portion LS of the curve is connected, for example linearly, from the Offset value in DB up to the maximum value of the control signal in AM, which represents the position of maximum inclination of the control lever J.

[0034] It is worth highlighting that if the original curve, i.e. without load, is not linear, for example hyperbolic or parabolic, the same behavior can be maintained after the application of the Offset, taking into account that the maximum value of the signal applied to the valve must remain unchanged to avoid damaging the valve.

[0035] In other words, the overall control signal of the control valve is the sum of a first contribution given by the offset (positive), calculated in DB, and a second LS contribution proportional to the current position of the control lever.

[0036] Preferably, each time the lever returns to the release position or in the dead band, a fourth step (Step 4) is performed to cancel the previously stored control signal value (Offset) to start over from the first step, i.e. from the beginning of this method.

[0037] It is worth noting that the processing unit is extremely fast by performing a significant number of calculation cycles in the time unit, therefore, the offset calculation is almost instantaneous. However, the increase in the command signal value up to the detection of the actuator displacement can be linear or follow different laws to make this identification of the Offset even faster.

[0038] For example some laws can be exponential or parabolic.

[0039] According to a preferred variant of the invention, it is also taken into account that the flow of hydraulic liquid entering the open center electro-hydraulic control valve OCV can vary.

[0040] With high flow rates of hydraulic liquid, small displacements of the movable spool can induce large actuator movement, therefore it is advisable that the law of increasing the command signal carried out during the second step for searching the Offset value is inversely proportional to the hydraulic liquid flow generated by the hydraulic fluid source.

[0041] Generally, the hydraulic source is a pump driven by the prime mover, which typically is an internal combustion engine, therefore, the law of increasing the drive signal of the movable spool in step 2 can have a progression inversely proportional to the flow generated by the hydraulic source or equivalently to the speed of rotation of the prime mover which drives the hydraulic pump which feeds the control valve OCV.

[0042] The present invention can be advantageously realized by means of a computer program which comprises coding means adapted to cause a control system as claimed in claim 1 and described before to carry out all steps of the claimed control method Therefore it is intended that the scope of protection extends to said computer program and further to computer readable means comprising a recorded computer program, said computer program comprising program coding means adapted to cause a control system as claimed in claim 1 and described to perform all steps of the claimed control method.

[0043] Implementation variants of the described non-limiting example are possible, without however departing from the scope of protection of the present invention as defined by the appended claims, including all the equivalent embodiments for a person skilled in the art, within the scope of the present invention as defined by the appended claims.

[0044] 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 system of an electro-hydraulic open center control valve (OCV) for operating a hydraulic actuator (ACT) of an organ (A, B) of a work or agricultural vehicle, powered by a pump (P), the control system comprising

   - a control lever (J) of the organ configured to generate a first signal proportional to a position of the control lever,
   - processing means (CPU, AMP) configured to generate a control signal (LS) of the control valve, proportionally to said first signal,
   - wherein the processing means (CPU, AMP) are configured to detect the overcoming of a predetermined position (DB) of the control lever (J) of the organ and consequently to increase the control signal and then to set a positive offset to the control signal (LS), as long as the position of the control lever (J) of the organ exceeds said predetermined position (DB),

   characterized in that, the control system comprises

   detection means (SS) configured to detect a movement of said hydraulic actuator as a result of the application of said control signal,

   wherein the processing means are operatively connected with said detection means

   and configured to measure a control signal value (Offset) at a starting of a movement of said hydraulic actuator and then to set the positive offset approximately equal to said control signal value (Offset).

2. Method of controlling a control system as claimed in claim 1 for control of an electro-hydraulic open center control valve (OCV) for the operation of a hydraulic actuator (ACT) of an organ (A, B) of a working or agricultural vehicle (VHE), powered by a pump (P), wherein a control signal of the control valve is generated proportionally to a position of a control lever (J) of the organ,

   the method including

   - a first step (Step 1) of detecting the exceeding of a predetermined position (DB) of the control lever (J) of the organ,
   - a second and consequent step (Step 2) of increasing the control signal and measuring a control signal value (Offset) and
   - a third step (Step 3) of setting a positive offset to the control signal (LS, as long as the position of the control lever (J) of the hydraulic organ exceeds said predetermined position (DB),

   the method is **characterized in that** the control signal value (Offset) in the second step (Step 2) is measured at a starting movement of said hydraulic actuator and the positive offset in the third step (Step 3) is approximately equal to said control signal value (Offset).

3. Method according to any one of the preceding claims, wherein said second step is performed by means of a closed loop control wherein the feedback variable consists in said movement of said hydraulic actuator.

4. Method according to any one of the preceding claims, wherein the overall control signal of the control valve is the sum of a first contribution given by said positive offset and a second contribution (LS) proportional to the current position of the control lever.

5. Method according to any one of the preceding claims, provides for a fourth step of erasing said control signal value (Offset) after returning the control lever to a position lower than said predetermined position (DB) and repeating the method from its Start.

6. Method according to any one of the preceding claims, wherein said second step comprises increasing said control signal according to a linear or exponential or parabolic trend.

7. Method according to any one of the preceding claims, wherein said increase has a progression inversely proportional to a flow rate generated by a source of hydraulic liquid feeding said control valve.

8. Method according to any one of the preceding claims 2 to 6, wherein said increase has a progression inversely proportional to a speed of rotation of a prime mover arranged to drive into rotation a hydraulic pump feeding said control valve.

9. Computer program comprising program coding means adapted to cause a control system as claimed in claim 1 to carry out all steps of any one of claims 2 to 6.

10. Computer readable means comprising a recorded computer program, said computer program comprising program coding means adapted to cause a control system as claimed in claim 1 to perform all steps of any one of claims 2 to 6.

11. Agricultural or work vehicle comprising an organ (A, B), a respective hydraulic actuator (ACT) and a control system of an electro-hydraulic open center control valve (OCV) for operating the hydraulic actuator (ACT), wherein the control system conforms to claim 1.

Patentansprüche

1. Steuersystem eines elektrohydraulischen Open-Center-Steuerventils (OCV) zum Betätigen einer hydraulischen Betätigungseinrichtung (ACT) eines Elements (A, B) eines Arbeits- oder Landwirtsfahrzeugs, das von einer Pumpe (P) angetrieben wird, wobei das Steuersystem umfasst

   - einen Steuerhebel (J) des Elements, der dazu eingerichtet ist, ein erstes Signal zu erzeugen, das proportional zu einer Position des Steuerhebels ist,
   - Verarbeitungsmittel (CPU, AMP), die dazu eingerichtet sind, ein Steuersignal (LS) des Steuerventils proportional zu dem ersten Signal zu erzeugen,
   - wobei die Verarbeitungsmittel (CPU, AMP) dazu eingerichtet sind, das Überschreiten einer vorbestimmten Position (DB) des Steuerhebels (J) des Elements zu erfassen und infolgedessen das Steuersignal zu erhöhen und dann einen positiven Offset für das Steuersignal (LS) einzustellen, solange die Position des Steuerhebels (J) des Elements die vorbestimmte Position (DB) überschreitet,

   dadurch gekennzeichnet, dass das Steuersystem Erfassungsmittel (SS) umfasst, die dazu eingerichtet sind, eine Bewegung der hydraulischen Betätigungseinrichtung in Folge des Anlegens des Steuersignals zu erfassen,

wobei die Verarbeitungsmittel wirkend mit den Erfassungsmitteln verbunden sind und dazu eingerichtet sind, einen Steuersignalwert (Offset) zu Beginn einer Bewegung der hydraulischen Betätigungseinrichtung zu messen und dann den positiven Offset in etwa gleich dem Steuersignalwert (Offset) zu setzen.

2. Verfahren zum Steuern eines Steuersystems nach Anspruch 1 zum Steuern eines elektrohydraulischen Open-Center-Steuerventils (OCV) zum Betätigen einer hydraulischen Betätigungseinrichtung (ACT) eines Elements (A, B) eines Arbeits- oder Landwirtsfahrzeugs (VHE), das von einer Pumpe (P) angetrieben wird, wobei ein Steuersignal des Steuerventils proportional zu einer Position eines Steuerhebels (J) des Elements erzeugt wird,

wobei das Verfahren umfasst:

- einen ersten Schritt (Step 1) des Erfassens des Überschreitens einer vorbestimmten Position (DB) des Steuerhebels (J) des Elements,
- einen zweiten und nachfolgenden Schritt (Step 2) des Erhöhens des Steuersignals und des Messens eines Steuersignalwerts (Offset)

und

- einem dritten Schritt (Schritt 3) des Festlegens eines positiven Offsets für das Steuersignal (LS), solange die Position des Steuerhebels (J) des hydraulischen Elements die vorbestimmte Position (DB) überschreitet,

wobei das Verfahren **dadurch gekennzeichnet ist, dass** der Steuersignalwert (Offset) im zweiten Schritt (Step 2) zu Beginn einer Bewegung der hydraulischen Betätigungseinrichtung gemessen wird und der positive Offset im dritten Schritt (Step 3) in etwa gleich dem Steuersignalwert (Offset) ist.

3. Verfahren nach einem der vorhergehenden Ansprüche, wobei der zweite Schritt mittels einer geschlossenen Regelschleife durchgeführt wird, wobei die Feedback-Variable aus der Bewegung der hydraulischen Betätigungseinrichtung besteht.

4. Verfahren nach einem der vorhergehenden Ansprüche, wobei das Gesamt-Steuersignal des Steuerventils die Summe eines ersten Anteils, der durch den positiven Offset gebildet wird, und eines zweiten Anteils (LS) ist, der proportional zur aktuellen Position des Steuerhebels ist.

5. Verfahren nach einem der vorhergehenden Ansprüche, das einen vierten Schritt des Löschens des Steuersignalwerts (Offset) nach dem Zurücksetzen des Steuerhebels in eine Position, die niedriger als die vorbestimmte Position (DB) ist, und des Wiederholens des Verfahrens von Beginn an vorsieht.

6. Verfahren nach einem der vorhergehenden Ansprüche, wobei der zweite Schritt ein Erhöhen des Steuersignals gemäß einem linearen, exponentiellen oder parabolischen Verlauf aufweist.

7. Verfahren nach einem der vorhergehenden Ansprüche, wobei die Erhöhung einen Verlauf aufweist, der umgekehrt proportional zu einer Durchflussrate ist, die von einer Hydraulikfluidquelle erzeugt wird, die das Steuerventil speist.

8. Verfahren nach einem der vorhergehenden Ansprüche 2 bis 6, wobei die Erhöhung einen Verlauf aufweist, der umgekehrt proportional zu einer Drehzahl einer Antriebsmaschine ist, die dazu ausgebildet ist, eine Hydraulikpumpe, die das Steuerventil speist, in Rotation zu versetzten.

9. Computerprogramm, das Programmcodemittel aufweist, die dazu eingerichtet sind, ein Steuersystem nach Anspruch 1 dazu zu veranlassen, alle Schritte von einem der Ansprüche 2 bis 6 auszuführen.

10. Computerlesbares Mittel, das ein gespeichertes Computerprogramm aufweist, wobei das Computerprogramm Programmcodemittel aufweist, die dazu eingerichtet sind, ein Steuersystem nach Anspruch 1 dazu zu veranlassen, alle Schritte nach einem der Ansprüche 2 bis 6 auszuführen.

11. Landwirtschaftliches Fahrzeug oder Arbeitsfahrzeug, das ein Element (A, B), eine entsprechende hydraulische Betätigungseinrichtung (ACT) und ein Steuersystem eines elektrohydraulischen Open-Center-Steuerventils (OCV) zum Betätigen der hydraulischen Betätigungseinrichtung (ACT) umfasst, wobei das Steuersystem gemäß Anspruch 1 ausgebildet ist.

Revendications

1. Système de commande d'une vanne de régulation électro-hydraulique à centre ouvert (OCV) pour le fonctionnement d'un actionneur hydraulique (ACT) d'un organe (A, B) d'un véhicule de travail ou agricole, alimenté par une pompe (P), le système de commande comprenant

- un levier de commande (J) de l'organe configuré pour générer un premier signal proportionnel à une position du levier de commande,

- des moyens de traitement (CPU, AMP) configurés pour générer un signal de commande (LS) de la vanne de régulation, proportionnellement audit premier signal,
- dans lequel les moyens de traitement (CPU, AMP) sont configurés pour détecter le dépassement d'une position prédéterminée (DB) du levier de commande (J) de l'organe et, par conséquent, pour augmenter le signal de commande, puis pour définir un décalage positif par rapport au signal de commande (LS), tant que la position du levier de commande (J) de l'organe excède ladite position prédéterminée (DB),

caractérisé en ce que le système de commande comprend des moyens de détection (SS) configurés pour détecter un mouvement dudit actionneur hydraulique suite à l'application dudit signal de commande,
les moyens de traitement étant raccordés de manière opérationnelle auxdits moyens de détection et configurés pour mesurer une valeur de signal de commande (Offset) au début d'un mouvement dudit actionneur hydraulique, puis pour régler le décalage positif approximativement égal à ladite valeur de signal de commande (Offset).

2. Procédé de commande d'un système de commande selon la revendication 1 pour la commande d'une vanne de régulation électro-hydraulique à centre ouvert (OCV) pour le fonctionnement d'un actionneur hydraulique (ACT) d'un organe (A, B) d'un véhicule de travail ou agricole (VHE), alimenté par une pompe (P), dans lequel un signal de commande de la vanne de régulation est généré proportionnellement à une position d'un levier de commande (J) de l'organe,

le procédé incluant

- une première étape (Étape 1) de détection du dépassement d'une position prédéterminée (DB) du levier de commande (J) de l'organe,
- une deuxième étape consécutive (Étape 2) d'augmentation du signal de commande et de mesure de la valeur du signal de commande (Offset)
et
- une troisième étape (Étape 3) de définition d'un décalage positif par rapport au signal de commande (LS) tant que la position du levier de commande (J) de l'organe hydraulique excède ladite position prédéterminée (DB),

le procédé est **caractérisé en ce que** la valeur du signal de commande (Offset) lors de la deuxième étape (Étape 2) est mesurée lors d'un mouvement initial dudit actionneur hydraulique et **en ce que** le décalage positif lors de la troisième étape (Étape 3) est approximativement égal à la valeur dudit signal de commande (Offset).

3. Le procédé selon l'une quelconque des revendications précédentes, dans lequel la deuxième étape est réalisée à l'aide d'une commande en boucle fermée dans laquelle la variable de rétroaction est constituée par ledit mouvement dudit actionneur hydraulique.

4. Procédé selon l'une quelconque des revendications précédentes, dans lequel le signal de commande global de la vanne de régulation correspond à la somme d'une première contribution apportée par ledit décalage positif et d'une seconde contribution (LS) proportionnelle à la position actuelle du levier de commande.

5. Le procédé selon l'une quelconque des revendications précédentes prévoit une quatrième étape consistant à effacer ladite valeur du signal de commande (Offset) après avoir ramené le levier de commande dans une position inférieure à ladite position prédéterminée (DB) et avoir répété le procédé à partir du début.

6. Procédé selon l'une quelconque des revendications précédentes, dans lequel ladite deuxième étape consiste à augmenter ledit signal de commande conformément à une tendance linéaire, exponentielle ou parabolique.

7. Procédé selon l'une quelconque des revendications précédentes, dans lequel ladite augmentation présente une progression inversement proportionnelle à un débit généré par une source de liquide hydraulique alimentant ladite vanne de régulation.

8. Procédé selon l'une quelconque des précédentes revendications 2 à 6, dans lequel ladite augmentation présente une progression inversement proportionnelle à une vitesse de rotation d'un moteur primaire agencé pour mettre en rotation une pompe hydraulique alimentant ladite vanne de régulation.

9. Programme informatique comprenant des moyens de codage de programme adaptés pour amener un système de commande selon la revendication 1 à effectuer toutes les étapes de l'une quelconque des revendications 2 à 6.

10. Moyens lisibles par ordinateur comprenant un pro-

gramme informatique enregistré, ledit programme informatique comprenant des moyens de codage de programme adaptés pour amener un système de commande selon la revendication 1 à exécuter toutes les étapes de l'une quelconque des revendications 2 à 6.

11. Véhicule agricole ou de travail comprenant un organe (A, B), un actionneur hydraulique respectif (ACT) et un système de commande d'une vanne de régulation électro-hydraulique à centre ouvert (OCV) pour le fonctionnement de l'actionneur hydraulique (ACT), dans lequel le système de commande est conforme à la revendication 1.

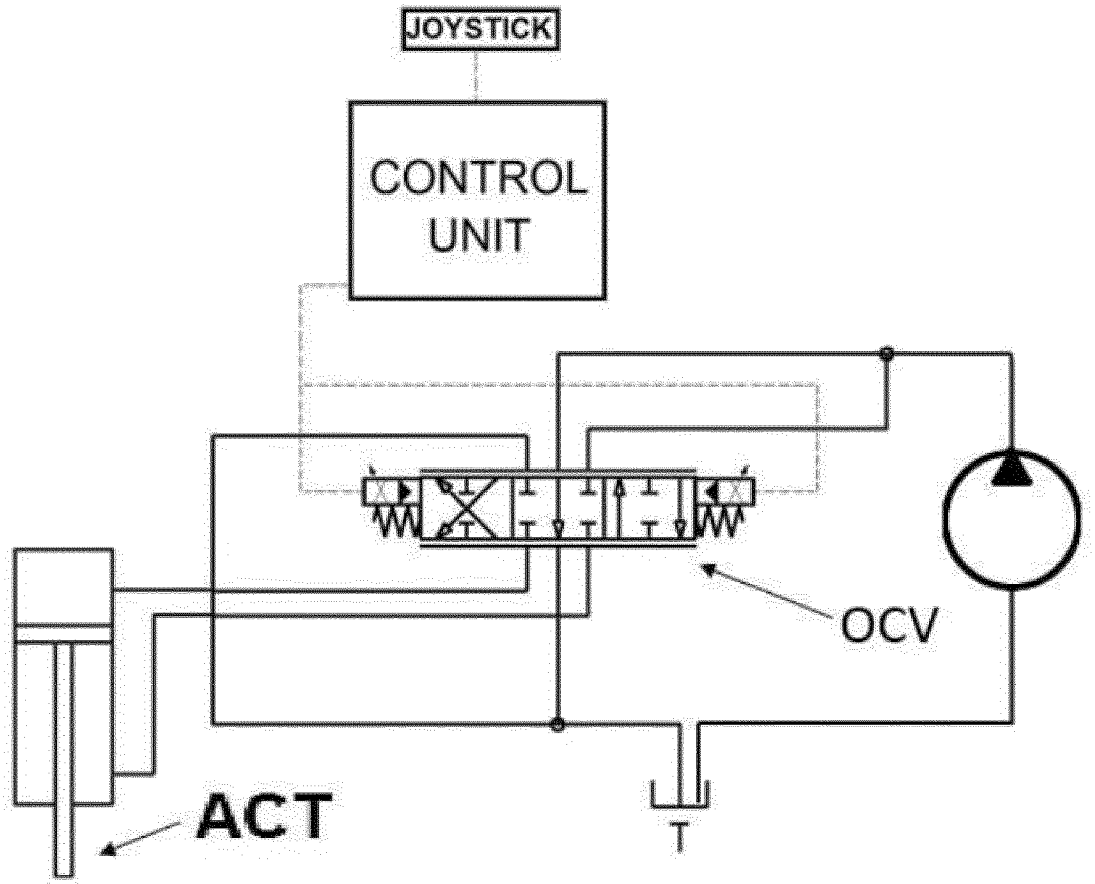

Fig. 1 (prior art)

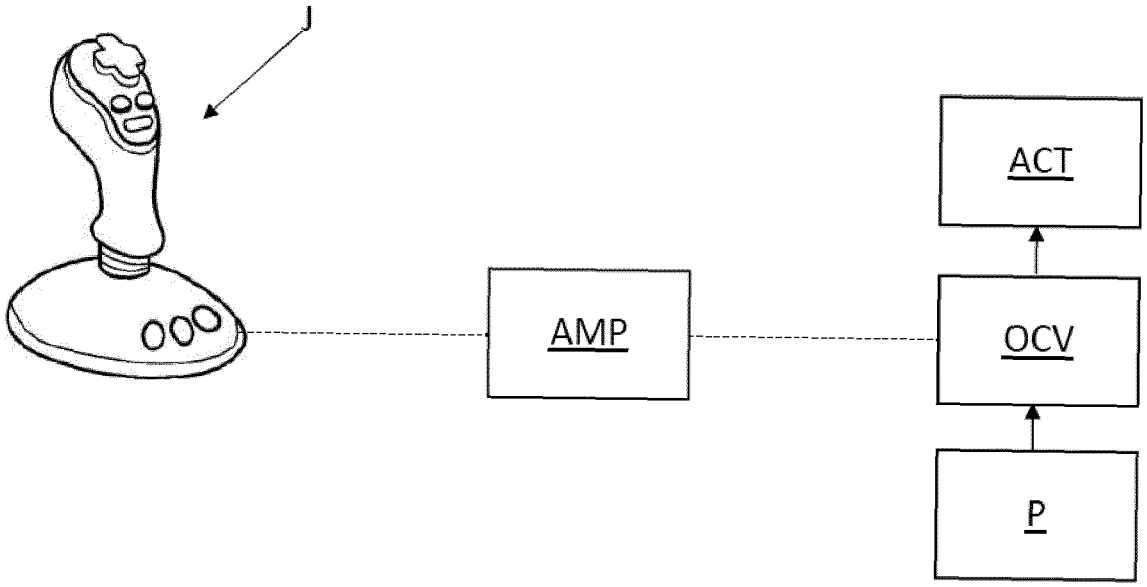

Fig. 2 (prior art)

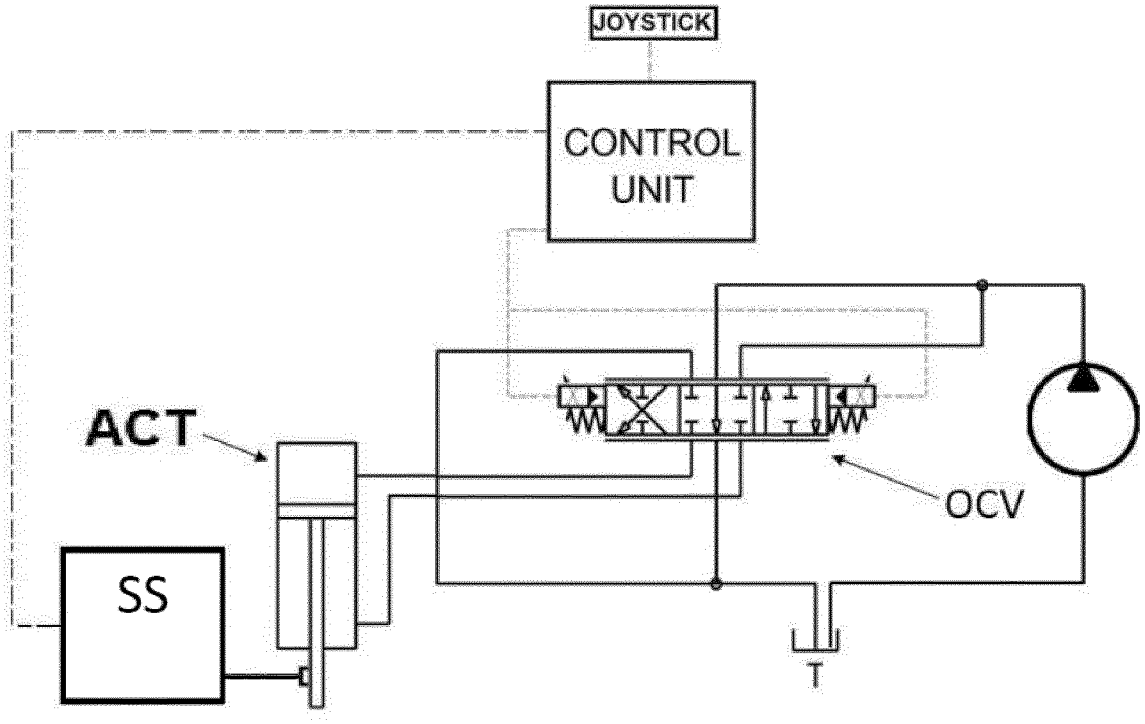

Fig. 3

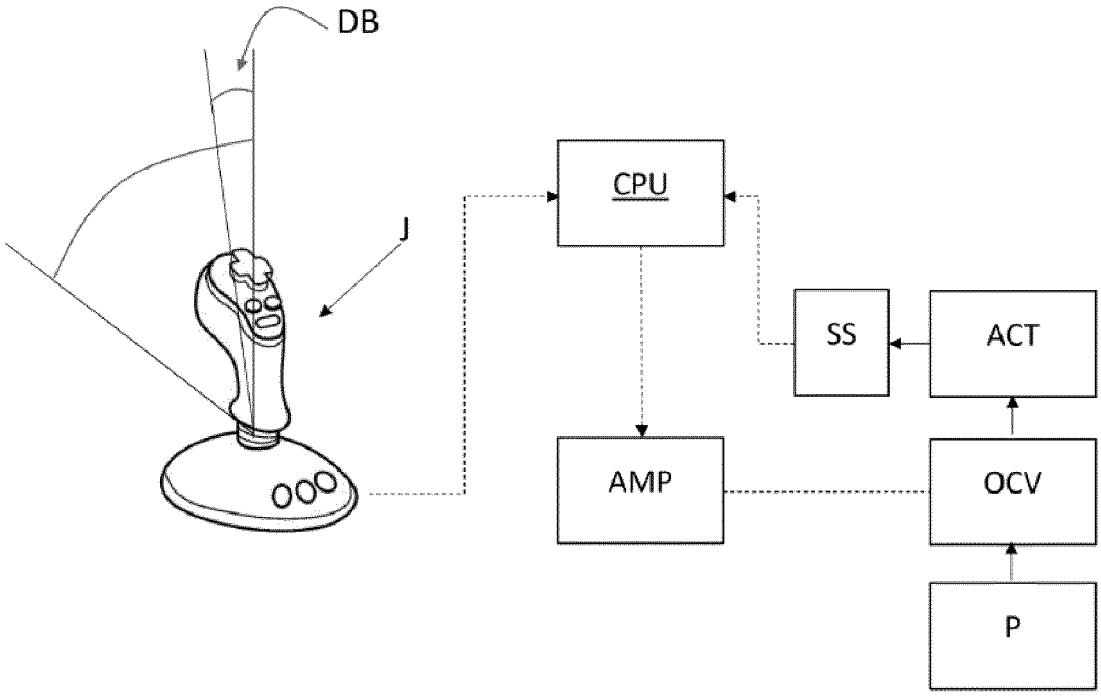

Fig. 4

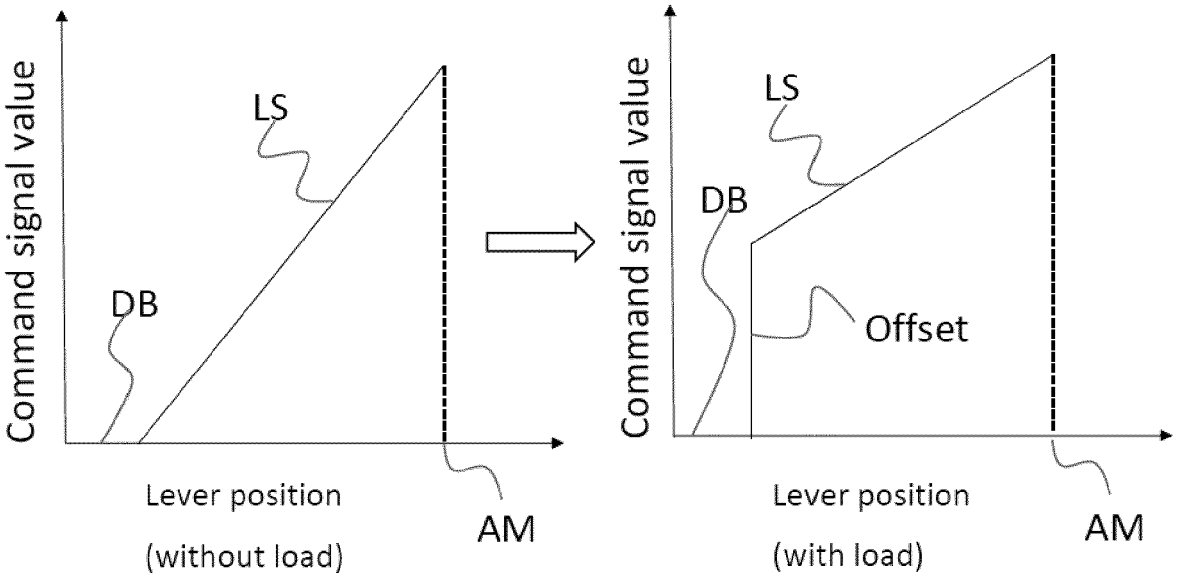
Command signal value
LS
DB
Lever position
(without load)
AM
Command signal value
LS
DB
Offset
Lever position
(with load)
AM

Fig. 5

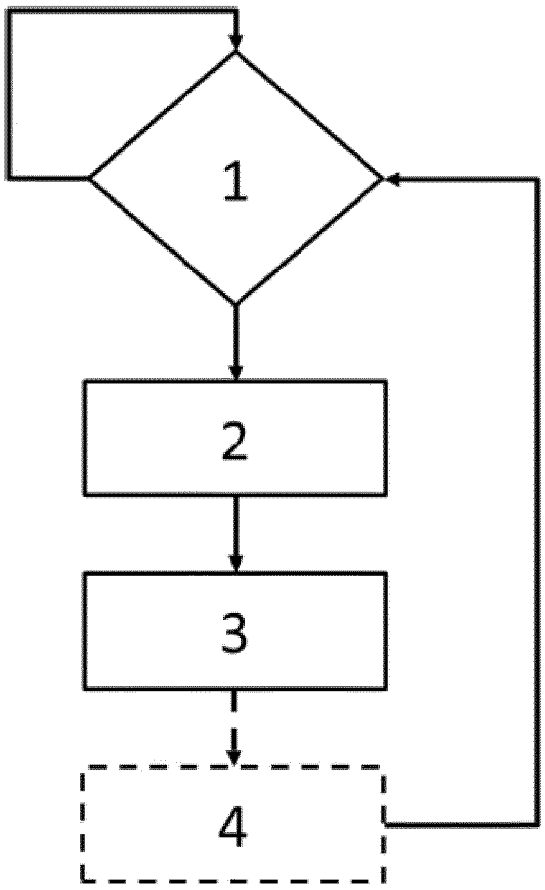

Fig. 6

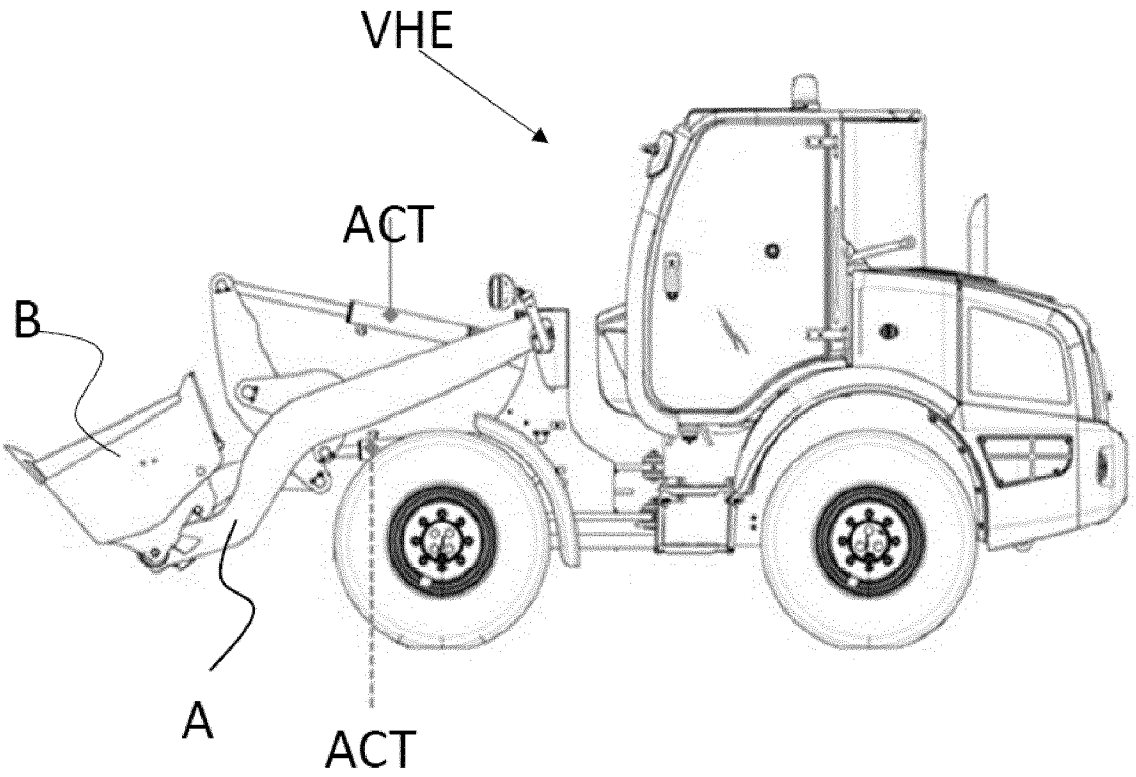

Fig. 7

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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- US 6615114 B1 **[0011]**
- US 6401456 B **[0011]**
- US 7512460 B2 **[0011]**