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(54) **HYDRAULIC EXCAVATOR CONTROL SYSTEM AND METHOD**

(57) The present invention discloses a hydraulic excavator control system and method. The method includes: collecting, by a controller, an oil path pressure signal of a hydraulic excavator, and calculating a required main pump power according to the oil path pressure signal; sending, by the controller, the required main pump power to an engine ECM; and first adjusting, by the engine ECM, an engine oil injection quantity according to the required main pump power, and then adjusting, by the controller, a main pump power according to the required main pump power. The present invention greatly reduces the loading response time of the engine, improves the working efficiency of the whole machine, avoids the problem of black smoke from idle loading, and can further reduce an idle rotation speed of the engine and reduce fuel oil consumption.

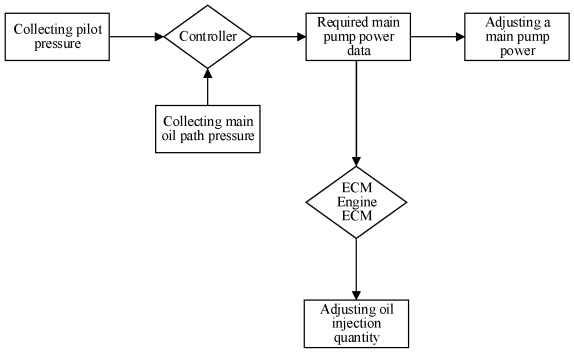

FIG. 1

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Description

Technical Field

[0001] The present invention relates to a hydraulic excavator control system and method, and belongs to the technical field of hydraulic excavators.

Background

[0002] Working conditions for the hydraulic excavator are extremely complicated, and loads are greatly changed. When the load of a hydraulic pump is increased, an engine increases an oil injection quantity, and an output torque is increased; due to mechanical transmission, the engine would have a relatively long hysteresis quality. The following working states would frequently occur to the engine: one is that when the engine is suddenly loaded in a low load state, the loading time would be excessively long, rendering reduction of the working efficiency; the second one is that when the engine is suddenly loaded in an idle state, a problem of black smoke would occur. Most manufacturers would reduce the loading time of the engine by changing a mixture ratio of oil to gas in a combustion chamber of the engine; however, at the same time, the problems of inadequate combustion and black smoke of the engine would occur; when the problem of the black smoke occurs when in the idle speed, most manufacturers would improve the idle rotation speed of the complete machine, rendering energy consumption and wastes.

Summary

[0003] The purpose of the present invention is to overcome disadvantages in the prior at and provide a hydraulic excavator control system and method to solve the technical problems of reduction of the working efficiency when the engine is suddenly loaded in a low load state and the occurrence of black smoke when the engine is suddenly loaded in an idle state.

[0004] To resolve the technical problems above, the technical solution adopted in the present invention is as follows.

[0005] For a first aspect, the present invention provides a hydraulic excavator control method, including the following steps:

collecting, by a controller, an oil path pressure signal of a hydraulic excavator, and calculating a required main pump power according to the oil path pressure signal;

sending, by the controller, the required main pump power to an engine ECM; and

first adjusting, by the engine ECM, an engine oil injection quantity according to the required main pump power, and then adjusting, by the controller, a main pump power according to the required main pump power.

[0006] By combining with the first aspect, furthermore, the oil path pressure signal includes a main oil path pressure value of the hydraulic excavator and each pilot pressure value corresponding to a current action of the hydraulic excavator.

[0007] By combining with the first aspect, furthermore, the time for the engine ECM to start to adjust the engine oil injection quantity is ahead of the time for the controller to start to adjust the main pump power by 0.05-0.6 second.

[0008] For a second aspect, the present invention provides a hydraulic excavator control system including a controller, an engine ECM, and an oil path pressure collection unit, where the engine ECM and the oil path pressure collection unit are respectively communicationally connected to the controller;

the controller calculates, according to an oil path pressure signal of a hydraulic excavator collected by the oil path pressure collection unit, a required main pump power of the hydraulic excavator, and sends the required main pump power to the engine ECM; and

the engine ECM first adjusts an engine oil injection quantity according to the required main pump power, and then the controller adjusts a main pump power according to the required main pump power.

[0009] By combining with the second aspect, furthermore, the controller is communicationally connected to the engine ECM using a CAN bus.

[0010] By combining with the second aspect, furthermore, the oil path pressure collection unit includes a first pressure sensor configured to collect a main oil path pressure value of the hydraulic excavator and a second pressure sensor configured to collect each pilot pressure value corresponding to a current action of the hydraulic excavator.

[0011] As compared with the prior art, the beneficial effects achieved by the present invention are the time for the engine ECM to start to adjust the engine oil injection quantity is earlier than the time for adjusting the main pump to the required main pump power, so as to greatly reduce a loading response time of the engine, improve a working efficiency of the whole machine, avoid the problem of black smoke from idle loading, and may further reduce an idle rotation speed of the engine and reduce fuel oil consumption. In addition, the control method further has advantages of simple implementations, low costs, and high reliability.

Brief Description of the Drawings

[0012]

FIG. 1 is a flowchart of a hydraulic excavator control method according to an embodiment of the present invention.

FIG. 2 is a hydraulic principle diagram of a hydraulic excavator control system according to an embodiment of the present invention.

FIG. 3 is a relation diagram between an engine oil injection quantity of a hydraulic excavator and time in the prior art.

FIG. 4 is a relation diagram between an engine oil injection quantity of a hydraulic excavator and time according to an embodiment of the present invention.

[0013] 10-engine; 11-main pump; 12-pilot pump; 13-electromagnetic proportional valve; 14-main value; 15-hydraulic pilot handle; 16-controller; 17-traveling valve core; 18-rotation value core; 19-moving arm valve core; 20-scraper pan valve core; 21-pan rod valve core; and 22-electromagnetic valve.

Detailed Description

[0014] The following further describes the hydraulic excavator control system and method provided in the present invention in detail with reference to the accompanying drawings and specific embodiments. It should be explained that the accompanying drawings all adopt a quite simplified mode, all use imprecise proportions, and only conveniently and clearly assist the explanation of the purposes of the embodiments of the present invention. Same or similar reference numerals in the accompanying drawings represent same or similar members.

Embodiment I

[0015] FIG. 1 is a flowchart of a hydraulic excavator control method according to an embodiment of the present invention. The method mainly includes the following steps:
collecting a main oil path pressure value of the hydraulic excavator and each pilot pressure value corresponding to a current action of the hydraulic excavator; obtaining, by the controller, a required main pump power according to the main oil path pressure value and each pilot pressure value corresponding to the current action of the hydraulic excavator, and sending the required main pump power to an engine ECM; the controller being capable of adjusting the main pump power according to the required main pump power; the engine ECM being capable of adjusting an engine oil injection quantity according to the required main pump power, and the time for the engine ECM to start to adjust the engine oil injection being earlier than the time for the controller to start to adjust the main pump power.

[0016] The time for the engine ECM to start to adjust the engine oil injection being earlier than the time for the controller to start to adjust the main pump power can greatly reduce a loading response time of the engine, improve a working efficiency of the whole machine, avoid the problem of black smoke from idle loading, and may further reduce an idle rotation speed of the engine and reduce fuel oil consumption. In addition, the control method further has advantages of simple implementations, low costs, and high reliability.

[0017] More specifically, the time for the engine ECM to start to adjust the engine oil injection quantity is ahead of the time for the controller to start to adjust the main pump power by 0.05-0.6 second, which matches and is consistent with the hydraulic system requirements, and improves the working efficiency of the entire machine by 1-5%.

Embodiment II

[0018] FIG. 2 is a hydraulic principle diagram of a hydraulic excavator control system according to an embodiment of the present invention. The system includes an engine 10, a main pump 11, a pilot pump 12, an electromagnetic proportional valve 13, a main value 14, a hydraulic pilot handle 15, a controller 16, a first pressure collection unit, and a second pressure collection unit.

[0019] The engine 10 is connected to the main pump 11 and the pilot pump 12 for providing power for the main pump 11 and the pilot pump 12.

[0020] The main valve 14 includes a traveling valve core 17, a rotation value core 18, a moving arm valve core 19, a scraper pan valve core 20, and a pan rod valve core 21. After an outlet of the main pump 11 is connected to an inlet of the main valve 14 through a pipeline, it is sequentially connected to the traveling valve core 17, the rotation value core 18, the moving arm valve core 19, the scraper pan valve core 20, and the pan rod valve core 21 for providing oil for each action valve core and constituting a main oil path; an oil return port of the main valve 14 is connected to an oil tank after passing through an electromagnetic valve 22.

[0021] The pilot pump 12 is connected to an inlet of the electromagnetic proportional valve 13; a path of an outlet of the electromagnetic proportional valve 13 is connected to a tilting plate adjuster control port of the main pump 11.

[0022] The hydraulic pilot handle 15 is separately connected to a pilot control oil port of each action valve core for controlling connection and disconnection of each action valve core.

[0023] The first pressure collection unit and the second pressure collection unit are respectively in communica-

tive connection to the controller 16. The first pressure collection unit is used for collecting the main oil path pressure value of the hydraulic excavator; the second pressure collection unit is used for collecting the pilot control oil path pressure value of each action valve core; the controller 16 can obtain the required main pump power according to the main oil path pressure value and the pilot control oil path pressure value of each action valve core and adjust the power of the main pump 11 of the hydraulic excavator according to the required main pump power.

[0024] The controller 16 is communicationally connected to the engine ECM for delivering the required main pump power to the engine ECM of the hydraulic excavator.

[0025] The time for the engine ECM to start to adjust the engine oil injection quantity is ahead of the time for the controller to start to adjust the main pump power; the time difference is generally 0.05-0.6 second, which can match and be consistent with the hydraulic system requirements, and improve the working efficiency of the entire machine by 1-5%. FIG. 3 is a relation diagram between an engine oil injection quantity of a hydraulic excavator and time in the prior art. FIG. 4 is a relation diagram between an engine oil injection quantity of a hydraulic excavator and time according to an embodiment of the present invention. The relation diagram is obtained when the difference between the time for the engine ECM to start to adjust the engine oil injection and the time for the controller to start to adjust the main pump power is 0.1 second; as can be seen from comparison and analysis that as compared with the hydraulic excavator in the prior art, a hydraulic excavator provided in embodiment II of the present invention can greatly reduce a loading response time of the engine 10, so as to improve a working efficiency of the whole machine, and avoid the problem of black smoke from idle loading, and may further reduce an idle rotation speed of the engine 10 and reduce fuel oil consumption. In addition, it further has advantages of simple implementations, low costs, and high reliability.

[0026] The first pressure collection unit, the second pressure collection unit, and the engine ECM can be connected to the controller 16 through the CAN bus.

[0027] The first pressure collection unit and the second pressure collection unit are pressure sensors; as shown in FIG. 2, a pressure sensor is separately disposed on the pilot control oil path of the rotation value core 18, the moving arm valve core 19, the scraper pan valve core 20, and the pan rod valve core 21.

[0028] In conclusion, the hydraulic excavator control system and method provided by the embodiment of the present invention includes: collecting a main oil path pressure value of the hydraulic excavator; obtaining, by a controller, a required main pump power according to the oil path pressure value; the controller being used for adjusting, according to the required main pump power, the power of the main pump and delivering the required main pump power to an engine ECM; the time for the engine ECM to start to adjust the engine oil injection being earlier than the time for the controller to start to adjust the main pump power so as to greatly reduce a loading response time of the engine, improve a working efficiency of the whole machine, avoid the problem of black smoke from idle loading, and further reduce an idle rotation speed of the engine and reduce fuel oil consumption. In addition, the control method further has advantages of simple implementations, low costs, and high reliability.

[0029] It should be explained that each embodiment in this specification is described in a progressive manner; each embodiment mainly illustrates the difference from other embodiments; same and similar parts among the embodiments can refer to one another. For the control method disclosed in the embodiments, since the adopted control device partially corresponds to the device disclosed by the embodiments, the description of the control device involved therein is relatively simple and the relevance can refer to the explanation of the device part.

[0030] The descriptions above are only used for describing the preferable embodiments of the present invention, rather than any limitation to the range of the present invention; any change and modification made by a person having ordinary skilled in the art of the present invention according to the contents disclosed above is within the scopes of protection of the claims.

Claims

1. A hydraulic excavator control method, comprising the following steps:

   collecting, by a controller, an oil path pressure signal of a hydraulic excavator, and calculating a required main pump power according to the oil path pressure signal;
   sending, by the controller, the required main pump power to an engine ECM; and
   first adjusting, by the engine ECM, an engine oil injection quantity according to the required main pump power, and then adjusting, by the controller, a main pump power according to the required main pump power.

2. The hydraulic excavator control method according to claim 1, wherein the oil path pressure signal comprises a main oil path pressure value of the hydraulic excavator and each pilot pressure value corresponding to a current action of the hydraulic excavator.

3. The hydraulic excavator control method according to claim 1, wherein the time for the engine ECM to start to adjust the engine oil injection quantity is ahead of the time for the controller to start to adjust the main pump power by 0.05-0.6 second.

4. A hydraulic excavator control system comprising a controller, an engine ECM, and an oil path pressure collection unit, wherein the engine ECM and the oil path pressure collection unit are respectively communicationally connected to the controller;

the controller calculates, according to an oil path pressure signal of a hydraulic excavator collected by the oil path pressure collection unit, a required main pump power of the hydraulic excavator, and sends the required main pump power to the engine ECM; and
the engine ECM first adjusts an engine oil injection quantity according to the required main pump power, and then the controller adjusts a main pump power according to the required main pump power.

5. The hydraulic excavator control system according to claim 4, wherein the controller is communicationally connected to the engine ECM using a CAN bus.

6. The hydraulic excavator control system according to claim 4, wherein the oil path pressure collection unit comprises a first pressure sensor configured to collect a main oil path pressure value of the hydraulic excavator and a second pressure sensor configured to collect each pilot pressure value corresponding to a current action of the hydraulic excavator.

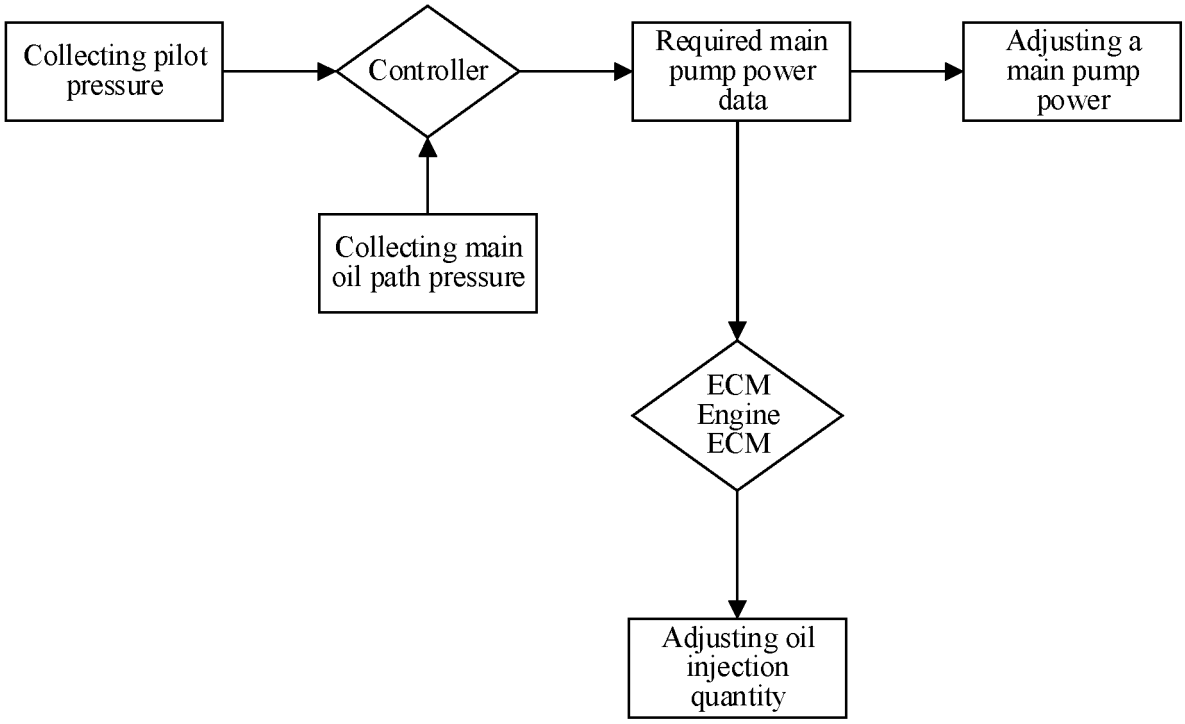
Collecting pilot pressure
Controller
Required main pump power data
Adjusting a main pump power
Collecting main oil path pressure
ECM Engine ECM
Adjusting oil injection quantity

FIG. 1

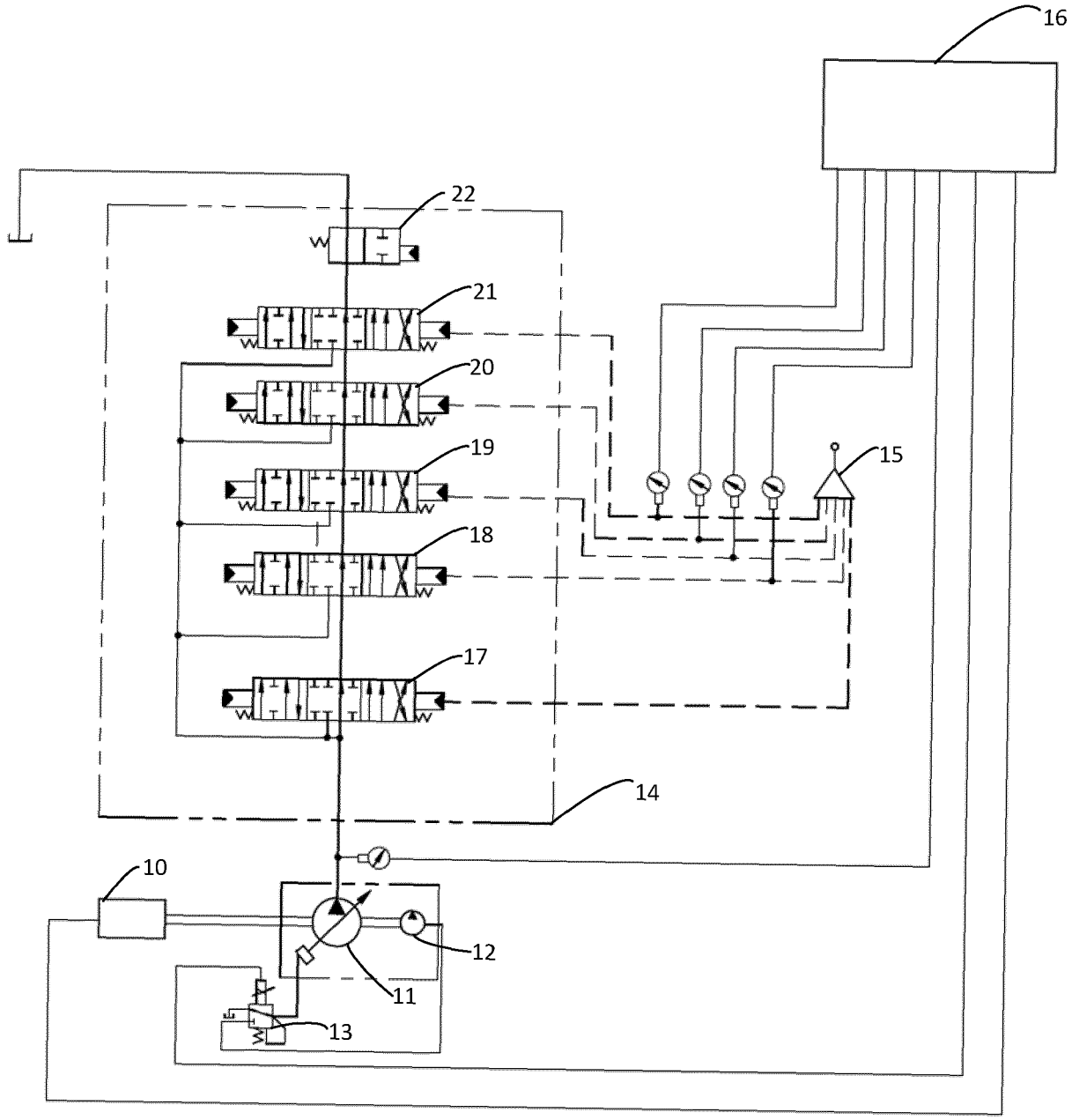

FIG. 2

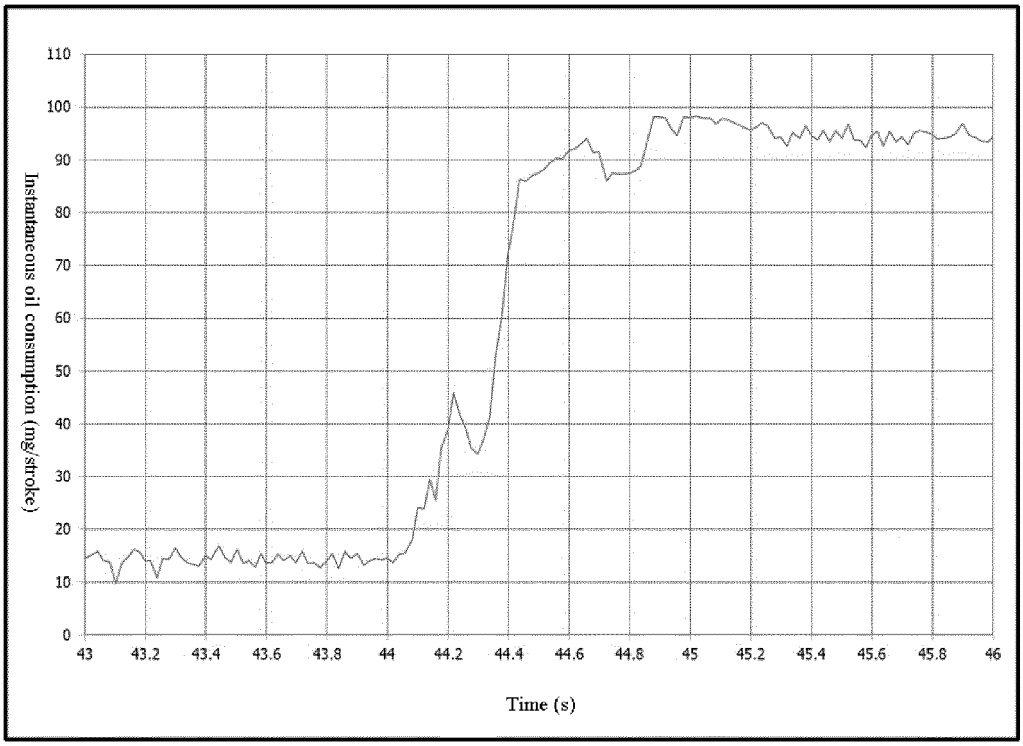
Instantaneous oil consumption (mg/stroke)
110
100
90
80
70
60
50
40
30
20
10
0
43
43.2
43.4
43.6
43.8
44
44.2
44.4
44.6
44.8
45
45.2
45.4
45.6
45.8
46
Time (s)

FIG. 3

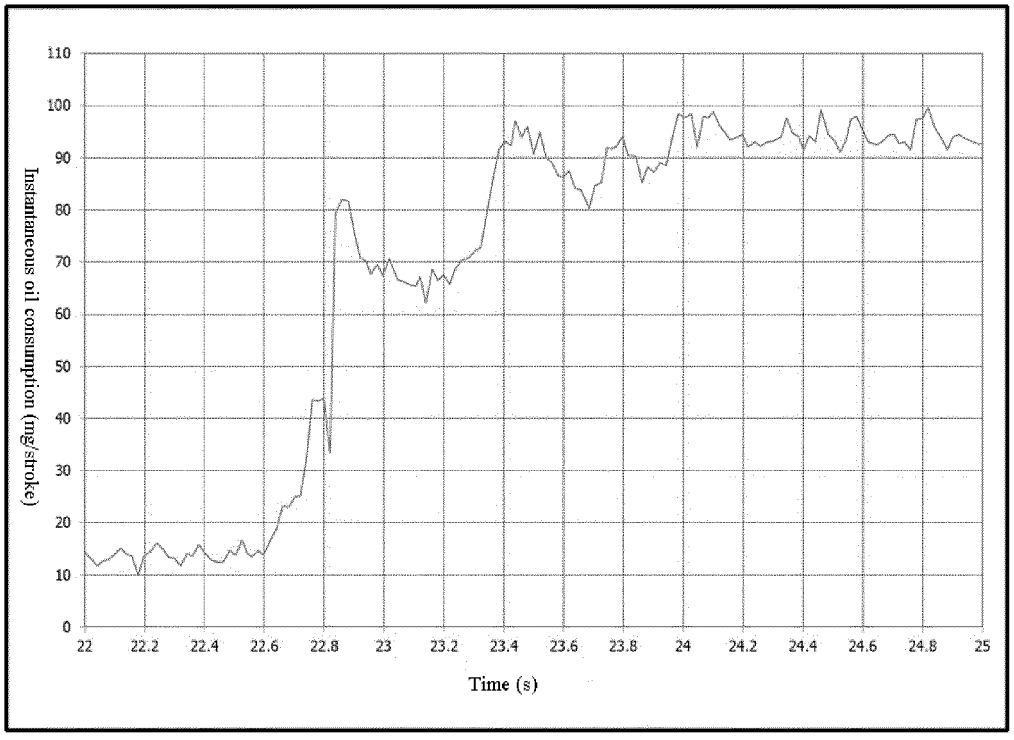
Instantaneous oil consumption (mg/stroke)
110
100
90
80
70
60
50
40
30
20
10
0
22
22.2
22.4
22.6
22.8
23
23.2
23.4
23.6
23.8
24
24.2
24.4
24.6
24.8
25
Time (s)

FIG. 4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2019/105276

A. CLASSIFICATION OF SUBJECT MATTER

E02F 9/22(2006.01)i

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)

E02F9

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

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

VEN; CNABS; CJFD: 液压挖掘机, 控制器, 电控, 控制模块, 控制单元, ECM, ECU, 降低, 提高, 避免, 油耗, 燃油消耗, 效率, 响应时间, 信号, 功率 reduc+, low+, decreas+, oil, speed, consumption, time, control+, module, ECM, ECU

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN 104074225 A (HUNAN MECHANICAL & ELECTRICAL POLYTECHNIC) 01 October 2014 (2014-10-01) claims 1-3, and description, paragraph [0022]	1-6
A	CN 107044147 A (GUIZHOU JONYANG KINETICS CO., LTD.) 15 August 2017 (2017-08-15) entire document	1-6
A	CN 104405002 A (LONKING MACHINERY CO., LTD.) 11 March 2015 (2015-03-11) entire document	1-6
A	CN 106869222 A (YAO, Qiuli) 20 June 2017 (2017-06-20) entire document	1-6
A	EP 0812965 A1 (KOBE STEEL LTD.) 17 December 1997 (1997-12-17) entire document	1-6
A	US 2008264499 A1 (BACON KEVIN A et al.) 30 October 2008 (2008-10-30) entire document	1-6

☐ Further documents are listed in the continuation of Box C. ☑ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
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"P" document published prior to the international filing date but later than the priority date claimed
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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
28 May 2020	**05 June 2020**

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Facsimile No. **(86-10)62019451**	Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2019/105276

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
CN	104074225	A	01 October 2014	CN	104074225	B	08 February 2017
CN	107044147	A	15 August 2017		None		
CN	104405002	A	11 March 2015		None		
CN	106869222	A	20 June 2017		None		
EP	0812965	A1	17 December 1997	KR	980002498	A	30 March 1998
				KR	100206511	B1	01 July 1999
				JP	H101978	A	06 January 1998
				US	5991677	A	23 November 1999
US	2008264499	A1	30 October 2008	US	7797934	B2	21 September 2010
				GB	0918111	D0	02 December 2009
				GB	2460797	A	16 December 2009
				GB	2460797	B	04 April 2012
				WO	2008133835	A1	06 November 2008

Form PCT/ISA/210 (patent family annex) (January 2015)