



(51) International Patent Classification:
F04B 49/06 (2006.01)

(21) International Application Number:
PCT/SE2009/050568

(22) International Filing Date:
19 May 2009 (19.05.2009)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
0801260-1 29 May 2008 (29.05.2008) SE

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(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG,

[Continued on next page]

(54) Title: HYDRAULIC DEVICE CONTROL

(57) Abstract: In a method and a system for controlling a hydraulic device of a motorized vehicle the risk of stalling an engine used to power a motorized vehicle and the hydraulic device is eliminated or reduced by invoking a safety margin when controlling the hydraulic device. The current maximum torque that the engine can deliver is continuously monitored along with the current torque demand. The control signal to the hydraulic device is then controlled in response to the difference between the maximum torque and the torque demand. Hereby it is possible to invoke a suitable torque safety margin preventing the engine from stalling, which could be the result if the torque demand would exceed the maximum torque available.

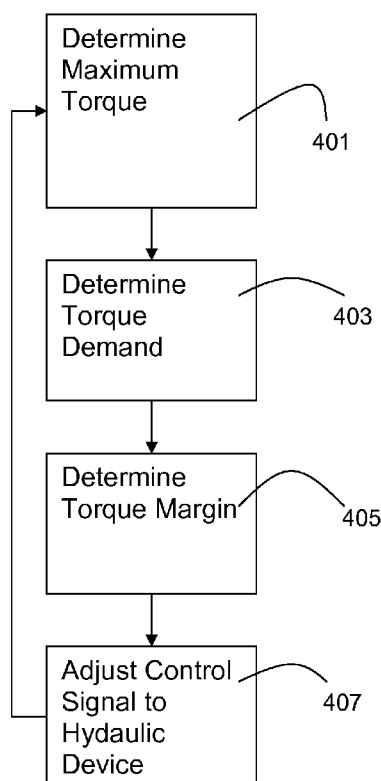


Fig. 4



SK, SL, SM, ST, SV, SY, TJ, TM, TN, TR, TT, TZ, UA,
UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (*unless otherwise indicated, for every kind of regional protection available*): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE,

ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— with international search report (Art. 21(3))

HYDRAULIC DEVICE CONTROL

5 TECHNICAL FIELD

The present invention relates to a method and an apparatus for controlling a hydraulic device powered by a hydraulic system of a heavy vehicle. In particular the present invention relates to a method and apparatus for controlling a hydraulic device of a heavy vehicle where the engine powers a
10 hydraulic pump for driving a hydraulic device.

BACKGROUND

Heavy vehicles can in many cases be provided with a hydraulic system driving a hydraulic device built on or connected to the heavy vehicle. An
15 example is a truck provided with a body work such as a hydraulically powered crane.

The engine of the heavy vehicle is adapted to power one or many hydraulic pumps which in turn generate a hydraulic flow that powers one or more
20 hydraulic devices of the heavy vehicle. Conventional systems for controlling the engine typically strive to maintain a preset speed of the engine when the hydraulic device is used.

There is a constant desire to reduce fuel consumption of heavy vehicles
25 including heavy vehicles having an engine powering hydraulic devices. At the same time there is a desire to provide a high power when driving a hydraulic device. Hence there exists a need for a control method which can provide high power to a hydraulic device of a heavy vehicle, but which at the same time keeps fuel consumption low and without risk for stalling the engine.

SUMMARY

It is an object of the present invention to provide a method and a system that provides an improved hydraulic device control of a heavy vehicle provided with a hydraulically driven device.

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This object and others are obtained by the method, device and computer program product as set out in the appended claims. Thus, in order to eliminate or reduce the risk of stalling an engine used to power a motorized vehicle and a hydraulic device of the vehicle such a body work of a truck for example a hydraulic crane or the like, the control method invokes a safety margin when controlling the hydraulic device. The current maximum torque that the engine can deliver is continuously monitored along with the current torque demand. The control signal to the hydraulic device is then controlled in response to the difference between the maximum torque and the torque demand. Hereby it is possible to invoke a suitable torque safety margin preventing the engine from stalling, which would be the result if the torque demand would exceed the maximum torque available.

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In accordance with one embodiment, the safety margin can be dependent on the current engine speed. Hereby the control can take into account information about the current engine speed when setting the torque safety margin.

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Using the method and system as described herein will provide an improved control of a hydraulic device of a motorized vehicle provided with a hydraulic device such as a truck provided with a crane or a front loader or any other motorized vehicle having an engine driving a hydraulic pump for powering a hydraulic device. By continuously monitoring the torque demand and comparing the current torque demand with the maximum torque at the current engine point of operation as determined by the engine speed and a

current turbo pressure if applicable and controlling the output signal to a hydraulic device in response to the torque possible to deliver at a given time the risk of stalling the engine is eliminated or greatly reduced.

5 BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will now be described in more detail by way of non-limiting examples and with reference to the accompanying drawings, in which:

- 10 - Fig. 1a is a general view of a system for controlling the engine speed of a motor vehicle provided with a hydraulically driven device,
- Fig. 2 is a flowchart illustrating steps performed when controlling the engine speed of a motor vehicle provided with a hydraulically driven device.
- Fig 3 is a view of a controller for controlling a hydraulic device, and
- 15 - Fig. 4 is a flowchart illustrating steps performed controlling the control signal to a hydraulic device.

DETAILED DESCRIPTION

- In Fig.1 a view of a system 100 for controlling the engine speed of an engine 105 powering a vehicle 101 provided with a hydraulic device 103 is depicted.
- 20 The system comprises a control module 109 for controlling the speed of the engine 105. The control module 109 is programmed to receive real time control signals from an engine controller 107 such as an Electronic Control Unit (ECU) provided signals indicative of a current engine operational
- 25 conditions. The control module 109 is also connected to a controller 111 for controlling the hydraulic device 103. The controller 111 is adapted to control the hydraulic device in accordance with user input signals received from a user for example using a control device shown in Fig. 3.

The control module 109 receives signals from the controller 111 indicative of a currently demanded engine speed to drive the hydraulic device 103. In accordance with one embodiment the controller emits a signal indicative of the current demanded flow in the hydraulic device 103. The control module is then programmed to convert the demanded flow to a pre-set engine speed for example using a look-up table. In accordance with another embodiment the controller 111 is adapted to emit a signal indicative of a demanded engine speed required for the demanded flow in the hydraulic device.

Using the signals from the engine controller 107 and the hydraulic controller the control module continuously sets the engine speed in response to at least both signals from the engine and the hydraulic device. In accordance with one embodiment the engine speed is set to the highest of the engine speeds indicated by the engine controller signal and the hydraulic controller signal.

For example if the signal from the engine controller indicates that the engine set speed should be 800 rpm and the demanded flow in the hydraulic device indicates that the engine set speed should be 900 rpm the controller module 109 sets the engine speed to the highest of the two, in this example the engine speed would be set to 900 rpm.

In Fig. 2 a flow chart illustrating some procedural steps performed when controlling the engine speed of motorized vehicle provided with a hydraulic device is shown. First in a step 201 an engine controlled engine speed as determined from engine signals is determined. Next in a step 203 a hydraulic controlled engine speed as determined from the currently requested flow in the hydraulic device is determined. Thereupon, the engine speed is set to a value in response to the engine speeds determined in steps 201 and 203. In particular the set value for the engine speed is set to the highest of the engine speeds determined in steps 201 and 203. Next, the procedure returns to step 201 to continuously update the engine speed in a step 207.

When a hydraulic device of a heavy vehicle is operated, for example in accordance with the above, the demanded torque resulting from the control signals from the hydraulic control device may result in a torque demand that results in that the engine stalls. This is of course not desired and should be avoided. In accordance with the present invention a controller for providing control signals to the hydraulic device is adapted to generate control signals in response to a currently available torque margin.

In Fig. 3 an exemplary controller 300 for controlling a hydraulic device of a heavy vehicle is shown. The device 300 comprises an input port 301 for receiving a signal indicative of the currently demanded torque. The controller 300 also receives the current engine speed via the input port 301. The controller 300 further comprises a memory 303 where the maximum torque for any given engine speed is stored. In accordance with another embodiment the controller can receive the maximum torque via a CAN-bus from the engine control unit. In accordance with one embodiment the controller receives a reference torque value corresponding to the maximum torque that the engine can generate, the percentage currently used of the maximum torque, and the percentage of the torque currently available at the current point of operation of the engine for the ECU via a CAN bus. The controller 300 also comprises a processor unit 305 connected to the input port 301 and to the memory 303. The processor unit 305 is adapted to continuously compare the currently demanded torque with the maximum torque for the current engine point of operation. The processor unit is further adapted to provide an output signal controlling a hydraulic controller 309 via an output port 307. The control signal to the hydraulic controller is correlated to the comparison of the maximum torque and the demanded torque. The output signal to the hydraulic controller controls the gain of the control signals to the hydraulic device.

For example in accordance with one embodiment if the torque demand at any given time is above the maximum torque possibly adjusted by a safety margin, the processor unit is adapted to output a signal "0" whereby the control signals from the hydraulic controller 309 is temporarily stopped. In accordance with another embodiment the output signal from the controller is a scaled signal dependent on the difference between the current maximum torque and the torque demand.

For example if the difference between the current maximum torque and the torque demand is above a first threshold value the hydraulic controller can use a normal output signal. In accordance with one embodiment, if the difference between the current maximum torque and the torque demand is below a second threshold value, the control signals from the hydraulic controller 309 is temporarily stopped. If the difference between the current maximum torque and the torque demand is above a first threshold value below a second threshold value, the output signal from the hydraulic controller can be down scaled. For example the signal can be down scaled in proportion to how close to the second threshold value the difference is.

The controller 300 can also take other parameters into consideration when determining the output signal to the hydraulic controller 309. For example the controller can take the current engine speed into account and if the engine is running at a high speed the torque demand can be allowed to be closer to the maximum torque before reducing the output signal from the hydraulic controller. Thus, the safety margin used for keeping the engine from stalling can be made dependent on the current engine speed.

In Fig. 4, a flow chart illustrating some procedural steps performed when controlling the control signal to a hydraulic device in accordance with the

above is show. First, in a step 401, maximum torque that the engine currently can deliver is determined. Next, in a step 403, the current torque demand is determined. Thereupon, in a step 405, the current maximum torque is compared with the current torque demand and the difference between the
5 current maximum torque and the torque demand is determined, i.e. the torque margin. Next, in a step 407, the control signal to the hydraulic device is adjusted in response to the comparison made in step 405 so that the control signal to the hydraulic device is controlled in response to the torque margin. The adjustment of the control signal, if any, to the hydraulic device
10 can be made in any suitable manner for example using any of the control strategies described above. The procedure then returns to step 401.

The control method as described herein can advantageously be computer implemented and the control algorithm can be stored as programmed
15 instructions in a computer program stored on a digital storage medium.

Using the method and system as described herein will provide an improved control of a hydraulic device of a motorized vehicle provided with a hydraulic device such as a truck provided with a crane or a front loader or any other
20 motorized vehicle having an engine driving a hydraulic pump for powering a hydraulic device. By continuously monitoring the torque demand and comparing the current torque demand with the maximum torque at the current engine speed and controlling the output signal to a hydraulic device in response to the torque possible to deliver at a given time the risk of stalling
25 the engine is eliminated or greatly reduced.

CLAIMS

1. A method of controlling a control signal to a hydraulic device (103) of a motorized vehicle comprising an engine (105), the hydraulic device (103) being driven by a hydraulic pump powered by the engine (105), the method comprising the steps of:

- determining a current maximum torque that the engine (105) currently can deliver,
- determining a current torque demand, and
- continuously controlling the control signal to the hydraulic device (103) in response to the difference between the maximum torque and the torque demand, and
- continuously controlling the control signal in response to the current engine speed, being the highest of the engine speeds indicated by the engine controller signal and the hydraulic controller signal starting from the present demanded flow in the hydraulic device (103), thus by comparison with a safety margin preventing the engine (105) from stalling.

2. The method according to claim 1, wherein if the difference between the maximum torque and the torque demand is below a threshold value the control signal to the hydraulic device (103) is suspended.

3. The method according to claim 1 or 2, wherein if the difference between the maximum torque and the torque demand is below a threshold value the control signal to the hydraulic device (103) is down scaled.

4. The method according to claim 3, wherein the control signal is down scaled in proportion to the difference between the maximum torque and the torque demand.

5. The method according to any of claims 2 – 4 wherein the threshold values are dependent on the current engine speed.

6. A controller for controlling a control signal to a hydraulic device (103) of a motorized vehicle comprising an engine (105), the hydraulic device (103) being driven by a hydraulic pump powered by the engine (105), the controller (111) comprising:

- means for receiving a current maximum torque that the engine (105) currently can deliver,

- means for receiving a current torque demand, and

- means for continuously controlling the control signal to the hydraulic device (103) in response to the difference between the maximum torque and the torque demand, and

- means for continuously controlling the control signal in response to the current engine speed, being the highest of the engine speeds indicated by the engine controller signal and the hydraulic controller signal starting from the present demanded flow in the hydraulic device (103), thus by comparison with a safety margin preventing the engine (105) from stalling.

7. The controller according to claim 6, comprising means for suspending the control signal to the hydraulic device (103) if the difference between the maximum torque and the torque demand is below a threshold value.

8. The controller according to claim 6 or 7, comprising means for down scaling the control signal to the hydraulic device (103) if the difference between the maximum torque and the torque demand is below a threshold value.

9. The controller according to claim 8, further comprising means for down scaling the control signal to the hydraulic device (103) in proportion to the difference between the maximum torque and the torque demand.

5 10. The controller according to any of claims 8 – 9, further comprising means for setting the threshold values dependent on the current engine speed.

11. A computer program product for controlling a control signal to a hydraulic device (103) of a motorized vehicle comprising an engine (105), the hydraulic
10 device (103) being driven by a hydraulic pump powered by the engine (105), wherein the computer program product comprises program segments that when executed on a computer causes the computer to perform the steps of:

- determining a current maximum torque that the engine (105) currently can deliver,
- 15 - determining a current torque demand, and
- continuously controlling the control signal to the hydraulic device (103) in response to the difference between the maximum torque and the torque demand, and
- continuously controlling the control signal in response to the current engine
20 speed, being the highest of the engine speeds indicated by the engine controller signal and the hydraulic controller signal starting from the present demanded flow in the hydraulic device (103), thus by comparison with a safety margin preventing the engine (105) from stalling.

25 12. The computer program product according to claim 11, further comprising program segments for suspending the control signal to the hydraulic device (103) if the difference between the maximum torque and the torque demand is below a threshold value.

13. The computer program product according to claim 11 or 12, further comprising program segments for down scaling the control signal to the hydraulic device (103) if the difference between the maximum torque and the torque demand is below a threshold value.

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14. The computer program product according to claim 13, further comprising program segments for down scaling the control signal to the hydraulic device (103) in proportion to the difference between the maximum torque and the torque demand.

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15. The computer program product according to any of claims 12 – 14 further comprising program segments for setting the threshold values dependent on the current engine speed.

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16. A digital storage medium having the computer program product according to any of claims 11 – 15 stored thereon.

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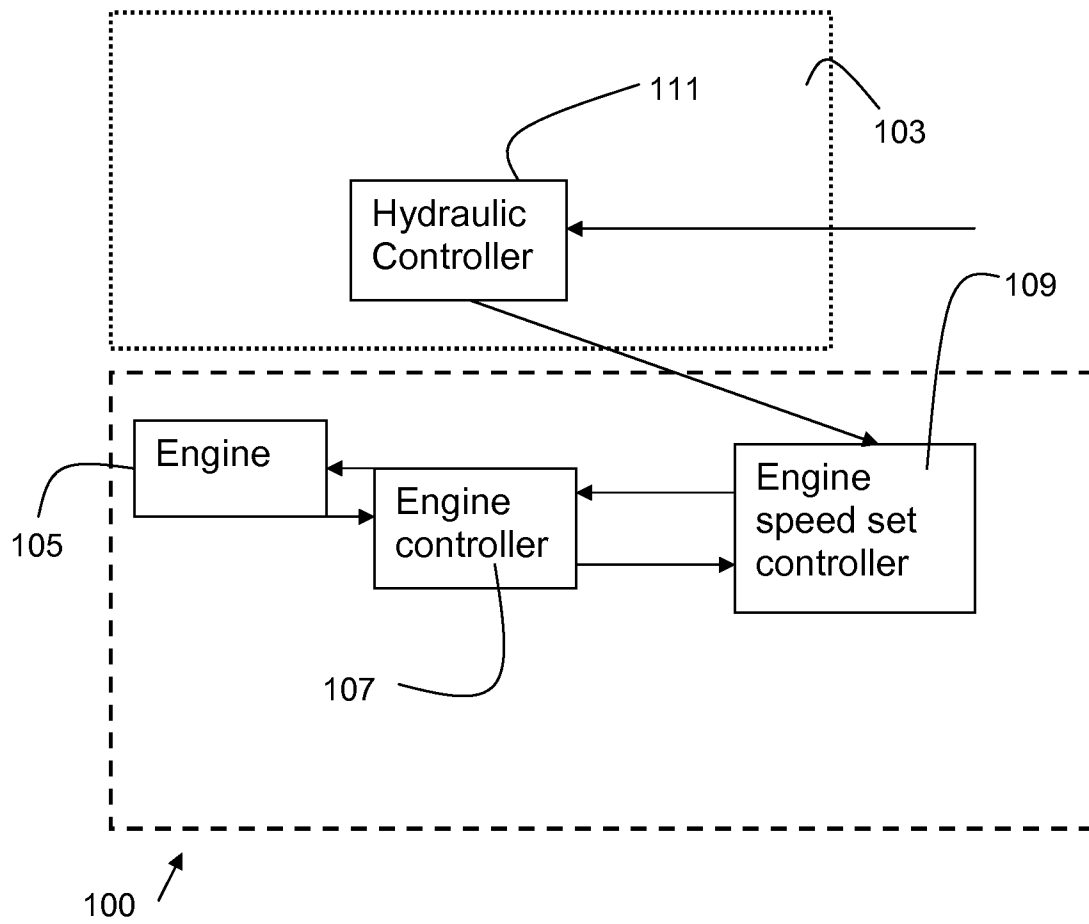


Fig. 1

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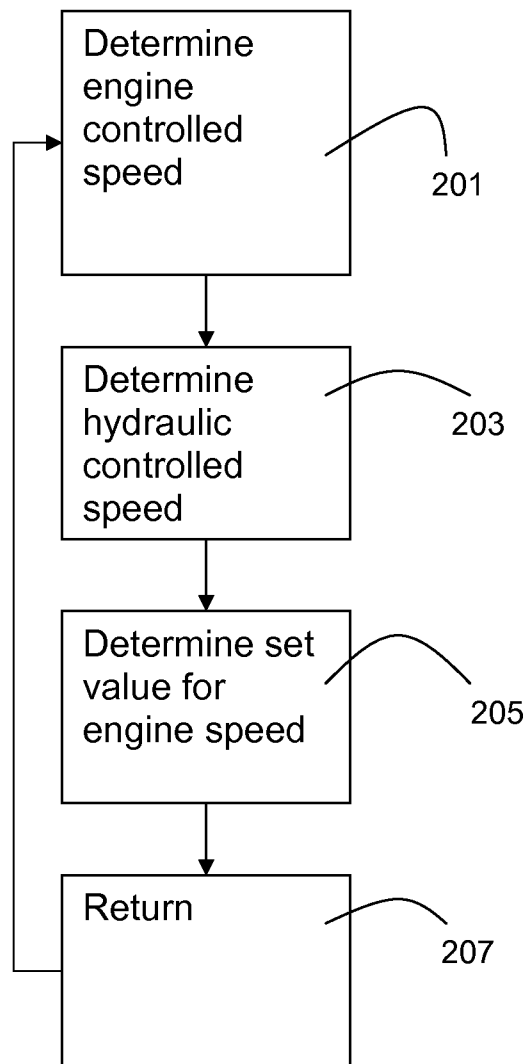


Fig. 2

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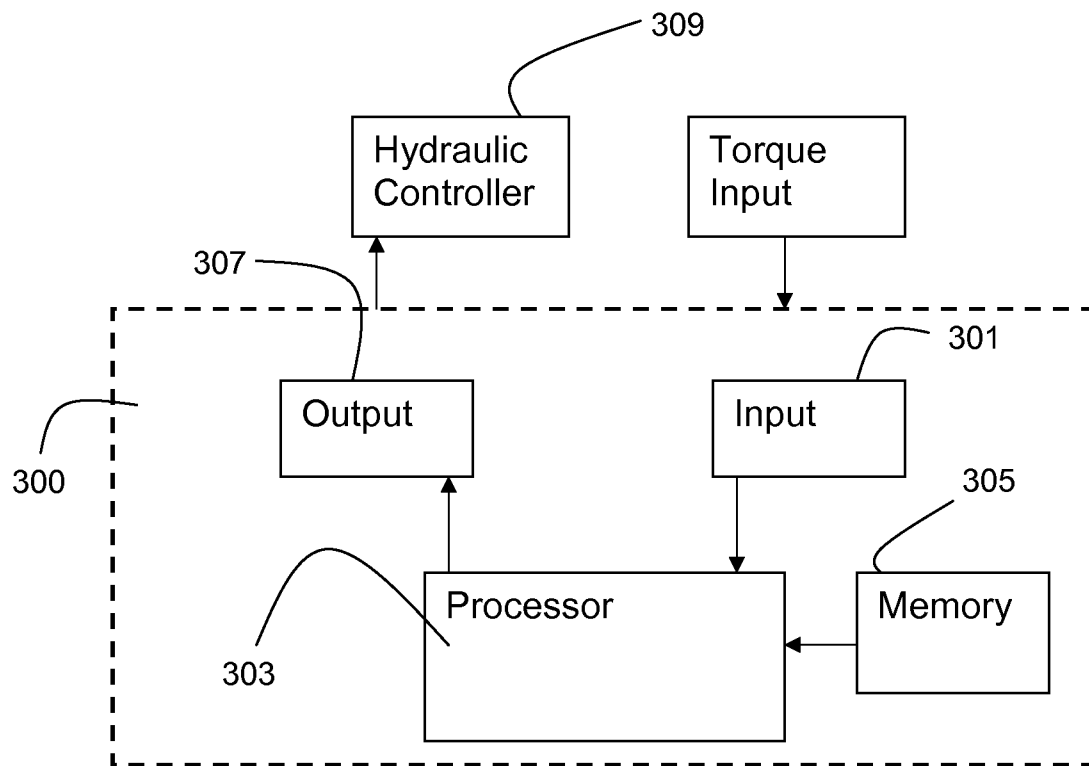


Fig. 3

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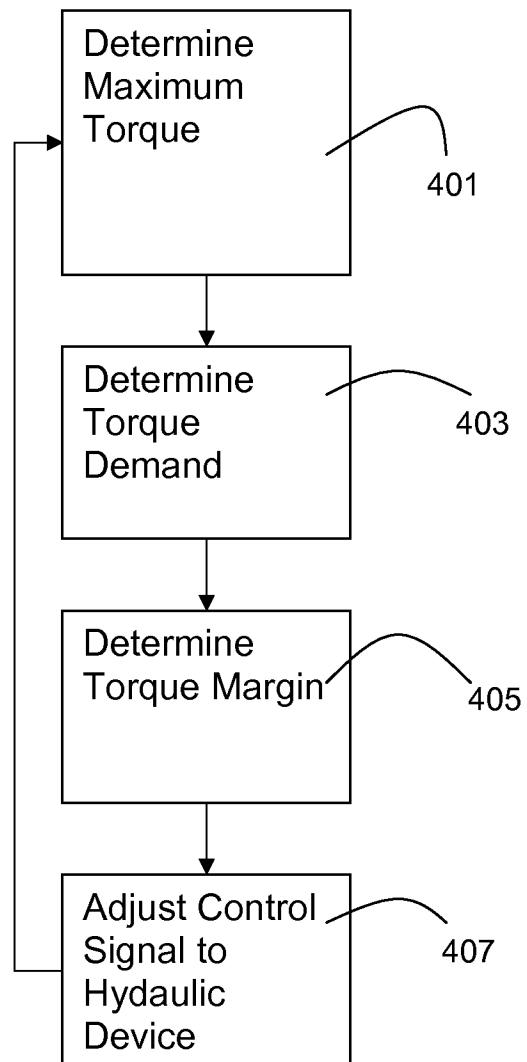


Fig. 4

INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE2009/050568

A. CLASSIFICATION OF SUBJECT MATTER

IPC: see extra sheet

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: F04B, B60W, B60K, E02F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-INTERNAL, WPI DATA, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 20050160727 A1 (NAKAMURA ET AL), 28 July 2005 (28.07.2005), figure 12, paragraphs (0010),(0109), (0117) --	1-16
A	US 20070204604 A1 (NARUSE), 6 Sept 2007 (06.09.2007), paragraph (0087) --	1-16
A	US 5944492 A (KONISHI ET AL), 31 August 1999 (31.08.1999), column 10, line 40 - line 48 --	1-16
A	US 4332531 A (MARIETTA), 1 June 1982 (01.06.1982), column 4, line 23 - line 29, abstract --	1-16

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Date of the actual completion of the international search

7 Sept 2009

Date of mailing of the international search report

07-09-2009

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE2009/050568

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 20060056978 A1 (TATSUNO ET AL), 16 March 2006 (16.03.2006), claims 9,11, paragraphs (0003)-(0004) --	1-16
A	US 6010309 A (TAKAMURA ET AL), 4 January 2000 (04.01.2000), abstract -- -----	1-16

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Cited literature, if any, will be enclosed in paper form.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

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