



(51) International Patent Classification:

F02D 19/06 (2006.01) *F02D 41/26* (2006.01)
F02D 41/22 (2006.01) *F02D 41/20* (2006.01)

(21) International Application Number:

PCT/FI2017/050136

(22) International Filing Date:

02 March 2017 (02.03.2017)

(25) Filing Language:

English

(26) Publication Language:

English

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KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, 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, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, 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, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

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

(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, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KH, KN, KP, KR,

(54) Title: ELECTRICAL SYSTEM FOR PISTON ENGINE AND METHOD FOR OPERATING ELECTRICAL DEVICE

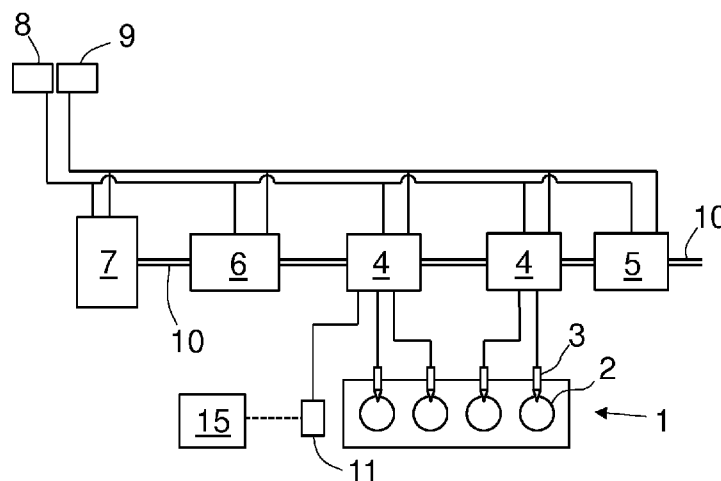


FIG. 2

(57) Abstract: The electrical system for a piston engine (1) comprises a first power source (8) and a second power source (9) for supplying electric energy, a first control module (4, 5), which is connected to both power sources (8) for receiving electric energy, the control module (4, 5) comprising a plurality of driver outputs (12) and being configured to supply electric energy to engine components (3) connected to the driver outputs (12) and to control operation of said components (3), and a second control module (15). The electrical system further comprises at least one device (11) that is connected to a driver output (12) of the first control module (4, 5) for receiving electric energy and to the second control module (15) for receiving a control signal and/or for transmitting a measurement signal.



Electrical system for piston engine and method for operating electrical device

Technical field of the invention

5 The present invention relates to an electrical system for a piston engine in accordance with the preamble of claim 1. The invention also concerns a method for operating an electrical device of a piston engine as defined in the preamble of the other independent claim,

Background of the invention

10 For safety reasons, redundancy is required from electrical systems of engines that are used in marine applications. Electric energy is supplied to the critical components of the engine, such as different control modules, from two independent power sources. This ensures that the engine can be kept running even when one of the power sources fails. Figure 1 shows an example of a
15 prior art electrical system of a piston engine. The electrical system comprises two independent power sources 8, 9, which supply electric energy to various control modules, such as a cylinder control module 4, an input/output module 5 and a main control module 6. Also the user interface 7 of the engine is connected to both power sources 8, 9. Engines are also provided with many de-
20 vices, which are important for optimal operation of the engine, but which are not necessary for keeping the engine running. These devices include, for instance, a waste gate valve and different sensors, such as a humidity sensor. These devices can be connected to only one of the power sources. A drawback of this kind of arrangement is that if the power supply from the power
25 source to which the device is connected fails, the device does not work. The operation of the engine may thus not be optimal. It is also possible to connect the device to both power sources, which ensures functioning of the device in case one of the power sources is lost. Figure 1 shows an arrangement, where a device 11 not requiring redundant power supply is connected to both power
30 sources 8, 9. A fuse 14 is arranged between the device 11 and the power sources 8, 9. However, if the device 11, which is designed for connection to a single power source, experiences a short circuit failure, it can cause shut-down of the whole electrical system until the fuse 14 between the device 11 and the

power sources 8, 9 is triggered. The engine can thus experience shut-down in spite of the redundancy of the electrical system.

Summary of the invention

5 An object of the present invention is to provide an improved electrical system for a piston engine. The electrical system comprises a first power source for supplying electric energy, a second power source for supplying electric energy, a first control module, which is connected to both the first power source and the second power source for receiving electric energy, the control module
10 comprising a plurality of driver outputs and being configured to supply electric energy to engine components connected to the driver outputs and to control operation of said components, a second control module, and at least one device that is connected to the second control module for receiving a control signal and/or for transmitting a measurement signal. The characterizing features
15 of the electrical system according to the present invention are given in the characterizing part of claim 1. Another object of the invention is to provide an improved method for operating an electrical device of a piston engine. The characterizing features of the method are given in the characterizing part of the other independent claim.

20 According to the invention, the device that is that is connected to the second control module for receiving a control signal and/or for transmitting a measurement signal is connected to a driver output of the first control module for receiving electric energy.

25 In the method according to the invention, electric energy is supplied to the device via a driver output of a first control module of the engine and a control signal is transmitted to the device from a second control module and/or a measurement signal is transmitted from the device to a second control module.

30 At least one driver output of the first control module is thus used for supplying power to a device, which is controlled by another control module. Since the first control module is connected to two power sources, power supply to the device is secured even when one of the power sources fails. An advantage compared to a device that is connected directly to both power sources is that a short-circuit failure of the device does not shut down the whole electrical sys-

tem. Also the need for mechanical fuses can be eliminated. The connection to the driver output also allows better monitoring of the device connected to the driver output.

5 According to an embodiment of the invention, the driver output to which the device is connected is provided with an electronic fuse. The fuse can have a variable current limit. An electronic fuse can be configured to have a suitable current limit for the device connected to the driver output. It is also possible to have different limits in different operating conditions. For instance, the limit can be higher during start-up of the device to allow temporary current peaks.

10 The device connected to the driver output can be a sensor, such as a humidity sensor. The device could also be a valve actuator, such as an actuator of a waste gate valve.

15 According to an embodiment of the invention, the first control module is a cylinder control module that is configured to control operation of one or more fuel injectors. Instead of a cylinder control module, the first control module could be an input/output module that is configured to receive measurement signals and to perform specific control functions of the engine.

A piston engine according to the invention comprises an electrical system defined above. The engine can be, for instance, a marine engine.

20

Brief description of the drawings

Embodiments of the invention are described below in more detail with reference to the accompanying drawings, in which

25 Fig. 1 shows a schematic view of a prior art electrical system of a piston engine,

Fig. 2 shows a schematic view of an electrical system of a piston engine according to an embodiment of the invention, and

Fig. 3 shows schematically a cylinder control module of the electrical system of figure 2.

30

Description of embodiments of the invention

Figure 2 shows a simplified view of an electrical system of a piston engine 1. The engine is a large internal combustion engine. The engine 1 can be a main or an auxiliary engine of a ship or some other marine engine. The engine 1 could also be used for some other purpose in an application where reliable running of the engine 1 is important and redundancy is required from the electrical system. The engine 1 can be a diesel engine, gas engine, dual-fuel engine or multi-fuel engine. The engine 1 can be either a compression ignition engine or a spark ignition engine.

- 10 The engine 1 comprises a plurality of cylinders 2. Four cylinders 2 are shown in figure 2, but the engine 1 can comprise any reasonable number of cylinders 2. Each cylinder 2 is provided with a fuel injector 3 for injecting fuel into the cylinder 2. The fuel injectors 3 can be either main fuel injectors of a diesel engine or a dual-fuel/multi-fuel engine or pilot fuel injectors of a gas engine or a dual-fuel/multi-fuel engine.

- The electrical system comprises various control modules. A main control module 6 handles the strategic control functions of the engine 1. These include, for instance, start/stop functions and speed/load control of the engine 1. In the example of figure 2, the electrical system comprises two cylinder control modules 4. In the embodiment of figure 2, each of the cylinder control modules 4 controls fuel injection into two cylinders 2. The cylinder control modules 4 thus control the cylinder-specific air-fuel ratio by adjusting the admission of fuel into the cylinders 2. An input/output module 5 handles measurements and limited control functions in a specific area. The electrical system also comprises a user interface 7. The user interface 7 can comprise a display and/or input means for local engine control. The input means can comprise a keyboard, push buttons and/or switches. The input means could also be integrated to a touch display. The various control modules and the user interface are connected to each other via a CAN-bus 10. The CAN-bus 10 is physically doubled for providing redundancy.

Electric energy is supplied to the control modules 4, 5, 6 and to the user interface 7 from a first power source 8 and a second power source 9. The power sources 8, 9 are independent and failing of one of the power sources 8, 9 does

thus not shut down the engine 1, but the critical functions of the engine 1 work as long as at least one of the power sources 8, 9 can supply power.

Figure 3 shows a schematic view of a cylinder control module 4 of figure 2. Each cylinder control module 4 is provided with a plurality of driver outputs 12.

- 5 The driver outputs 12 are configured to supply power and to control the operation of the fuel injectors 3. Each fuel injector 3 is provided with a solenoid 13 for actuating the fuel injector 3. The fuel injectors 3 are current-controlled and the driver outputs 12 are responsible for both supplying the energy required for the operation of the solenoids 13 of the fuel injectors 3 and for controlling the
10 fuel injection timing and duration.

- An electrical system according to the invention comprises at least one device 11 that is connected to a driver output 12 of a control module 4, 5 for receiving electric energy and to another control module 15 for receiving a control signal and/or transmitting a measurement signal. In the embodiment of the figures,
15 electric energy is supplied to the device 11 from a driver output 12 of a cylinder control module 4. However, the device 11 could also be connected to the input/output module 5. Since the cylinder control modules 4 and the input/output module 5 are connected to both power sources 8, 9, the power supply to the device 11 is secured even when one of the power sources 8, 9 fails. If the de-
20 vice 11 was connected directly to the power sources 8, 9, a short-circuit failure of the device 11 could shut-down the whole electrical system, if a fuse between the device 11 and the power supplies could not disconnect the device 11 from the system fast enough. With the arrangement according to the invention, this problem can be avoided.

- 25 The device 11 can be, for instance, an actuator of a valve or a sensor. The device 11 could thus be an actuator of a waste gate valve of the exhaust system of the engine 1 or a humidity sensor that is used for measuring the moisture content of the intake air of the engine 1. The device 11 could also be some other non-critical actuator or sensor.

- 30 Each driver output 12 of the cylinder control module 4 is provided with an electronic fuse. The current supply to the device 11 can thus be limited. The electronic fuse can be easily configured to take into account the characteristics of the device 11 connected to the driver output 12. The current limit of the electronic fuse can also be made variable. The fuse can thus have different current

limits for different operating states of the device 11. For instance, during start-up of the device 11, the current limit can be higher for allowing temporary current peaks.

- 5 The electrical system according to the invention allows better monitoring of the device 11 connected to the driver output 12 of the control module 4, 5. For instance, the current supplied to the device 11 can be easily monitored.

It will be appreciated by a person skilled in the art that the invention is not limited to the embodiments described above, but may vary within the scope of the appended claims.

Claims

1. An electrical system for a piston engine (1), the electrical system comprising
 - a first power source (8) for supplying electric energy,
 - 5 - a second power source (9) for supplying electric energy,
 - a first control module (4, 5), which is connected to both the first power source (8) and the second power source (9) for receiving electric energy, the control module (4, 5) comprising a plurality of driver outputs (12) and being configured to supply electric energy to engine components (3) connected to the driver outputs (12) and to control operation of said components (3),
 - 10 - a second control module (15), and
 - at least one device (11) that is connected to the second control module (15) for receiving a control signal and/or for transmitting a measurement signal,
 - 15
- characterized** in that said device (11) is connected to a driver output (12) of the first control module (4, 5) for receiving electric energy.
2. An electrical system according to claim 1, wherein the driver output (12) to which the device (11) is connected is provided with an electronic fuse.
- 20 3. An electrical system according to claim 2, wherein the electronic fuse has a variable current limit.
4. An electrical system according to any of claims 1–3, wherein the device (11) connected to the driver output (12) is a sensor, such as a humidity sensor.
5. An electrical system according to any of claims 1–3, wherein the device (11) connected to the driver output (12) is a valve actuator, such as an actuator of a waste gate valve.
- 25 6. An electrical system according to any of the preceding claims, wherein the first control module (4, 5) is a cylinder control module (4) that is configured to control operation of one or more fuel injectors (3).
- 30 7. An electrical system according to any of claims 1–6, wherein the first control module (4, 5) is an input/output module (5) that is configured to receive

measurement signals and to perform specific control functions of the engine (1).

8. A piston engine (1) comprising an electrical system according to any of the preceding claims.

5 9. A piston engine (1) according to claim 8, wherein the engine (1) is a marine engine.

10. A method for operating an electrical device (11) of a piston engine (1), **characterized** in that electric energy is supplied to the device (11) via a driver output (12) of a first control module (4, 5) of the engine (1) and a control signal is transmitted to the device (11) from a second control module (15) and/or a measurement signal is transmitted from the device (11) to a second control module (15).

11. A method according to claim 10, wherein the electric current supplied to the device (11) is limited by means of an electronic fuse.

15 12. A method according to claim 11, wherein the current limit of the electronic fuse is varied according to the operating state of the device (11).

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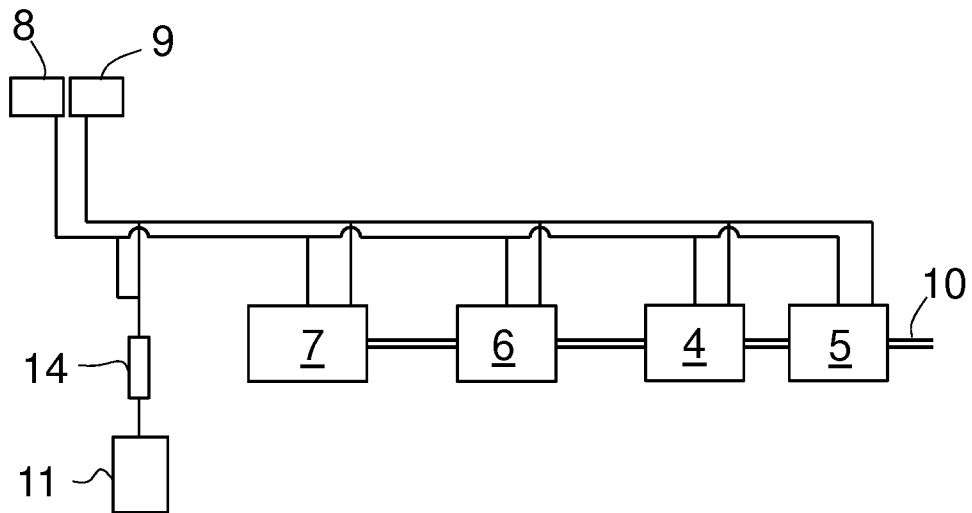


FIG. 1 Prior art

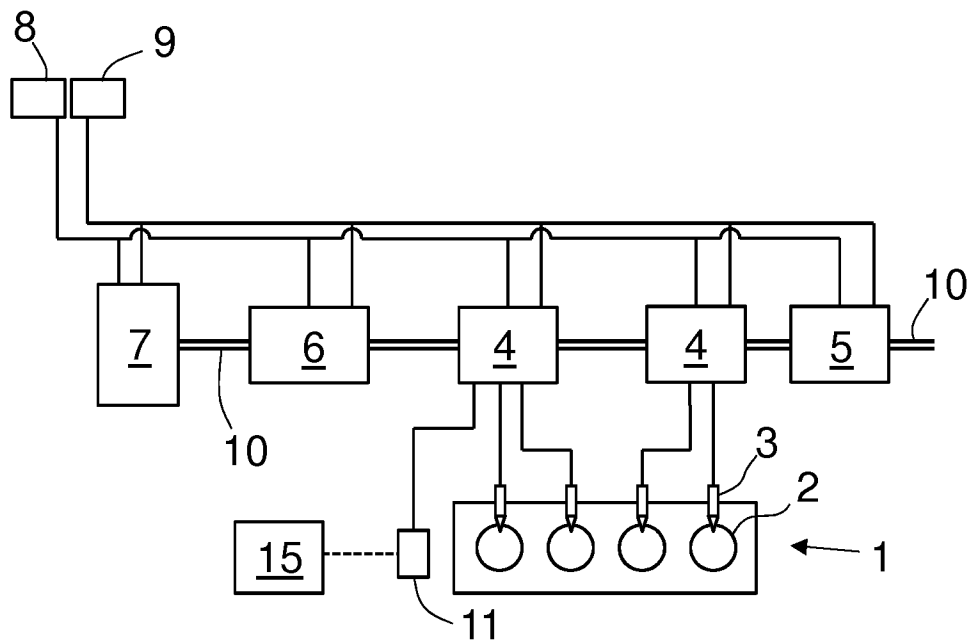


FIG. 2

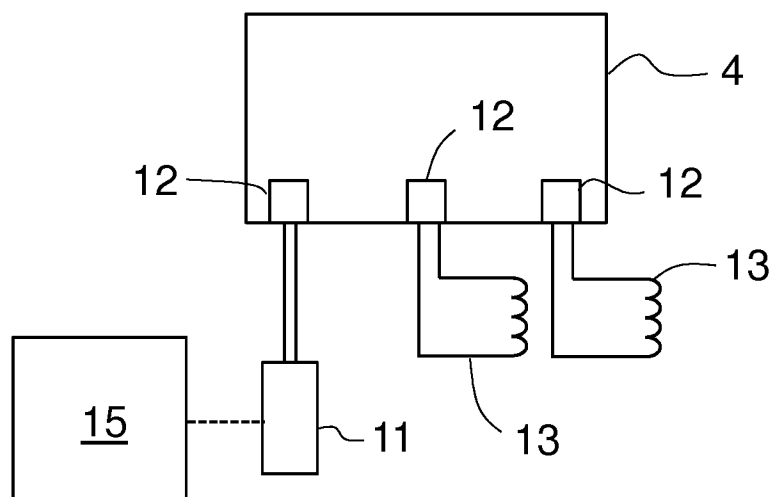


FIG. 3

INTERNATIONAL SEARCH REPORT

International application No
PCT/FI2017/050136

A. CLASSIFICATION OF SUBJECT MATTER

INV. F02D19/06 F02D41/22 F02D41/26 F02D41/20
ADD.

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)
F02D

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)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2016/087710 A1 (WÄRTSILÄ FINLAND OY [FI]) 9 June 2016 (2016-06-09)	1,4-10
Y	pages 3-5; figure 1	2,3,11,12
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A	----- US 5 775 296 A (GOERAS ANDERS J [SE] ET AL) 7 July 1998 (1998-07-07) columns 3-5; figure 1	1,10



Further documents are listed in the continuation of Box C.



See patent family annex.

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Date of the actual completion of the international search

14 November 2017

Date of mailing of the international search report

22/11/2017

Name and mailing address of the ISA/

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

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