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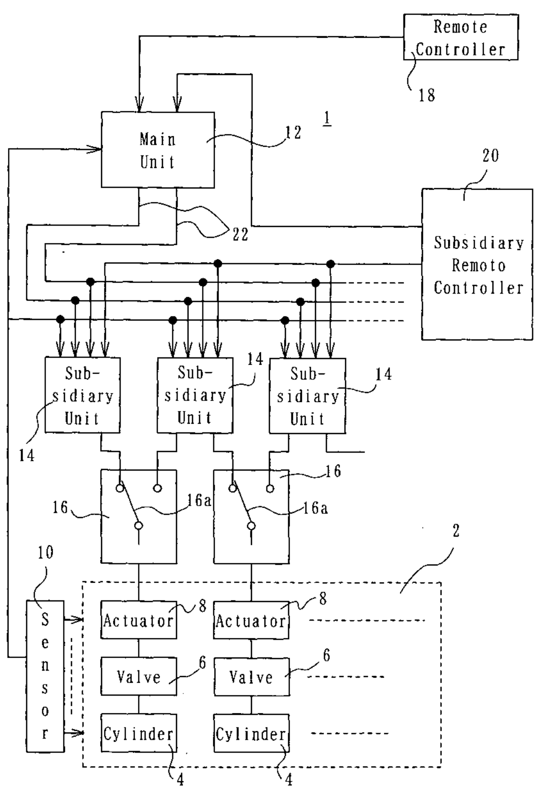
(54) Ship engine control system

(57) A command signal is applied to a main unit (12) from a remote control unit (18) operated by an operator of a ship. A sensor unit (10) detects an operating state of a ship engine (2) and develops an operating state representative signal. The main unit (12) prepares and provides a main command based on the command signal and the operating state representative signal. A set including a subsidiary unit (14) and a valve (6) is provided for each of cylinders (4) of the engine (2). Each subsidiary unit (14) computes, from the operating state representative signal and the main command, operation timing, provides an operation timing command in accordance with the operation timing. The valve (6) is adapted to supply fuel to the associated cylinder (4) in accordance with the operation timing command. A subsidiary remote controller (20) is disposed at a location remote from the remote control unit (18), and is adapted to provide a first subsidiary command signal to the main unit (12) and a second subsidiary command signal to the subsidiary units (14). The main unit (12) is also capable of providing the main signal based on the first subsidiary command signal and the operating state representative signal. The subsidiary units (14) are also arranged to provide an operation timing command based on the second subsidiary command signal and the operating state representative signal.



Description

[0001] The present invention relates to a control system for controlling an engine, e.g. a diesel engine, of a ship.

BACKGROUND OF THE INVENTION

[0002] If a ship engine fails at sea, it is not easy to repair it. Accordingly, ship engines should be hard to fail. Even if only part of such ship engine fails to operate well, the engine must be operated to move the ship to a port. A technique dealing with such situation is disclosed in Japanese Patent Application Publication No. HEI 6-330772 A published on November 29, 1994.

[0003] According to the technique disclosed in this Japanese publication, an engine control cable through which a governor of a ship engine can be operated is adapted to be driven by an actuator. The actuator is controlled through a transmitter which generates an engine control signal. A manually operable control cable through which the governor can be operated is also provided. The manually operable control cable is driven through a manual remote controller. When it happens that the engine control cable cannot be operated through the actuator due to, for example, failure of the transmitter, the governor is operated by driving the manually operable control cable through the manual remote controller.

[0004] With this technique, the engine can be continuously operated by manual operation even when the transmitter or the actuator through which the engine is electronically controlled, becomes out of order. It is, however, difficult for the manual operation to flexibly deal with variable operating conditions.

[0005] An object of the present invention is to provide a ship engine control system with improved reliability, which can flexibly deal with various operating conditions of a ship engine when failure occurs.

SUMMARY OF THE INVENTION

[0006] A ship engine control system for controlling an engine of a ship, according to the present invention includes a remote control unit, an operating state detector, and a main unit. The remote control unit is operated by a steersman or an operator to output a command signal. The operating state detector detects the operating state of the ship engine and outputs an operating state representative signal. The main unit provides a main command prepared based on the command signal and the operating state representative signal, and causes the ship engine to be controlled in accordance with the main command.

[0007] The engine has a plurality of cylinders, and subsidiary units and fuel supplies are provided in association with respective cylinders. Each subsidiary unit computes operating timing of associated one of the cylinders based on the operating state representative signal and the main command, and provides an operating timing command corresponding to the computed operating timing. The associated fuel supplying device supplies fuel to the associated cylinder in response to the operating timing command. A subsidiary remote controller is disposed at a located remote from the remote control unit. The subsidiary remote controller is adapted to provide a first subsidiary command signal to the main unit and a second subsidiary command signal to the subsidiary units. The main unit is also arranged to provide the main signal in accordance with the first subsidiary command signal and with the operating state representative signal. Each subsidiary unit is also adapted to provide the operating timing command based on the second subsidiary command signal and the operating state representative signal.

[0008] With the above-described arrangement of the ship engine control system, when the remote control unit, for example, becomes to fail to properly operate, the first subsidiary command signal is applied from the subsidiary remote controller to the main unit, to thereby enable the control of the engine through the subsidiary remote controller in a manner same as the control through the remote control unit. If the main unit fails, the second subsidiary command signal is supplied from the subsidiary remote controller to the subsidiary units to control the engine. If the subsidiary remote controller becomes out of order, the engine can be controlled through the remote control unit and the main unit. Like this, according to the present invention, even when any one of the remote control unit, the main unit, and the subsidiary units fails, the engine can be control. The control is electronic control, which can be highly reliable.

[0009] The remote control unit may be arranged to provide, as the command signal, an aimed rotation rate representative signal representing an aimed rotation rate of the engine. In this case, the main unit has a governor function for computing an actual rotation rate of the engine based on the operating state representative signal, and computing the amount of fuel to be supplied to the cylinders based on the actual rotation rate and the aimed rotation rate representative signal. The main unit provides, as the main signal, a primary operation timing representative signal prepared based on the computed amount of fuel to be supplied to the cylinders and engine environmental conditions. Each of the subsidiary units computes an engine crank angle from the operating state representative signal, and provides an operating timing command in accordance with the primary operation timing representative signal. The subsidiary remote controller is adapted to provide, as the first subsidiary command signal, a signal equivalent to the aimed rotation rate representative signal to the main unit, and to provide, as the second subsidiary command signal, a fuel amount representative signal, which represents the amount of fuel to be supplied to the cylinder, to the subsidiary units. The subsidiary units are arranged to provide an operation timing representative signal prepared based on the fuel amount representative signal.

[0010] With this arrangement, the subsidiary remote controller can provide to the main unit a signal equivalent to the aimed rotation rate representative signal the remote control unit supplies to the main unit. Accordingly, even when the remote control unit fails to properly operate, the engine can be controlled in the same manner as the remote control unit.

BRIEF DESCRIPTION OF THE DRAWING

[0011] The sole FIGURE is a block circuit diagram of a ship engine control system according to an embodiment of the present invention.

DETAILED DESCRIPTION OF EMBODIMENT

[0012] As shown in the sole FIGURE, a ship engine control system 1 according to an embodiment of the present invention is used to control a ship engine, e.g. diesel engine 2. The diesel engine 2 has a plurality of cylinders 4. Each cylinder 4 is provided with a fuel supplying device, e.g. a fuel supply valve 6. Fuel is supplied to a combustion chamber of each cylinder 4 through the associated one of the valves 6. Opening and closing of the valves 6 are controlled through actuators, e.g. solenoid valves 8, associated with the respective valves 6. Each cylinder 4 is also provided with an exhaust valve (not shown), through which exhaust gases produced in the combustion chamber due to combustion in the cylinder 4 are exhausted. Although not shown, an actuator for controlling the exhaust valve is also provided for each cylinder 4.

[0013] The diesel engine 2 is provided with an operating state detector, e.g. a sensor unit 10. The sensor unit 10 includes sensors for measuring various physical quantities relating to the rotation or operation of the diesel engine 2. Specifically, the sensor unit 10 measures the top dead centers, the crank angles, the rotation rates, etc. of the respective cylinders 4, and supplies the measurements to the diesel engine control system 1. The sensors of the sensor unit 10 may be a combination of pulse type sensors and absolute type sensors, or all of the sensors may be of either one type. A pulse type sensor is a sensor which provides an output signal in the form of pulse trains, and an absolute type sensor is a sensor providing an output signal in the form of analog signal or in the form of Gray code signal formed of ten to twenty bits, e.g. twelve, fourteen or sixteen bits.

[0014] The engine control system 1 has a main unit 12, a plurality of subsidiary units 14, a plurality of actuator drivers 16, a remote control unit 18, and a subsidiary remote controller 20. The main unit 12 is disposed at a location remote from the engine 2. The subsidiary remote controller 20 is disposed at a location remote from the remote control unit 18.

[0015] The main unit 12 receives a command signal, e.g. an aimed rotation rate representative signal, from the remote control unit 18. The aimed rotation rate representative signal represents the rotation rate at which the engine 2 is to be operated, and is produced through an operating unit (not shown) on the remote control unit 18 operated by an operator or steersman. The main unit 12 has a governor function to compute the amounts of fuel to be supplied to the respective cylinders 4. Using the governor function, the main unit 12 computes the actual rotation rate of the engine 2 from the measured rotation rates of the respective cylinders 4 supplied from the sensor unit 10, and computes the amounts of fuel to be supplied to the respective cylinders 4 based on the computed actual rotation rate of the engine 2 and the aimed rotation rate representative signal supplied from the remote control unit 18. Furthermore, based on the computed amounts of fuel to be supplied to the respective cylinders 4 and environmental conditions of the engine 2, such as the loading condition on the engine 2, the scavenging pressure, the exhaust temperature and/or differences among the valves 6, the main unit 12 prepares main signals, e.g. primary operation timing signals and provides them to respective ones of the subsidiary units 14. In addition, the main unit 12, in accordance with set values set through a setting device (not shown), computes and optimizes the fuel injection timings, the amounts of fuel to be injected, the opening and closing timings of the exhaust valves, etc. and provides the optimized factors to respective ones of the subsidiary units 14.

[0016] The transmission of the signals are done through a dual network system 22. Accordingly, if one of the networks fails, the primary operation timing signals can be sent to the respective subsidiary units 14 via the other network.

[0017] The subsidiary units 14 are disposed at locations nearer to the engine 2 than the main unit 12. The respective subsidiary units 14 control associated driver units 16 so that the actuators 8 can be driven at the transmitted primary operation timings. When the actuators 8 are driven, the associated valves 6 allow the fuel to be supplied to the respective cylinders 4. In order for the actuators 8 to be driven at the primary operation timings, the subsidiary units 14 compute the crank angle of the engine 2 from the measurements made by the sensor unit 10 and correct the delays in operation of the actuators 8 in accordance with the computed crank angle.

[0018] Two of the subsidiary units 14 are allocated to each driver unit 16. Each driver unit 16 is provided with a changeover switch 16a. Each actuator 8 is driven with a signal from a predetermined one of two subsidiary units 14 through the driver unit 16 associated with the two subsidiary units 14. If that one of the two subsidiary units 14 fails to provide a normal signal, the changeover switch 16a is switched to the other one of the subsidiary units 14 so that the actuator 8 can be driven from the signal from the other subsidiary unit 14. If both of the two subsidiary units 14 associated with one actuator 8 fail to operate normally, the cylinder 4 to which these two subsidiary units 14 are allocated is not operated, and the engine 2 operates with a reduced number of the cylinders 4.

[0019] The subsidiary remote controller 20 is arranged to be able to provide command signals for the main unit 12 and the subsidiary units 14. The subsidiary remote controller 20 is provided with a changeover switch (not shown), which is switched to place the subsidiary remote controller 20 in a first state in which it can provide a first subsidiary command signal, e.g. a command signal for the main unit 12, or a second state in which it can provide a second subsidiary command signal, e.g. a command signal for each subsidiary unit 14.

[0020] The subsidiary remote controller 20 in the first state can provide the aimed rotation rate representative signal to the main unit 12 when means to cause the aimed rotation rate representative signal to be generated, e.g. a potentiometer (not shown) on the remote controller 20, is operated. Therefore, if the remote control unit 18 fails, the subsidiary remote controller 20 can substitute for the remote control unit 18.

[0021] The subsidiary remote control unit 20 in the second state can provide, to the respective subsidiary units 14, fuel amount representative signals representative of the amounts of fuel to be supplied to the cylinders 4, when means to cause the fuel amount representative signals to be generated, e.g. a potentiometer (not shown) on the remote controller 20, is operated. This is done when the main unit 12 fails.

[0022] The subsidiary units 14 receiving the respective fuel amount representative signals control the associated actuators 8 so as to cause the associated valves 6 to inject amounts of fuel corresponding to the amounts as represented by the respective signals at respective appropriate timings. In this case, too, delays in operation of the respective actuators are compensated for based on the crank angles.

[0023] When the main unit 12, the subsidiary units 14 and the remote control unit 18 are operating normally, the main unit 12, in response to the aimed rotation rate representative signal from the remote control unit 18, provides the primary operation timing signals to the respective subsidiary units 14 via the dual network 22, and the respective subsidiary units 14 control the associated actuators 8 so that fuel can be supplied at the primary operation timing, whereby the amounts of fuel injected into the respective cylinders 4 are properly controlled so that the rotation rate of the engine 2 can be properly controlled and maintained.

[0024] If the remote control unit 18 fails to properly operate, the aimed rotation rate representative signal is supplied from the subsidiary remote controller 20 to the main unit 12 so that the rotation rate of the engine 2 can be controlled and maintained as in the normal operation.

[0025] If the main unit 12 fails, signals representative of the amounts of fuel to be injected are supplied from the subsidiary remote controller 20 to the respective subsidiary units 14, and the subsidiary units directly control the amounts of fuel to be injected.

[0026] If the subsidiary remote controller 20 fails, controls as provided in the normal operation are provided.

[0027] The described engine control system can continue to provide electronic controls of the engine 2 and can flexibly deal with various operating conditions even when any of the remote control unit 18, the subsidiary remote controller 20 and the main unit 12 fails. Furthermore, even when any of the subsidiary units 14 allocated to one of the cylinders 14 fails, that cylinder 4 can be electronically controlled through another one of the subsidiary units 14 sharing that cylinder 4. If all of the subsidiary units 14 sharing one cylinder 4 fail, that cylinder 4 stops operating, but the engine 2 does not stop since the control of the remaining cylinders 4 is maintained.

[0028] In the above-described embodiment, the sensors of the sensor unit 10 are used for the main unit 12 and the subsidiary units 14 in common, but separate sensor units may be provided for the main unit 12 and the subsidiary units 14.

[0029] Although the main unit 12 has been described to have a governor function, but a separate governor unit may be provided between the main unit 12 and the remote control unit 18. In this case, the subsidiary remote controller 20 preferably supplies fuel amount representative signals to the main unit 12 and to the subsidiary units 14, and a signal equivalent to the aimed rotation rate representative signal to the governor unit.

[0030] Alternatively, each subsidiary unit 14 may be provided with a governor unit. In this case, it is preferable to arrange that the main unit 12 provides, to each governor unit, a signal equivalent to the aimed rotation rate representative signal provided by the remote control unit 18, and each subsidiary unit 14 provides, to the governor unit, a signal equivalent to the aimed rotation rate representative signal provided by the subsidiary remote controller 20.

[0031] Also, in place of the subsidiary remote controller 20, separate controllers may be used for providing signals for the main unit 12 and signals for the subsidiary units 14, respectively.

Claims

1. A ship engine control system comprising: a remote control unit adapted to be operated by an operator for outputting a command signal, an operating state detector for detecting an operating state of said engine and developing an operating state representative signal, and a main unit for preparing a main command based on said command signal and said operating state representative signal and controlling said engine in accordance with said main command;

   characterized in that:

a subsidiary unit and a fuel supplying device are provided for each of cylinders of said engine, each of said subsidiary units computing operation timing based on said operating state representative signal and said main command, and providing an operation timing command corresponding to said computed operation timing, each of said fuel supplying devices supplying fuel to an associated one of said cylinders in accordance with said operating timing command;

a subsidiary remote controller is disposed at a location remote from said remote control unit, said subsidiary remote controller being capable of providing a first subsidiary command signal to said main unit and providing a second subsidiary command signal to each of said subsidiary units; and

said main unit is also adapted to provide said main signal based on said first subsidiary command signal and said operating state representative signal, each of said subsidiary units being also adapted to provide said operation timing command based on said second subsidiary command signal and said operating state representative signal.

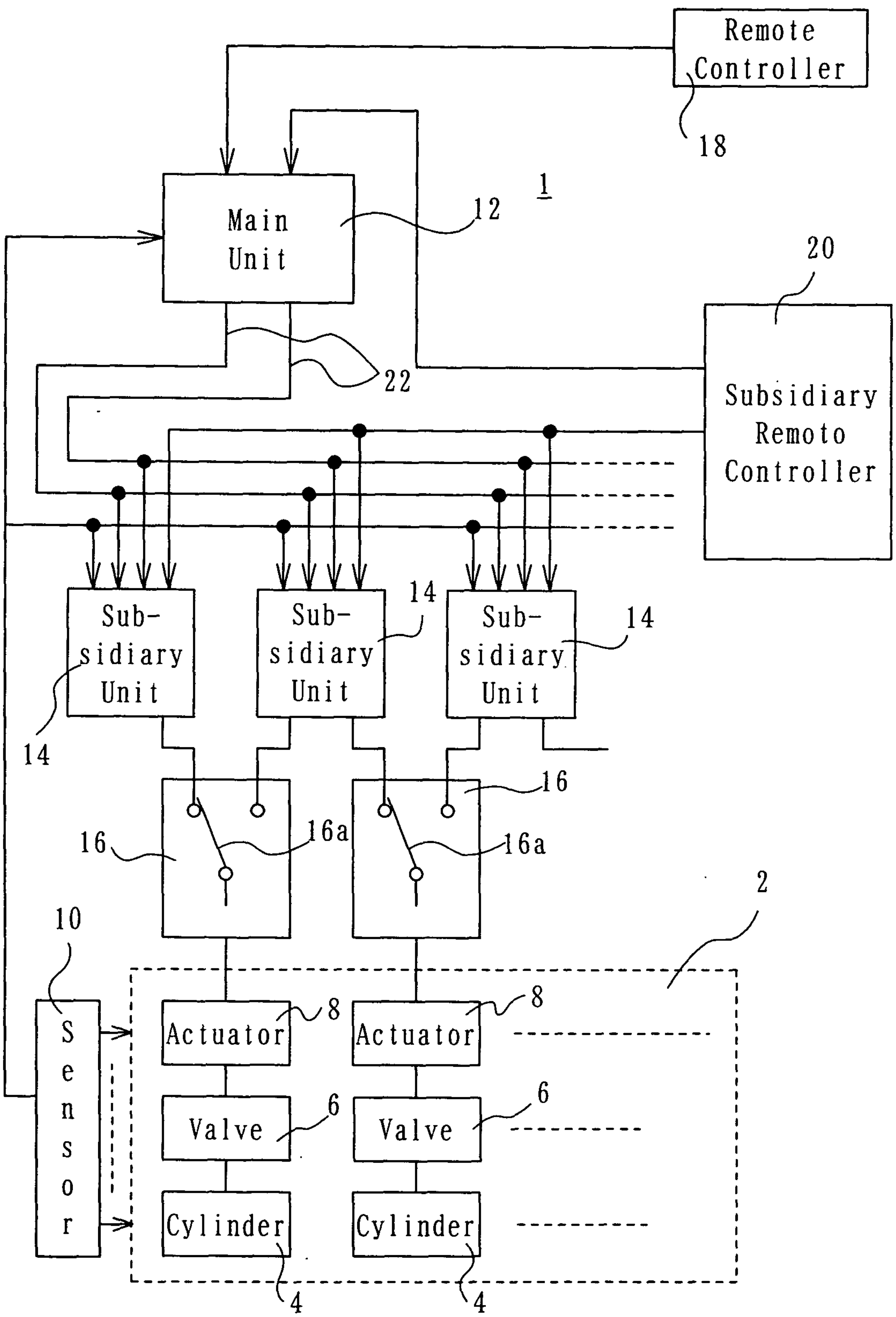
2. The ship engine control system according to Claim 1 wherein:

said remote control unit provides, as said command signal, an aimed rotation rate representative signal representing an aimed rotation rate of said engine;

said main unit has a governor function for computing an actual rotation rate of said engine from said operating state representative signal and also computing amounts of fuel to be supplied to respective ones of said cylinders based on said actual rotation rate and said aimed rotation rate representative signal, said main unit further providing, as said main signal, a primary operation timing signal prepared based on said computed amounts of fuel to be supplied and environmental conditions of said engine, said subsidiary units computing, from said operating state representative signal, a crank angle of said engine and developing said operation timing command in accordance with said primary operation timing signal;

said subsidiary remote controller is adapted to provide, as said first subsidiary command signal, a signal equivalent to said aimed rotation rate representative signal to said main unit and to provide to said subsidiary units, fuel amount representative signals representing said amounts of fuel to be supplied, as said second subsidiary command signal; and

said subsidiary units are adapted to provide said operation timing command based on said fuel amount representative signals.



Remote Controller
18
1
Main Unit
12
20
22
Subsidiary Remoto Controller
14
Sub-sidiary Unit
Sub-sidiary Unit
Sub-sidiary Unit
14
14
16
16a
16
16a
2
10
Sensor
Actuator
8
Actuator
8
Valve
6
Valve
6
Cylinder
Cylinder
4
4