(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
16 July 2009 (16.07.2009)

PCT

(10) International Publication Number
WO 2009/088437 A1

(51) International Patent Classification:
G06F 19/00 (2006.01)

(21) International Application Number:
PCT/US2008/013939

(22) International Filing Date:
17 December 2008 (17.12.2008)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:

12/006,268	31 December 2007 (31.12.2007)	US
12/006,262	31 December 2007 (31.12.2007)	US
12/006,274	31 December 2007 (31.12.2007)	US
12/006,237	31 December 2007 (31.12.2007)	US

(71) Applicant *(for all designated States except US)*: **SEARETE LLC** [US/US]; 1756 114th Ave. SE, Ste. 110, Bellevue, Washington 98004 (US).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: **HYDE, Roderick, A.** [US/US]; 9915 - 161st Avenue N.E., Redmond, WA 98052 (US). **ISHIKAWA, Muriel, Y.** [US/US]; 1185 Hillcrest Avenue, Livermore, CA 94550-4921 (US). **KARE, Jordin, T.** [US/US]; 908 15th Ave. East, Seattle, WA 98112 (US). **NUGENT, Thomas, J., Jr.** [US/US]; 4263 181st Place S.E., Issaquah, Washington 98027 (US). **WOOD, Lowell, L., Jr.** [US/US]; 989 112th Avenue NE #2310, Bellevue, WA 98004 (US). **WOOD, Victoria, Y.H.** [US/US]; 1185 Hillcrest Avenue, Livermore, CA 94550-4921 (US).

(74) Agents: **MALASKA, Stephen, L.** et al.; 1756 114th Ave. S.E., Suite 110, Bellevue, WA 98004 (US).

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

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MT, NL,

[Continued on next page]

(54) Title: SYSTEM AND METHOD FOR REMOTELY MODIFYING VEHICLE OPERATIONS

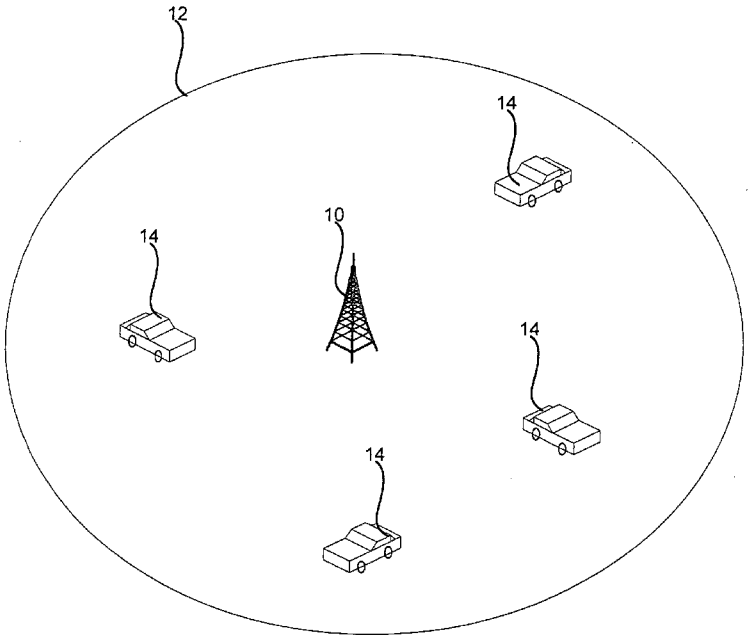


FIG. 1

(57) Abstract: A method and control system for controlling an engine in a vehicle includes broadcasting a control signal including instructions for modification of a vehicle parameter to the vehicle during operation of the engine.

WO 2009/088437 A1

NO, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report*

System and Method for Remotely Modifying Vehicle Operations

Inventor(s):
Roderick A. Hyde
Muriel Y. Ishikawa
Jordin T. Kare
Thomas J. Nugent, Jr.
Lowell L. Wood, Jr.
Victoria Y.H. Wood

SUMMARY

In one aspect, a method of controlling an engine in a vehicle includes broadcasting a control signal to the vehicle during operation of the engine, the signal including instructions for modification of a vehicle operating parameter (*e.g.*, compression ratio, timing of commencement of fuel combustion, timing of fuel injection, timing of fuel introduction into an air-inlet stream, valve timing, fuel composition, fuel-oxidizer ratio, air inlet temperature, air inlet pressure, number of operating cylinders, battery usage, battery charge, engine or drive-train usage of electrical energy, engine operating rate, output torque, exhaust gas temperature, exhaust gas temperature profile, exhaust gas composition, exhaust gas back pressure, catalytic converter reactive area, exhaust gas flow path, catalyst selection, sequestration of at least one exhaust gas component, exhaust gas flow rate, exhaust particulates density, exhaust particulate composition, exhaust particulate size, concentration of exhaust components at a selected location in an exhaust flow path, coolant temperature, or inlet-exhaust thermal coupling). Broadcasting a control

signal may include sending an electromagnetic control signal (*e.g.*, a wireless signal), an optical control signal, or an acoustic control signal. The control signal may be broadcast to a plurality of vehicles, or a second control signal may be broadcast to a second vehicle. The method may further include receiving an acknowledgement signal from the vehicle (*e.g.*, a signal including identifying information, location, information about the vehicle operating parameter such as changes made in response to the control signal, or information about other vehicle operating parameter(s)). A control signal may be selected for broadcast responsive to one or more acknowledgement signals. The method may further include transmitting information about the acknowledgement signal or the control signal to a remote compliance system. Broadcasting may include broadcasting verifying information selected to allow the vehicle to determine authenticity of the control signal. The method may include determining an identifying property of the vehicle, for example by receiving an identifying signal from the vehicle, where selecting the control signal is in response to the identifying property (*e.g.*, car make, car model, engine type, exhaust type, vehicle identification number, license number, location, settings of the engine control unit, or fuel type). The control signal may include a first set of instructions for a vehicle having a first characteristic (*e.g.*, vehicle type or vehicle operating parameter), and a second set of instructions for a vehicle having a second characteristic. The control signal may include instructions to select one member of a group of preprogrammed instruction sets. The control signal may be selected probabilistically, or may include a condition for performing the instructions such as a probabilistic condition. Instructions for modification of the vehicle operating parameter may include a designated value, designated range, designated average value within a time interval, or designated time profile for the vehicle operating parameter, or may include instructions for modification of a plurality of vehicle operating parameters. Instructions may be at least partially based on previous compliance history for the vehicle. The control signal may be selected responsive to an environmental parameter (*e.g.*, temperature, pressure, partial pressure of an atmospheric component, local level of a selected pollutant, local insolation values, humidity, precipitation, wind conditions, road cover conditions, time, traffic

conditions, local rules, altitude, or local level of CO, CO_2, NO_x, O_3, or airborne particulates), including a predicted environmental parameter.

In another aspect, a control system for controlling an operating parameter of vehicles in a target area includes a control signal broadcast unit configured to broadcast a control signal (*e.g.*, an electromagnetic control signal such as a wireless signal, an optical control signal, or an acoustic control signal) including instructions for modification of a vehicle operating parameter (*e.g.*, compression ratio, timing of commencement of fuel combustion, timing of fuel injection, timing of fuel introduction into an air-inlet stream, valve timing, fuel composition, fuel-oxidizer ratio, air inlet temperature, air inlet pressure, number of operating cylinders, battery usage, battery charge, engine or drive-train usage of electrical energy, engine operating rate, output torque, exhaust gas temperature, exhaust gas temperature profile, exhaust gas composition, exhaust gas back pressure, catalytic converter reactive area, exhaust gas flow path, catalyst selection, sequestration of at least one exhaust gas component, exhaust gas flow rate, exhaust particulates density, exhaust particulate composition, exhaust particulate size, concentration of exhaust components at a selected location in an exhaust flow path, coolant temperature, or inlet-exhaust thermal coupling) to at least one vehicle in the target area. The control system may further include a signal determination unit configured to select instructions for modification of the vehicle operating parameter for incorporation into the control signal. The signal determination unit may be, for example, configured to allow an operator to select the vehicle operating parameter, to use a lookup table to determine a permitted value or range of values for the vehicle operating parameter, or to select a permitted value or range of values for the vehicle operating parameter in response to an environmental condition (*e.g.*, temperature, pressure, partial pressure of an atmospheric component, local level of a selected pollutant, local insolation values, humidity, precipitation, wind conditions, road cover conditions, time, traffic conditions, local rules, altitude, or local level of CO, CO_2, NO_x, O_3, or airborne particulates), including a predicted environmental condition. The control signal broadcast unit may be configured to broadcast a control signal including instructions conditional on a vehicle characteristic (*e.g.*, vehicle type or one or more vehicle

operating parameters. It may be configured to broadcast a control signal including instructions to select one member of a group of preprogrammed instruction sets. The control signal may be selected probabilistically, or may include a condition for performing the instructions such as a probabilistic condition. Instructions for modification of the vehicle operating parameter may include a designated value, designated range, designated average value within a time interval, or designated time profile for the vehicle operating parameter, or may include instructions for modification of a plurality of vehicle operating parameters. Instructions may be at least partially based on previous compliance history for the vehicle. The control system may further include an acknowledgement signal receiving unit configured to receive an acknowledgement signal from the vehicle (*e.g.*, a signal including identifying information, location, information about the vehicle operating parameter such as compliance actions taken, or information about other vehicle operating parameter(s)). The control system may further include a compliance transmitter configured to transmit information about the control signal or the acknowledgement signal to a remote compliance system. A control signal may be selected for broadcast responsive to one or more acknowledgement signals. The control system may include a vehicle identification units configured to determine a property of the vehicle, for example by receiving an identification signal, the control signal broadcast unit being configured to broadcast the control signal responsive to the determined vehicle property (*e.g.*, car make, car model, engine type, exhaust type, vehicle identification number, license number, location, settings of the engine control unit, or fuel type). The control signal may include verifying information selected to allow the vehicle to determine authenticity of the control signal.

In yet another aspect, a method of operating a vehicle having an engine includes, during operation of the engine, receiving a control signal (*e.g.*, an electromagnetic control signal such as a wireless signal, an optical control signal, or an acoustic control signal) broadcast from outside the vehicle, the control signal including instructions for modification of a vehicle operating parameter (*e.g.*, compression ratio, timing of commencement of fuel combustion, timing of fuel injection, timing of fuel introduction into an air-inlet stream, valve timing, fuel

composition, fuel-oxidizer ratio, air inlet temperature, air inlet pressure, number of operating cylinders, battery usage, battery charge, engine or drive-train usage of electrical energy, engine operating rate, output torque, exhaust gas temperature, exhaust gas temperature profile, exhaust gas composition, exhaust gas back pressure, catalytic converter reactive area, exhaust gas flow path, catalyst selection, sequestration of at least one exhaust gas component, exhaust gas flow rate, exhaust particulates density, exhaust particulate composition, exhaust particulate size, concentration of exhaust components at a selected location in an exhaust flow path, coolant temperature, or inlet-exhaust thermal coupling), and modifying the vehicle operating parameter in accordance with the instructions. The method may further including sending an acknowledgement signal in response to receiving a control signal, which may include, for example, information about the vehicle operating parameter, information about the modification of the vehicle operating parameter, information about identity of the vehicle, or information about one or more vehicle operating parameters. The method may further include sending an identifying signal characterizing a property of the vehicle (*e.g.*, car make, car model, engine type, exhaust type, vehicle identification number, license number, location, settings of the engine control unit, or fuel type). Modifying the vehicle operating parameter in accordance with the instructions may include determining applicable portions of a signal conditional on a vehicle characteristic (*e.g.*, vehicle type or one or more vehicle operating parameters) and modifying the vehicle operating parameter in accordance only with the applicable portions of the signal. Modifying the vehicle operating parameter may include selecting one of a plurality of preprogrammed instruction sets, or may include determining whether a condition included in the instructions obtains (*e.g.*, a probabilistic condition) and modifying the vehicle operating parameter only if the condition obtains. Modifying the vehicle operating parameter may include maintaining a designated value, designated range, designated average value within a time interval, or designated time profile for the vehicle operating parameter, or may include modifying a plurality of vehicle operating parameters. The method may further include verifying authenticity of the control signal, for example before modifying the vehicle operating parameter.

In still another aspect, an engine control system for a vehicle having an engine includes a control signal receiving unit configured to receive a control signal (*e.g.*, an electromagnetic control signal such as a wireless signal, an optical control signal, or an acoustic control signal) broadcast from outside the vehicle during engine operation, the control signal including instructions for modification of a vehicle operating parameter (*e.g.*, compression ratio, timing of commencement of fuel combustion, timing of fuel injection, timing of fuel introduction into an air-inlet stream, valve timing, fuel composition, fuel-oxidizer ratio, air inlet temperature, air inlet pressure, number of operating cylinders, battery usage, battery charge, engine or drive-train usage of electrical energy, engine operating rate, output torque, exhaust gas temperature, exhaust gas temperature profile, exhaust gas composition, exhaust gas back pressure, catalytic converter reactive area, exhaust gas flow path, catalyst selection, sequestration of at least one exhaust gas component, exhaust gas flow rate, exhaust particulates density, exhaust particulate composition, exhaust particulate size, concentration of exhaust components at a selected location in an exhaust flow path, coolant temperature, or inlet-exhaust thermal coupling), and an engine controller configured to modify the vehicle operating parameter in accordance with the instructions. The engine control system may further include an acknowledgement signal sending unit configured to send an acknowledgement signal, for example indicating any modification of the vehicle operating parameter responsive to the control signal, indicating identity of the vehicle, indicating location of the vehicle, or indicating state or history of one or more vehicle operating parameters. The control signal receiving unit may be configured to determine authenticity of the control signal. It may be configured to receive a plurality of instruction sets, and to select at least one of the plurality corresponding to a characteristic of the vehicle (*e.g.*, vehicle type or a vehicle operating parameter). It may be configured to receive an instruction to select one of a group of preprogrammed instruction sets, or to receive a conditional signal and to determine if the condition (*e.g.*, a probabilistic condition) obtains, and to direct the engine controller to comply with the signal instructions only if the condition obtains. The engine controller may be configured to maintain a designated value, designated range, designated average value within a time interval, or

designated time profile for the vehicle operating parameter, or to modify a plurality of vehicle operating parameters.

In yet still another aspect, an exhaust control system for a vehicle having an engine and an exhaust system includes an exhaust controller configured to determine an acceptable range for an exhaust parameter responsive to an ambient condition (*e.g.*, temperature, pressure, partial pressure of an atmospheric component, local level of a selected pollutant, local insolation values, humidity, precipitation, wind conditions, road cover conditions, traffic conditions, local rules, altitude, or location, any of which may be a predicted value), and to direct the exhaust system to maintain the exhaust parameter within the acceptable range, the exhaust parameter being selected from the group consisting of exhaust gas temperature, exhaust gas temperature profile, exhaust gas composition, exhaust gas back pressure, catalytic converter reactive area, exhaust gas flow path, catalyst selection, sequestration of at least one exhaust gas component, exhaust gas flow rate, exhaust particulates density, exhaust particulate composition, exhaust particulate size, concentration of exhaust components at a selected location in an exhaust flow path, coolant temperature, and inlet-exhaust thermal coupling. The system may further include a compliance reporting unit configured to transmit a record of exhaust parameter adjustments (*e.g.*, by wireless transmission). The system may further include an exhaust parameter sensor, the exhaust controller being configured to accept a sensor signal from the exhaust parameter sensor indicative of the state of the exhaust parameter and to use the sensor signal to direct the exhaust system to maintain the exhaust parameter within the acceptable range. Sensors may be, for example, electromagnetic sensors, spectroscopic sensors, thermal sensors, chemical sensors, pressure sensors, acoustic sensors, vibration sensors, mass sensors, electromechanical sensors, electrochemical sensors, microelectromechanical devices, or optical sensors, and may be configured to measure temperature, pressure, gas composition, vapor composition, particulate content, particulate composition, particulate size distribution, flow rate, density, force, strain, or displacement. The sensor may be internal or external to the vehicle. The exhaust controller may be configured to determine an acceptable range for an exhaust parameter responsive to an ambient condition by selecting from a set of

exhaust profiles. The acceptable range for the exhaust parameter may include an acceptable range for a time-averaged value of the exhaust parameter during a time interval, an acceptable range for a designated function of the exhaust parameter, an acceptable range for a second exhaust parameter, or an acceptable range for a designated function of a plurality of exhaust parameters, an acceptable range for the value of the exhaust parameter during a probability weighted time interval, or a time profile for the acceptable range for the exhaust parameter.

In a further aspect, a vehicle control system for a vehicle having an engine and an exhaust system includes an exhaust controller configured to determine an acceptable range for a vehicle parameter for a selected local time period and to direct the vehicle to maintain the vehicle parameter within the acceptable range during the selected local time period, the vehicle parameter being selected from the group consisting of compression ratio, timing of commencement of fuel combustion, timing of fuel injection, timing of fuel introduction into an air-inlet stream, valve timing, fuel composition, fuel-oxidizer ratio, air inlet temperature, air inlet pressure, number of operating cylinders, battery usage, battery charge, engine or drive-train usage of electrical energy, engine operating rate, output torque, exhaust gas temperature, exhaust gas temperature profile, exhaust gas composition, exhaust gas back pressure, catalytic converter reactive area, exhaust gas flow path, catalyst selection, sequestration of at least one exhaust gas component, exhaust gas flow rate, exhaust particulates density, exhaust particulate composition, exhaust particulate size, concentration of exhaust components at a selected location in an exhaust flow path, coolant temperature, and inlet-exhaust thermal coupling. The vehicle may be configured to determine the acceptable range for the vehicle parameter for the selected local time period based at least in part on vehicle location. The vehicle control system may further include a compliance reporting unit configured to transmit a record of vehicle parameter adjustments (*e.g.*, by a wireless transmission). The vehicle controller may include an internal clock, or may be configured to determine time from an external signal.

In yet a further aspect, a method of controlling an exhaust system in a vehicle includes determining an ambient condition (*e.g.*, temperature, pressure, partial

pressure of an atmospheric component, local level of a selected pollutant, local insolation values, humidity, precipitation, wind conditions, road cover conditions, traffic conditions, local rules, altitude, or location) and, responsive to the ambient condition, adjusting an exhaust parameter of the exhaust system selected from the group consisting of exhaust gas temperature, exhaust gas temperature profile, exhaust gas composition, exhaust gas back pressure, catalytic converter reactive area, exhaust gas flow path, catalyst selection, sequestration of at least one exhaust gas component, exhaust gas flow rate, exhaust particulates density, exhaust particulate composition, exhaust particulate size, concentration of exhaust components at a selected location in an exhaust flow path, coolant temperature, and inlet-exhaust thermal coupling. The method may further include transmitting a record of the adjusting of the exhaust parameter (*e.g.*, by wireless transmission).

In still a further aspect, a method of controlling a vehicle includes, responsive to local time, adjusting a vehicle parameter of the vehicle selected from the group consisting of compression ratio, timing of commencement of fuel combustion, timing of fuel injection, timing of fuel introduction into an air-inlet stream, valve timing, fuel composition, fuel-oxidizer ratio, air inlet temperature, air inlet pressure, number of operating cylinders, battery usage, battery charge, engine or drive-train usage of electrical energy, engine operating rate, output torque, exhaust gas temperature, exhaust gas temperature profile, exhaust gas composition, exhaust gas back pressure, catalytic converter reactive area, exhaust gas flow path, catalyst selection, sequestration of at least one exhaust gas component, exhaust gas flow rate, exhaust particulates density, exhaust particulate composition, exhaust particulate size, concentration of exhaust components at a selected location in an exhaust flow path, coolant temperature, and inlet-exhaust thermal coupling. The method may further include transmitting a record of the adjusting of the vehicle parameter (*e.g.*, by wireless transmission).

In yet still a further aspect, an engine control system for a vehicle having an engine includes an engine controller configured to determine an acceptable range for an engine operating parameter responsive to traffic conditions and to direct the engine to maintain the engine operating parameter within the acceptable range, the engine

operating parameter being selected from the group consisting of compression ratio, timing of commencement of fuel combustion, timing of fuel injection, timing of fuel introduction into an air-inlet stream, valve timing, fuel composition, air inlet temperature, air inlet pressure, number of operating cylinders, battery usage, battery charge, engine or drive-train usage of electrical energy, engine operating rate, and output torque. The engine control system may further include a compliance reporting unit configured to transmit a record of engine operating parameter adjustments. The engine controller may be configured to receive a traffic condition signal from an external source (*e.g.*, a central repository of traffic information or another vehicle), or may be configured to monitor vehicle operation in order to determine traffic conditions.

In an additional aspect, a method of controlling a vehicle having an engine includes, responsive to traffic conditions, determining an acceptable range for an engine operating parameter and directing the engine to maintain the engine operating parameter within the acceptable range, the engine operating parameter selected from the group consisting of compression ratio, timing of commencement of fuel combustion, timing of fuel injection, timing of fuel introduction into an air-inlet stream, valve timing, fuel composition, air inlet temperature, air inlet pressure, number of operating cylinders, battery usage, battery charge, engine or drive-train usage of electrical energy, engine operating rate, and output torque. The method may further include transmitting a record of engine operating parameter adjustments (*e.g.*, wirelessly). The method may include receiving a traffic condition signal from an external source (*e.g.*, a central repository of traffic information or another vehicle), monitoring vehicle operation in order to determine traffic conditions.

The foregoing summary is illustrative only and is not intended to be in any way limiting. In addition to the illustrative aspects, embodiments, and features described above, further aspects, embodiments, and features will become apparent by reference to the drawings and the following detailed description.

BRIEF DESCRIPTION OF THE FIGURES

FIG. 1 is a schematic showing a control system for controlling vehicle emissions in a geographic area.

FIG. 2 is a schematic of a vehicle control system.

FIG. 3 is a schematic of an exhaust controller for a vehicle.

FIG. 4 is a schematic of a time-sensitive exhaust controller for a vehicle.

FIG. 5 is a schematic of a traffic-condition-responsive engine controller for a vehicle.

DETAILED DESCRIPTION

In the following detailed description, reference is made to the accompanying drawings, which form a part hereof. In the drawings, similar symbols typically identify similar components, unless context dictates otherwise. The illustrative embodiments described in the detailed description, drawings, and claims are not meant to be limiting. Other embodiments may be utilized, and other changes may be made, without departing from the spirit or scope of the subject matter presented here.

As used herein, the term "vehicle" encompasses devices for conveying persons or objects, including without limitation automobiles, trucks, trains, and other land conveyances, boats, ships, and other watergoing vessels, and aircraft. In some embodiments, vehicles may possess internal combustion engines, but conveyances using other sources of locomotive power are also encompassed in the term "vehicle".

FIG. 1 is a schematic showing a control system for controlling vehicle emissions in a geographic area. Control tower **10** broadcasts a control signal including instructions for modifying a vehicle operating parameter (*e.g.*, compression ratio, timing of commencement of fuel combustion, timing of fuel injection, timing of fuel introduction into an air-inlet stream, valve timing, fuel composition, fuel-oxidizer ratio, air inlet temperature, air inlet pressure, number of operating cylinders, battery usage, battery charge, engine or drive-train usage of electrical energy, engine operating rate, output torque, exhaust gas temperature, exhaust gas temperature profile, exhaust gas composition, exhaust gas back pressure, catalytic converter reactive area, exhaust gas flow path, catalyst selection, sequestration of at least one

exhaust gas component, exhaust gas flow rate, exhaust particulates density, exhaust particulate composition, exhaust particulate size, concentration of exhaust components at a selected location in an exhaust flow path, coolant temperature, or inlet-exhaust thermal couplingg) to vehicles **14** in a defined area **12** around the tower **10**. (In other embodiments, control tower **10** may be replaced by other systems that broadcast to vehicles in a selected area, such as a satellite communications system, a peer-to-peer network, a bucket-brigade network, or other means of communication between at least one central point and a vehicle.) Vehicles **14** receive the broadcast signal from control tower **10** and adjust their operating parameters to comply with the instructions. For example, a municipality may specify that within its boundaries, fuel-oxidizer ratios must be lean, and may erect one or more control towers **10** that broadcast signals instructing vehicles **14** to adjust their fuel injection systems to comply.

The instructions for the operating parameter may be adjusted according to ambient conditions (*e.g.*, temperature, pressure, partial pressure of an atmospheric component, local level of a selected pollutant, local insolation values such as local UV fraction, humidity, precipitation, wind conditions such as magnitude or direction, road cover conditions, time, traffic conditions, local rules, altitude, or local level of CO, CO_2, NO_x, O_3, or airborne particulates), including predicted ambient conditions. For example, richer fuel mixtures may be allowed when colder weather is predicted, or when local air pollution levels are found to be relatively low. Vehicles configured to run on more than one possible fuel composition may be directed which fuel to use, for example in response to ambient weather conditions or to traffic patterns.

The control signal broadcast by control tower **10** may be an electromagnetic signal (*e.g.*, a digital signal), an optical signal, or an acoustic signal. In some embodiments, the control tower **10** may broadcast a plurality of different signals, for example at the same time or in succession. For example, different signals may be intended for different vehicles or classes of vehicles, or for vehicles in different areas. The control tower **10** may also broadcast a conditional signal. For example, the signal may direct that if a vehicle has a certain property (*e.g.*, make, model, number of cylinders, fuel type, or other operating parameter), then it should operate with an

operating parameter in a particular range. The range may also be conditional on other vehicle properties or operating parameters. Vehicles **14** may transmit information about their properties or operating parameters to the control tower **10**. For example, a control tower may note that there are cars of three makes in its vicinity by reading their transmissions, and may then broadcast a signal tailored to those three makes, such as a conditional signal that specifies an operating parameter for each of those three makes. Rather than explicitly setting a value or range for an operating parameter, the control tower **10** may broadcast a signal directing the vehicle **14** to select from one or more preprogrammed instruction sets (*e.g.*, instructing the vehicle to switch to a carbon monoxide emission minimizing mode).

The control tower **10** may also select a control signal for broadcast probabilistically. For example, the control tower **10** may select every fourth vehicle (or a randomly selected 25%, or any other percentage) of vehicles to shift to a lower-emissions mode. The control signal may also include a condition for performing the functions. This condition may be deterministic (*e.g.*, if exhaust back pressure exceeds a threshold value, adjust compression ratios) or probabilistic (*e.g.*, generate a random or pseudorandom number between 0 and 1, and shift to a low-emissions mode if it exceeds 0.75).

In some embodiments, the control signal may include a designated value for the vehicle operating parameter. In other embodiments, the control signal may include a designated range, a designated average value, or a designated time profile for the vehicle operating parameter (*e.g.*, an instruction to run in a lower-emissions mode during a particular time interval). The control signal may include instructions for modifying a plurality of vehicle operating parameters. In some embodiments, the instructions may be at least partially based on previous compliance history for the vehicle (*e.g.*, sending more stringent instructions to vehicles that have not previously complied). The control tower **10** may also notify enforcement agents (*e.g.*, the local police) of noncompliance of specific vehicles or of the existence of a noncompliant vehicle in a particular area. Control signals to be sent may be generated by a signal determination unit (not shown), and may be determined automatically or by an operator (onsite or remote).

The control tower **10** may also receive an acknowledgement signal from one or more vehicles. The acknowledgement signal may include identifying information for the vehicle (*e.g.*, make or model of car, engine type, exhaust type, VIN, license number, or settings of the engine control unit), location information for the vehicle, information about one or more vehicle operating parameters (*e.g.*, values of one or more operating parameters, or information about changes made in a vehicle operating parameter in response to the control signal), or information about the received signal (*e.g.*, confirming that the signal was received correctly or identifying which signal was received). The control tower **10** may transmit information about the acknowledgement signal (*e.g.*, confirmation that the vehicle has complied with the control signal) or the control signal to a remote compliance system (not shown). The control tower **10** may select a control signal responsive to one or more acknowledgement signals (*e.g.*, the tower may adjust the control signals that it sends depending on the number or type of acknowledgement signals received).

The control tower **10** may further include a vehicle identification unit (not shown), which may be configured to determine a property of a vehicle (*e.g.*, make, model, engine type, exhaust type, VIN, license number, location, settings of the engine control unit, or fuel type). In some embodiments, the control signal may be determined at least in part based on the determined vehicle property.

In some embodiments, a vehicle **14** may verify authenticity of the control signal before modifying the vehicle operating parameter in accordance with its instructions. For example, the vehicle **14** may decrypt the signal, or may transmit a signal requesting that the control tower **10** broadcast an authentication sequence, or may recognize that the signal includes self-authenticating elements.

FIG. 2 is a schematic of a vehicle control system. Vehicle **14** includes an engine **20**, a control signal receiving unit **22**, and an engine controller **24**. It may also include acknowledgement signal sending unit **26** or optional sensors **28**, which may be configured to exchange information with engine controller **24** or acknowledgement signal sending unit **26**. Control signal receiving unit **22** is configured to receive a broadcast signal from outside the vehicle (*e.g.*, a control signal such as that sent by control tower **10** described herein). The broadcast signal includes instructions for

modifying a vehicle operating parameter. The receiving unit **22** then communicates with the engine controller **24**, which carries out the instructions.

In some embodiments, the receiving unit **22** may perform other functions, such as signal filtering. For example, a broadcast signal may not be applicable to all vehicles, and the receiving unit **22** may determine whether the signal is applicable and transmit the instructions to engine controller **24** only if they apply to vehicle **14**. The receiving unit may also include circuitry for determining whether the broadcast signal is authentic, and transmit the instructions to engine controller **24** only if they are determined to originate from a broadcaster with authority to direct the requested changes to vehicle operation. Receiving unit **22** or other components may also determine that vehicle **14** cannot safely comply with the received instructions, and may decline to transmit the instructions to engine controller **24** or may countermand previously transmitted instructions if compliance would be unsafe.

Engine controller **24** alters engine settings as necessary to comply with broadcast instructions. For example, in engines capable of running at a variable compression ratio, the broadcast signal may specify a particular compression ratio, in which case engine controller **24** directs engine **20** accordingly. Alternatively, the broadcast signal may specify that the compression ratio is to be adjusted to place some other operating parameter within a specific range, for example to specify that exhaust gas may contain no more than a selected quantity of NO_x. (It will be understood that while compression ratio is referred to in these examples, other vehicle operating parameters may also be used, including without limitation combustion timing, fuel composition, fuel-oxidizer ratio, exhaust temperature, exhaust temperature profile, exhaust gas mixture, exhaust gas back pressure, catalytic area, exhaust flow path, catalyst selection, number of operating cylinders, battery usage, engine usage of electrical energy, exhaust gas sequestration, inlet temperature, or inlet-exhaust thermal coupling. In particular, some examples of engines which may operate with variable compression ratios or variable numbers of operating cylinders may be found in copending and commonly owned US Application Nos. 11/973,297, filed October 4, 2007 and entitled "ELECTROMAGNETIC ENGINE," 11/973,343, filed October 5, 2007 and entitled "FREE PISTON ELECTROMAGNETIC

ENGINE," 11/973,640, filed October 9, 2007 and entitled "OPPOSED PISTON ELECTROMAGNETIC ENGINE," and 11/974,173, filed October 10, 2007 and entitled "METHOD OF RETROFITTING AN ENGINE," all of which are incorporated herein by reference.)

In some embodiments, the necessary modification of the engine operating parameter may be determined *a priori* by engine controller **24**. In other embodiments, engine controller **24** may receive information from optional sensors **28**. For example, gas sensors may provide information about exhaust composition, or temperature sensors may provide temperatures in different locations in the engine (*e.g.*, combustion temperature or exhaust temperature). This sensor information may be used as a feedback control for engine controller **24** to further adjust one or more engine operating parameters. Suitable sensors for use in these embodiments includewithout limitation sensors for properties of gases or liquids such as temperature, pressure, density, flow rate, or composition (*e.g.*, partial pressure sensors for specific gases), acoustic or vibration sensors, and force, strain, or displacement sensors for solid components. In some embodiments, sensors may be implemented using conventional electromechanical or electrochemical means (*e.g.*, strain gages, oxygen sensors), microelectromechanical (MEMS) devices, optical sensing (*e.g.*, absorption or emission spectrometers, optical thermometers) using free-space or fiber optics, or by other means.

The vehicle may also include optional acknowledgement signal sending unit **26**. This unit may be configured to communicate with engine controller **24** or sensors **28** (if present) and to transmit information about vehicle operation. For example, acknowledgement signal sending unit **26** may inform control tower **10** that its instructions have been complied with, may report any compliance actions taken, or may report engine controller settings, sensor data, or other vehicle status information such as location or vehicle operating parameter values or history.

FIG. 3 is a schematic of an exhaust controller **40** for a vehicle **42** having an engine **44** and an exhaust system **46**. The exhaust controller **40** may optionally be operatively linked to one or more ambient condition sensors **48** or exhaust parameter sensors **50**, a broadcast signal receiving unit **52**, or a compliance reporting unit **54**.

The exhaust controller **40** is configured to determine an acceptable range for an exhaust parameter (exhaust gas temperature, exhaust gas temperature profile, exhaust gas composition, exhaust gas back pressure, catalytic converter reactive area, exhaust gas flow path, catalyst selection, sequestration of at least one exhaust gas component, exhaust gas flow rate, exhaust particulates density, exhaust particulate composition, exhaust particulate size, concentration of exhaust components at a selected location in an exhaust flow path, coolant temperature, or inlet-exhaust thermal coupling) responsive to an ambient condition (*e.g.*, temperature, pressure, partial pressure of an atmospheric component, local level of a selected pollutant, local insolation values such as local UV fraction, humidity, precipitation, wind conditions such as magnitude or direction, road cover conditions, time, traffic conditions, local rules, altitude, location, or local level of CO, CO_2, NO_x, O_3, or airborne particulates), including a predicted ambient condition. Exhaust controller **40** then directs engine **44** or exhaust system **46** to maintain the exhaust parameter within the acceptable range (*e.g.*, using one or more exhaust parameter sensors **50** for feedback control of the exhaust parameter). The acceptable range may include an acceptable range for the time averaged value of the exhaust parameter during a time interval, or it may include an acceptable range for a designated function of the exhaust parameter (*e.g.*, allowing some out-of-range values as long as extreme values are not reached, or preferring lower values to higher values within the range). The acceptable range may also be established for multiple exhaust parameters, or for a function of multiple exhaust parameters. The acceptable range may also include an acceptable range for the value of the exhaust parameter during a probability weighted time interval (*e.g.*, the parameter must be within range for at least 80% of the time).

In one embodiment, exhaust controller **40** may use an ambient condition sensor **48** to determine that precipitation is falling around the vehicle, and may direct the engine **44** or the exhaust system **46** to shift to an operational mode that minimizes output of waterborne contaminants. In another embodiment, the exhaust controller **40** may recognize that the vehicle has entered an emissions-controlled zone (*e.g.*, by receiving a broadcast signal via receiving unit **52** or by determination of vehicle location via GPS or other navigational systems) and may direct the exhaust system **46**

to maintain emissions below a specified level for the emissions-controlled zone, for example by shifting the exhaust flow path to change catalytic area or catalyst types. The exhaust controller **40** may further be linked to a compliance reporting unit **54**, which may be configured to transmit a record of exhaust parameter adjustments. For example, the compliance reporting unit **54** may include a transmitter that sends a compliance signal to a remote unit during vehicle operation, or it may include a memory device that stores a record of exhaust parameter values for later transmission (*e.g.*, for transmission via a direct or wireless connection during vehicle fueling).

Optional exhaust parameter sensors **50** may be internal or external to the vehicle, and may include without limitation sensors for exhaust temperature, pressure, gas composition, water vapor content or content of other specific gases or vapors, or particulate content, size distribution, and composition. Exhaust parameters may be sensed as a function of time, position, or other parameter (*e.g.*, engine load). Sensors may include electromechanical sensors (*e.g.*, for pressure or temperature), electrochemical sensors, MEMS sensors, active or passive optical sensors employing free-space or fiber optics (*e.g.*, laser absorption spectrometer or laser particulate sensor), electromagnetic sensors including RF, microwave, and millimeter-wave sensors, or acoustic sensors. In some cases, a plurality of sensors **50** may be used to measure an exhaust parameter (*e.g.*, an array of temperature sensors may produce a temperature profile along the exhaust path, or a plurality of gas sensors may be used to analyze exhaust composition).

FIG. 4 is a schematic of a local-time-sensitive vehicle controller **60** for a vehicle **62** having an engine **64** and an exhaust system **66**. The vehicle controller **60** is configured to determine an acceptable range for a vehicle parameter during a selected time period and to direct engine **64** or exhaust system **66** to maintain the vehicle parameter in the acceptable range during the selected time period. For example, vehicle controller **60** may determine that more CO_2 may be emitted during nighttime hours, and direct the exhaust system to relax limits on CO_2 production between sunset and sunrise. In some embodiments, the selection of a time period and a corresponding acceptable range for the exhaust parameter may be based upon local statutes (which may be preloaded into the logic of vehicle controller **60**, determined

by downloading or otherwise receiving information from a central source such as a municipal control tower, or determined by other means).

FIG. 5 is a schematic of an engine controller **80** for a vehicle **82** having an engine **84** and an exhaust system **86**. The engine controller **80** may be operatively linked to one or more ambient condition sensors **88** or vehicle parameter sensors **90**, a signal receiving unit **92**, or a compliance reporting unit **94**. The engine controller is configured to determine an acceptable range for an engine operating parameter (compression ratio, combustion timing, fuel composition, number of operating cylinders, battery usage, engine usage of electrical energy, inlet temperature, or inlet-exhaust thermal coupling) responsive to traffic conditions. It then directs the engine **84** to maintain the engine operating parameter within the determined acceptable range. For example, a vehicle may shift to a smaller number of operating cylinders when traffic is determined to be flowing at a relatively constant speed and high power is not expected to be needed.

In some embodiments, traffic conditions may be sensed by ambient condition sensors **88** (*e.g.*, optical sensing of positions of nearby vehicles), by vehicle parameter sensors **90** (*e.g.*, accelerometers, GPS, or other vehicle location sensors), or by monitoring vehicle operation (*e.g.*, throttle and gear settings or brake usage). In other embodiments, traffic data may be received from an external source (*e.g.*, via optional signal receiving unit **92**), such as a central repository of traffic information, or another vehicle or vehicles.

In some embodiments, optional compliance reporting unit **94** may be configured to transmit a record of engine operating parameter adjustments. For example, the compliance reporting unit **94** may include a transmitter that sends a compliance signal to a remote unit during vehicle operation, or it may include a memory device that stores a record of engine parameter values for later transmission (*e.g.*, for transmission via a direct or wireless connection during vehicle fueling).

Various embodiments of vehicle controllers and signaling units have been described herein. In general, features that have been described in connection with one particular embodiment may be used in other embodiments, unless context dictates otherwise. For example, the acknowledgement signal sending units described in

connection with **FIG. 1** and **FIG. 2** may be employed in any of the embodiments described herein. For the sake of clarity, descriptions of such features have not been repeated, but will be understood to be included in the different aspects and embodiments described herein.

In a general sense, those skilled in the art will recognize that the various aspects described herein which can be implemented, individually or collectively, by a wide range of hardware, software, firmware, or any combination thereof can be viewed as being composed of various types of "electrical circuitry." Consequently, as used herein, "electrical circuitry" includes, but is not limited to, electrical circuitry having at least one discrete electrical circuit, electrical circuitry having at least one integrated circuit, electrical circuitry having at least one application specific integrated circuit, electrical circuitry forming a general purpose computing device configured by a computer program (*e.g.*, a general purpose computer configured by a computer program which at least partially carries out processes or devices described herein, or a microprocessor configured by a computer program which at least partially carries out processes or devices described herein), electrical circuitry forming a memory device (*e.g.*, forms of random access memory), or electrical circuitry forming a communications device (*e.g.*, a modem, communications switch, or optical-electrical equipment). Those having skill in the art will recognize that the subject matter described herein may be implemented in an analog or digital fashion or some combination thereof.

It will be understood by those within the art that, in general, terms used herein, and especially in the appended claims are generally intended as "open" terms (*e.g.*, the term "including" should be interpreted as "including but not limited to," the term "having" should be interpreted as "having at least," the term "includes" should be interpreted as "includes but is not limited to," etc.). It will be further understood by those within the art that if a specific number of an introduced claim recitation is intended, such an intent will be explicitly recited in the claim, and in the absence of such recitation no such intent is present. For example, as an aid to understanding, the following appended claims may contain usage of introductory phrases such as "at least one" or "one or more" to introduce claim recitations. However, the use of such

phrases should not be construed to imply that the introduction of a claim recitation by the indefinite articles "a" or "an" limits any particular claim containing such introduced claim recitation to inventions containing only one such recitation, even when the same claim includes the introductory phrases "one or more" or "at least one" and indefinite articles such as "a" or "an" (*e.g.*, "a cylinder" should typically be interpreted to mean "at least one cylinder"); the same holds true for the use of definite articles used to introduce claim recitations. In addition, even if a specific number of an introduced claim recitation *is* explicitly recited, those skilled in the art will recognize that such recitation should typically be interpreted to mean *at least* the recited number (*e.g.*, the bare recitation of "two cylinders," or "a plurality of cylinders," without other modifiers, typically means *at least* two cylinders). Furthermore, in those instances where a phrase such as "at least one of A, B, and C," "at least one of A, B, or C," or "an [item] selected from the group consisting of A, B, and C," is used, in general such a construction is intended in the sense one having skill in the art would understand the convention (*e.g.*, any of these phrases would include but not be limited to systems that have A alone, B alone, C alone, A and B together, A and C together, B and C together, and/or A, B, and C together). It will be further understood by those within the art that virtually any disjunctive word and/or phrase presenting two or more alternative terms, whether in the description, claims, or drawings, should be understood to contemplate the possibilities of including one of the terms, either of the terms, or both terms. For example, the phrase "A or B" will be understood to include the possibilities of "A" or "B" or "A and B."

While various aspects and embodiments have been disclosed herein, other aspects and embodiments will be apparent to those skilled in the art. The various aspects and embodiments disclosed herein are for purposes of illustration and are not intended to be limiting, with the true scope and spirit being indicated by the following claims.

What is claimed is:

CLAIMS

1. A method of controlling an engine in a vehicle, comprising:
   broadcasting a control signal to the vehicle during operation of the engine,
      wherein the signal includes instructions for modification of a vehicle operating parameter.

2. The method of claim 1, wherein the vehicle operating parameter is selected from the group consisting of compression ratio, timing of commencement of fuel combustion, timing of fuel injection, timing of fuel introduction into an air-inlet stream, valve timing, fuel composition, fuel-oxidizer ratio, air inlet temperature, air inlet pressure, number of operating cylinders, battery usage, battery charge, engine or drive-train usage of electrical energy, engine operating rate, output torque, exhaust gas temperature, exhaust gas temperature profile, exhaust gas composition, exhaust gas back pressure, catalytic converter reactive area, exhaust gas flow path, catalyst selection, sequestration of at least one exhaust gas component, exhaust gas flow rate, exhaust particulates density, exhaust particulate composition, exhaust particulate size, concentration of exhaust components at a selected location in an exhaust flow path, coolant temperature, and inlet-exhaust thermal coupling.

3. The method of claim 1, wherein broadcasting a control signal includes sending an electromagnetic control signal.

4. The method of claim 3, wherein sending the electromagnetic control signal includes sending the electromagnetic control signal wirelessly.

5. The method of claim 1, wherein broadcasting a control signal includes broadcasting an optical control signal.

6. The method of claim 1, wherein broadcasting a control signal includes broadcasting an acoustic control signal.

7. The method of claim 1, wherein broadcasting the control signal includes broadcasting to a plurality of vehicles.

8. The method of claim 1, further comprising broadcasting a second control signal to a second vehicle.

9. The method of claim 1, further comprising receiving an acknowledgement signal from the vehicle.

10. The method of claim 9, wherein the acknowledgement signal includes identifying information for the vehicle.

11. The method of claim 9, wherein the acknowledgement signal includes location information for the vehicle.

12. The method of claim 9, wherein the acknowledgement signal includes information about the vehicle operating parameter.

13. The method of claim 12, wherein the information about the vehicle operating parameter includes information about any changes made in response to the control signal.

14. The method of claim 9, wherein the acknowledgement signal includes information about a second vehicle operating parameter.

15. The method of claim 9, wherein broadcasting a control signal includes selecting a control signal responsive to one or more acknowledgement signals.

16. The method of claim 9, further comprising transmitting information about the acknowledgement signal to a remote compliance system.

17. The method of claim 1, further comprising transmitting information about the control signal to a remote compliance system.

18. The method of claim 1, wherein broadcasting a control signal includes broadcasting verifying information selected to allow the vehicle to determine authenticity of the control signal.

19. The method of claim 1, further comprising determining an identifying property of the vehicle, wherein the control signal is selected in response to the identifying property.

20. The method of claim 19, wherein the identifying property is selected from the group consisting of car make, car model, engine type, exhaust type, vehicle identification number, license number, location, settings of the engine control unit, and fuel type.

21. The method of claim 19, wherein determining the identifying property includes receiving an identifying signal from the vehicle.

22. The method of claim 1, wherein the control signal includes a first set of instructions for a vehicle having a first characteristic, and a second set of instructions for a vehicle having a second characteristic.

23. The method of claim 22, wherein the first characteristic is a vehicle type.

24. The method of claim 22, wherein the first characteristic is a vehicle operating parameter.

25. The method of claim 1, wherein the control signal includes instructions to select one member of a group of preprogrammed instruction sets.

26. The method of claim 1, wherein broadcasting a control signal includes selecting a control signal probabilistically.

27. The method of claim 1, wherein the instructions for modification of a vehicle operating parameter include a condition for performing the instructions.

28. The method of claim 27, wherein the condition includes a probabilistic determination.

29. The method of claim 1, wherein the instructions for modification of a vehicle operating parameter include a designated value for the vehicle operating parameter.

30. The method of claim 1, wherein the instructions for modification of a vehicle operating parameter include a designated range for the vehicle operating parameter.

31. The method of claim 1, wherein the instructions for modification of a vehicle operating parameter includes a designated average value for the vehicle operating parameter within a time interval.

32. The method of claim 1, wherein the instructions for modification of a vehicle operating parameter include instructions for the modification of a plurality of vehicle operating parameters.

33. The method of claim 1, wherein the instructions for modification of a vehicle operating parameter include a designated time profile for the vehicle operating parameter.

34. The method of claim 1, wherein the instructions for modification of a vehicle operating parameter are at least partially based upon previous compliance history of the vehicle.

35. The method of claim 1, wherein broadcasting a control signal includes selecting a control signal responsive to an environmental parameter.

36. The method of claim 35, wherein the environmental parameter is selected from the group consisting of temperature, pressure, partial pressure of an atmospheric component, local level of a selected pollutant, local insolation values, humidity, precipitation, wind conditions, road cover conditions, time, traffic conditions, local rules, and altitude.

37. The method of claim 35, wherein selecting a control signal responsive to an environmental parameter includes selecting a control signal responsive to a predicted environmental parameter.

38. The method of claim 35, wherein the environmental parameter is local level of CO, CO_2, NO_x, O_3, or airborne particulates.

39. A control system for controlling an operating parameter of vehicles in a target area, comprising:

a control signal broadcast unit configured to broadcast a control signal including instructions for modification of a vehicle operating parameter to at least one vehicle in the target area.

40. The control system of claim 39, wherein the control signal broadcast unit is configured to broadcast a control signal including instructions for modification of a vehicle operating parameter selected from the group consisting of compression ratio, timing of commencement of fuel combustion, timing of fuel injection, timing of fuel introduction into an air-inlet stream, valve timing, fuel composition, fuel-oxidizer ratio, air inlet temperature, air inlet pressure, number of operating cylinders, battery usage, battery charge, engine or drive-train usage of electrical energy, engine operating rate, output torque, exhaust gas temperature, exhaust gas temperature profile, exhaust gas composition, exhaust gas back pressure, catalytic converter reactive area, exhaust gas flow path, catalyst selection, sequestration of at least one exhaust gas component, coolant temperature, and inlet-exhaust thermal coupling.

41. The control system of claim 39, further comprising:

a signal determination unit configured to select instructions for modification of the vehicle operating parameter for incorporation into the control signal.

42. The control system of claim 41, wherein the signal determination unit is configured to allow an operator to select the vehicle operating parameter.

43. The control system of claim 41, wherein the signal determination unit is configured to use a lookup table to determine a permitted value or range of values for the vehicle operating parameter.

44. The control system of claim 41, wherein the signal determination unit is configured to select a permitted value or range of values for the vehicle operating parameter in response to an environmental condition.

45. The control system of claim 44, wherein the environmental condition is selected from the group consisting of temperature, pressure, partial pressure of an atmospheric component, local level of a selected pollutant, local insolation values, humidity, precipitation, wind conditions, road cover conditions, time, traffic conditions, local rules, and altitude.

46. The control system of claim 44, wherein the signal determination unit is configured to select a permitted value or range of values for the vehicle operating parameter in response to a predicted environmental condition.

47. The control system of claim 44, wherein the environmental condition is local level of CO, CO_2, NO_x, O_3, or airborne particulates.

48. The control system of claim 39, wherein the control signal broadcast unit is configured to broadcast a control signal including instructions conditional on a vehicle characteristic.

49. The control system of claim 48, wherein the vehicle characteristic is selected from the group consisting of vehicle type and one or more vehicle operating parameters.

50. The control system of claim 39, wherein the control signal broadcast unit is configured to broadcast a control signal including instructions to select one member of a group of preprogrammed instruction sets.

51. The control system of claim 39, wherein the control signal broadcast unit is configured to select a control signal for broadcast probabilistically.

52. The control system of claim 39, wherein the control signal broadcast unit is configured to broadcast a control signal including a condition for performing the instructions.

53. The control system of claim 52, wherein the condition includes a probabilistic determination.

54. The control system of claim 39, wherein the control signal broadcast unit is configured to broadcast a control signal including a designated value for the vehicle operating parameter.

55. The control system of claim 39, wherein the control signal broadcast unit is configured to broadcast a control signal including a designated range for the vehicle operating parameter.

56. The control system of claim 39, wherein the control signal broadcast unit is configured to broadcast a control signal including a designated average value for the vehicle operating parameter within a time interval.

57. The control system of claim 39, wherein the control signal broadcast unit is configured to broadcast a control signal including instructions for the modification of a plurality of vehicle operating parameters.

58. The control system of claim 39, wherein the control signal broadcast unit is configured to broadcast a control signal including a designated time profile for the vehicle operating parameter.

59. The control system of claim 39, wherein the control signal broadcast unit is configured determine a control signal for broadcast at least partially in response to previous compliance history of the vehicle.

60. The control system of claim 39, further comprising an acknowledgement signal receiving unit configured to receive an acknowledgement signal from the vehicle.

61. The control system of claim 60, wherein the acknowledgement signal receiving unit is configured to receive an acknowledgement signal indicating a compliance action taken by the vehicle.

62. The control system of claim 60, wherein the acknowledgement signal receiving unit is configured to receive an acknowledgement signal indicating a vehicle identity.

63. The control system of claim 60, wherein the acknowledgement signal receiving unit is configured to receive an acknowledgement signal indicating a vehicle location.

64. The control system of claim 60, wherein the acknowledgement signal receiving unit is configured to receive an acknowledgement signal indicating one or more vehicle operating parameters.

65. The control system of claim 60, further comprising a compliance transmitter configured to transmit information about the acknowledgement signal to a remote compliance system.

66. The control system of claim 65, wherein the compliance transmitter is further configured to transmit information about the control signal to the remote compliance system.

67. The control system of claim 60, wherein the acknowledgement signal receiving unit is configured to select a control signal responsive to one or more acknowledgement signals.

68. The control system of claim 39, further comprising a vehicle identification unit configured to determine a property of the vehicle, wherein the control signal broadcast unit is configured to broadcast the control signal responsive to the determined vehicle property.

69. The control system of claim 68, wherein the vehicle identification unit is configured to receive an identification signal from the vehicle.

70. The control system of claim 68, wherein the property of the vehicle is selected from the group consisting of car make, car model, engine type, exhaust type, vehicle identification number, license number, location, settings of the engine control unit, and fuel type.

71. The control system of claim 39, wherein the control signal includes verifying information selected to allow the vehicle to determine authenticity of the control signal.

72. The control system of claim 39, wherein the control signal broadcast unit is configured to send an electromagnetic control signal.

73. The control system of claim 39, wherein the control signal broadcast unit is configured to send the control signal wirelessly.

74. The control system of claim 39, wherein the control signal broadcast unit is configured to send an optical control signal.

75. The control system of claim 39, wherein the control signal broadcast unit is configured to send an acoustic control signal.

76. A method of operating a vehicle having an engine, comprising:
during operation of the engine, receiving a control signal broadcast from outside the vehicle, the control signal including instructions for modification of a vehicle operating parameter; and
modifying the vehicle operating parameter in accordance with the instructions.

77. The method of claim 76, wherein the vehicle operating parameter is selected from the group consisting of compression ratio, timing of commencement of fuel combustion, timing of fuel injection, timing of fuel introduction into an air-inlet stream, valve timing, fuel composition, fuel-oxidizer ratio, air inlet temperature, air inlet pressure, number of operating cylinders, battery usage, battery charge, engine or drive-train usage of electrical energy, engine operating rate, output torque, exhaust gas temperature, exhaust gas temperature profile, exhaust gas

composition, exhaust gas back pressure, catalytic converter reactive area, exhaust gas flow path, catalyst selection, sequestration of at least one exhaust gas component, exhaust gas flow rate, exhaust particulates density, exhaust particulate composition, exhaust particulate size, concentration of exhaust components at a selected location in an exhaust flow path, coolant temperature, and inlet-exhaust thermal coupling.

78. The method of claim 76, wherein receiving a control signal includes receiving an electromagnetic signal.

79. The method of claim 76, wherein receiving a control signal includes receiving a wireless signal.

80. The method of claim 76, wherein receiving a control signal includes receiving an optical signal.

81. The method of claim 76, wherein receiving a control signal includes receiving an acoustic signal.

82. The method of claim 76, further comprising sending an acknowledgment signal in response to receiving a control signal.

83. The method of claim 82, wherein the acknowledgement signal includes information about the vehicle operating parameter.

84. The method of claim 82, wherein the acknowledgement signal includes information about the modification of the vehicle operating parameter.

85. The method of claim 82, wherein the acknowledgement signal includes information about identity of the vehicle.

86. The method of claim 82, wherein the acknowledgement signal includes information about one or more vehicle operating parameters.

87. The method of claim 76, further comprising sending an identifying signal characterizing a property of the vehicle.

88. The method of claim 87, wherein the property of the vehicle is selected from the group consisting of car make, car model, engine type, exhaust type, vehicle identification number, license number, location, settings of the engine control unit, and fuel type.

89. The method of claim 76, wherein modifying the vehicle operating parameter in accordance with the instructions includes determining applicable portions of a signal conditional on a vehicle characteristic and modifying the vehicle operating parameter in accordance only with the applicable portions of the signal.

90. The method of claim 89, wherein the vehicle characteristic is selected from the group consisting of vehicle type and one or more vehicle operating parameters.

91. The method of claim 76, wherein modifying the vehicle operating parameter in accordance with the instructions includes selecting one of a plurality of preprogrammed instruction sets.

92. The method of claim 76, wherein modifying the vehicle operating parameter in accordance with the instructions includes determining whether a condition included in the instructions obtains and modifying the vehicle operating parameter only when the condition obtains.

93. The method of claim 92, wherein the condition includes a probabilistic determination.

94. The method of claim 76, wherein modifying the vehicle operating parameter in accordance with the instructions includes maintaining a designated value for the vehicle operating parameter.

95. The method of claim 76, wherein modifying the vehicle operating parameter in accordance with the instructions includes maintaining a designated range for the vehicle operating parameter.

96. The method of claim 76, wherein modifying the vehicle operating parameter in accordance with the instructions includes maintaining a designated average value for the vehicle operating parameter within a time interval.

97. The method of claim 76, wherein modifying the vehicle operating parameter in accordance with the instructions includes modifying a plurality of vehicle operating parameters.

98. The method of claim 76, wherein modifying the vehicle operating parameter in accordance with the instructions includes maintaining a designated time profile for the vehicle operating parameter.

99. The method of claim 76, further comprising verifying authenticity of the control signal.

100. The method of claim 99, wherein verifying authenticity includes verifying authenticity of the control signal before modifying the vehicle operating parameter.

101. An engine control system for a vehicle having an engine, comprising:
a control signal receiving unit configured to receive a control signal broadcast from outside the vehicle during engine operation, the control signal including instructions for modification of a vehicle operating parameter; and
an engine controller configured to modify the vehicle operating parameter in accordance with the instructions.

102. The engine control system of claim 101, wherein the control signal receiving unit is configured to receive instructions for modification of a vehicle operating parameter selected from the group consisting of compression ratio, timing of commencement of fuel combustion, timing of fuel injection, timing of fuel introduction into an air-inlet stream, valve timing, fuel composition, fuel-oxidizer ratio, air inlet temperature, air inlet pressure, number of operating cylinders, battery usage, battery charge, engine or drive-train usage of electrical energy,

engine operating rate, output torque, exhaust gas temperature, exhaust gas temperature profile, exhaust gas composition, exhaust gas back pressure, catalytic converter reactive area, exhaust gas flow path, catalyst selection, sequestration of at least one exhaust gas component, exhaust gas flow rate, exhaust particulates density, exhaust particulate composition, exhaust particulate size, concentration of exhaust components at a selected location in an exhaust flow path, coolant temperature, and inlet-exhaust thermal coupling.

103. The engine control system of claim 101, further comprising an acknowledgement signal sending unit configured to send an acknowledgement signal indicating any modification of the vehicle operating parameter responsive to the control signal.

104. The engine control system of claim 101, further comprising an acknowledgement signal sending unit configured to send an acknowledgement signal indicating identity of the vehicle.

105. The engine control system of claim 101, further comprising an acknowledgement signal sending unit configured to send an acknowledgement signal indicating location of the vehicle.

106. The engine control system of claim 101, further comprising an acknowledgement signal sending unit configured to send an acknowledgement signal indicating a state of one or more vehicle operating parameters.

107. The engine control system of claim 101, further comprising an acknowledgement signal sending unit configured to send an acknowledgement signal indicating a history of one or more vehicle operating parameters.

108. The engine control system of claim 101, wherein the control signal receiving unit is configured to determine authenticity of the control signal.

109. The engine control system of claim 101, wherein the control signal receiving unit is configured to receive the control signal wirelessly.

110. The engine control system of claim 101, wherein the control signal receiving unit is configured to receive an electromagnetic control signal.

111. The engine control system of claim 101, wherein the control signal receiving unit is configured to receive an optical control signal.

112. The engine control system of claim 101, wherein the control signal receiving unit is configured to receive an acoustic control signal.

113. The engine control system of claim 101, wherein the control signal receiving unit is configured to receive a plurality of instruction sets, and to select at least one of the plurality of instruction sets corresponding to a characteristic of the vehicle.

114. The engine control system of claim 113, wherein the characteristic of the vehicle is vehicle type.

115. The engine control system of claim 113, wherein the characteristic of the vehicle is a vehicle operating parameter.

116. The engine control system of claim 101, wherein the control signal receiving unit is configured to receive an instruction to select one of a group of preprogrammed instruction sets.

117. The engine control system of claim 101, wherein the control signal receiving unit is configured to determine whether a condition included in the instructions obtains and the engine controller is configured to modify the vehicle operating parameter only when the condition obtains.

118. The engine control system of claim 117, wherein the condition includes a probabilistic determination.

119. The engine control system of claim 101, wherein the engine controller is configured to maintain a designated value for the vehicle operating parameter in accordance with the instructions.

120. The engine control system of claim 101, wherein the engine controller is configured to maintain a designated range for the vehicle operating parameter in accordance with the instructions.

121. The engine control system of claim 101, wherein the engine controller is configured to maintain a designated average value for the vehicle operating parameter within a time interval in accordance with the instructions.

122. The engine control system of claim 101, wherein the engine controller is configured to modify a plurality of vehicle operating parameters in accordance with the instructions.

123. The engine control system of claim 101, wherein the engine controller is configured to maintain a designated time profile for the vehicle operating parameter in accordance with the instructions.

124. An exhaust control system for a vehicle having an engine and an exhaust system, comprising:

an exhaust controller configured to determine an acceptable range for an exhaust parameter responsive to an ambient condition and to direct the exhaust system to maintain the exhaust parameter within the acceptable range,

wherein the exhaust parameter is selected from the group consisting of exhaust gas temperature, exhaust gas temperature profile, exhaust gas composition, exhaust gas back pressure, catalytic converter reactive area, exhaust gas flow path, catalyst selection, sequestration of at least one exhaust gas component, exhaust gas flow rate, exhaust particulates density, exhaust particulate composition, exhaust particulate size, concentration of exhaust components at a selected location in an exhaust flow path, coolant temperature, and inlet-exhaust thermal coupling.

125. The exhaust control system of claim 124, wherein the ambient condition is selected from the group consisting of temperature, pressure, partial pressure of an atmospheric component, local level of a selected pollutant, local insolation values,

humidity, precipitation, wind conditions, road cover conditions, traffic conditions, local rules, altitude, and location

126. The method of claim 124, wherein determining an acceptable range for an exhaust parameter responsive to an ambient condition includes determining an acceptable range for an exhaust parameter responsive to a predicted ambient condition.

127. The exhaust control system of claim 124, further comprising a compliance reporting unit configured to transmit a record of exhaust parameter adjustments.

128. The exhaust control system of claim 127, wherein the compliance reporting unit is configured to transmit a record wirelessly.

129. The exhaust control system of claim 124, further comprising an exhaust parameter sensor, wherein the exhaust controller is configured to accept a sensor signal from the exhaust parameter sensor indicative of the state of the exhaust parameter and to use the sensor signal to direct the exhaust system to maintain the exhaust parameter within the acceptable range.

130. The exhaust control system of claim 129, wherein the exhaust parameter sensor is selected from the group consisting of electromagnetic sensors, spectroscopic sensors, thermal sensors, chemical sensors, pressure sensors, acoustic sensors, vibration sensors, mass sensors, electromechanical sensors, electrochemical sensors, microelectromechanical devices, and optical sensors.

131. The exhaust control system of claim 129, wherein the exhaust parameter sensor is configured to measure a property selected from the group consisting of temperature, pressure, gas composition, vapor composition, particulate content, particulate composition, particulate size distribution, flow rate, density, force, strain, and displacement.

132. The exhaust control system of claim 129, wherein the exhaust parameter sensor is internal to the vehicle.

133. The exhaust control system of claim 129, wherein the exhaust parameter sensor is external from the vehicle.

134. The exhaust control system of claim 124, wherein the exhaust controller is configured to determine an acceptable range for an exhaust parameter responsive to an ambient condition by selecting from a set of exhaust profiles.

135. The exhaust control system of claim 124, wherein the acceptable range for an exhaust parameter includes an acceptable range for the time averaged value of the exhaust parameter during a time interval.

136. The exhaust control system of claim 124, wherein the acceptable range for an exhaust parameter includes an acceptable range for a designated function of the exhaust parameter.

137. The exhaust control system of claim 124, wherein the acceptable range for an exhaust parameter includes an acceptable range for a second exhaust parameter.

138. The exhaust control system of claim 124, wherein the acceptable range for an exhaust parameter includes an acceptable range for a designated function of a plurality of exhaust parameters.

139. The exhaust control system of claim 124, wherein the acceptable range for an exhaust parameter includes an acceptable range for the value of the exhaust parameter during a probability weighted time interval.

140. The exhaust control system of claim 124, wherein the acceptable range for an exhaust parameter includes a time profile for the acceptable range for an exhaust parameter.

141. A vehicle control system for a vehicle having an engine and an exhaust system, comprising:

an exhaust controller configured to determine an acceptable range for a vehicle parameter for a selected local time period and to direct the vehicle to

maintain the vehicle parameter within the acceptable range during the selected local time period,

wherein the vehicle parameter is selected from the group consisting of compression ratio, timing of commencement of fuel combustion, timing of fuel injection, timing of fuel introduction into an air-inlet stream, valve timing, fuel composition, fuel-oxidizer ratio, air inlet temperature, air inlet pressure, number of operating cylinders, battery usage, battery charge, engine or drive-train usage of electrical energy, engine operating rate, output torque, exhaust gas temperature, exhaust gas temperature profile, exhaust gas composition, exhaust gas back pressure, catalytic converter reactive area, exhaust gas flow path, catalyst selection, sequestration of at least one exhaust gas component, exhaust gas flow rate, exhaust particulates density, exhaust particulate composition, exhaust particulate size, concentration of exhaust components at a selected location in an exhaust flow path, coolant temperature, and inlet-exhaust thermal coupling.

142. The vehicle control system of claim 141, wherein the vehicle is configured to determine the acceptable range for the vehicle parameter for the selected local time period based at least in part on vehicle location.

143. The vehicle control system of claim 141, further comprising a compliance reporting unit configured to transmit a record of vehicle parameter adjustments.

144. The vehicle control system of claim 143, wherein the compliance reporting unit is configured to transmit a record wirelessly.

145. The vehicle control system of claim 141, wherein the vehicle controller includes an internal clock.

146. The vehicle control system of claim 141, wherein the vehicle controller is configured to determine time from an external signal.

147. A method of controlling an exhaust system in a vehicle, comprising:
determining an ambient condition; and
responsive to the determined ambient condition, adjusting an exhaust parameter of the exhaust system, the exhaust parameter selected from the group consisting of exhaust gas temperature, exhaust gas temperature profile, exhaust gas composition, exhaust gas back pressure, catalytic converter reactive area, exhaust gas flow path, catalyst selection, sequestration of at least one exhaust gas component, exhaust gas flow rate, exhaust particulates density, exhaust particulate composition, exhaust particulate size, concentration of exhaust components at a selected location in an exhaust flow path, coolant temperature, and inlet-exhaust thermal coupling.

148. The method of claim 147, wherein the ambient condition is selected from the group consisting of temperature, pressure, partial pressure of an atmospheric component, local level of a selected pollutant, local insolation values, humidity, precipitation, wind conditions, road cover conditions, traffic conditions, local rules, altitude, and location.

149. The method of claim 147, further comprising transmitting a record of the adjusting of the exhaust parameter.

150. The method of claim 149, wherein transmitting a record includes transmitting a record wirelessly.

151. A method of controlling a vehicle, comprising:
responsive to a local time, adjusting a vehicle parameter of the vehicle, the vehicle parameter selected from the group consisting of compression ratio, timing of commencement of fuel combustion, timing of fuel injection, timing of fuel introduction into an air-inlet stream, valve timing, fuel composition, fuel-oxidizer ratio, air inlet temperature, air inlet pressure, number of operating cylinders, battery usage, battery charge, engine or drive-train usage of electrical energy, engine operating rate, output torque,

exhaust gas temperature, exhaust gas temperature profile, exhaust gas composition, exhaust gas back pressure, catalytic converter reactive area, exhaust gas flow path, catalyst selection, sequestration of at least one exhaust gas component, exhaust gas flow rate, exhaust particulates density, exhaust particulate composition, exhaust particulate size, concentration of exhaust components at a selected location in an exhaust flow path, coolant temperature, and inlet-exhaust thermal coupling.

152. The method of claim 151, further comprising transmitting a record of the adjusting of the vehicle parameter.

153. The method of claim 152, wherein transmitting a record includes transmitting a record wirelessly.

154. An engine control system for a vehicle having an engine, comprising:

an engine controller configured to determine an acceptable range for an engine operating parameter responsive to traffic conditions and to direct the engine to maintain the engine operating parameter within the acceptable range,

wherein the engine operating parameter is selected from the group consisting of compression ratio, timing of commencement of fuel combustion, timing of fuel injection, timing of fuel introduction into an air-inlet stream, valve timing, fuel composition, air inlet temperature, air inlet pressure, number of operating cylinders, battery usage, battery charge, engine or drive-train usage of electrical energy, engine operating rate, and output torque.

155. The engine control system of claim 154, further comprising a compliance reporting unit configured to transmit a record of engine operating parameter adjustments.

156. The engine control system of claim 154, wherein the engine controller is further configured to receive a traffic condition signal from an external source.

157. The engine control system of claim 156, wherein the external source is a central repository of traffic information.

158. The engine control system of claim 156, wherein the external source is another vehicle.

159. The engine control system of claim 154, wherein the engine controller is further configured to monitor vehicle operation in order to determine traffic conditions.

160. A method of controlling a vehicle having an engine, comprising:

responsive to traffic conditions, determining an acceptable range for an engine operating parameter and directing the engine to maintain the engine operating parameter within the acceptable range,

wherein the engine operating parameter is selected from the group consisting of compression ratio, timing of commencement of fuel combustion, timing of fuel injection, timing of fuel introduction into an air-inlet stream, valve timing, fuel composition, air inlet temperature, air inlet pressure, number of operating cylinders, battery usage, battery charge, engine or drive-train usage of electrical energy, engine operating rate, and output torque.

161. The method of claim 160, further comprising transmitting a record of engine operating parameter adjustments.

162. The method of claim 160, further comprising receiving a traffic condition signal from an external source.

163. The method of claim 162, wherein the external source is a central repository of traffic information.

164. The method of claim 162, wherein the external source is another vehicle.

165. The method of claim 160, further comprising monitoring vehicle operation in order to determine traffic conditions.

FIG. 1
1/5

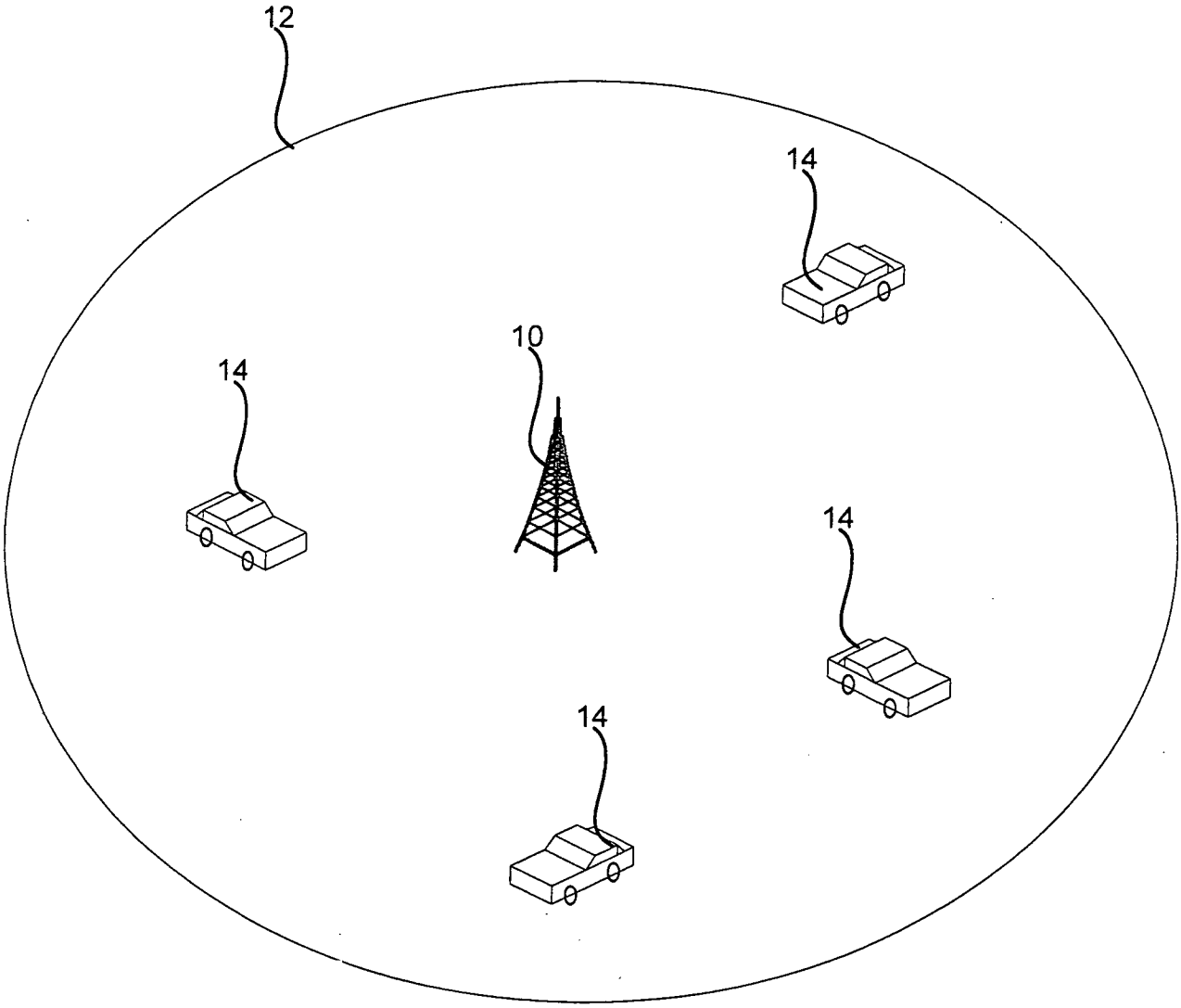


FIG. 2
2/5

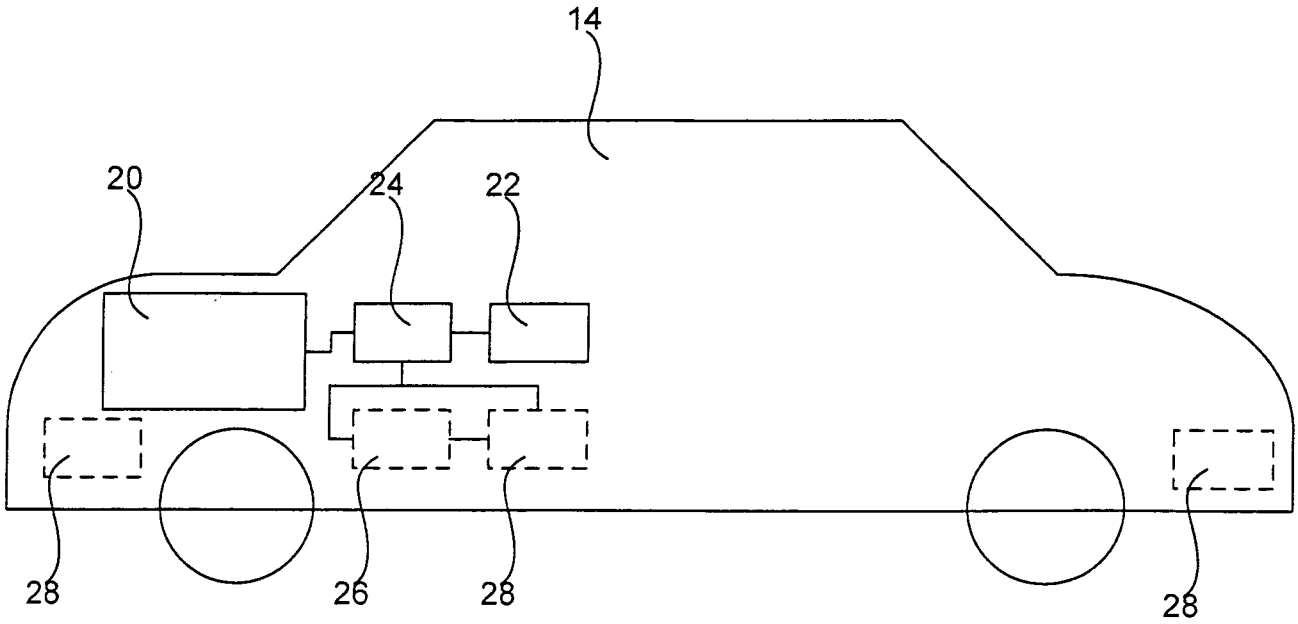


FIG. 3
3/5

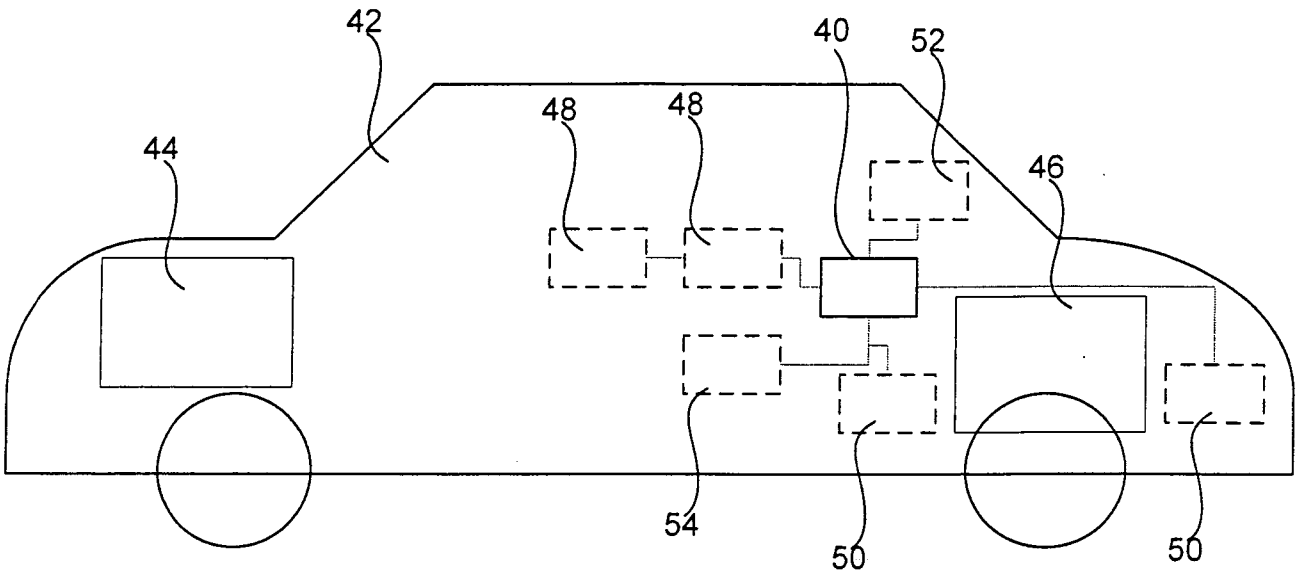


FIG. 4
4/5

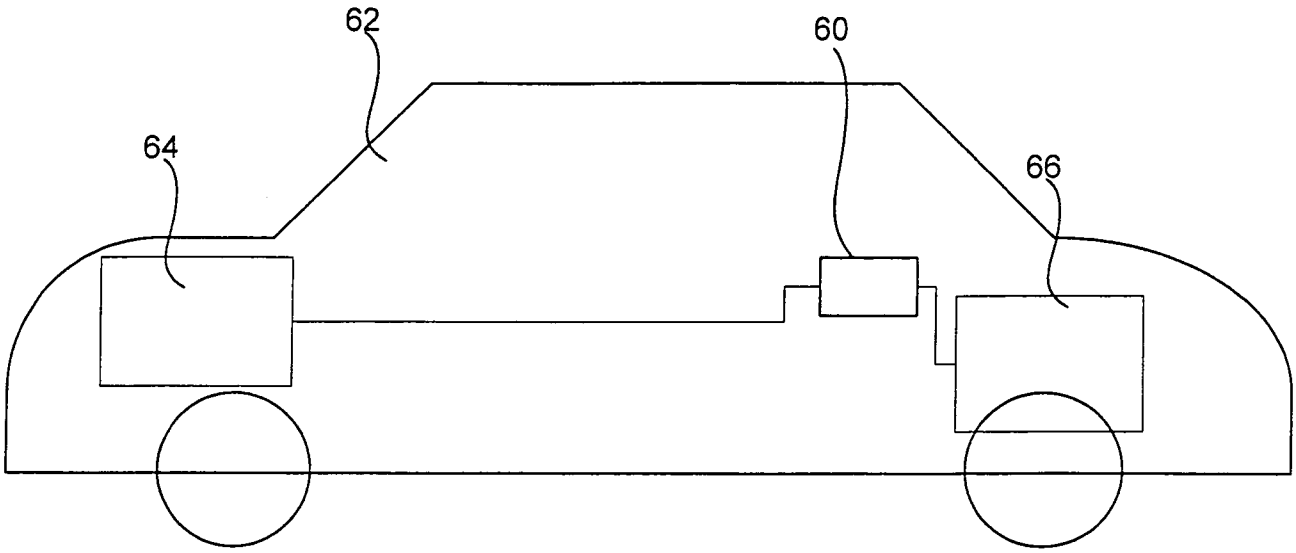
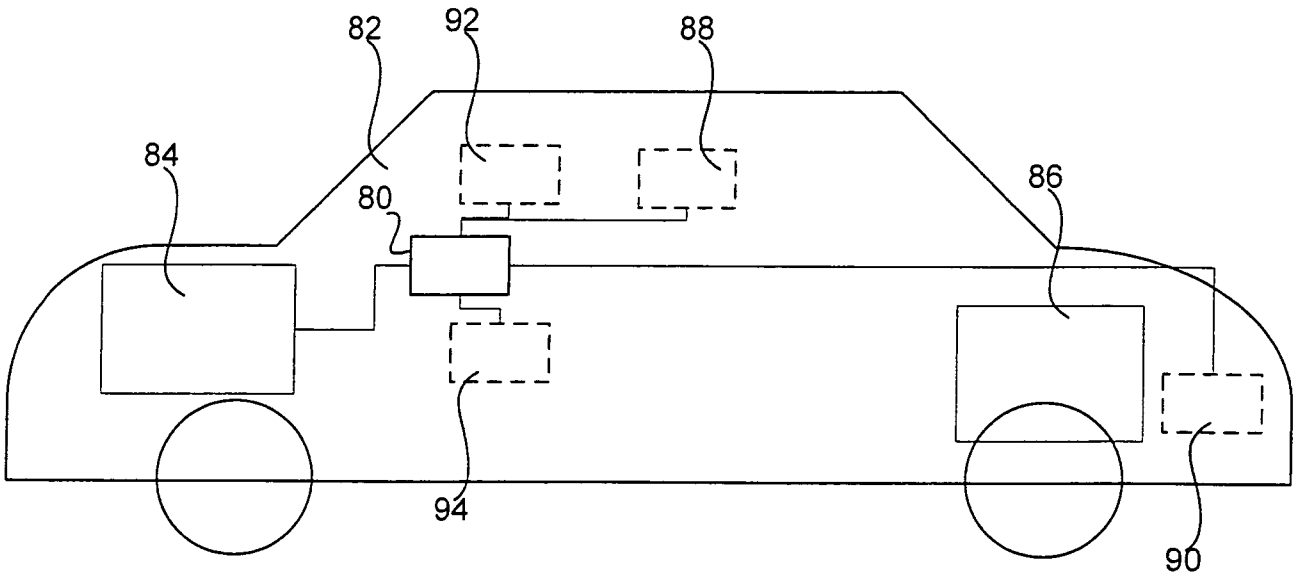


FIG. 5
5/5



INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2008/013939

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - G06F 19/00 (2009.01)
USPC - 701/115
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC(8) - B60T 7/18; F02M 51/00; G06F 19/00 (2009.01)
USPC - 60/601; 123/436, 478; 180/167; 701/115, 207, 213, 217, 218

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)
PatBase; Google Patents

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y	US 6,151,549 A (ANDREWS et al) 21 November 2000 (21.11.2000) entire document	1-4, 9-17, 19-25, 27, 29-30, 32-33, 35-50, 52, 54-55, 57-58, 60-70, 72-73, 76-79, 82-92, 94-95, 97-98, 101-106, 109-110, 113-117, 119-120, 122-123 ---------- 5-8, 18, 26, 28, 31, 34, 51, 53, 56, 59, 71, 74-75, 80-81, 93, 96, 99-100, 107-108, 111-112, 118, 121
Y	US 2002/0116117 A1 (MARTENS et al) 22 August 2002 (22.08.2002) entire document	5-8, 74-75, 80-81, 111-112
Y	US 6,112,151 A (KRUSE) 29 August 2000 (29.08.2000) entire document	18, 26, 28, 34, 51, 53, 59, 71, 93, 99-100, 107-108, 118
Y	US 2001/0021893 A1 (WEISMAN II) 13 September 2001 (13.09.2001) entire document	31, 56, 96, 121

☐ Further documents are listed in the continuation of Box C. ☐

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
03 April 2009	14 APR 2009
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	Authorized officer: Blaine R. Copenheaver PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

Form PCT/ISA/210 (second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2008/013939

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

See extra sheet.

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:
1-123

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2008/013939

This application contains the following inventions or groups of inventions which are not so linked as to form a single general inventive concept under PCT Rule 13.1. In order for all inventions to be examined, the appropriate additional examination fees must be paid.

Group I, claims 1-123, drawn to a method and system for operating or controlling a vehicle comprising broadcasting a control signal from a source external to the vehicle including instructions for modification of a vehicle operating parameter.
Group II, claims 124-140 and 147-150, drawn to an exhaust control system configured to determine an acceptable range for an exhaust parameter and to direct the system to maintain the exhaust parameter within the acceptable range.
Group III, claims 141-146 and 151-153, drawn to an exhaust control system configured to determine an acceptable range for a vehicle parameter and to direct the system to maintain the vehicle parameter within the acceptable range.
Group IV, claims 154-165, drawn to an engine control system configured to determine an acceptable range for an engine operating parameter responsive to traffic conditions.

The inventions listed as Groups I-IV do not relate to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons: the special technical feature of the Group I invention: broadcasting a control signal from a source external to the vehicle as claimed therein is not present in the invention of Groups II-IV.

The special technical feature of the Group II invention: an exhaust control system configured to determine an acceptable range for an exhaust parameter and to direct the system to maintain the exhaust parameter within the acceptable range as claimed therein is not present in the invention of Groups I or III-IV.

The special technical feature of the Group III invention: an exhaust control system configured to determine an acceptable range for a vehicle parameter and to direct the system to maintain the vehicle parameter within the acceptable range as claimed therein is not present in the invention of Groups I-II or IV.

The special technical feature of the Group IV invention: an engine control system configured to determine an acceptable range for an engine operating parameter responsive to traffic conditions as claimed therein is not present in the invention of Groups I-III.

Groups I-IV lack unity of invention because even though the inventions of these groups require the technical feature of: broadcasting a control signal from a source external to the vehicle; an exhaust control system configured to determine an acceptable range for an exhaust parameter and to direct the system to maintain the exhaust parameter within the acceptable range; an exhaust control system configured to determine an acceptable range for a vehicle parameter and to direct the system to maintain the vehicle parameter within the acceptable range; and an engine control system configured to determine an acceptable range for an engine operating parameter responsive to traffic conditions, this technical feature is not a special technical feature as it does not make a contribution over the prior art in view of (U.S. 6,151,549 A, Andrews et al., 21 November 2000, Col. 10, Ln. 17 - Col. 11, Ln. 27; Col. 14, Lns. 35-44; Col. 12, Lns. 5-15; Col. 1, Lns. 29-37).

Since none of the special technical features of the Group I-IV inventions are found in more than one of the inventions, unity of invention is lacking.