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(54) **ENERGY RECOVERY SYSTEM IN AN ENGINE**

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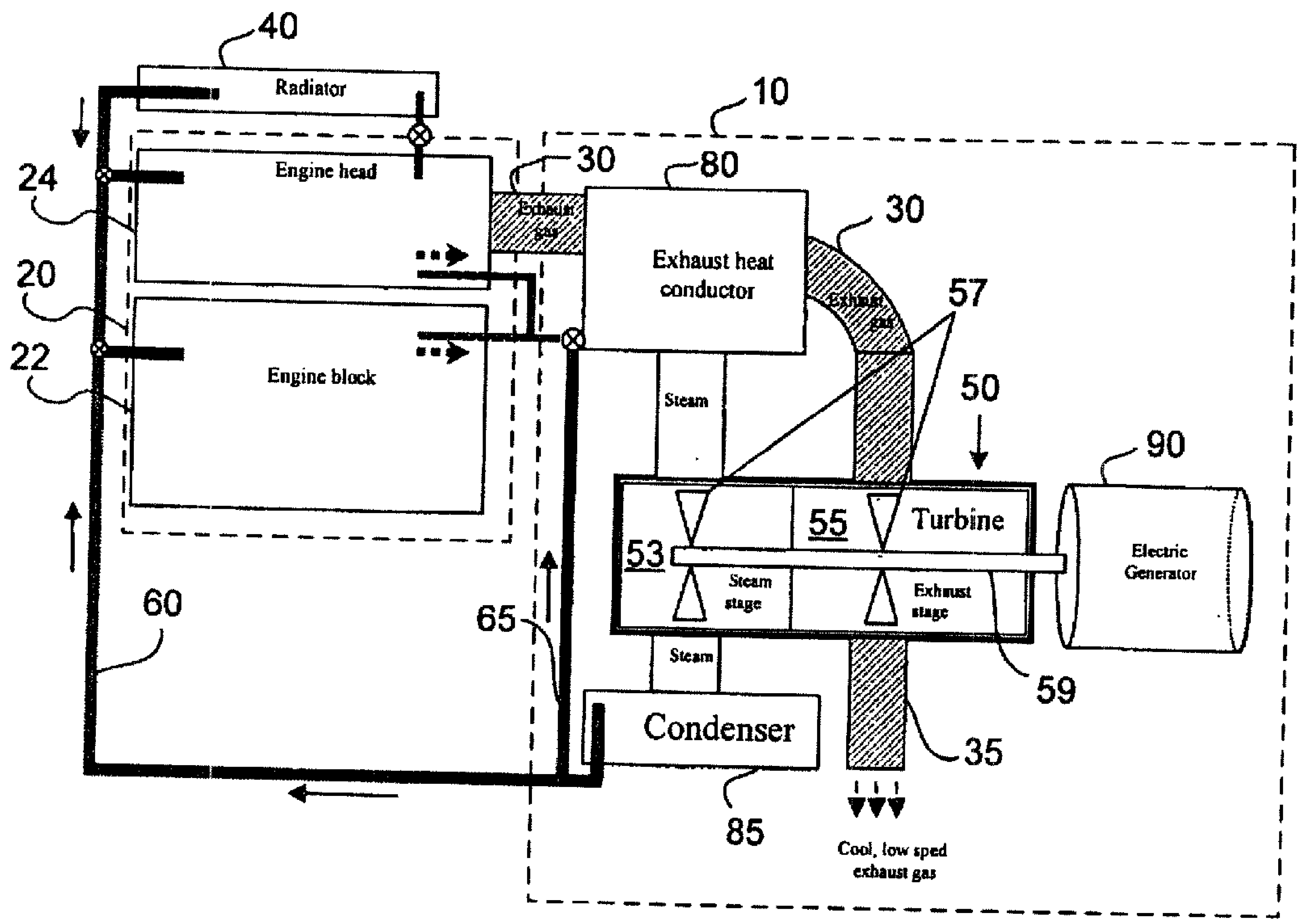
(57) **ABSTRACT**

A energy recovery system for an internal combustion engine which dynamically allocates heat energy to multiple vehicle accessory systems



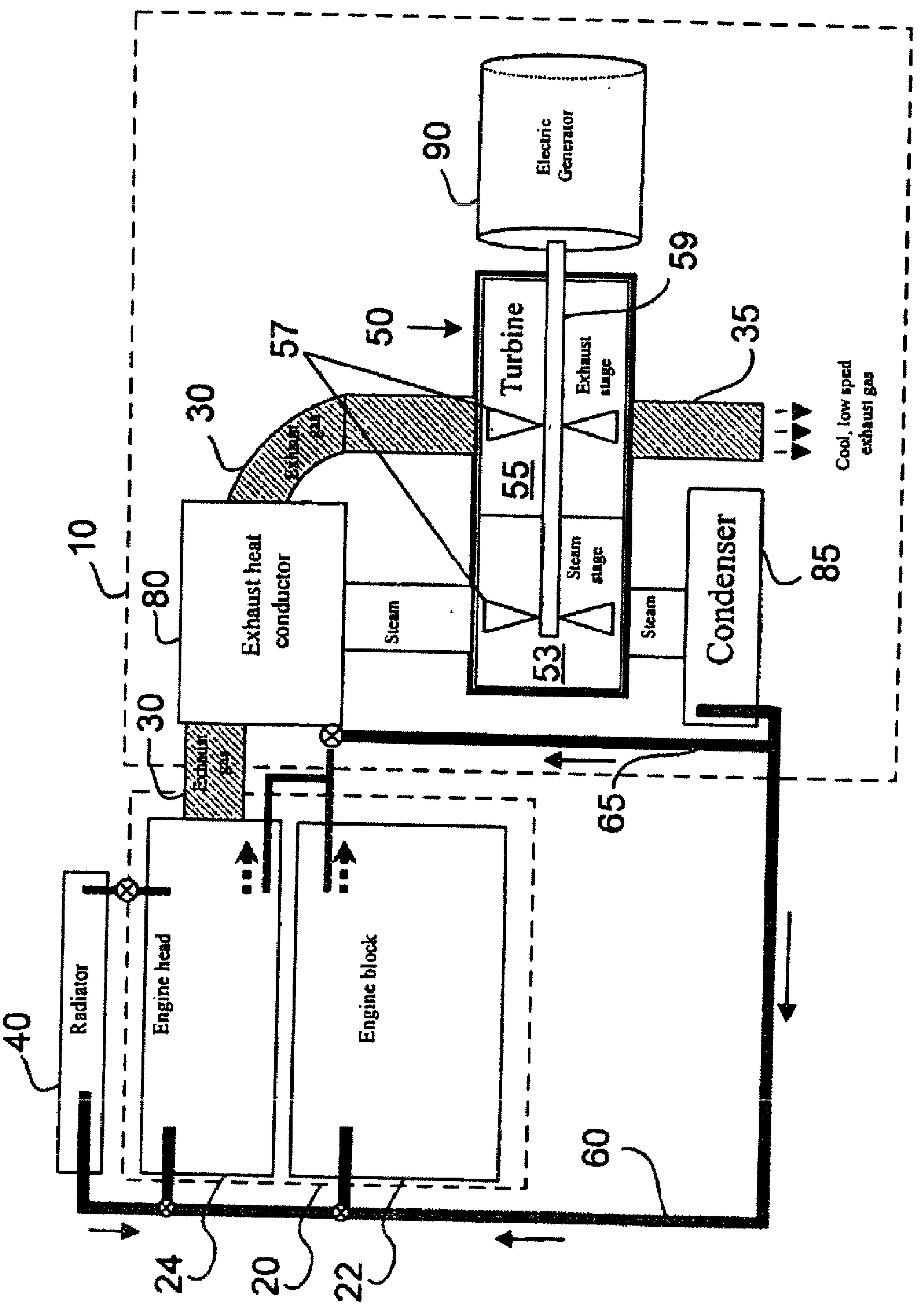

10
90
Electric Generator
59
50
Turbine
Exhaust stage
57
30
35
Cool, low sped exhaust gas
55
Exhaust gas
80
Exhaust heat conductor
Steam
Steam stage
53
Steam
Condenser
85
30
Exhaust gas
65
40
Radiator
Engine head
Engine block
60
24
20
22

FIGURE 1

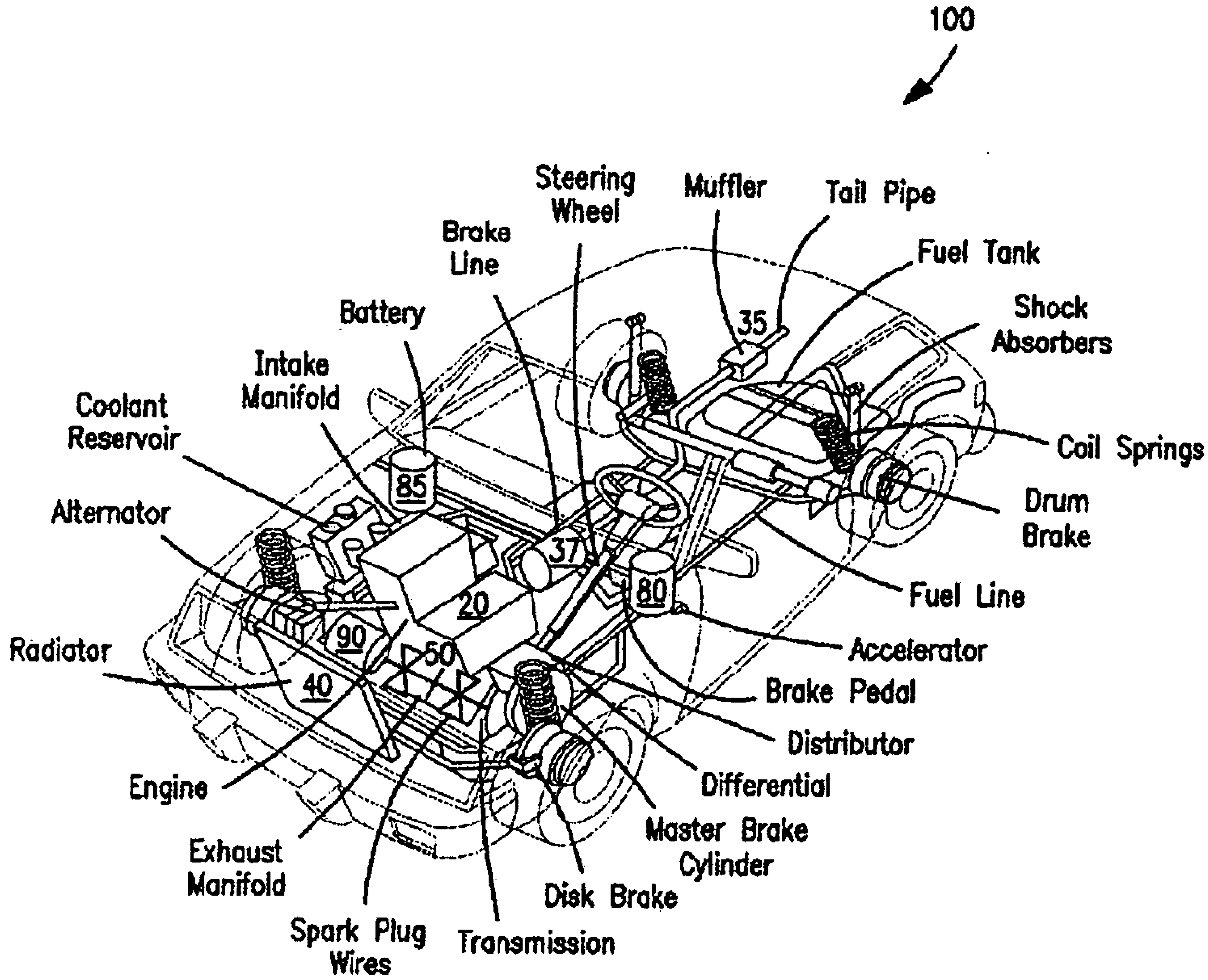

100
Steering Wheel
Muffler
Tail Pipe
Brake Line
Fuel Tank
Battery
Shock Absorbers
Intake Manifold
Coolant Reservoir
Coil Springs
Drum Brake
Alternator
85
37
35
20
80
90
50
40
Fuel Line
Radiator
Accelerator
Brake Pedal
Distributor
Engine
Differential
Exhaust Manifold
Master Brake Cylinder
Disk Brake
Spark Plug Wires
Transmission

FIGURE 2

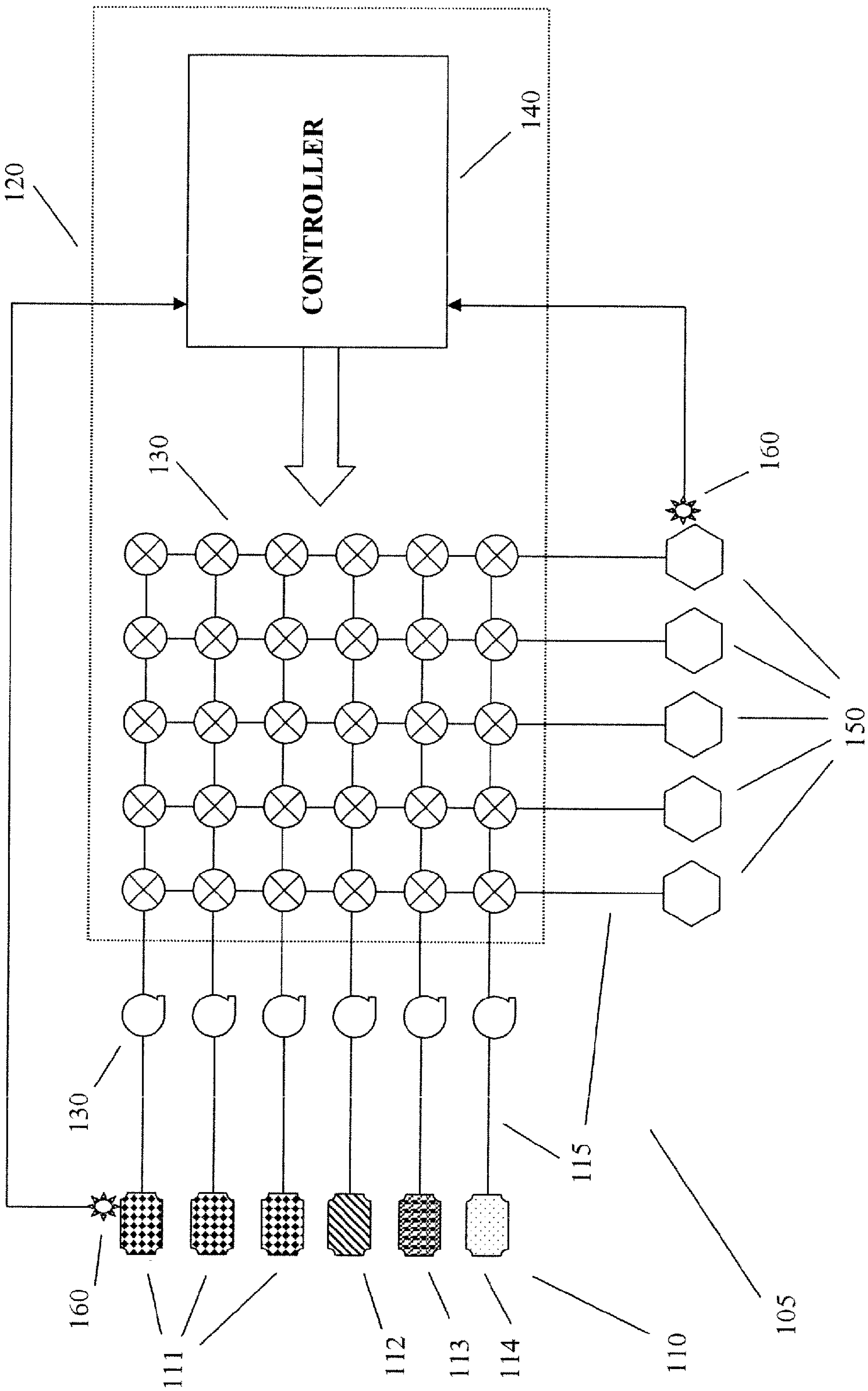

CONTROLLER
120
140
130
130
160
160
150
115
105
110
111
112
113
114

FIG. 3

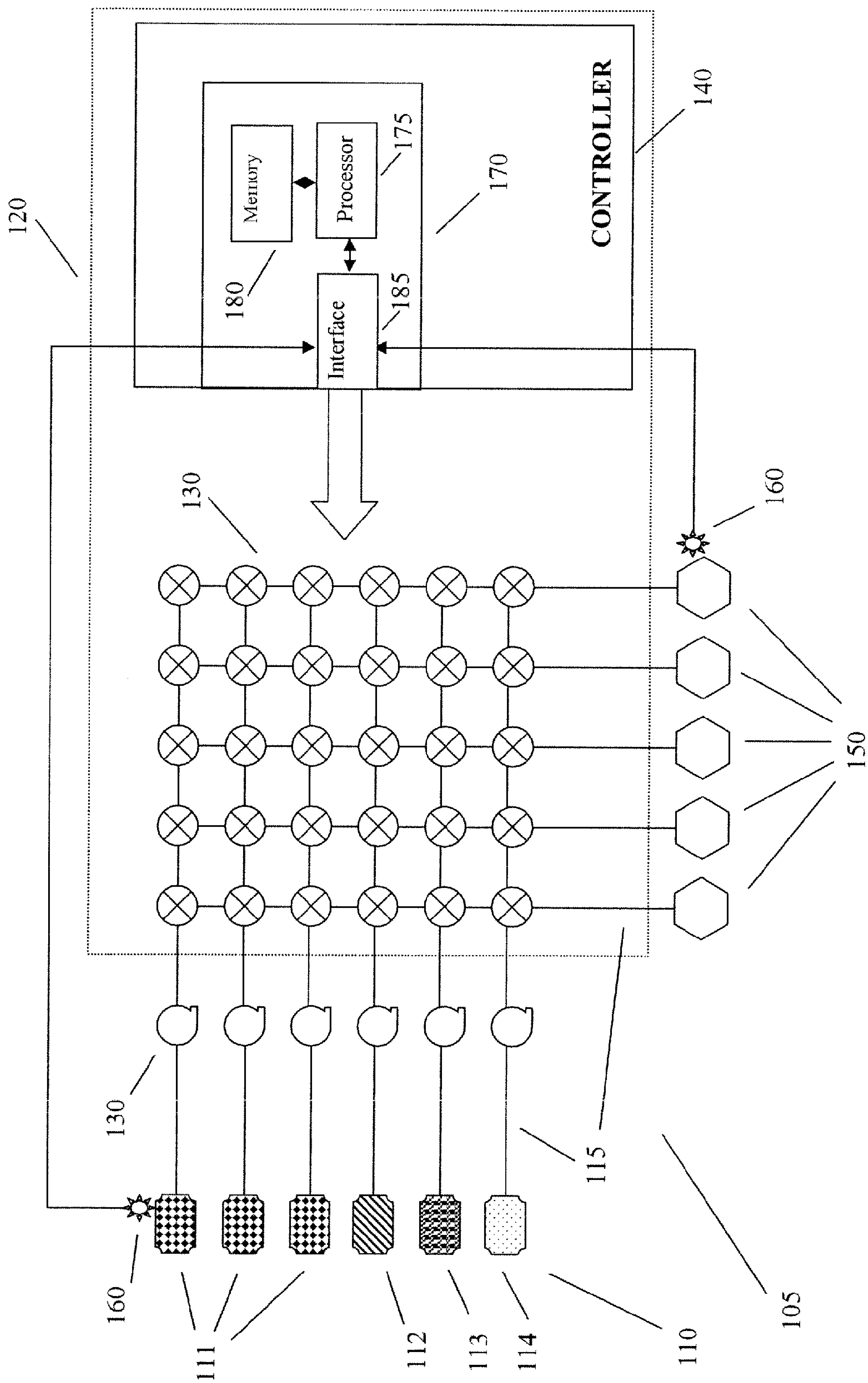

CONTROLLER
Memory
Processor
Interface
120
140
175
170
180
185
130
160
150
115
105
110
111
112
113
114

FIG. 4

FIG 5

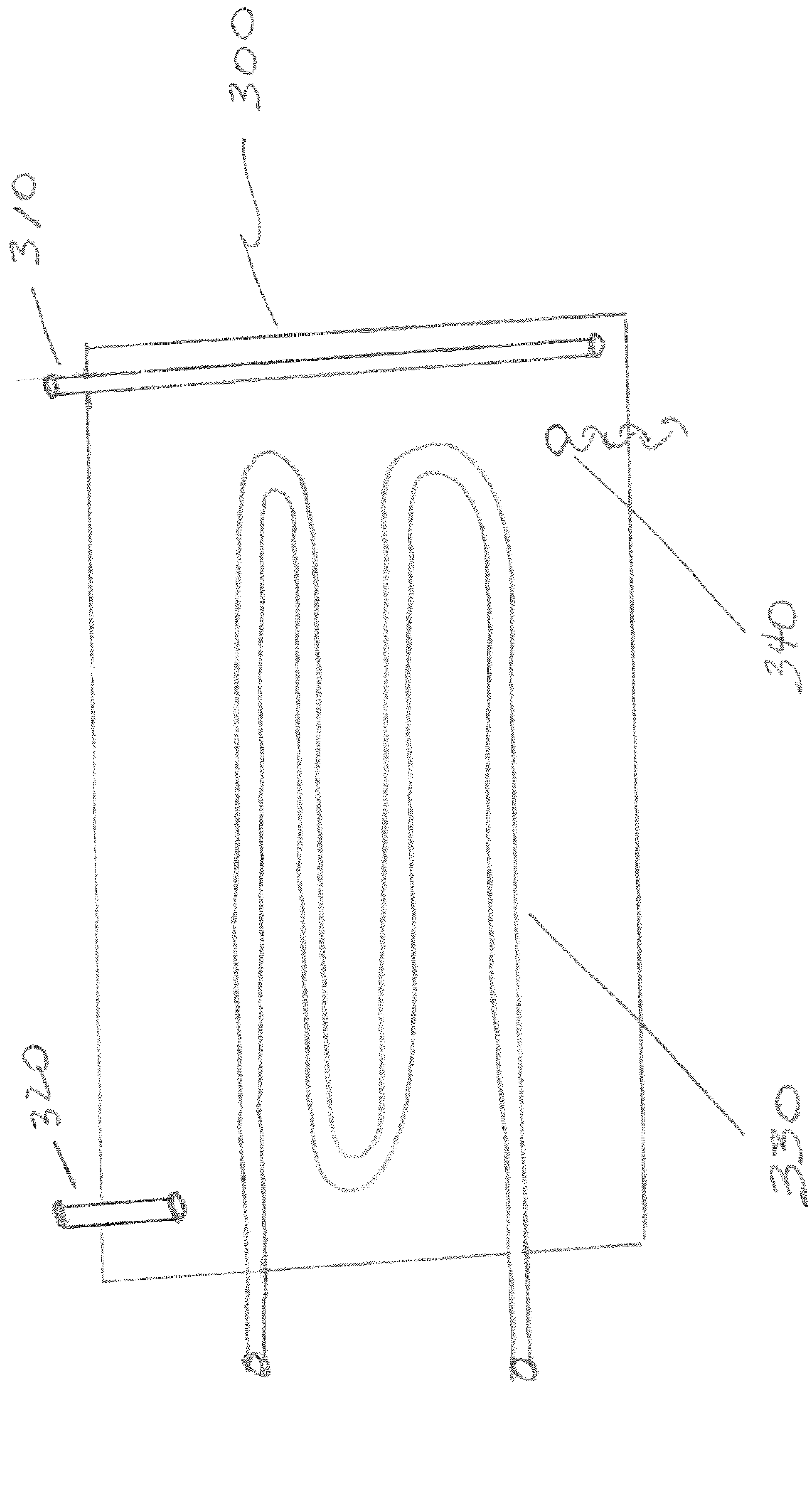
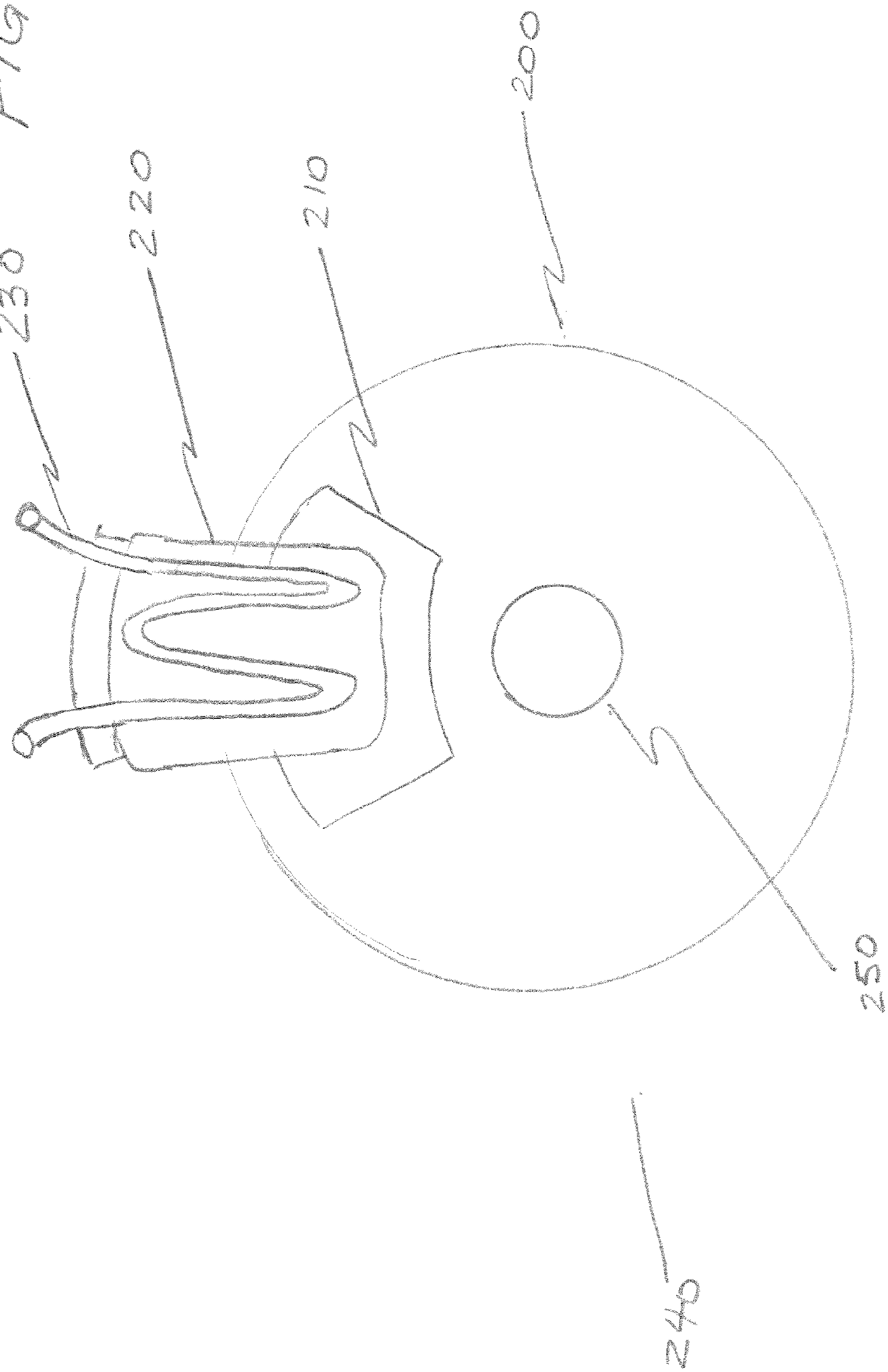


FIG 6



ENERGY RECOVERY SYSTEM IN AN ENGINE

[0001] This application is a continuation-in-part application of U.S. patent application Ser. No. 11/266,948, filed Nov. 4, 2005. All references cited in this specification, and their references, are incorporated by reference herein where appropriate for teachings of additional or alternative details, features, and/or technical background.

BACKGROUND OF THE INVENTION

[0002] 1. Field of Invention

[0003] The present invention includes an energy capture system and method for recovering heat energy from the exhaust gases of an internal combustion engine.

[0004] 2. Description of Related Art

[0005] In conventional internal combustion engines, a mixture of air and fuel is introduced into the engine, where it is compressed and then ignited. The burning gases expand, do work, and then are expelled from the engine. The actual amount of kinetic energy or mechanical work that is extracted from the internal combustion generally depends upon the thermal efficiency of the internal combustion engine. What is not extracted is expended as waste heat.

[0006] Thermal efficiency is the percentage of energy taken from the combustion which is actually converted to mechanical work. In a typical low compression engine, the thermal efficiency may be only about 26%. In a highly modified engine, such as a race engine, the thermal efficiency may be about 34%.

[0007] In a generic internal combustion engine, only 20% of the total energy available may be converted to useful energy. Of the remaining 80% of the total energy, approximately 38% may be lost through exhaust heat, 36% through water heating in the cooling system and 6% through motor friction.

[0008] There have been various schemes to capture energy from the exhaust gases and heated engine cooling water.

[0009] U.S. Pat. No. 4,439,999, Mori, et aL., discloses an internal combustion engine and an absorption type refrigeration system which makes use of both the engine exhaust gas and the heated engine cooling water. The internal combustion engine and the absorption type refrigeration system are combined in such a manner that the exhaust gas of the internal combustion engine is utilized as the heat source for a first gaseous refrigerant generator having the highest operating temperature in the system, while heated engine cooling water is utilized as the heat source for another generator which operates at a temperature lower than the operating temperature of the first gaseous refrigerant generator.

[0010] U.S. Pat. No. 6,119,457 to Kawamura describes a heat exchange apparatus having high and low temperature heat sources comprising porous material provided in an exhaust passage from a ceramic engine in communication with a supercharger connected to the ceramic engine. The heat exchange apparatus comprises a high temperature heat exchanger having a steam passage provided in an exhaust gas passage through which an exhaust gas passes whereby steam is heated, and a low temperature heat exchanger provided in the portion of the exhaust gas passage on the downstream side of the high temperature heat exchanger which has a water passage for heating water by the exhaust gas. The ceramic engine has a steam turbine type supercharger provided with a steam turbine driven by the steam from the high temperature heat exchanges, a compressor, and a condenser which separates a fluid discharged from the steam turbine into water and low temperature steam. Pressurized air from the compressor is supplied to the combustion chamber, which presses down a piston to carry out compression work during an intake stroke. Thus, the supercharger is driven by the thermal energy recovered from an exhaust gas by the same heat exchanger apparatus.

[0011] An example of an energy recovery system is also disclosed in Japanese Patent Laid-Open No. 1799721993. This energy recovery system has an energy recovery unit provided with a first turbine installed in an exhaust passage and a generator operated by the first turbine, a turbocharger provided with a second turbine connected to an outlet-side passage of the first turbine and a supercharging compressor operated by the second turbine, and a waste gate provided in the outlet-side passage of the first turbine. The energy recovering operation is carried out by the energy recovery unit when the temperature of the exhaust gas is high.

[0012] Exhaust gas energy from an internal combustion engine may also be used to provide a heated water source, for example, while the mechanical power of the engine may be used simultaneously to generate electricity. In Japanese Patent Laid-Open No. 33707/1994, there is disclosed a system making use of exhaust gas energy from a turbocharger attached to a heat insulation type gas engine to produce steam that is used to drive a steam turbine so as to produce electric energy and heated water. A turbocharger is driven by the exhaust gas energy from the heat insulating gas engine and the generator/energy recovery unit is driven by the exhaust gas energy from the turbocharger. The thermal energy of the exhaust gas directed to the energy recovery unit is converted into steam by a first heat exchanger, and recovered as electric energy by driving a steam turbine. Heated water is generated by the high-temperature steam from the steam turbine by an operation of a second heat exchanger, and utilized as a hot water supply source.

[0013] In U.S. Pat. No. 4,803,958 to Erickson, there is disclosed an open-cycle absorption apparatus for compressing steam from a low pressure to a higher pressure. The apparatus is used for upgrading low-temperature jacket-cooling heat from an internal combustion engine to useful pressure steam. A simple heat-exchange apparatus is involved, using the extra temperature availability of the hot exhaust gas as the driving medium.

[0014] There have recently been higher efficiency vehicles powered using hybrid concepts that involve internal combustion engines in combination with an electric generator that powers an electric motor. The generator utilizes some of the kinetic energy that would otherwise be converted into heat by friction in the vehicle is braking system. While systems such as described above in combination with such hybrid systems may further improve energy storage in such cars, the loss of energy through the emission system would remain high. What is needed is a system that would convert a significant percentage of the power lost as heat to electrical power and create a more efficient hybrid vehicle.

BRIEF DESCRIPTION OF DRAWINGS

[0015] FIG. 1 is a drawing showing the integration of components of an embodiment energy recovery system, including a heat collection subsystem and a heat expending exhaust subsystem, as well as a two-stage turbine that interfaces with the two subsystems simultaneously;

[0016] FIG. 2 is a drawing showing the incorporation of the energy recovery system of FIG. 1 in an automobile, according to an embodiment of the present invention.

[0017] FIG. 3 is a drawing schematically showing an energy recovery system which derives heat from various engine components and allocates the energy to a plurality of accessories. For purposes of clarity, the figure shows only the forward paths from the heat sources to the accessories. A complete presentation would also include the corresponding return paths returning from the accessories to the heat sources.

SUMMARY OF THE INVENTION

[0018] The disclosed system comprises an energy recovery system in internal combustion engines.

[0019] In a first embodiment, the energy recovery system comprises a steam generating chamber located proximal to the engine, such as immediate contact with the exhaust manifold, that is operatively configured to receive exhaust fumes from one or more combustion chambers in the internal combustion engine and one or more fluids from a fluid reserve and to convert such fluid into steam. In such embodiment, the steam generated in the steam chamber is directed through a steam inlet to an electrical generator component comprising a turbine and electrical generator. The electrical generator component is operatively configured with respect to the steam inlet such that the steam turns the turbine which in turn causes the generator to generate electricity. The electricity produced may be used by the engine contemporaneously or stored for later use, for example, when the engine is not using combustion to generate rotation of the wheels on a hybrid vehicle.

[0020] In one embodiment, the system involves a heat collection system proximal to an internal combustion engine block, the heat collection system configured to transfer heat to a steam generating boiler. Both the steam and exhaust gases simultaneously drive a turbine of an electric generator which in turn is connected to an electric motor. The power from the electric motor supplants the power from the internal combustion engine to propel a vehicle, for example. In one embodiment, the heat collection system is immediately proximal to the engine, such as connected to the manifold.

[0021] Aspects disclosed herein include:

[0022] An internal combustion engine system comprising an internal combustion engine producing heated emissions from one or more combustion chamber(s); a steam generator connected proximal to the combustion chamber(s), the steam generator operatively configured to receive the heated emissions from the one or more combustion chamber(s) and to apply the heat from the heated emissions to produce steam, and configured to direct the steam towards a turbine in a manner to cause the turbine to turn; an electric generator operatively connected to the turbine, the electric generator operatively configured to produce electricity upon turning of the turbine.

[0023] An energy recovery, system comprising an engine having a combustion chamber; a coolant subsystem communicating with the combustion chamber; an exhaust subsystem integral to the combustion chamber; a boiler in communication with the coolant subsystem, the boiler operatively configured to generate steam in cooperation with the coolant subsystem, an energy converter operatively configured to simultaneously receive the steam from the boiler and to receive the exhaust gases from the exhaust subsystem and to convert energy associated with the steam and exhaust gases into mechanical energy; an electric generator in communication with the energy converter operatively configured to convert the mechanical energy from the energy converter to electrical energy, wherein the engine and the electric generator are cooperatively configured to propel a vehicle.

[0024] An energy recovery system comprising an engine having a combustion chamber producing hot pressured exhaust gases; an energy collection subsystem housing a liquid energy carrier medium, the energy collection subsystem operatively configured to allow heat from the hot pressured exhaust gases of the combustion chamber to pass into the liquid energy carrier medium; an energy chamber connected to the energy collection subsystem operatively configured to convert the energy carrier medium from a liquid to a gaseous state; a combustion exhaust subsystem integral to the combustion chamber, the combustion exhaust subsystem operatively configured to receive hot pressured exhaust gases from the combustion chamber; an energy converter operatively configured to communicate simultaneously with the energy chamber and with the combustion exhaust subsystem, the energy converter having a shaft operatively configured to be rotated by the energy carrier medium in a gaseous state and to convert pressure energy from the exhaust gases in the combustion exhaust system into mechanical power; a converter attached to the energy converter operatively configured to convert the mechanical power of the energy converter to electrical power; wherein the engine and the converter are configured to provide energy to propel a vehicle.

[0025] A method of recovering waste heat energy from exhaust gases produced by combustion in an internal combustion engine, the method comprising the steps of: transferring heat from the engine to a primary coolant loop; directing exhaust gases from the engine to a first impeller in a first chamber connected to a shaft operatively connected to an electric generator; directing the exhaust gases from the first chamber to an exhaust conduit; transferring heat from the exhaust conduit to a heat conducting member connected to a secondary cooling loop; transferring heat from the primary and secondary cooling loops to a second chamber operatively configured to produce steam; directing steam from the second chamber to a second impeller operatively connected to the shaft operatively connected to the first impeller, the second chamber being positioned in a third chamber: directing the steam from the third chamber to a condenser operatively configured to condense the steam to liquid; directing the liquid from the condenser to the primary cooling circuit.

[0026] In a further embodiment, heat from the engine and exhaust system may be used to heat a working fluid that may then be used to operate, or heat, a variety of passenger compartment and engine accessories. Examples of such accessories include windshield de-icers, windshield wiper heaters, locks, door handles, windshield wiper fluid tank heaters, electric motor bearing heaters, battery heaters, passenger compartment contact heaters, fuel tank heaters, and brake system component heaters.

[0027] The capacity of the energy recovery system may not be sufficient to simultaneously operate the full suite of accessories. In addition, the duty cycle of some of the accessories may depend on environmental conditions. The distribution of the available heated working fluid may therefore be selectively controllable on a prioritized basis. Such distribution may be manually selected or automatically selected by means of a feedback system employing sensors on one or more of the accessories.

[0028] In another embodiment, various engine components have different temperature and heat capacity characteristics. As an example, a catalytic converter produces extremely high temperatures while the engine water jacket has a high heat capacity. The dynamic behavior of temperature of these engine components additionally exhibits different time responses, especially on engine starting. An aspect of this embodiment is the matching of the temperature and heat capacity characteristics of the individual heat sources, coupled to the various engine components, to the accessory heat demands.

[0029] In an embodiment herein disclosed, the working fluid is heated by means of a plurality of heat-sources in contact with suitable engine and exhaust system components. The heated working fluid is pumped, by means of insulated conduits, to a distribution allocator which, in turn, routes appropriate flows of working fluid to selected accessories and accessory heaters. The energy-expended working fluid is returned, via the distribution allocator, to the heat-sources.

[0030] The distribution allocator comprises, in one embodiment, a matrix of electrically actuated valves that can perform the necessary routing. A controller that actuates the valves may be based on manual inputs, dynamically established priorities and sensor detected environmental conditions, or a combination of the same, to control each valve in the matrix. The controller may include a computer which executes stored programs to set the correct valve settings. A network of sensors may be distributed at appropriate monitoring sites and provide real time measurements to the controller. When heated fluid is used to effectuate heating of the working fluid, one or more working fluid pumps may be located at various points in the insulated conduit network to power circulation. Of course, accessories described herein may be heated by means of electrical input rather than heated fluid; that is, accessories may include electrical heaters, rather than, or in addition to, fluid conduits.

[0031] In a further embodiment, it is recognized that different engine and exhaust system components can provide differing temperatures and quantities of heat and have different time-heat profiles relative to engine starting and operating cycles. The associated heat-sources can therefore supply working fluids having differing dynamically varying characteristics. The distribution allocator, to the extent possible, matches supply characteristics, of the various sources, to the individual accessory demands.

[0032] Embodiments herein disclosed include a temperature maintaining compartment in a vehicle comprising: a heat source, containing a fluid, comprising an input source fluid port and an output source fluid port; a distribution allocator, containing the fluid, connected to the heat source by a fluid conduit, comprising electrically operable fluid valves operatively configured to interconnect a plurality of input fluid ports and output fluid ports; a fluid pump operatively, containing the fluid, connected to the distribution allocator, the fluid pump capable of pumping fluid through the heat source and into the distribution allocator; and a gas-absorption refrigerator comprised of a closed-loop flow-through heated fluid conduit connected to at least one input port and one output port of the distribution allocator and a cooled fluid conduit connected to at least one input port and one output port of the distribution allocator; and a sealable compartment incorporating temperature sensors and a closed-loop flow-through fluid conduit connected to at least one input port and one output port of the distribution, the sensors electrically connected to the controller.

[0033] Embodiments herein disclosed further include an energy recovery system in a vehicle comprising: a heat source, containing a fluid, comprising an input source fluid port and an output source fluid port; a distribution allocator, containing the fluid, connected to the heat source by a fluid conduit, comprising electrically operable fluid valves operatively configured to interconnect a plurality of input fluid ports and output fluid ports: a fluid pump operatively, containing the fluid, connected to the distribution allocator, the fluid pump capable of pumping fluid through the heat source and into the distribution allocator; and a rechargeable battery heater, containing the fluid, and having a closed-loop flow-through conduit connected to at least one input port and one output port of the allocator.

DETAILED DESCRIPTION OF THE INVENTION

[0034] In an embodiment shown in FIG. **1**, there is illustrated an energy recovery system **10** for an internal combustion engine **20**. Internal combustion engine **20** is powered by the expansion of hot combustion products of fuel directly combusted within the engine. As is known, a piston internal combustion engine works by burning hydrocarbon or hydrogen fuel that presses on a piston, which does work, such as propelling an automobile; and a jet engine works as the hot combustion products press on the interior parts of the nozzle and combustion chamber, directly accelerating the engine forwards. The engine of such embodiment may be a gasoline or diesel engine, for example, a two-cycle, four-cycle or a rotary Wankle engine. Energy recovery system **10** shown in FIG. **1** is configured to capture and convert specific energy, that is, the amount of energy per unit mass of the fuel burned in engine **20** into useful work that is otherwise wasted, for example, in the form of heat that escapes into the environment.

[0035] In certain internal combustion engines, only a portion (about 20%) of the total available specific energy in the consumed fuel is directly converted to mechanical work by the action of the hot combustion products on engine components such as pistons (which maybe connected to a shaft, which in turn may do work such as rotating the wheels on a car—shown in FIG. **2**). Of the remaining portions of energy lost through exhaust gases **30** and through water heating in the radiator **40** are converted to useful work through the use of a two-stage turbine **50** as shown in FIG. **1**.

[0036] In an aspect of an embodiment, the two-stage turbine **50** is configured to operate with impellers **57** that are mounted onto a common shaft **59** which spans two chambers **53** and **55**, and which drives an electric generator **90** as shown in FIG. **1**. The impellers are rotatable by gaseous matter such as the exhaust gases issuing from exhaust subsystem **30** and steam issuing from exhaust heat conductor **80**, as explained further below. Alternatively, only one impeller may be employed with rotation by gaseous inflow or steam alone, or both gaseous inflow and steam. The electricity generated by generator **90** provides additional energy recovered from the otherwise would-be wasted heat energy to be put into useful work. It will be appreciated by those skilled in the art that this additional energy recovered from waste heat alone can supplant the energy recovered from kinetic energy dissipated in the braking system of an automobile, and hence, can be used to enhance the current hybrid technologies for automobiles. The efficiency of current internal combustion engines may be significantly improved thereby, for example, by a factor of two or more.

[0037] Another embodiment of the present invention involves pick-up of heat and exhaust gas from engine block **22** and engine head **24** (shown separate from the engine block for purposes of illustration) at points closest to the heat source generated by the combusting fuel in combustion chambers of engine block **22** in FIG. **1**. The main cooling circuit comprises a primary loop **60** (shown in solid line arrows) which circulates a coolant (such as water). Exhaust heat conductor **80** generates steam which enters chamber **53** of the two-stage turbine **50** to turn shaft **59** connected to electric generator **90**. In one aspect, the electricity from generator **90** may be used to increase steam production from exhaust heat conductor **80**. The expended steam is then collected at condenser **85** where another phase change occurs from steam to liquid, thus completing the first cooling loop **60**, as shown in FIG. **1**. The components and conduits of the first cooling loop **60**, including the condenser **85** and the boiler, containing the condensate may be enclosed by a liquid jacket through which is circulated heated engine coolant. During steady state engine operation the coolant temperature is typically maintained between 90 and 95 degrees C. by means of thermostatically controlled circulation valves. The steam condensate will thereby be maintained at approximately 90 degrees C. before its reintroduction to the boiler. This preheating of the fluid will improve energy recovery efficiency.

[0038] In another aspect, a secondary loop **65** picks up condensed steam from condenser **85** (shown in FIG. **1**). Exhaust **30** from internal combustion engine **20** is directed to chamber **55** where the high-pressure hot gases perform work on the turbine shaft **59**, and leave the system through exhaust conduit **35**. A shroud over exhaust conduit **35** may be configured to augment (using highly thermal conductive ceramic heat sinks, for example) heat conduction from the exhaust gases to the secondary loop **65**. In one aspect, secondary loop **65** is connected ultimately to exhaust heat conductor **80**. Valves may be used to adjust and balance the coolant flow through loops **60** and **65**.

Relatively cool and low speed exhaust gases may leave the system through exhaust conduit **35** as shown in FIG. **1**.

[0039] Various aspects of certain embodiments of the present invention may be superimposed schematically over the various known components of an automobile **100** as depicted in FIG. **2** and the labeled known components are not described here so as to not obscure the key aspects of the present invention. The cooling loops are not shown as they can be arranged in any number of ways to connect the components of embodiments, for example, engine block **22**, exhaust heat conductor **80**, condenser **85**, radiator **40**, two-stage turbine **50**, electric generator **90** and exhaust conduit **35**. Electricity generated by electric generator **90** can be used to power the drive of the car, or power any component of the car, or the electricity can be stored in the car battery or secondary, storage battery **37**. It will be understood that the placement of the disclosed new components can be varied dependent upon factors affecting space, and safety considerations of an automobile. It will also be obvious to those skilled in the art that the energy recovery system disclosed herein can be applied to improve the efficiency of any engine used to produce useful work.

[0040] In operation, an embodiment of a method of recovering waste heat energy in an internal combustion engine **20** involves transferring the heat developed in internal combustion engine **20** to primary cooling loop **60** at the closest points to the combusting fuel in the chambers (as, for example, receiving emissions directly from the exhaust manifold) (see, FIG. **1**). The heat carrying coolant fluid, for example, water in loop **60** is directed to a suitably designed exhaust heat conductor **80** where the fluid is heated to generate advantageously pressured steam. Steam is next allowed to enter two-stage turbine **50** to drive impeller **57** mounted on shaft **59**, which in turn drives electric generator **90**. The expended steam is then condensed into liquid through a second phase change in condenser **85**. The coolant liquid then completes the circuit back to engine block **22** joining primary cooling loop **60**. The method may involve circulating the coolant through the engine block **22** as well as the engine head **24** to promote most efficient energy recovery from the combusting fuel in combustion engine **20**.

[0041] In an aspect of an embodiment, the method also involves directing the exhaust gases **30** to the two-stage turbine **50** as shown in FIG. **1**. The high speed exhaust gases are directed to impart energy to another impeller **57** of the turbine which further enhances the rotation of shaft **59**, which in turn drives the electric generator **90**. Before the expended gases are ejected out into the environment via an exhaust conduit **35**, any remaining heat energy may be extracted by means of further heat conducting elements and then transferred appropriately into the system as, for example, into secondary loop **65**. In another embodiment, exhaust gas may pass first from the turbine exhaust stage and subsequently be channeled to exhaust heat conductor **80**.

EXAMPLE 1

[0042] The exhaust from the exhaust manifold of a single piston outboard motor is directed to a water jacketed chamber. The temperature of the exhaust and the water in the jacket is measured by way of thermocouples during the combustion of 100 ml of regular gasoline. Steam is generated with maximum temperatures over 400.degree.C. measured in the gas exhaust.

[0043] Other embodiments of the energy recovery system embodiment of the present invention utilize the heat generated in an internal combustion engine directly or from components of the exhaust system. In an embodiment, the heat energy may be efficiently transported from the various heat sources and the heat loads by means of a working fluid flowing through insulated conduits.

[0044] There are a variety of heat sources available from the vehicles engine and associated support components other than heat generated by, or subsequent to, firing of the internal combustion engine. For example, a heat source may be an electrical heater powered by the steam turbine driven generator described above or by the battery of the vehicle itself. It is also possible to heat the working fluid directly with the generated steam.

[0045] In a system analogous to a hybrid vehicle propulsion system, the electrical heater may obtain its power from the steam turbine driven generator when sufficient steam is available. When steam is not available to drive the generator, the electrical power for the heater may be derived from a rechargeable battery. This hybrid approach permits the system to operate before the engine is started. Other heat sources may be employed such as heat exchangers thermally coupled to various engine and exhaust system components which heat during normal engine operation.

[0046] Referring to FIG. 3, an energy recovery system embodiment **105** is schematically diagrammed and includes a plurality of heat sources **110** affixed to engine and exhaust system components, a network of interconnecting insulated conduits **115**, a distribution allocator **120**, a working fluid distribution pump **130**, and a plurality of accessory heaters **150** thermally affixed to vehicle accessories. The heat sources **110** may, include one or more engine and exhaust system mounted heat exchangers **111**, steam turbine-generator powered electrical fluid heaters **112**, battery powered fluid heaters **113**, and steam heated heat exchangers **114**. The distribution allocator **120** includes a matrix of electrically actuated valves **130** and a controller **140**. The working fluid is heated in the plurality of heat sources **110** and is then pumped to the distribution allocator **120**. The distribution allocator **120** routes the heated working fluid to the appropriate conduits **115** to supply the plurality of accessories **150**. The expended fluid is then returned from the plurality of accessories **150**, back to the distribution allocator **120**, from which it is returned to the heat sources **110**. Each of the distribution allocator valves **130**, operated by the controller **140**, may be adjusted within the range from fully open to fully closed.

[0047] In an embodiment, sensors **160** may be thermally coupled to the heat sources **110**, accessories, and accessory heaters **150** and operatively connected to report temperatures to the controller **140**. Additional sensors (not shown) may be used to report environmental temperatures and other conditions to the controller **140**

[0048] In an embodiment, as shown in FIG. 4, the controller **140**, may include a controller logic unit **170**. The controller logic unit **170** comprises a processor **175**, to perform stored control algorithms, an electronic memory **180** to store executable software or firmware, and the necessary interfaces **185** to receive measurements from temperature sensors **160** dispersed throughout the system and to transmit the computed commands to the controller. Thus the energy recovery system may be dynamically managed using closed loop feedback techniques.

[0049] During cold weather operation of vehicles employing internal combustion engines, liquid fuels, hydraulic and lubrication fluids, may experience undesirable changes in viscosity and other properties. The temperature of these fluids also may vary in response to the variation in engine starting and operating conditions. In an embodiment, the engine fluids may be heated to the desirable temperature by means of heating coils located at the respective fluid supply reservoirs and their supply lines. The heating coils may be fed by the heated working fluid provided by the disclosed energy recovery system. As shown in FIG. **5**, a fluid reservoir **300** is shown with its input port **310** and output port **320**. A heating coil **330** is shown affixed to the wall of the fluid reservoir **300**. Heated fluid may be pumped through the heating coil **330** thereby warming the fluid reservoir **300**. Temperature sensors **340** may be located at key points of the fluid distribution system and may telemeter temperatures to the distribution allocator thereby maintaining the working fluid in its desired temperature range. Separate heaters may be located at different points in a given fluid distribution pathway permitting differential heating input as determined by the distribution allocator.

[0050] Operation of vehicles at temperatures below freezing can result in the formation of ice on brake system components. Highway driving, characterized by infrequent application of the brakes, is especially conducive to brake system icing. In an embodiment a vehicle brake de-icing system where heated working fluid may be circulated through conduits thermally coupled to brake shoes and/or pads and other brake system components thereby reducing the probability of ice formation. In FIG. **6**, a disk brake system **240** is shown. A brake rotor **200** is fastened to the wheel axle **250**. A disk brake pad **210** is held by a brake caliper mechanism **220**. A conduit **230**, which may be supplied with heated fluid from the energy recovery system, is thermally coupled to the caliper **220** whereby the caliper **220** and the attached disk pad **210** may be heated or de-iced. Additionally, when brakes are applied, in a manner analogous to regenerative braking, the frictionally generated heat may warm the working fluid thereby serving as an additional source of heat for the energy recovery system.

Statement Regarding Preferred Embodiments

[0051] While the invention has been described with respect to preferred embodiments, those skilled in the art will readily appreciate that various changes and/or modifications can be made to the invention without departing from the spirit or scope of the invention as defined by the appended claims.

What is claimed is:

1. An internal combustion engine system comprising: an internal combustion engine producing heated emissions from one or more combustion chamber(s), a gaseous matter generator connected proximal to said combustion chamber(s), said gaseous matter generator operatively configured to receive said heated emissions from said one or more combustion chamber(s) and to apply the heat from said heated emissions to produce gaseous matter; a turbine, driven by said gaseous matter, having a compartment with a shaft extending therethrough, said compartment housing an impeller on said shaft; an exhaust gas conduit configured to direct exhaust gas into said compartment in a manner to impel said impeller; and a gaseous matter conduit from said gaseous matter generator configured to direct exhaust gas into compartment in a manner to impel said impeller.

2. An internal combustion engine system, in accordance with claim 1, wherein said gaseous matter is steam.

3. An internal combustion engine system, in accordance with claim 1, wherein said gaseous matter generator comprises a condenser, operatively connected to said turbine by a first conduit and a boiler, operatively connected to said condenser by a second conduit; said condenser and said first and second conduits enclosed in a fluid jacket operatively configured to circulate heated coolant.

4. An internal combustion engine system, in accordance with claim 1, further comprising a fluid reservoir heater having a gaseous matter conduit, said gaseous matter conduit operatively connected to said gaseous matter generator by conduits.

5. A heated engine fluid reservoir comprising:

a heat source, containing a fluid, comprising an input source fluid port and an output source fluid port;

a distribution allocator, containing said fluid, connected to said heat source by a fluid conduit, comprising electrically operable fluid valves operatively configured to interconnect a plurality of input fluid ports and output fluid ports;

a fluid pump operatively, containing said fluid, connected to said distribution allocator, said fluid pump capable of pumping fluid through said heat source and into said distribution allocator; and

an engine fluid reservoir having a fluid conduit thermally coupled to the internal surface of said engine fluid reservoir, said fluid conduit operatively connected to said input port and said output port of said distribution allocator.

6. A heated engine fluid reservoir, in accordance with claim 5, where said heat source further comprises a temperature sensor.

7. A heated engine fluid reservoir, in accordance with claim 5, where said fluid reservoir heater further comprises a temperature sensor.

8. A heated engine fluid reservoir, in accordance with claim 5, where said heat source is a heat-exchanger.

9. A heated engine fluid reservoir, in accordance with claim 5, where said heat source is a battery powered electrical heater.

10. A heated engine fluid reservoir, in accordance with claim 5, where said beat source is an electrical heater powered by electricity generated from engine heat.

11. A heated engine fluid reservoir, in accordance with claim 5, wherein said heat source is powered by electricity produced by a turbine-generator.

12. A heated engine fluid reservoir, in accordance with claim 11, wherein the turbine-generator is a steam powered turbine-generator.

13. A heated engine fluid reservoir, in accordance with claim 5, wherein said fluid is anti-freeze fluid.

14. A heated engine fluid reservoir, in accordance with claim 13, wherein said anti-freeze fluid is alcohol.

15. A heated engine fluid reservoir, in accordance with claim 13, wherein said anti-freeze fluid is methanol.

16. A heated engine fluid reservoir, in accordance with claim 13, wherein said anti-freeze fluid is ethylene glycol.

17. A heated engine fluid reservoir, in accordance with claim 13, wherein said anti-freeze fluid is propylene glycol.

18. A heated engine fluid reservoir, in accordance with claim 13, wherein said anti-freeze fluid is a mixture of ethylene glycol and propylene glycol.

19. A heated engine fluid reservoir, in accordance with claim 13, wherein said anti-freeze fluid is organic acid technology anti-freeze.

20. A heated engine fluid reservoir, in accordance with claim 5, where said heat source is chosen, on a priority basis, from the prioritized group consisting of an electrical heater powered by electricity generated from engine heat and a battery powered electrical heater.

21. An energy recovery system in a vehicle comprising:

a heat source, containing a fluid, comprising an input source fluid port and an output source fluid port;

a distribution allocator, containing said fluid, connected to said heat source by a fluid conduit, comprising electrically operable fluid valves operatively configured to interconnect a plurality of input fluid ports and output fluid ports;

a fluid pump operatively, containing said fluid, connected to said distribution allocator, said fluid pump capable of pumping fluid through said heat source and into said distribution allocator;

a controller electrically connected to said distribution allocator and operatively configured to control the position of said electrically operable fluid valves; and

a plurality of temperature sensors configured to perform temperature measurements of said fluid at diverse locations; and

a controller logic unit comprising a processor and an electronic memory containing executable code to generate controller commands, said controller logic unit operatively configured to receive said temperature measurements from said plurality of temperature sensors, perform said executable code, and transmit said generated commands to said controller.

22. An energy recovery system, in accordance with claim 21, where said heat source is a heat-exchanger.

23. An energy recovery system, in accordance with claim 21, where said heat source is a battery powered electrical heater.

24. An energy recovery system, in accordance with claim 21, where said heat source is an electrical heater powered by electricity generated from engine heat.

25. An energy recovery system, in accordance with claim 21, wherein said heat source is powered by electricity produced by a turbine-generator.

26. An energy recovery system, in accordance with claim 25, wherein the turbine-generator is a steam powered turbine-generator.

27. An energy recovery system, in accordance with claim 21, wherein said fluid is anti-freeze fluid.

28. An energy recovery system, in accordance with claim 27, wherein said anti-freeze fluid is alcohol.

29. An energy recovery system, in accordance with claim 27, wherein said anti-freeze fluid is methanol.

30. An energy recovery system, in accordance with claim 27, wherein said anti-freeze fluid is ethylene glycol.

31. An energy recovery system, in accordance with claim 27, wherein said anti-freeze fluid is propylene glycol.

32. An energy recovery system, in accordance with claim 27, wherein said anti-freeze fluid is a mixture of ethylene glycol and propylene glycol,

33. An energy recovery system, in accordance with claim 27, wherein said anti-freeze fluid is organic acid technology anti-freeze.

34. An energy recovery system, in accordance with claim 21, where said heat source is chosen, on a priority basis, from the prioritized group consisting of an electrical heater powered by electricity generated from engine heat and a battery powered electrical heater.

35. A vehicle brake de-icing system comprising:

a heat source, containing a fluid, comprising an input source fluid port and an output source fluid port;

a distribution allocator, containing said fluid, connected to said heat source by a fluid conduit, comprising electrically operable fluid valves operatively configured to interconnect a plurality of input fluid ports and output fluid ports;

a fluid pump operatively, containing said fluid, connected to said distribution allocator, said fluid pump capable of pumping fluid through said heat source and into said distribution allocator; and

a fluid conduit thermally coupled to at least one vehicle brake system component, said fluid conduit operatively connected to said input port and said output port of said distribution allocator.

36. A vehicle brake de-icing system, in accordance with claim 35, where said heat source further comprises a temperature sensor.

37. A vehicle brake de-icing system, in accordance with claim 35, where said brake system component further comprises a temperature sensor.

38. A vehicle brake de-icing system, in accordance with claim 35, where said heat source is a heat-exchanger.

39. A vehicle brake de-icing system, in accordance with claim 35, where said heat source is a battery powered electrical heater.

40. A vehicle brake de-icing system, in accordance with claim 35, where said heat source is an electrical heater powered by electricity generated from engine heat.

41. A vehicle brake de-icing system, in accordance with claim 35, wherein said heat source is powered by electricity produced by a turbine-generator.

42. A vehicle brake de-icing system, in accordance with claim 41, wherein the turbine-generator is a steam powered turbine-generator.

43. A vehicle brake de-icing system, in accordance with claim 35, wherein said fluid is anti-freeze fluid.

44. A vehicle brake de-icing system, in accordance with claim 43, wherein said anti-freeze fluid is alcohol.

45. A vehicle brake de-icing system, in accordance with claim 43, wherein said anti-freeze fluid is methanol.

46. A vehicle brake de-icing system, in accordance with claim 43, wherein said anti-freeze fluid is ethylene glycol.

47. A vehicle brake de-icing system, in accordance with claim 43, wherein said anti-freeze fluid is propylene glycol.

48. A vehicle brake de-icing system, in accordance with claim 43, wherein said anti-freeze fluid is a mixture of ethylene glycol and propylene glycol.

49. A vehicle brake de-icing system, in accordance with claim 43, wherein said anti-freeze fluid is organic acid technology anti-freeze.

50. A vehicle brake de-icing system, in accordance with claim 35, where said heat source is chosen, on a priority basis, from the prioritized group consisting of an electrical heater powered by electricity generated from engine heat and a battery powered electrical heater.

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