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Fell

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(54) **ENGINE-GENERATOR WITH LOAD BANK AND CONTROL SYSTEM**

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H02P 11/00 (2006.01)

(52) **U.S. Cl.**
USPC **322/21**; 322/37

(58) **Field of Classification Search**
USPC 322/21, 22, 23, 37
See application file for complete search history.

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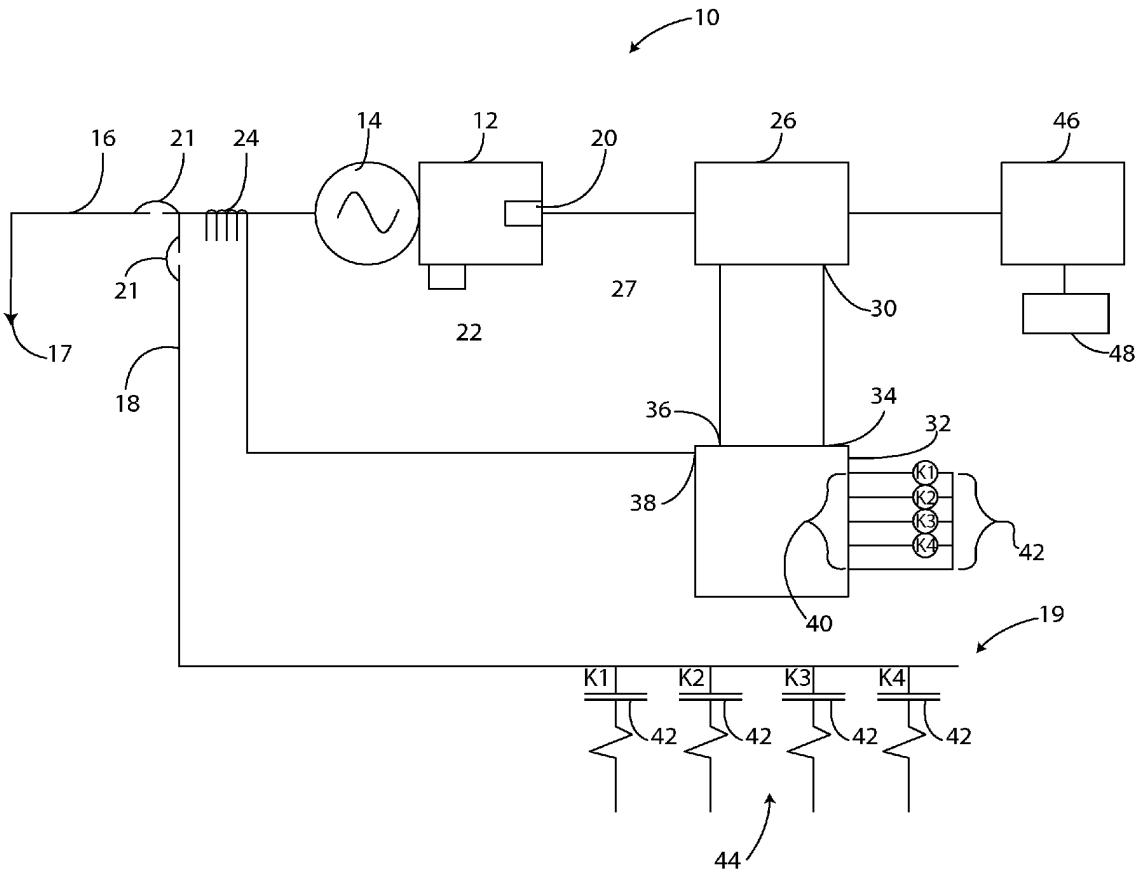
(57) **ABSTRACT**

A load bank comprises one or more load resistors connected to an engine-generator and a control system for maintaining a minimum generator load when necessary for optimal operation. The control system operates the load bank to mitigate harmful effects of generator neglect and maintains loading for efficient DPF regeneration while allowing the generator to quickly dump the load bank when real load increases.

38 Claims, 4 Drawing Sheets



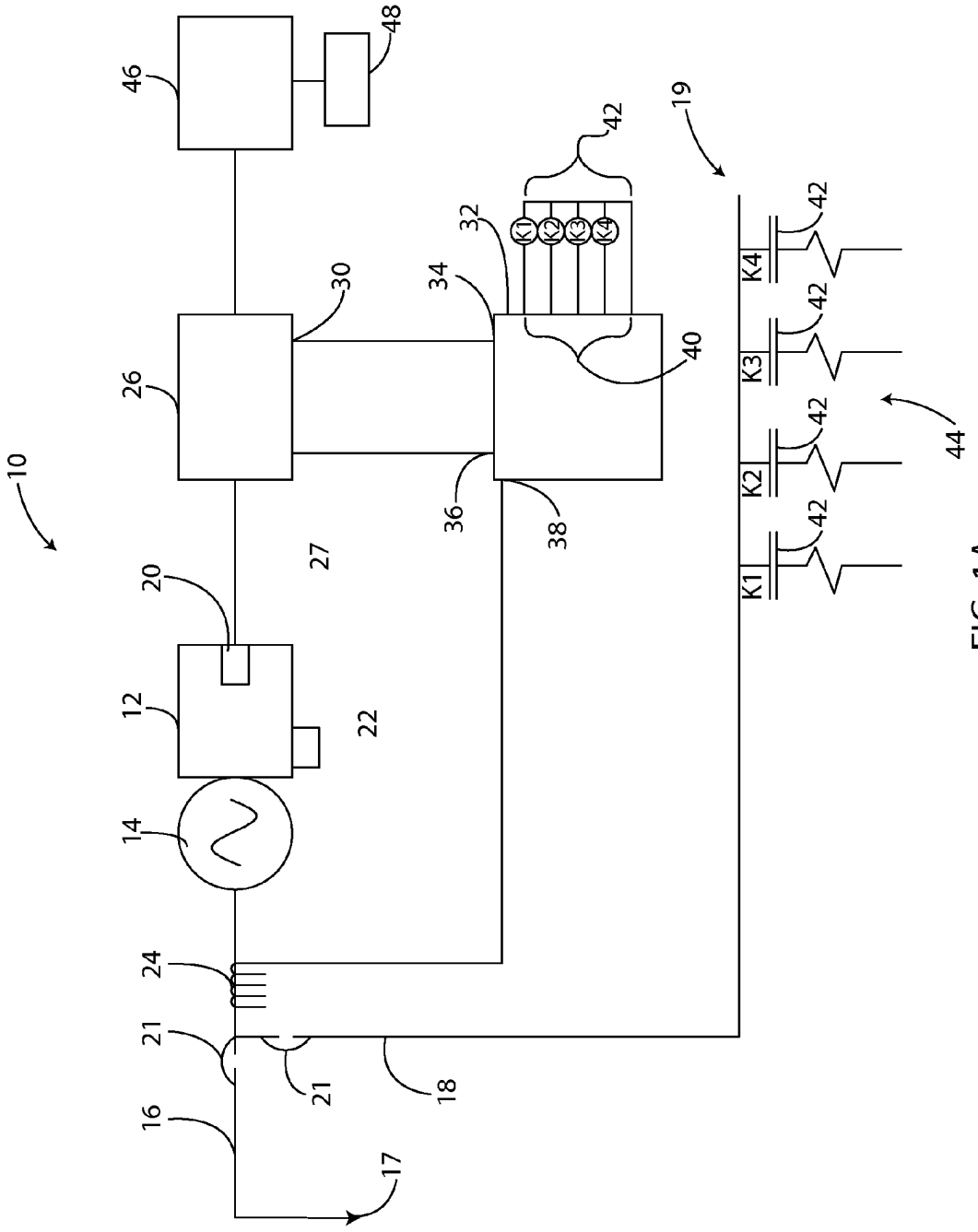

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FIG. 1A

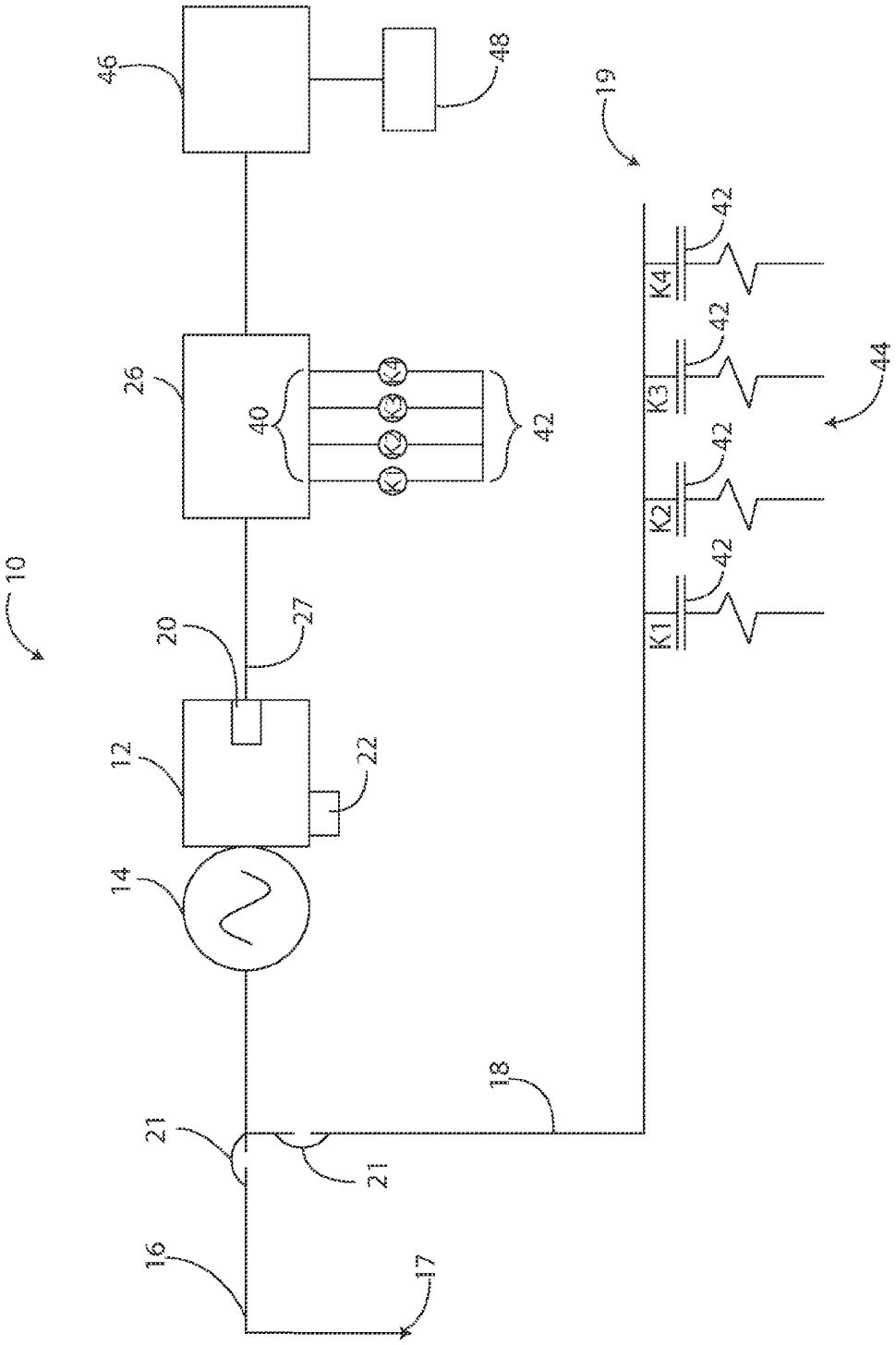
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FIG. 1B

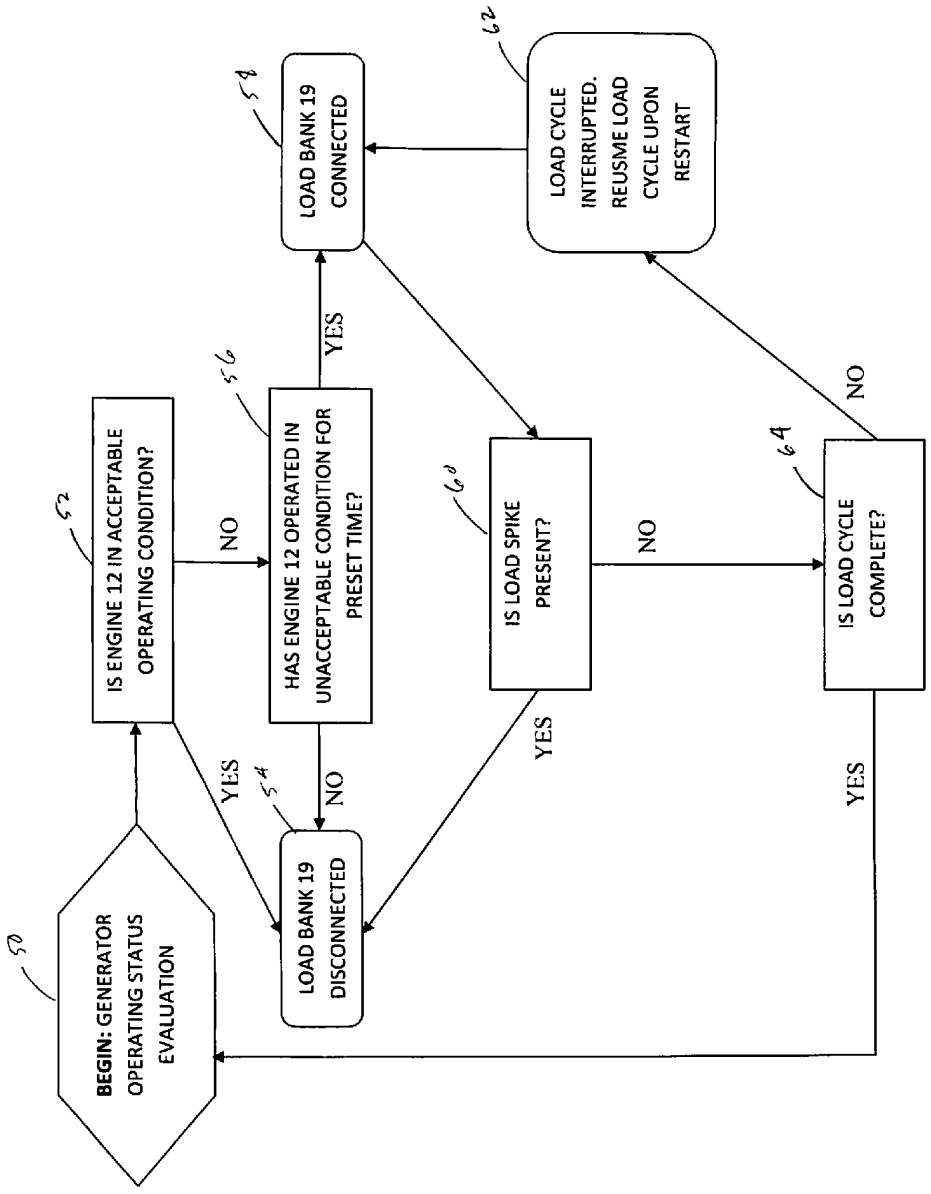
BEGIN: GENERATOR OPERATING STATUS EVALUATION
50
IS ENGINE 12 IN ACCEPTABLE OPERATING CONDITION?
52
NO
YES
HAS ENGINE 12 OPERATED IN UNACCEPTABLE CONDITION FOR PRESET TIME?
56
YES
NO
LOAD BANK 19 CONNECTED
58
LOAD BANK 19 DISCONNECTED
54
IS LOAD SPIKE PRESENT?
60
NO
YES
IS LOAD CYCLE COMPLETE?
64
NO
YES
LOAD CYCLE INTERRUPTED. REUSME LOAD CYCLE UPON RESTART
62

FIG. 2

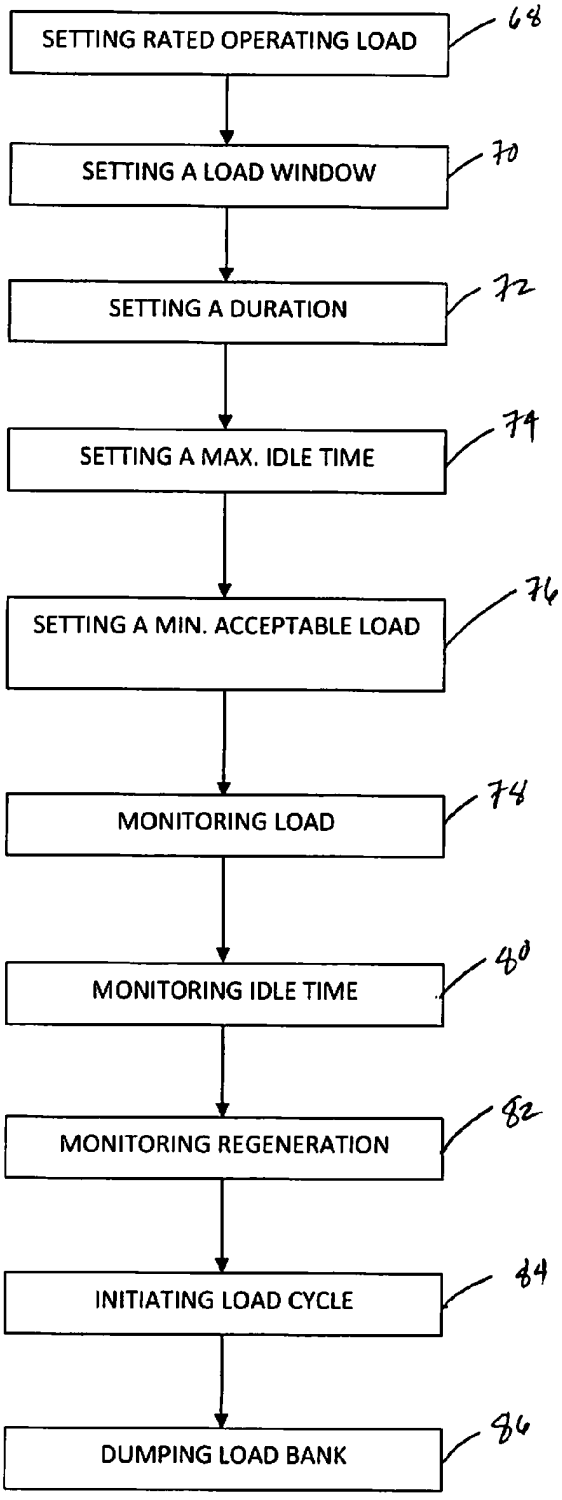
SETTING RATED OPERATING LOAD
68
SETTING A LOAD WINDOW
70
SETTING A DURATION
72
SETTING A MAX. IDLE TIME
74
SETTING A MIN. ACCEPTABLE LOAD
76
MONITORING LOAD
78
MONITORING IDLE TIME
80
MONITORING REGENERATION
82
INITIATING LOAD CYCLE
84
DUMPING LOAD BANK
86

FIG. 3

ENGINE-GENERATOR WITH LOAD BANK AND CONTROL SYSTEM

TECHNICAL FIELD

The disclosed embodiments relate generally to systems of engine-generators with load banks.

BACKGROUND

Electric generators, particularly portable engine-generator units, are often operated under variable load conditions. Such portable units are also often left unattended, which further causes them to be operated in sub-optimal conditions. It is well known that operating engine-generators under fluctuating load conditions can present a number of problems. As explained in U.S. Pat. No. 3,530,300 to Gunther, et al., diesel-fueled engine-generators are especially susceptible to problems associated with light-load conditions. In particular, a lightly loaded, diesel-fueled engine-generator may cause the engine portion of the machine to operate such that fuel within the engine remains unburned. This unburned fuel forms tar or carbon deposits, or both, which can collect within various parts of the engine, including exhaust pipes. This condition has historically been referred to as "wet stacking."

Diesel engines also create soot during their combustion process. When an engine is operating under lightly load conditions, it tends to create more soot. Historically, the soot was exhausted from the engine to the atmosphere via exhaust pipes. More recently, however, increasing concern about, and regulation of particulate emissions has lead to changes in the manner in which diesel engines may legally operate. Modern diesel engines, including so-called Tier IV Interim and newer engines, are equipped with particulate filters that serve to capture and remove soot from engine exhaust. The problem is that these particulate filters, which are also called diesel engine particulate filters or DPF, tend to clog with the particulate that they filter. Those clogs inhibit engine exhaust, which may significantly or entirely decrease the operability of an engine. To combat this DPF-clogging issue, modern diesel engines are often equipped with a "regeneration" feature. Regeneration involves a process in which the engine doses a DPF with diesel and then ignites that diesel to burn-off accumulated soot. The soot is reduced to ash, which falls away from the DPF, thus clearing the DPF and the engine exhaust system.

Complicating DPF regeneration in engine-generator applications is the effect of generator loading on engine performance. Engine exhaust temperature is proportional to generator loading. Thus, a lightly loaded generator causes the engine to operate with lower exhaust temperature than a generator operating under greater loading conditions. The problem is that regeneration efficiency is inversely proportional to exhaust temperature. That is, regeneration works better when an engine is operating with higher exhaust temperatures. So, in engine-generator applications, regeneration is more efficient when a generator is operating under loaded conditions.

It is known in the art that wet stacking may be mitigated by connecting to the generator a "dummy" load in parallel with the actual, or "real," load. Such dummy loads often comprise banks of resistors that may be switched in steps, often automatically, in inverse proportion to the real load. In this way, a generator may be connected so that it always experiences some minimum demand. As Gunther, et al. explains, this is represented by the equation $P_G=P_{RL}+P_{DL}$, where P_G is the total generator demand, P_{RL} is the demand of the real load, and P_{DL} is the demand of the dummy load. This same method of operation helps reduce soot in the engine.

But despite the benefits of the system of Gunther, et al., and other similar configurations, such schemes tend to be wasteful because they cause the engine portion of the engine-generator to burn a set amount of fuel, at all times, in order to maintain P_G. This is because the engine must burn more fuel to maintain an increased generator output. So while the system is burning cleaner, it uses more fuel than necessary. In a world of rapidly decreasing oil supplies, and rapidly increasing fuel costs, it is desirable to balance the benefits of minimum generator loading with economic realities. Said differently, it is advantageous to decrease soot production and wet-stacking events with dummy loads (aka load banks), while at the same time being mindful of the fuel costs associated with operating dummy loads. Furthermore, load banks have not previously been employed to aid with DPF regeneration.

SUMMARY OF THE DISCLOSURE

Disclosed here is a load bank that provides a dummy load to an electric generator, which allows an engine-generator unit to more efficiently operate by decreasing the frequency of regeneration cycles an engine must initiate, and, when regeneration occurs, ensures a minimum generator load to raise exhaust temperatures and thus increase regeneration efficiency.

In accordance with some embodiments of the disclosed technology, an engine-generator and load bank system comprises a plurality of load resistors and load step contactors for engaging the load resistors. The plurality of load resistors are configured to allow for variability, or "stepping," of the total resistance of the dummy load. In other words, when the load bank is engaged, or connected, the load bank is configured to add or remove load resistors in steps, as required by system parameters. The disclosed technology is operable to entirely disconnect, or "dump," the load bank from the generator within a specified time, which may be necessary when the real load of the generator rapidly increases.

In accordance with some embodiments of the disclosed technology, the system is equipped with a generator controller and a load bank controller, which could be physically combined, that are configured to monitor both the engine side and the generator load of an engine-generator and to operate the load bank. In according with some embodiments, the system is equipped with a single controller that is configured to monitor the engine side of an engine-generator and to operate the load bank.

In accordance with some embodiments of the disclosed technology, the generator and load bank controllers are configured to initiate the load bank when certain conditions exist. The load bank is initiated when there is a "neglect scenario" or "neglect case." The generator controller, via the load bank controller, monitors the load connected to the generator to ensure that the load is within a "window" or "load window" bounded by pre-set lower and upper load levels. If the load connected to the generator remains at or below some pre-set load condition—i.e., below the window—for a pre-set duration, the generator controller signals the load bank controller to initiate the load bank. The load bank controller then increases or decreases the total resistance of the load bank by connecting or disconnecting load step resistors as necessary to maintain the load within window. If the load rises above the window, the steps of the load bank are disconnected as necessary. In this way, the total load on the generator—i.e., the real load and the resistance of the load bank—remains within

pre-set limits. The pre-set load corresponds to a power demand on the generator that provides for optimal operation, which minimizes wet stacking and soot build up.

Restricting the load bank to operation in a neglect case allows one to save fuel because the load bank will only draw power from the generator when necessary to prevent wet stacking and soot build up. The generator will thus be allowed to operate in a sub-optimal state until such time as wet stacking and soot build up are likely to occur. The load window and duration variables necessary for determining a neglect scenario will thus be based on manufacturer or user-defined values directed at pinpointing the time when wet stacking and soot build up is likely to begin.

In accordance with some embodiments of the disclosed technology, the duration variable for neglect is cumulative. The generator controller will constantly monitor load levels and will track the time period for which load levels are below the window. If the cumulative time the system is operated below the window reaches the pre-set duration, the generator controller signals the load bank controller to initiate the load bank. This cumulative timing of sub-optimal operation occurs even the system is operated for short periods of time at load levels within and above the window. If, however, the system operates for a pre-set time within the window, a neglect scenario may be avoided. The system thus accounts for the cumulative nature of soot build up in the engine. The problems associated with this soot accumulation can be avoided if the engine is operated under loaded conditions for a pre-determined duration. The generator controller therefore ensures the system is operated under a designated load for a pre-set duration. This operation for a pre-set duration under set load conditions at full engine speed is disclosed here a "load cycle."

In accordance with some embodiments of the disclosed technology, the generator controller is configured to signal the load bank controller to initiate the load bank when the engine control module initiates regeneration to clean the DPF. In such a "regeneration scenario" or "regeneration case," as it is referred to here, the generator controller will signal the load bank controller to initiate the load bank, thus providing a minimum load for the system in order to maintain an engine exhaust temperature necessary for the DPF regeneration to effectively clean the DPF.

In accordance with some embodiments of the disclosed technology, the generator controller will monitor engine idle time. In a configuration disclosed here as "excessive idle control," the generator controller may be configured with a pre-set maximum allowed idle time. If the maximum idle time is reached—a condition referred to here as an "excessive idle scenario" or an "excessive idle case"—the generator controller will signal the load bank controller to initiate the load bank. The system will then be required to complete a load cycle, as described above, before resuming idle speeds. If a user attempts to disrupt the load cycle, the generator controller will initiate a warning to the user. If a user nonetheless disrupts the load cycle, the generator controller will disable the system and will not allow operation until a load cycle has been completed at full engine speed. The load under which the generator operates during the load cycle could include any combination of real load and dummy load levels, as long as P_G is maintained. In accordance with some embodiments, for every three (3) hour period of engine idle time, the engine must complete a load cycle of one (1) hour.

In accordance with some embodiments of the disclosed technology, the generator controller may be configured with what is disclosed here as a "load dump" feature. In such a configuration, the generator controller signals the load bank controller to disconnect, or dump, the load bank if the generator controller and/or load bank recognizes a "load spike" of monitored load. Load spike, as used here, is a scenario in which the load connected to the engine-generator exceeds some pre-set value.

In accordance with some embodiments of the disclosed technology, the generator controller controls the load bank directly, thus obviating the need for a separate load bank controller.

In accordance with some embodiments of the disclosed technology, the system may be equipped with remote monitoring.

In accordance with some embodiments of the disclosed technology, the generator controller is configured with a manual setting. In the manual setting, the load bank may be engaged or disengaged by manual operation. In the manual setting, an operator may manually direct the controller to increase or decrease total resistance of the load bank.

In accordance with some embodiments of the disclosed technology, the load bank may be completely disabled and locked out of operation. In such a state, the total load of the generator is equal to the real load.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1**A is a single-line diagram of an embodiment of the disclosed system.

FIG. **1**B is a single-line diagram of an embodiment of the disclosed system.

FIG. **2** is a flow chart depicting an operating configuration of an embodiment of the disclosed system.

FIG. **3** is a block diagram depicting a method of operating embodiments of the disclosed system.

DETAILED DESCRIPTION

Reference will now be made in detail to embodiments, examples of which are illustrated in the accompanying drawings. In the following detailed description, numerous specific details are set forth in order to provide a thorough understanding of the disclosed concepts. It will, however, be apparent to one of ordinary skill in the art that the disclosed concepts may be practiced without these specific details. Well-known methods, procedures, components, circuits, and networks have not been described in detail so as not to unnecessarily obscure aspects of the embodiments.

FIG. **1**A depicts an engine-generator and load bank system **10** comprising an engine **12** mechanically connected and configured to drive an alternator **14**. This combination is referred to as an engine-generator. The generator portion of the engine-generator, or alternator **14**, is connected to an output bus **16**, which is connected to a real load **17**, and a load bank bus **18**, which is connected to a load bank **19**. The output bus **16** and load bank bus **18** are connected to the alternator **14** by way of disconnects **21**. The disconnects **21** could comprise circuit breakers or fused switches.

The alternator **14** may be sized and configured for a variety of rated output. In some embodiments, the alternator **14** is adjustable to provide a variety of voltage outputs as selected by a user. The alternator **14** may be single-phase or polyphase; and it may be rated for a variety of operating frequencies. In one embodiment, the alternator **14** is rated 240Y/139 V, three-phase, four-wire, 60 Hz, and is adjustable for operation at 208Y/120 V. In one embodiment, the alternator **14** is rated 480Y/277 V, three-phase, four-wire, 60 Hz.

The engine **12** is equipped with an engine control module **20** and a diesel particulate filter (DPF) **22**. The system **10** also

has at least one load monitoring device **24** that is in electrical communication with the output bus **16** and the load bank bus **18**. The load monitoring device **24** could be any piece or combination of electrical metering equipment suitable for gathering and communicating data about system voltage, current, and/or power. In a preferred embodiment, the load monitoring device **24** comprises current transformers.

The system **10** comprises a generator controller **26** which is connected to the engine control module **20** via a communication means **27**. The communication means **27** could be any communication bus suitable for communication between, and for diagnostics of engine components. In a preferred embodiment, the communication means **27** comprises SAE J1939-based protocol.

The generator controller **26** has a load dump output **28** and a load enable output **30**. The system **10** also includes a load bank controller **32** which has a load enable input **34**, a load dump input **36**, and a load sensor **38**. The load sensor **38** is connected to and accepts an input from the load monitoring device **24** for monitoring the combined load of the real load **17** and the load bank **19**.

The load bank controller **32** is also equipped with at least one load step output **40**. The load bank controller **32** could have one or a plurality of load step outputs **40**. The at least one load step output **40** is connected to at least one load step contactor **42**, which control(s) the electrical connection of at least one load step resistor **44** to the load bank bus **18**. The output bus **16**, load bank bus **18**, and load step resistor(s) **44** may be single- or poly-phase, as required for operation with the configuration of the alternator **14**. In a preferred embodiment, the load bank controller **32** is equipped with four load step outputs **40**. In a preferred embodiment, there are four (4) load step resistors **44**, each rated 25 kW at 480 V, such that the total rated resistance of the load bank **19** is 100 kW at 480 V, with a power factor of 1.0.

In one embodiment, the engine **12**, which is equipped with a radiator, and alternator **14** are mounted within one enclosure, and the load bank **19** is mounted within a separate enclosure that is physically connected to the engine-generator enclosure adjacent to the radiator of the engine **12**. In such an embodiment, the radiator of the engine **12** forces air over the load step resistor(s) **44**. In another embodiment, the load bank **19** is remotely located, and it is physically connected to the engine **12** and alternator **14** only to the extent necessary to facilitate electrical communication and control. In another embodiment, the load bank **19**, the engine **12**, and the alternator **14** are configured on a common base, which could include a common trailer or skid, within a single enclosure.

The system **10** may also be equipped with a remote communications module **46** and an antenna **48**. The remote communications module **46** could comprise terrestrial wireless or satellite communications technology, or a combination of both, in tandem or redundantly. The remote communications module **46** allows the system **10** to periodically, or on demand, transmit data that may be monitored. Such data may include the status of the engine **12**, the DPF **22**, and the load bank **19**. The remote communications module **46** could also be equipped with means for transmitting a location via a global positioning system (GPS), or the like. The remote communications module **46** may also be equipped to receive data and relay it to the generator controller **26** for remote control of the system **10**. In one embodiment of the system **10** equipped with a remote communications module **46**, a fault condition in any portion of the system **10** will cause an alert to be sent to an operator via phone text message (SMS) or via electronic mail.

Specific data transmitted by the remote communications module **46** may include: the fuel level of the engine **12** in a range from 0 to 100%; the fuel consumption rate of the engine **12** in gallons per hour; oil pressure of the engine **12** in pounds per square inch; temperature of the coolant in the engine **12** in degrees Fahrenheit or degrees Celsius; the on/off status of the DPF **22**; the soot level of the DPF **22**; whether the DPF **22** regeneration function has been inhibited or disabled; the temperature of the exhaust of the engine **12** at various points within engine **12**; the operating status of the load bank **19**, and whether the load bank **19** has correctly responded to a demand request from the generator controller **26**.

FIG. **1**B depicts an embodiment of an engine-generator and load bank system **10** comprising an engine **12** mechanically connected and configured to drive an alternator **14**. The alternator **14** is connected to an output bus **16**, which is connected to a real load **17**, and a load bank bus **18**, which is connected to a load bank **19**. The outputs bus **16** and load bank bus **18** are connected to the alternator by way of disconnects **21**, which could comprise circuit breakers or fused switches. In such an embodiment, the alternator **14** may be sized and configured as described above.

In the embodiment of FIG. **1**B, the engine **12** is equipped with an engine control module **20** and a DPF **22**. The system **10** comprises a generator controller **26** that is connected to the engine **12** via a communication means **27**, which could be any suitable communication bus as described above. The generator controller **26** is equipped with at least one load step output **40**; it could have one or a plurality of load step outputs **40**. The load step output(s) **40** is/are connected to one or more load step contactor(s) **42**, which control the electrical connection of at least one load step resistor **44** to the load bank bus **18**. The electrical system of such an embodiment may be single- or poly-phase, as described above.

In the embodiment of FIG. **1**B, the generator controller **26** monitors the loading of the alternator **14** by extrapolation. The generator controller **26** receives engine operation information from the engine control module **20** via the communication means **27**, which information the generator controller **26** uses to determine loading conditions of alternator **14**. The generator controller **26** then directly controls the load bank **19** by way of the load step output(s) **40** and load step contactor(s) **42** as necessary in cases of neglect, regeneration, and excessive idle.

FIG. **2** depicts a control system that the generator controller **26** may employ to control the system **10**. The generator controller **26** first evaluates generator operating status **50** to determine if the engine **12** is in an acceptable operating condition **52**. Whether the engine **12** is in an acceptable operating condition is a function of whether a neglect scenario or excessive idle scenario is present. Cases of neglect and excessive idle correspond to an engine **12** being in an unacceptable operating condition. Further, whether the engine **12** is in an acceptable operating condition depends on whether the exhaust temperature is sufficient to provide for effective regeneration. If the exhaust temperature is too low for effective regeneration, and if the engine **12** is in a regeneration scenario, the engine is not in an acceptable operating condition.

If the engine **12** is in an acceptable operating condition, the load bank **19** is or remains disconnected **54**. If the engine **12** is not in an acceptable operating condition, the generator controller **26** determines whether the engine **12** has operated in an unacceptable state for a pre-set time **56**. If the engine **12** has operated in an unacceptable condition for a pre-set time, the load bank **19** is connected **58**. That is, the generator controller **26** signals the load bank controller **32** via the load enable output **30** and load enable input **34** to initiate the load

bank **19** by way of the load step output **40** and the load step contactor(s) **42**. Or, in an embodiment without a load bank controller **32**, the generator controller **26** controls the load bank **19** directly. The load bank **19** is then operated as described supra. If the engine **12** has not operated in an unacceptable condition for a pre-set time, the load bank **19** is or remains disconnected **54**.

Once the load bank **19** is connected, it remains connected for a pre-set time, as required for a load cycle. While the load bank **19** is connected, the generator controller **26** and/or the load bank controller **32** determine whether a load spike is present **60**. If a load spike is present, the generator controller **26** effects a load dump by signaling the load bank controller **32**, either directly or via load dump output **28** and load dump input **36**, so that the load bank **19** is disconnected **54**. If a load spike is not present, the generator controller **26** determines whether the load cycle is complete **64**. If the load cycle is complete, the evaluation begins anew **50**. If the load cycle is not complete, the load cycle will resume upon restarting **62** the system **10**.

FIG. **3** depicts a method of operating the system **10** by configuring the generator controller **26**. The method involves first setting a rated operating load **68**. Then, it requires setting: a load window **70**, a duration **72**, a max idle time **74**, and a minimum acceptable load **76** for DPF regeneration. Next, it involves monitoring: the load **78**, idle time **80**, and regeneration status **82**. Then, it involves initiating a load cycle **84** when monitored conditions reach set points that correspond to cases of neglect, regeneration, or excessive idle. Finally, it involves dumping the load bank **86** in the presence of a load spike.

The foregoing description, for purpose of explanation, has been described with reference to specific embodiments. The illustrative discussion above, however, is not intended to be exhaustive or to limit the disclosed concepts to any particular form. The embodiments were chosen and described in order to best explain the principles of the disclosed concepts in order to enable others skilled in the art.

What is claimed is:

1. An engine-generator and load bank system comprising:

an engine mechanically connected to and capable of driving an alternator;

said engine having an engine control module and a particulate filter;

said alternator in electrical communication with an output bus and a load bank bus;

at least one load monitoring device in electrical communication with said output and load bank buses;

a generator controller comprising a load dump output and a load enable output, said generator controller in electrical communication with said engine control module;

a load bank controller comprising a load enable input, a load dump input, a load sensor, and at least one load step output;

said load dump output in electrical communication with said load dump input;

said load enable output in electrical communication with said load enable input;

said load monitoring device in electrical communication with said load sensor;

at least one load step contactor in electrical communication with said at least one load step output; and

at least one load step resistor in electrical communication with said load bank bus by way of said at least one load step contactor;

wherein said generator controller provides a control signal via said load enable output in at least one of the following cases: neglect and regeneration; and

wherein said generator controller provides a control signal via said load dump output in case of a load spike.

2. The engine-generator and load bank system of claim **1** wherein the generator controller is further configured with excessive idle control.

3. The engine-generator and load bank system of claim **1** comprising one load step resistor.

4. The engine-generator and load bank system of claim **1** comprising a plurality of load step resistors.

5. The engine-generator and load bank system of claim **1** which further comprises a remote communication module and antenna.

6. The engine-generator and load bank system of claim **5** wherein the remote communications module communicates via satellite.

7. The engine-generator and load bank system of claim **5** wherein the remote communications module communicates via a terrestrial wireless network.

8. The engine-generator and load bank system of claim **1** wherein the engine is a diesel engine.

9. The engine-generator and load bank system of claim **1** wherein the engine is a Tier IV Interim or newer diesel engine.

10. The engine-generator and load bank system of claim **1** wherein said alternator, output bus, load bank bus, and at least one load step resistor comprise a poly-phase electrical system.

11. The engine-generator and load bank system of claim **1** wherein said alternator, output bus, load bank bus, and at least one load step resistor comprise a three-phase electrical system.

12. The engine-generator and load bank system of claim **1** which further comprises a common base and enclosure.

13. The engine-generator and load bank system of claim **1** wherein said at least one load step resistor is physically located in an enclosure connected to the radiator of said engine.

14. The engine-generator and load bank system of claim **1** wherein said at least one load step resistor is located remotely from said engine-generator.

15. The engine-generator and load bank system of claim **1** wherein the generator controller and engine control module are configured to communicate via SAE J1939 protocol.

16. The engine-generator and load bank system of claim **1** wherein the generator controller is configured to provide said control signal to said load dump output within 10 seconds.

17. The engine-generator and load bank system of claim **1** wherein the generator controller is configured to provide said control signal to said load dump output within 1 second.

18. The engine-generator and load bank system of claim **1** wherein the generator controller is configured to provide said control signal to said load dump output within 0.1 second.

19. An engine-generator and load bank system comprising:

an engine mechanically connected to and capable of driving an alternator;

said engine having an engine control module and a particulate filter;

said alternator in electrical communication with an output bus and a load bank bus;

a generator controller in electrical communication with said engine control module, said generator controller having at least one load step output;

at least one load step contactor in electrical communication with said at least one load step output; and

at least one load step resistor in electrical communication with said load bank bus by way of said at least one load step contactor;

wherein said generator controller is capable of operating said load step contactor to connect said load step resistor in at least one of the following cases: neglect and regeneration; and

wherein said generator controller is capable of operating said load step contactor to disconnect said load step resistor in case of a load spike.

20. The engine-generator and load bank system of claim **19** wherein the generator controller is further configured with excessive idle control.

21. The engine-generator and load bank system of claim **19** comprising one load step resistor.

22. The engine-generator and load bank system of claim **19** comprising a plurality of load step resistors.

23. The engine-generator and load bank system of claim **19** which further comprises a remote communication module and antenna.

24. The engine-generator and load bank system of claim **23** wherein the remote communications module communicates via satellite.

25. The engine-generator and load bank system of claim **23** wherein the remote communications module communicates via a terrestrial wireless network.

26. The engine-generator and load bank system of claim **19** wherein the engine is a diesel engine.

27. The engine-generator and load bank system of claim **19** wherein the engine is a Tier IV Interim or newer diesel engine.

28. The engine-generator and load bank system of claim **19** wherein said alternator, output bus, load bank bus, and at least one load step resistor comprise a poly-phase electrical system.

29. The engine-generator and load bank system of claim **19** wherein said alternator, output bus, load bank bus, and at least one load step resistor comprise a three-phase electrical system.

30. The engine-generator and load bank system of claim **19** which further comprises a common base and enclosure.

31. The engine-generator and load bank system of claim **19** wherein said at least one load step resistor is physically located in an enclosure connected to the radiator of said engine.

32. The engine-generator and load bank system of claim **19** wherein said at least one load step resistor is located remotely from said engine-generator.

33. The engine-generator and load bank system of claim **19** wherein the generator controller and engine control module are configured to communicate via SAE J1939 protocol.

34. The engine-generator and load bank system of claim **19** wherein the generator controller is configured to operate said load step contactor to disconnect said load step resistor within 10 seconds.

35. The engine-generator and load bank system of claim **19** wherein the generator controller is configured to operate said load step contactor to disconnect said load step resistor within 1 seconds.

36. The engine-generator and load bank system of claim **19** wherein the generator controller is configured to operate said load step contactor to disconnect said load step resistor within 0.1 seconds.

37. A method for operating an engine-generator and load bank system with a generator controller and an engine control module, the generator controller configured with logic and hardware to control the load bank, the method comprising the following steps:

a. setting a rated operating load;

b. setting a load window bounded by a low load and an upper load in said generator controller;

c. setting a duration in said generator controller;

d. setting a minimum acceptable load corresponding to optimal engine exhaust temperature for regeneration;

e. monitoring connected load of said engine-generator;

f. monitoring regeneration of said engine-generator with said engine control module;

g. activating said load bank if said generator operates in a neglect scenario as defined by said window and said duration;

h. activating said load bank if said connected load is less than said minimum acceptable load and said engine-generator initiates regeneration; and

i. dumping said load bank if a load spike is detected.

38. The method of claim **37** that further comprises the steps of:

a. setting an maximum idle time;

b. monitoring idle time of said engine control module; and

c. initiating a load cycle if said idle time corresponds to maximum idle time.

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